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LIST OF APPENDICES

Appendix

LIST OF ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Full Phrase
ACC	American Coastal Coalition
ACGIH	American Conference of Governmental Industrial Hygienists
ACP	Area Contingency Plan
ADC&ED	Alaska Department of Community and Economic Development
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ADOT&PF	Alaska Department of Transportation and Public Facilities
AMAP	Arctic Management and Assessment Program
AMPD	average most probable discharge
ANWR	Arctic National Wildlife Refuge
API	American Petroleum Institute
ASA	Applied Science Associates
ASA	Abandoned Shipwreck Act of 1987
ASA	American Sportfishing Association
ASMFC	Atlantic States Marine Fisheries Commission
ASOT	American Samoa Office of Tourism
ATIA	Alaska Travel Industry Association
b.p.	Before Present
BaP	benzo[a]pyrene
bbl	barrels
BIOS	Baffin Island Oil Study
BLM	Bureau of Land Management
BPD	barrels per day
BTEX	benzene, toluene, ethlybezene, and xylene
CAA	Clean Air Act
CalCOFI	California Cooperative Oceanic Fisheries Investigation
Caps	capabilities
CCC	Criterion Continuous Concentration
CDC	Centers for Disease Control and Prevention
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFMC	Caribbean Fishery Management Council
CFR	Code of Federal Regulations
CFR	Code of Federal Regulations
CHEMMAP	Chemical Spill Model Application Package
CIA	Central Intelligence Agency
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMC	Criterion Maximum Concentration
CNMI	Commonwealth of Northern Mariana Islands
COMDTINST	Commandant Instruction Manual
CoRIS	Coral Reef Information System

Acronym/Abbreviation	Full Phrase
CROSERF	Chemical Response to Oil Spills: Ecological Effects Forum
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DIN	dissolved inorganic nitrogen
DOI	U.S. Department of the Interior
DOT	U.S. Department of Transportation
EC50	effects concentration causing 50 percent reduction
EDBC	estimated daily burn capacity
EEZ	U.S. Exclusive Economic Zone
EFH	Essential Fish Habitat
EIA	Energy Information Administration
ERL	effects range-low
ERM	effects range-median
ESA	Endangered Species Act of 1973
ESI	Environmental Sensitivity Index
FAO	Food and Agriculture Organization, United Nations
FCMA	Fishery Conservation and Management Act of 1976
FDEP	Florida Department of Environmental Protection
FDI	foreign direct investment
FMC	Fishery Management Council
FMP	Fishery Management Plan
FOSC	Federal On-Scene Coordinator
FR	Federal Register
ft	feet
ft/yr	foot per year
GaDNR	Georgia Department of Natural Resources
gal	gallons
GDP	gross domestic product
GIC&VB	Galveston Island Conventions & Visitors Bureau
GIS	Geographical Information System
GMFMC	Gulf of Mexico Fishery Management Council
GOA	Gulf of Alaska
HAPC	Habitat Area of Particular Concern
HDBEDT	Hawaii Department of Business, Economic Development, & Tourism
HMRAD	Hazardous Materials Response and Assessment Division
hr	hour
IDLH	immediate danger to life and health
IMO	International Maritime Organization
in	inches
in/s	inches per second
Ins	insignificant
ITA	International Trade Administration
ITCZ	Intertropical Convergence Zone

LIST OF ACRONYMS AND ABBREVIATIONS *(continued)*

Acronym/Abbreviation	Full Phrase
ITOPF	International Tanker Owners Pollution Federation, Ltd.
km	kilometers
kt	knots
lb	pounds
LC50	lethal concentration to 50 percent of exposed organism
LDEQ	Louisiana Department of Environmental Quality
m	meters
m^3/s	meters cubed per second
MAFMC	Mid-Atlantic Fishery Management Council
MAH	monoaromatic hydrocarbon
MARPOL	International Convention for the Prevention of Pollution from Ships
mi	miles
MMPA	Marine Mammal Protection Act
MMPD	maximum most probable discharge
MMS	Minerals Management Service
MOA	Memorandum of Agreement
Mod	moderate
MPA	marine protected area
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act of 1996
MSO	Marine Safety Office
MTR facility	marine transportation-related facility
NAAQS	National Ambient Air Quality Standards
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEFMC	New England Fishery Management Council
NEPA	National Environmental Policy Act of 1969
NIMA	National Imagery and Mapping Agency
NIOSH	National Institute for Occupational Safety and Health
nm	nautical miles
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
NOAA	National Oceanic and Atmospheric Administration
NOBE	Newfoundland Offshore Burn Experiment
NODC	National Oceanic Data Center
NOI	Notice of Intent
NOS	National Ocean Service
NPCA	National Parks Conservation Association
NPFMC	North Pacific Fishery Management Council
NPRM	Notice of Proposed Rule-Making
NPS	National Park Service
NPV	net present value
NRC	National Research Council
NRDAM/CME	Natural Resource Damage Assessment Model for Coastal and Marine Environments

LIST OF ACRONYMS AND ABBREVIATIONS *(continued)*

Acronym/Abbreviation	Full Phrase
NRS	National Response System
NRT	National Response Team
OCS	Outer Continental Shelf
OES Program	Occupational Employment Statistics Program
OPA 90	Oil Pollution Act of 1990
OPEC	Organization of Petroleum Exporting Countries
ORCA	Office of Ocean Resources, Conservation and Assessment
OSHA	Occupational Safety and Health Administration
OTA	Office of Technology Assessment, U.S. Congress
PAH	polynuclear aromatic hydrocarbon
PAOG	Port Authority of Guam
PEIS	Programmatic Environmental Impact Statement
PEL	permissible exposure limit
PFMC	Pacific Fishery Management Council
PM10	particulate matter (10 microns or larger)
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
PR	Puerto Rico
PREP	Preparedness for Response Exercise Program
PSMFC	Pacific States Marine Fisheries Commission
RCP	Regional Contingency Plan
RCRA	Resource Conservation and Recovery Act
REL	recommended exposure limit
RRT	Regional Response Team
SAFMC	South Atlantic Fishery Management Council
SARS	severe acute respiratory syndrome
SHPD	[HI] State Historic Preservation Division
Sig	significant
SIMAP	Oil Spill Impact System Model
SMART	Special Monitoring of Applied Response Technologies
SONS	Spill of National Significance
SOPEP	shipboard oil pollution emergency plan
SOPs	standard operating procedures
TDA	Texas Department of Agriculture
TESS	Threatened and Endangered Species System
TGLO	Texas General Land Office
TLV	threshold limit value
TOC	total organic carbon
TPH	total petroleum hydrocarbon
TROPICS	Tropical Oil Pollution Investigations in Coastal Systems Study
TSP	total suspended particulate
TWA	time weighted average

LIST OF ACRONYMS AND ABBREVIATIONS *(continued)*

Acronym/Abbreviation	Full Phrase
U.S.C.	U.S. Code
UC	Unified Command
UN	United Nations
UNEP	United Nations Environment Programme
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USCOP	U.S. Commission on Ocean Policy
USDA	U.S. Department of Agriculture
USDOC	U.S. Department of Commerce
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USVI	U.S. Virgin Islands
USVI BER	U.S. Virgin Islands Bureau of Economic Research
USVI DPNR	U.S. Virgin Islands Department of Planning and Natural Resources
USVIDT	U.S. Virgin Islands Department of Tourism
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound
VRP	vessel response plan
WAF	water accommodated fraction
WCD	worst case discharge
WHSRN	Western Hemisphere Shorebird Reserve Network
WPRFMC	Western Pacific Regional Fishery Management Council
WTTC	World Travel & Tourism Council

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EXECUTIVE SUMMARY

BACKGROUND

The Oil Pollution Act of 1990 (OPA 90) and Executive Order 12777 authorized the U.S. Coast Guard (USCG) to issue regulations requiring the owners and operators of tank vessels and marine transportation-related (MTR) facilities to prepare and submit response plans and comply with USCG approved plans. We published those regulations in 1996, requiring the owners and operators of tank vessels and MTR facilities to have certain oil spill response capabilities available by contract or other approved means. These regulations also state that we will periodically review oil removal equipment requirements to determine if increases in equipment and additional requirements for new response technologies are practicable.

The USCG *Response Plan Equipment Caps* [capability] *Review* in 1999 concluded that there had been major technological advances and considerable improvements in the effectiveness and availability of on-water mechanical oil recovery equipment. In 2000, we increased existing mechanical recovery requirements by 25 percent and began evaluating the potential for additional capabilities increases, including stockpiling dispersant and *in situ* burn equipment. That resulted in our proposed changes to increase the minimum available oil spill removal equipment required for tank vessels and MTR facilities, add requirements for new response technologies, and clarify methods and procedures for responding to oil spills in coastal waters (this rulemaking). We examined the feasibility of a program to implement these proposed regulations that could include any one or more of the following elements: increase on-water mechanical recovery equipment levels, require on-water dispersant application capability, establish on-water *in situ* burn credit, and require aerial tracking capability.

Since the action area covers regions throughout waters of the U.S. and its territories, we prepared a Programmatic Environmental Impact Statement (PEIS) according to the National Environmental Policy Act (NEPA). In September 2000, we published a Notice of Intent (NOI) to prepare and circulate the Draft PEIS (DPEIS) for regulations to increase the oil spill removal capacity. We requested public input on environmental concerns related to the alternatives and suggestions regarding analyses or methodologies to include in the PEIS. We evaluated comments on the NOI and on a notice of proposed rulemaking (NPRM), and collected input from public workshops.

The information obtained from the public, in combination with Area Committee and Regional Response Team (RRT) investigations, led to our determination that mechanical recovery, *in situ* burning and chemical dispersion meet the criteria to increase the response plan equipment capability requirements, potentially reducing the amount of spilled oil reaching sensitive marine resources. We then published the DPEIS and held four public hearings in 2005. As a result of further analysis and public comments on the DPEIS, we decided not to include *in situ* burning or burn credits in the regulatory scheme, because allowing such a credit may reduce the amount of mechanical recovery response equipment available in areas where *in-situ* burn pre-authorizations are in place. They are still, however, evaluated as reasonable alternatives in the Final PEIS (FPEIS). This FPEIS describes the reasonable alternatives that were evaluated, the affected environment, and the environmental impacts associated with the alternatives on the resources analyzed.

We would implement the action under the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), which was modified under OPA 90 to encourage active government planning at the local and regional levels, and to develop and implement environmentally appropriate oil spill response strategies.

PURPOSE AND NEED FOR ACTION

The purpose of the proposed action is to increase the oil removal capability (Caps) requirements for tank vessels and MTR facilities and thus increase the available spill removal capability for oil discharges. This action is needed to ensure the ability to mitigate the adverse impacts of oil spills on the environment to the extent practicable, as mandated by the Clean Water Act, by optimizing the uniform availability of oil spill response capabilities.

ALTERNATIVES

We identified six alternatives for oil spill response options that meet the Purpose and Need or are required by NEPA. The alternatives are based on public input, Coast Guard experience, and evaluations by technical consultants. Options for response within each alternative include mechanical recovery equipment (containment booms and skimmers that block the spread of oil, concentrate it in one area, and physically remove it from the water surface); chemical dispersion, in which dispersants are applied by aircraft or vessel to break the oil into small droplets and disperse it down into the water column to rapidly dilute and naturally degrade; and *in situ* burning and burn credits.

Alternative 1—No Action

Although Alternative 1 does not meet the Purpose and Need, it is required by NEPA to form the basis of a comparison for other alternatives. Under this alternative, also known as the basic response scenario, the Coast Guard would not change response plan regulations, continuing current levels of mechanical recovery and *in situ* burning when circumstances permit for the Atlantic, Caribbean, Pacific, and Oceania regions. For the Gulf of Mexico and Alaska regions, this alternative is the basic response scenario with or without the addition of chemical dispersion.

Alternative 2—Twenty-five Percent Increase in Mechanical Recovery Equipment, Plus Aerial Tracking Capability

Alternative 2 would require a 25 percent increase in the amount of mechanical recovery equipment that tank vessel and MTR planholders must have available under contract to respond to an oil discharge. This alternative would also require aerial tracking capability.

Alternative 3— Twenty-five Percent Increase in Mechanical Recovery Equipment, Option A Dispersant Application Capability, *In Situ* Burn Credit, Plus Aerial Tracking Capability

Alternative 3 would require a 25 percent increase in available mechanical recovery equipment; establish a dispersant application capability specified by Option A of Table ES-1, establish an *in situ* burn credit, and establish aerial tracking capability.

Alternative 4— Twenty-five Percent Increase in Mechanical Recovery Equipment, Option B Dispersant Application Capability, *In Situ* Burn Credit, Plus Aerial Tracking Capability

Alternative 4 would require a 25 percent increase in available mechanical recovery equipment; establish a dispersant application capability specified by Option B of Table ES-1; establish an *in situ* burn credit, and establish aerial tracking capability.

Alternative 5 — Current Mechanical Recovery Capability, Option B Dispersant Application Capability, *In Situ* Burn Credit, Plus Aerial Tracking Capability

Alternative 5 would require planholders to maintain on-water mechanical recovery capability at current levels, establish a dispersant application capability specified by Option B of Table ES-1, establish an *in situ* burn credit, and establish aerial tracking capability.

Alternative 6—Preferred Alternative—Current Mechanical Recovery Capability, Option B Dispersant Application Capability, Plus Aerial Tracking Capability

The preferred alternative would require planholders to maintain on-water mechanical recovery capability at current levels, establish a dispersant application capability specified by Option B of Table ES-1, and establish aerial tracking capability.

Table ES-1
Tiers for Effective Daily Application of Dispersant Capability (Options A and B) under the Proposed Regulations

Tier	Response Time for Completed Application (hr)	Dispersant Applies (gal) : Oil Treated (bbl)	
		Gulf of Mexico Region	Non–Gulf of Mexico Regions
1 Option A	12	5,500:110,000	2,750:55,000
1 Option B	12	8,250:165,000	4,125:82,500

Source: Adapted from FR 67, No. 198, October 11, 2002.

Note: Gulf of Mexico region Tier 1 (Options A and B) are higher than non–Gulf of Mexico region Tier 1 (Options A and B) because of greater potential spill size and frequency in the Gulf region; it is assumed that dispersant stockpiles would be centralized in the Gulf region. The 1:20 dispersant-to-oil application ratio is a planning assumption that relies on the generally agreed on estimate of the effectiveness of current dispersant formulations.

None of the alternatives would require the use of a particular technology or dictate the methods or circumstances for use of any oil spill removal technology for any specific oil spill incident. That would remain the discretion of the Federal On-Scene Coordinator (FOSC), in accordance with the Regional Contingency Plans and Area Contingency Plans.

Under current regulations, vessel planholders with dispersant capability and carrying certain oil cargoes can apply for a credit of up to 25 percent against their mechanical equipment requirements if certain requirements are met. The proposed requirement that planholders establish dispersant application capability under Alternatives 3, 4, and 5, and 6, however, would replace the existing dispersant credit provisions.

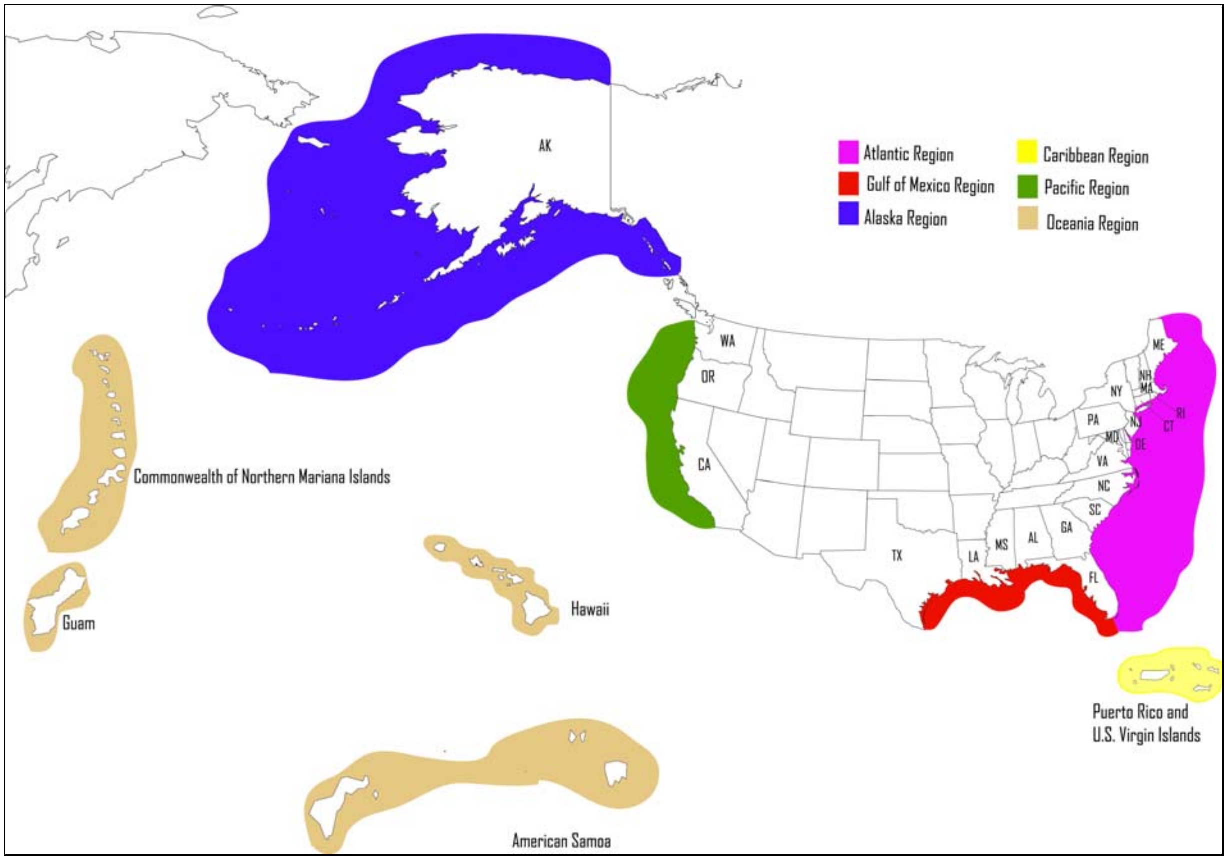
AFFECTED ENVIRONMENT

Due to the programmatic scope of the analysis, the area of influence for this action was broken down into 6 geographic regions for impact determinations. The regions are: Alaska, Atlantic, Caribbean, Gulf of Mexico, Oceania and Pacific (Figure ES-1). Neither this FPEIS nor the proposed regulations consider or anticipate extending the requirements to the Great Lakes or rivers and canals. We assessed those environmental and socioeconomic conditions relevant to the project scope and programmatic-level discussion, including resources in the physical, biological, and socioeconomic environments. Since the FPEIS is programmatic, it is limited to a discussion of the general impacts resulting from implementing the action.

Specific resources that were analyzed in each region were: coastal water quality; marine water quality; air quality; marine mammals; marine and coastal birds; plankton and fish; intertidal and subtidal habitats; sea turtles; areas of special concern; essential fish habitat; coastal communities, demography, and employment; economic status; vessel transportation and ports; fisheries; subsistence; archaeological and historic resources; recreation and tourism; environmental justice; and public safety and worker health.

The proposed regulations apply only to waters where dispersant pre-authorization area agreements currently exist, which are waters in the United States greater than 3 nm from shore, with the exception of some coastal State and island Territory areas with dispersant pre-authorization agreements covering different distances from shore, and some states which have case-by-case pre-authorization agreements[1]. Some Pacific Territories waters where dispersant pre-authorization agreements are not currently in effect are included for completeness only, and not because we intend to apply the proposed regulations to those areas. The proposed regulations do not affect the decision whether to pre-authorize the use of chemical dispersion or to authorize its use in a specific incident--those decisions properly remain with the local area response community and RRTs in the area at risk.

Figure ES-1
Areas of Influence Considered in This PEIS



Note: Map is not to scale. The areas of influence depicted in the map are the six geographic regions considered in this PEIS. In addition, the map shows the breadth of the U.S. Exclusive Economic Zone (EEZ) in each region.

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[1] *http://www.uscg.mil/vrp/maps/dispmap.shtml*, last updated August 19, 2004

ENVIRONMENTAL CONSEQUENCES

The environmental consequences (impacts) were determined for the resources discussed in the affected environment, using modeling results, risk assessment, scientific literature reviews, and qualitative analysis. The objective of the evaluation is to compare the overall impacts of each alternative for each resource. To make these comparisons, a standard basis was established, and a risk matrix approach was used to define levels of concern (as an indicator of significance) for the ecological effects. The levels of concern are based on the consensus of the project senior professional staff using their experience with oil spills, damage assessment studies, and local ecological risk assessments. The risk matrix (Figure ES-2) is based on an evaluation of (1) the proportion of the resource affected by the action and (2) the time for the resource to recover, for each ecological resource included in the model. Thus the model also accounts for whether the impacts were judged to be short or long term.

A representative area within each region was selected as the modeling area. However, in the Caribbean and Oceania regions, there was no readily available modeling data, so representative areas in other regions were used. The modeling and risk assessment focused on the direct effects of removing the spilled oil, and are based on the assumption that a spill has already occurred. Hence, the assessment of each alternative includes both the impact of the spilled oil and any impacts caused by the response action. Potential impacts on all resources within each region are based on the analysis of three representative spill sizes: small (200 bbl), medium (2,500 bbl), and large (40,000 bbl). The determination of the severity of potential impacts under each alternative was based on the use of a concentration threshold for adverse impact: 10 g/m^2 for oiled shoreline and 0.01 g/m^2 for oiled surface water (technical report, French McCay et al., 2004).

The environmental consequences discussed below focus on the impacts that result under Alternatives 1 and 3. Alternative 1 represents Alternatives 1 and 2 for potential adverse impacts, because the impacts of those alternatives can be assumed to be equivalent: Alternative 2 would not result in increased recovery efficiency or produce an increase in oil treated; it only increases mechanical recovery equipment, and adding more equipment will not increase the amount of oil treated (additional equipment would not increase the number of opportunities to actually use it).

Alternative 3 represents Alternatives 3, 4, 5, and 6 for potential adverse impacts. Alternatives 3 and 4 include a 25 percent increase in available mechanical recovery equipment, but as discussed above for Alternative 2, this does not result in increased efficiency or produce an increase in oil treated compared to Alternatives 5 and 6 (no increase in mechanical recovery equipment). Regarding dispersant delivery capacity, for this analysis, we estimated the amount of oil that could be treated during response operations for Alternatives 3 through 6 based on Option B of Table ES-1, even though Alternative 3 requires only Option A (slightly less delivery capacity). Thus the impacts from the model for dispersants associated with Alternatives 4, 5, and 6 are equivalent to those for Alternative 3. This was done to simplify the impacts analysis and ensure that the highest potential levels of exposure to dispersants and dispersed oil in the water column were considered (conservative approach). Alternatives 3 through 6 would ensure the uniform availability of dispersant capability in the four regions (Atlantic, Caribbean, Oceania, and Pacific) where appropriate response times cannot currently be met. For the Gulf of Mexico and Alaska regions, the dispersants impacts under Alternatives 3 through 6 are the same as those under Alternatives 1 and 2, due to dispersant use, as shown in Table ES-2.

Table ES-2
Response Options for Each Region under Alternative 1

Region	Mechanical Recovery	Chemical Dispersion
Atlantic	Yes	No

Caribbean	Yes	No
Gulf of Mexico	Yes	Yes
Pacific	Yes	No
Alaska	Yes	Yes
Oceania	Yes	No

Source: Adapted from USCG, 2002.

The potential adverse effects from mechanical recovery and dispersants include impacts from hydrocarbon emissions and impacts from operating equipment, including noise. The hydrocarbon emissions from exposure to dispersants or from equipment for dispersant delivery and mechanical recovery are minimal relative to emissions from the actual spilled oil. Although potential environmental impacts of exposure to dispersants are much less critical than exposure to dispersed oil, there are concerns about overspraying beyond the area of floating oil. Appendix G addresses dispersant exposure and concludes that, while dispersants can cause adverse environmental impacts, these impacts are limited in extent, very short term, and minimal in comparison to the potential effects of the dispersed oil. The amount of dispersant is relatively small, the risk of exposure is low (if overspray is avoided), and although dispersants show a low level of toxicity in the laboratory, any dispersant that is oversprayed is rapidly diluted to levels below toxicity.

Physical damage to habitat or organisms can occur when oil recovery equipment is operated in shallow water, but is not a substantial concern in the deeper water scenarios considered here. Noise impacts from response operations are a concern around sensitive organisms, particularly marine mammals, marine and coastal birds, and sea turtles. Minimizing noise and dispersant exposure impacts on sensitive organisms should be addressed under Area Contingency Plans. Thus, the potential adverse impacts of dispersants and mechanical recovery are minimal or can be controlled. Potential additional impacts related to the storage and maintenance of response equipment and its actual use in training exercises are not expected to occur and are not analyzed in this FPEIS. Mechanical recovery is the only response option that removes oil from the marine environment and places it under containment. Any subsequent disposal of recovered oil is subject to a controlled decision process and any environmental consequences of this are not addressed in the assessment of the alternatives.

Environmental Consequences of Current Practices

Alternative 1 (No Action) represents existing conditions and produces no change in current response options. The incorporation of *in situ* burning does not change the amount of oil treated, so it does not reduce the severity of potential adverse effects in most scenarios. It might slightly increase the risk of oil residue sinking to the bottom, but this residual oil is expected to have little or no adverse effect because the majority of its toxic components either evaporate or are destroyed during burning. On-water mechanical recovery is currently available in all regions with pre-authorization agreements. Dispersant equipment is currently approved for use only in the Alaska and Gulf of Mexico regions; therefore, the impacts of chemical dispersion for those regions are considered under Alternative 1 (Table ES-2). Alternative 1 represents Alternatives 1 and 2 for potential adverse impacts, because their impacts can assumed to be equivalent. The consequences to the physical, biological, and socioeconomic environments discussed below were assessed using modeling (French McCay et al., 2004) and scientific literature review. The following impacts are the same with or without dispersant use, except where stated otherwise.

Physical Environment

The water-quality criterion we used for oil spills was "volume of water contaminated," applying a conservative time weighted concentration, i.e., less than all established water-quality criteria and thresholds for effects on aquatic biota. For air quality, concentrations of hydrocarbons of concern in the air resulting from oil spills and response operations were compared to air quality standards to evaluate the potential for adverse effects. See Table ES-3 for a summary of the impacts on resources from each alternative.

Potential adverse impacts of oil spills on **water quality** are related to hydrocarbon contamination. For water quality in coastal waters, Alternative 1 would have an insignificant influence on the volume of water adversely affected. Contamination levels would decrease rapidly, even for large spills, due to natural dilution, evaporation, biological processes, and recovery. Adverse impacts could be important locally for medium and large spills if the oil moved into shallow and confined coastal waters under conditions where it is mixed into the water by strong turbulence or in areas where it collects for weeks to months after a spill.

The modeling indicates that the impacts on both **marine water quality** and **air quality** for all regions are expected to be insignificant for small, medium, and large spill sizes. In marine waters that are 3 or more statute miles offshore, natural dispersion of contamination would be very rapid after a spill, and recovery time would be on the order of hours to days. Although chemical dispersion could increase soluble aromatic hydrocarbon concentrations if applied, this would occur after much of the toxic components have evaporated (more than 12 hours after a spill), so any resulting increase in concentrations of toxic components would be relatively small. The addition of chemical dispersion would disperse some of the volatile hydrocarbons into the water, where they would enter the atmosphere over a larger area, further diluting their concentrations in the air.

Biological Environment

Marine mammals are vulnerable to spilled oil because they spend considerable time at the water's surface. Potential regional adverse impacts on both marine mammals and sea turtles under Alternative 1 range from minor to moderate.

Marine and coastal birds are highly susceptible to the acutely toxic effects from oil. High concentrations of birds may be found in many areas in each region. Potential adverse impacts on marine and coastal birds under Alternative 1 range from moderate to significant. The addition of chemical dispersion is expected to reduce the amount of oil that strands onshore in most regions, thus reducing the adverse effects on shoreline nesting and staging areas.

Plankton and fish are important to the marine food web, ecosystem function, and fisheries. These species are adversely affected either directly or via the food web by the toxic effects of oil components that enter the water column. With chemical dispersion, there would be an increase in the amount of oil that is mixed into the water column. Potential adverse impacts on plankton and fish under Alternative 1 range from insignificant to minor.

Intertidal habitats can take many years to recover from a spill, especially if they are heavily oiled and are difficult to access for spill response (natural recovery often becomes the primary response). The addition of chemical dispersion, which decreases the amount of oil that strands onshore, can be beneficial. Potential regional adverse impacts on intertidal habitats under Alternative 1 range from insignificant to significant.

Subtidal (benthic) habitats consist of the bottom substrate below the low tide level and the species that live in, on, and near the substrate. Exposure risk is primarily from sinking oil or dispersed oil that is deposited onto the ocean floor. However, substantial natural dispersion of oil and sediment into the water column occurs only during storms or from nearshore oil spills. Chemical dispersion is only expected to have a minor influence on the adverse effects associated with subtidal habitats – although there would be an increase in the amount of oil dispersed into the water column, the available depth for mixing makes it unlikely that oil would concentrate in subtidal sediments. The potential regional adverse impacts on subtidal habitats under Alternative 1 range from insignificant to moderate.

Areas of special concern are set aside for their uniqueness and are given particular protection. These include National Marine Sanctuaries and National Wildlife Refuges. The potential risks and adverse effects associated with shoreline areas and subtidal areas of special concern are identical to those discussed for intertidal habitats and subtidal habitats, respectively. Additionally, for this analysis, the habitat type with the higher risk ranking is assumed to indicate the risk to areas of special concern.

Each region has a variety of **threatened, endangered, or candidate species**, and adverse effects on these species for any spill size depend on location and season, and are difficult to predict. Although the overall regional risk that a threatened, endangered, or candidate species would be adversely affected or even present in the area of a spill is low, the mortality of a single individual of such a species can be considered a severe adverse effect. Potential adverse effects on marine mammals, marine and coastal birds, or fish that are threatened, endangered, or candidate species are identical to those discussed in the preceding paragraphs regarding those species resources. For this analysis, the resource with the highest risk ranking was used as a conservative estimate of the potential adverse effects on threatened, endangered, or candidate species. The risk to threatened, endangered, or candidate species of sea turtles is discussed in Chapter 3. Chemical dispersion is expected to reduce adverse effects by reducing the amount of oil that strands onshore and the amount of floating oil. No additional risk from chemical dispersion is expected for fish. Potential regional adverse impacts on threatened, endangered, or candidate species under Alternative 1 range from minor to significant.

Virtually all waters in each region are considered **essential fish habitat (EFH)**. Areas such as bays, river mouths, and harbors are designated EFH for at least one life stage of at least one species and are protected by legislation. The primary issue with respect to EFH is either (1) exposure of sensitive resources in the water column to hydrocarbon concentrations of concern, or (2) the contamination of bottom sediments, both of which could lead to either acute or chronic exposures. Adverse effects would include either the death of individual organisms, the possibility of sublethal effects on long-term population viability, and degradation of habitat that reduces its availability to managed species. For this analysis, the risk to EFH is assumed to be defined by the risk to plankton and fish or to subtidal habitat, whichever is greater. With the addition of chemical dispersion, there would be an increase in the proportion of the water column exceeding 1 ppb of dissolved aromatic hydrocarbons. This is expected to have a minor influence on the adverse effects associated with EFH because the proposed regulations apply only to waters with established pre-authorization agreement areas where chemical dispersion is allowed because prevailing depth and hydrodynamic conditions provide reasonable dilution over a shorter distance. The potential regional adverse impacts on EFH under Alternative 1 range from insignificant to moderate.

Socioeconomic Environment

Oil spills can produce a variety of adverse social and economic effects that are generally not substantial at the regional level, but instead are typically felt in communities located near resources oiled by the spill.

The analysis used for socioeconomic impacts evaluates the effects of oil spills based on the risk of adverse effects on various aspects of the socioeconomic environment rather than changes in monetary benefits. This incremental change analysis assumes that the risk to the socioeconomic environment posed by oil spills is directly related to the extent to which coastal resources are oiled above selected thresholds of concern, and assesses the economic and social effects of enhanced spill response in terms of the degree of risk posed to economic and social factors. The analysis generates estimates of the degree of risk reduction achieved.

The potential regional adverse impacts on **coastal communities, demography, and employment** and **economic status** under Alternatives 1 and 3 for small, medium, and large spill sizes range from insignificant to minor. On average, under both Alternatives 1 and 3, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills; any adverse impacts are expected to be localized.

For **vessel transportation and ports**, oil spills occurring 3 or more statute mi offshore are not likely to cause substantial adverse effects, and any adverse effects would likely be of short duration. However, an oil spill can disrupt marine commerce if it occurs in or around a shipping channel or port and results in limits on watercraft movement as a means of facilitating spill response.

Archaeological and historic resources are likely to be found in each region. Archaeological resources can be buried under offshore sediments; historic sites can be either located on land and protected from oiling by bulwarks or other barriers, or are submerged shipwrecks that can either not be well preserved due to strong currents and wave action or buried under sediments and coral formations. Mechanical recovery, *in situ* burning, and/or chemical dispersion may help reduce the amount of oil that strands on the shoreline.

The **recreation and tourism** assets of coastal communities can be adversely affected by oil spills, both directly and indirectly. For example, visitors may be less likely to visit and spend money in an area perceived as affected by a spill. The recreational assets vary by region and include parks, seashores, beaches, recreational fishing areas, and scenic vistas.

Potential adverse effects on **public health and worker safety** are defined as the risk to the public from direct exposure to oil or response activities as a result of the spill. In each region, there are areas with high population concentrations along the coast. However, adverse effects on public safety from oil spills that occur 3 or more statute mi offshore for any of the spill sizes considered are unlikely, regardless of the response options. Potential adverse effects on worker health are related to direct exposure to oil during response operations, including inhalation of fumes, and operating oil spill response equipment. The risk increases as the spill size and the corresponding intensity and duration of operations increase, but is minimized if safety standards are followed.

Potential regional adverse impacts on vessel transportation and ports, archaeological and historic resources, recreation and tourism, and public health and worker safety in each region under Alternatives 1 and 3 are expected to be insignificant for small, medium, and large spill sizes.

Commercial and recreational fisheries are vulnerable to oil spills because of both closures and perceived taint. A moratorium on fishing operations in the wake of an oil spill can lead to considerable revenue losses for the commercial fishing and related industries. Potential regional adverse impacts on fisheries (commercial and recreational) under Alternatives 1 and 3 for small, medium, and large spill sizes range from insignificant to significant. For both Alternatives 1 and 3, any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Subsistence use of marine species is especially important in the Pacific, Alaska, and Oceania regions, where there is a traditional use of these resources. A particular effect from oil spills would be tissue tainting. Potential regional adverse impacts on subsistence resources under Alternative 1 range from insignificant to moderate.

Environmental justice concerns the impacts on low-income, indigenous, and minority populations. In some coastal areas these groups may experience the effects of an oil spill more severely than the general population. Poverty in these populations is the best indicator of potential environmental justice issues, and the modeling assumes that low-income groups would disproportionately suffer adverse socioeconomic effects from an oil spill. Potential regional adverse impacts on environmental justice under Alternative 1 range from insignificant to significant.

Environmental Consequences of the Preferred Action and Alternatives

The same resources addressed above in the Environmental Consequences of Current Practices section are also addressed here. As explained in the Environmental Consequences section, Alternative 1 represents Alternatives 1 and 2 for potential adverse impacts and, similarly, Alternative 3 represents Alternatives 3, 4, 5, and 6 for potential adverse impacts. Chemical dispersion reduces both shoreline oiling and surface-water oiling for both medium and large spills. Thus, in general, chemical dispersion will decrease the severity of social or economic effects, but this is of greatest potential benefit on a local, rather than on a regional, basis. As with the environmental consequences of current practices, the following impacts are the same with or without dispersant use except where stated otherwise.

Alternative 3 would produce an increase in oil treated compared with Alternatives 1 and 2 because Alternative 3 adds dispersant application capability requirements that potentially result in treating a larger quantity of oil. Alternative 3 includes dispersant Option A (Table ES-1), which requires slightly less delivery capacity under Tier 1 (0–12 hours) than Option B (required under Alternatives 4, 5, and 6).

Alternatives 5 and 6 would produce the same increase in oil treated as Alternative 4, with the same quantity of dispersant application equipment, but at less cost because they would maintain mechanical recovery capability at current levels, while Alternative 4 would require a 25 percent increase.

Physical Environment

The consequences to the physical environment for **coastal water quality** under Alternative 3 include the factor that chemical dispersion would not be a response option in estuaries and coastal waters within 3 nm[2] of shore, so mechanical-only recovery would be used. If dispersants were applied offshore, the dispersed oil plume could move into nearshore areas, but the level and duration of exposure would be negligible due to dilution. Potential adverse impacts on coastal water quality range from insignificant to moderate.

Potential adverse impacts on **marine water quality** and **air quality** in each region under Alternatives 3 are insignificant. Under Alternative 3, the volume of water contaminated by a small spill remains unchanged because dispersants could be applied only after most of the spill has already dispersed naturally. Chemical dispersion of medium or large oil spills increases the volume of water contaminated, but does not change the level of concern. The addition of chemical dispersion would disperse some of the volatile hydrocarbons into the water; causing them to enter the atmosphere over a larger area, further diluting their concentrations.

Biological Environment

Under Alternative 3, the potential adverse impacts on **marine mammals** range from minor to moderate. The addition of chemical dispersion would reduce the amount of oil that strands onshore.

The potential adverse impacts on **marine and coastal birds** under Alternative 3 range from insignificant to significant; for **plankton and fish**, from insignificant to moderate; for **intertidal habitats**, from insignificant to significant; and for **subtidal habitats**, from insignificant to moderate.

The risk to **areas of special concern** under Alternative 3 is based on the risk to intertidal habitats in the Atlantic, Pacific, and Oceania regions for small, medium, and large oil spill sizes. In the Caribbean region, the

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[2] With the exception of several areas that have pre-authorization agreements at different distances from shore, including Maine (>0.5 nm), Massachusetts (>2 nm), Puerto Rico (>0.5 nm and >60 ft depth), the U.S. Virgin Islands (>1 nm from shore or reef, if reef < 20ft from surface and >60 ft depth), and Hawaii (>60 ft depth), as well as areas such as Washington, Oregon, Connecticut, and large portions of Alaska, which have case-by-case pre-authorization agreements (*http://www.uscg.mil/vrp/maps/dispmap.shtml*, last updated August 19, 2004).

risk is based on intertidal habitats for small and large spill sizes, but on subtidal habitats for medium spill sizes. Potential regional adverse impacts on areas of special concern under Alternative 3 range from insignificant to significant.

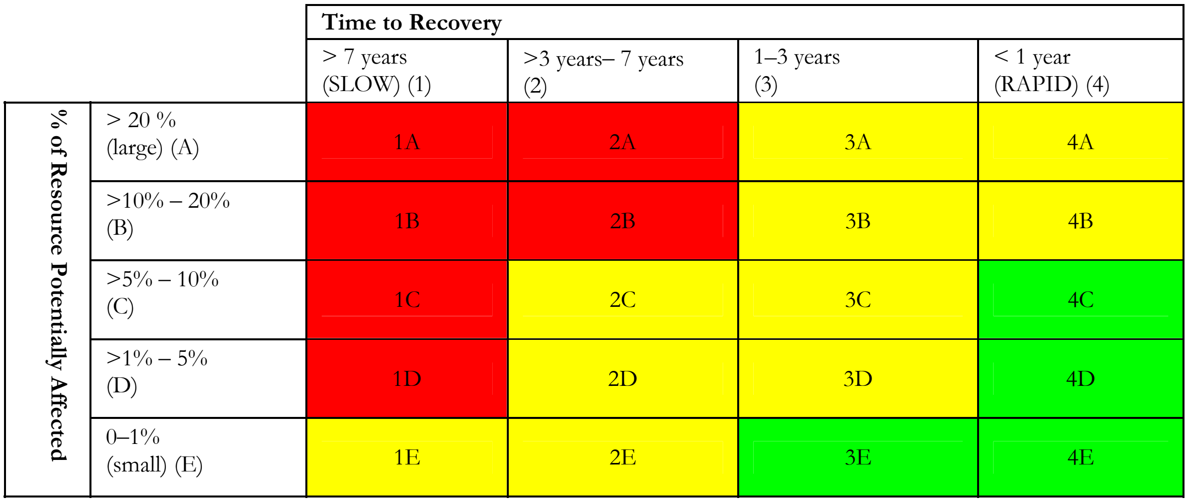
The risk to **threatened, endangered, or candidate species** is based on the risk to marine and coastal birds in the Atlantic, Caribbean, and Oceania regions and on the risk to marine mammals and marine and coastal birds for the Pacific region. Potential regional adverse impacts on threatened, endangered, or candidate species under Alternative 3 range from minor to significant.

The risk to **EFH** is based on the risk to plankton and fish and to subtidal habitats for the Atlantic and Caribbean regions, and to plankton and fish for the Pacific and Oceania regions. Potential regional adverse impacts on EFH under Alternative 3 range from insignificant to moderate.

Socioeconomic Environment

The environmental impacts for most of the socioeconomic resources are the same for Alternatives 1 and 3 (**coastal communities, demography, and employment**; **economic status**; **vessel transportation and ports**; **fisheries**; **archaeological and historic resources**; **recreation and tourism**; **and public health and worker safety**). The exceptions are **subsistence** and **environmental justice**, for which the impacts in each region for Alternative 3 are slightly different from those of Alternative 1. However, the *range* of impacts for both resource areas remains the same.

Figure ES-2
Risk Matrix and Definition of Levels of Concern



		Time to Recovery			
		> 7 years (SLOW) (1)	>3 years– 7 years (2)	1–3 years (3)	< 1 year (RAPID) (4)
% of Resource Potentially Affected	> 20 % (large) (A)	🟥 1A	🟥 2A	🟨 3A	🟨 4A
	>10% – 20% (B)	🟥 1B	🟥 2B	🟨 3B	🟨 4B
	>5% – 10% (C)	🟥 1C	🟨 2C	🟨 3C	🟩 4C
	>1% – 5% (D)	🟥 1D	🟨 2D	🟨 3D	🟩 4D
	0–1% (small) (E)	🟨 1E	🟨 2E	🟩 3E	🟩 4E

Source: Adapted from Part A of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern; yellow, a medium level of concern; and green, a low level of concern.

COMPARISON OF ALTERNATIVES AND CONCLUSIONS

The action alternatives have varying potential adverse impacts on environmental and socioeconomic resources, ranging from insignificant to significant, depending on the resource and geographic region and the oil spill size. The impacts are summarized in Table ES-3. An assessment of the beneficial or adverse impacts of a particular response alternative can be determined by comparing the effects of an oil spill on a particular resource under that alternative to those impacts under Alternative 1, the difference being the net environmental impact, which is an indication of the beneficial or adverse impacts of a particular response option. The potential adverse impacts on environmental resources from the action alternatives are less than impacts from Alternative 1, while the socioeconomic resource impacts for both are similar.

The areas of greatest environmental impact identified in the FPEIS under Alternative 1 are: marine and coastal birds for large spill sizes in the Alaska region; intertidal habitats for medium and large spill sizes in the Caribbean and Oceania regions; intertidal habitats for large spill sizes in the Alaska region (impacts decrease to moderate with the addition of chemical dispersion); threatened, endangered, or candidate species for large spill sizes in the Alaska region; fisheries for large spill sizes in the Alaska region; and environmental justice for large spill sizes in the Alaska region.

For Alternative 3, there are potential significant regional adverse impacts: on intertidal habitats for medium spill sizes in the Caribbean and Oceania regions (impacts decrease to moderate and insignificant with the addition of chemical dispersion at 45 and 80 percent efficiency, respectively), and for large spill sizes Caribbean and Oceania areas; to areas of special concern for medium and large spill sizes in the Caribbean and Oceania regions (impacts decrease to moderate with the addition of chemical dispersion), and to areas of special concern for large spills in those two regions. For the Gulf of Mexico and Alaska regions, the impacts under Alternative 3 are the same as those under Alternative 1.

While the analysis shows that mechanical recovery can provide some environmental benefits, there is still the potential for oil spills to cause significant adverse impacts on physical, biological, and socioeconomic resources. Overall, the analysis shows that the uniform availability of dispersant capability has the potential to provide additional protection to certain biological and socioeconomic resources, including sensitive resources that recover relatively slowly such as intertidal habitats, sea turtles, and marine and coastal birds.

Alternative 6 is the USCG's preferred alternative because of its increased effectiveness in removing or treating spilled oil, based on an examination of historical oil spill data (USCG, 1999) and the regulatory analysis (USCG, 2008). Alternative 6 meets our objectives to increase the response plan equipment capability requirements for tank vessels and MTR facilities at reasonable cost and with substantial benefit. This alternative would produce the same increase in the amount of oil treated as Alternatives 3, 4, and 5 because it requires the same quantity of dispersant application equipment. Since the increase in mechanical recovery equipment (under Alternatives 2, 3, and 4) would not increase the quantity of oil removed or treated, requiring those additional capabilities does not offset the costs incurred in establishing and maintaining them.

The net adverse and beneficial impacts depend on the size and location of the oil spill, and the effectiveness of the response option used. Alternatives 2 through 6 are compared to Alternative 1 to ascertain the net adverse or beneficial impacts of each alternative. For example, an improvement in the level of concern from a significant adverse impact to a minor adverse impact indicates that the response option employed had a net beneficial impact on reducing the adverse impact of the oil spill. Because Alternatives 1 and 2 have similar impacts and Alternatives 3, 4, 5, and 6 have similar impacts, the net adverse or beneficial impacts were determined by comparing the potential regional adverse impacts of the two sets of alternatives.

Net Beneficial Impacts

A net beneficial impact occurs under Alternatives 3, 4, 5, and 6 (which would ensure the uniform availability of dispersant capability in each region) in certain regions and certain spill sizes for the biological resources and one socioeconomic resource listed below.

- **Marine and coastal birds:** Atlantic region (medium spills), Pacific region (small spills), and Oceania region (small spills)
- **Intertidal habitats:** Atlantic region (medium and large [45 percent dispersant efficiency] spills), Caribbean region (medium spills), Gulf of Mexico region (medium spills), Pacific (small and medium spills), Alaska region (medium and large spills), and Oceania region (small and medium spills)

- **Sea turtles:** Caribbean region (large spills), Gulf of Mexico (medium spills), and Oceania region (medium spills)
- **Areas of special concern:** Atlantic region (medium and large [45 percent dispersant efficiency] spills, Caribbean region (medium spills), Gulf of Mexico region (medium spills), Pacific region (small and medium spills), Alaska region (medium spills), and Oceania region (small and medium spills)
- **Environmental justice:** Caribbean (large spills) and Oceania region (large spills)

Net Adverse Impacts

A net adverse impact occurs under Alternatives 3, 4, 5, and 6 (which would ensure the uniform availability of dispersant capability in each region) in certain regions and certain spill sizes are listed below:

- **Coastal water quality:** Caribbean region (large spills), Pacific region (medium and large spills), and Alaska region (medium and large spills)
- **Plankton and fish:** Pacific region (large spills)
- **Essential Fish Habitat:** Pacific region (large spills)
- **Subsistence:** Atlantic region (large spills), Caribbean region (small, medium, and large spills), Gulf of Mexico (large [80 percent dispersant efficiency] spills), and Pacific region (medium [80 percent dispersant efficiency] and large spills)

For the remainder of the resources analyzed, a comparison of the alternatives found that the potential adverse impacts would remain at the same impact level as under the currently available response option (Alternative 1).

National Net Beneficial and Adverse Impacts of the Alternatives

Oil spill impacts on U.S. waters are mostly localized and generally short lived; therefore, the potential benefits associated with a reduction in oil spill impacts would also be localized and short lived. The national-level impacts are extrapolated from the regional-level findings. Any change in the net beneficial or adverse impact levels can be attributed to a particular region and are expected to be localized; therefore, national impacts are unlikely to result from even the largest spill scenarios.

Table ES-3
Summary of Potential Adverse Regional Impacts of Offshore Oil Spills* under All Alternatives in the Six Geographic Regions Considered in This FPEIS

		Resources of Concern																			
		Physical Environment			Biological Environment								Socioeconomic Environment								
Response Alternative	**Spill Size**	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals†**	**Marine and Coastal Birds†**	**Plankton and Fish†**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles†**	**Areas of Special Concern**	**Essential Fish Habitat**	**Coastal Communities, Demography, and Employment**	**Economic Status**	**Vessel Transportation and Ports**	**Fisheries**	**Subsistence**	**Archaeological/Historic Resources**	**Recreation and Tourism**	**Environmental Justice**	**Public Safety and Worker Health**
Alternative 1, 2	Small	Ins	Ins	Ins	Min	Mod	Ins	Ins–Mod	Ins	Min	Ins–Mod	Ins	Ins–Min	Ins–Min	Ins	Ins–Min	Ins	Ins	Ins	Ins–Min	Ins
	Medium	Ins–Min	Ins	Ins	Min–Mod	Mod	Ins–Min	Ins–Sig	Ins–Mod	Min–Mod	Ins–Sig	Ins–Mod	Ins–Min	Ins–Min	Ins	Ins–Mod	Ins–Min	Ins	Ins	Ins–Mod	Ins
	Large	Min–Mod	Ins	Ins	Min–Mod	Mod–Sig	Ins–Min	Mod–Sig	Ins–Mod	Min–Mod	Mod–Sig	Ins–Mod	Ins–Min	Ins–Min	Ins	Ins–Sig	Ins–Mod	Ins	Ins	Ins–Sig	Ins
Alternative 3, 4, 5‡	Small	Ins	Ins	Ins	Min	Ins–Mod	Ins	Ins–Mod	Ins	Min	Ins–Mod	Ins	Ins–Min	Ins–Min	Ins	Ins–Min	Ins–Min	Ins	Ins	Ins–Min	Ins
	Medium	Ins–Min	Ins	Ins	Min–Mod	Min–Mod	Ins–Min	Ins–Mod	Ins–Mod	Min	Ins–Mod	Ins–Mod	Ins–Min	Ins–Min	Ins	Ins–Mod	Ins–Min	Ins	Ins	Ins–Mod	Ins
	Large	Min–Mod	Ins	Ins	Min–Mod	Mod–Sig	Ins–Mod	Min–Sig	Ins–Mod	Min–Mod	Min–Sig	Ins–Mod	Ins–Min	Ins–Min	Ins	Ins–Sig	Min–Mod	Ins	Ins	Ins–Sig	Ins

Note: Based on the risk ranking tables for each region in Sections 4.5 and 4.7. Small, 200 bbl; medium, 2,500 bbl; and large, 40,000 bbl. Sig, significant; Mod, moderate; Min, minor; and Ins, insignificant.

* Average spills.

† Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles (sea turtles are not considered in the Alaska region).

‡ Range for Alternatives 3, 4, and 5. Alternative 3 dispersant Option A requires slightly less delivery capacity under Tier 1 (0–12 hours) than Alternatives 4 and 5 dispersant Option B. For the purpose of this analysis, however, the USCG estimated the amount of oil that could be treated during response operations based only on Option B. This was done to simplify the analysis and ensure that the highest potential levels of exposure to dispersants and dispersed oil in the water column were considered.

CHAPTER 1
PURPOSE OF AND NEED FOR THE PROPOSED ACTION

1.1. INTRODUCTION

Under the Oil Pollution Act of 1990 (OPA 90) (Public Law 101-380) and Executive Order 12777 ("Implementation of Section 311 of the Federal Water Pollution Control Act of October 18, 1972, as amended, and the Oil Pollution Act of 1990," 56 FR 5457), the U.S. Coast Guard (USCG) is authorized to issue regulations requiring the owners and operators of tank vessels and marine transportation-related (MTR) facilities to prepare and submit response plans. In 1996, the USCG published final tank vessel and MTR facility response plan regulations (33 CFR parts 155 and 154, respectively). These regulations contain requirements for on-water oil removal[1] capacity that planholders transporting or transferring petroleum oil are required to meet in planning for an oil discharge.

These regulations also state that the USCG periodically will review the existing response plan equipment capabilities requirements to determine if increases in mechanical recovery systems, plus additional requirements for new response technologies, are practicable. In 1999, the USCG completed an in-depth *Response Plan Equipment Caps Review*, and subsequently increased existing mechanical recovery requirements by 25 percent, effective April 5, 2000 (65 FR 710). This review also concluded that the USCG should begin another regulatory project to evaluate additional increases in on-water mechanical recovery and new requirements for other response technologies.

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[1] The term "remove" or "removal" is used throughout the PEIS as it is defined by section 311(a)(8) of the Clean Water Act, and refers to containment and removal of oil from the water and shorelines or the taking of such other actions as may be necessary to minimize or mitigate damage to the public health or welfare of the United States (including, but not limited to, fish, shellfish, wildlife, public and private property, and shorelines and beaches) or to the environment. While the use of dispersants, which break an oil slick into small droplets that then disperse into the water column, renders further manual removal attempts infeasible, the use of dispersants increases the opportunity for the oil to undergo natural bioremediation. The terms "removal" and "treatment" are used interchangeably throughout this PEIS.

Preliminary scoping indicates that there may be both beneficial and adverse effects to the environment. The USCG believes the effects on the environment, as a whole, will be significantly beneficial. However, the implementing regulations of the Council on Environmental Quality's (CEQ's) National Environmental Policy Act of 1969 (NEPA) (Public Law 91-190, 42 U.S.C. 4321 *et seq.*) state that a significant environmental impact may exist even if an agency believes that the net balance of environmental effects are beneficial. Therefore, the USCG has decided to prepare a Programmatic Environmental Impact Statement (PEIS).

The PEIS for developing these proposed regulations will examine the possible impacts to the environment on the regional and national levels. In addition, the PEIS will be limited in scope to a discussion of the general impacts resulting from implementing the action, and will be prepared in accordance with (1) NEPA, (2) CEQ's "Regulations for Implementing the Procedural Provisions of NEPA" (40 CFR part 1500), and (3) USCG's NEPA procedures and policies (COMDTINST M16475.1D, "National Environmental Policy Act Implementing Procedures and Policy for Considering Environmental Impacts").

1.2. PURPOSE OF PROPOSED ACTION

The purpose of the proposed action is to increase the oil removal capability (Caps) requirements for tank vessels and MTR facilities and thus, increase the available spill removal capability for oil discharges.

1.3. NEED FOR PROPOSED ACTION

One of the USCG's primary missions is protection of the marine environment, including implementing a variety of oil pollution prevention, preparedness, and response strategies, as mandated by OPA 90 and other statutes. In carrying out this responsibility, the USCG promulgated regulations (33 CFR parts 155 and 154) requiring the owners and operators of tank vessels and MTR facilities to have certain oil spill response equipment available by contract or other approved means. Based on a review of those regulations (USCG, 1999), and adoption of regional and local area pre-authorization agreements for chemical dispersion and *in situ* burning and in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR part 300), the USCG must examine the practicability of the proposed regulations that could do any one of, or a combination of, the following:

- Increase on-water mechanical recovery equipment levels
- Require on-water dispersant application capability
- Establish *in situ* burn credit
- Require aerial tracking capability.

The need for this action is to ensure the ability to mitigate the adverse impacts of oil spills on the environment to the greatest extent practicable, as mandated by the Clean Water Act, by optimizing the uniform availability of oil spill response capabilities. The need for this action is further outlined below.

1.3.1. Oil Pollution Act of 1990

This public law was enacted in response to the *EXXON VALDEZ* oil spill in Alaska and other oil spills. One of the important goals of OPA 90 was to increase overall spill response capability in the United States.

The USCG was one of several agencies tasked with implementing OPA 90. The USCG must monitor and oversee the oil transportation industry's capability to respond to oil pollution incidents from vessels and facilities engaged in transport of oil by water. To implement OPA 90, the USCG promulgated regulations that require vessels and facilities to develop plans describing how they will respond to an oil pollution incident, including a worst case oil discharge.

In addition, OPA 90 requires changes in the National Response System (NRS) (described in 40 CFR part 300), including the establishment of Area Committees. In cooperation with existing Regional Response Teams (RRTs), Area Committees were tasked with determining potential oil spill risks and devising strategies to mitigate oil spills in the most environmentally protective manner practicable.

1.3.2. Regulatory Requirements

In response to the OPA 90 mandates, the USCG published response plan regulations as Interim Final Rules on February 5, 1993 (for tank vessels, 58 FR 7376; for MTR facilities, 58 FR 7330) and as Final Rules on January 12, 1996 for tank vessels (33 CFR part 155) and on February 29, 1996 for MTR facilities (33 CFR part 154). The goal of these regulations was to ensure prompt response to and clean up of oil discharged anywhere within U.S. waters.

The regulations required vessel and MTR facility planholders to have available, by contract or other approved means, mechanical recovery equipment suitable for removing spilled oil from the environment. In establishing mechanical recovery equipment standards, the USCG recognized that there were technological as well as availability limits on mechanical recovery equipment. Therefore, the regulations established requirements for equipment capabilities in response plans regarding the amount of mechanical recovery resources that planholders were required to ensure were available.

The regulations did not impose capability requirements to employ alternatives such as dispersants and *in situ* burning because of the lack of availability. However, the regulations did allow certain planholders to apply for a reduction in the amount of required mechanical recovery equipment if the planholders could establish a dispersant capability based on certain conditions. These conditions were proven to be too restrictive, and no planholder applied for the "dispersant mechanical recovery offset."

The regulations recognized that changes in technology, equipment availability, and general acceptance of certain alternative technologies might occur over time. Therefore, the regulations required the USCG to review the original response plan equipment capabilities requirements to determine whether the mechanical recovery capabilities should be increased and whether other response technologies in addition to mechanical recovery were practicable.

1.3.3. Response Plan Equipment Caps Review

In conducting the *Response Plan Equipment Caps Review* (USCG, 1999), the USCG evaluated improvements in technology, availability, and general acceptance of mechanical recovery equipment and other response technologies. As a result, existing on-water mechanical recovery requirements increased by 25 percent, effective April 5, 2000 (65 FR 710). The review also concluded that there have been sufficient improvements in these areas to initiate a new regulatory project. The new regulatory project would aim at increasing oil removal capacity even further, thus ensuring that planholders have even better capabilities available to respond to oil discharges in the future.

1.3.4. National Oil and Hazardous Substances Pollution Contingency Plan

The NCP was modified in accordance with OPA 90 mandates to encourage more active government planning at the local and regional levels, and focused on developing and implementing environmentally appropriate oil spill response strategies. Specifically, the NCP directs Area Committees and RRTs to consider, as part of their planning activities, the desirability of using other response technologies in addition to mechanical recovery. The NCP also directs that the employed response technologies are those that best minimize the overall impact to the environment.

1.3.5. Pre-Authorization Agreements

In carrying out the NCP mandates, Area Committees and RRTs around the country have engaged in intensive examination of the environmental tradeoffs involved in responding to oil spills using mechanical recovery, dispersants, and *in situ* burning. Based on local and regional environmental evaluations, almost every coastal Area Committee and RRT has adopted dispersant and *in situ* burn pre-authorization agreements for oil spill response. All these agreements are limited in geographic extent and conditions for use, and were developed and approved through a concurrence of appropriate federal and state natural resource trustees. The general acceptance of these response options imposes on the USCG the responsibility to ensure these options' availability in the event of a spill incident where their actual use may provide environmental benefit.

1.4. SCOPE OF THIS PEIS

The PEIS for developing the proposed regulations will examine the possible impacts to the environment on the regional and national levels and will be limited in scope to a discussion of the general impacts resulting from implementing these proposed regulations. The PEIS will also serve to encourage public involvement and to address agency and public concerns.

The proposed action could potentially affect all areas in which oil spill response operations could occur, including marine waters of the U.S. Exclusive Economic Zone (EEZ) off the coasts of the continental United States, Alaska, Hawaii, Guam, Puerto Rico, and other U.S. territories. The proposed regulations only apply to waters where dispersant pre-authorization agreement areas exist, which are demarcated as waters in the United States greater than 3 nm from shore with the exception of several areas with dispersant pre-authorization agreements at different distances from shore, including Maine (>0.5 nm), Massachusetts (>2 nm), Puerto Rico (>0.5 nm and >60 ft depth), the U.S. Virgin Islands (>1 nm from shore or reef, if reef <20 ft from surface and >60 ft depth), and Hawaii (>60 ft depth), as well as areas such as Washington, Oregon, Connecticut, and large portions of Alaska, which have case-by-case pre-authorization agreements[2]. The underlying rationale for the establishment of dispersant pre-authorization agreements for waters closer than 3 nm from shore is the ability of the environment in these locations to provide reasonable dilution over a shorter distance due to depth and hydrodynamic conditions. This PEIS also addresses waters where dispersant pre-authorization agreements are not currently in place—American Samoa, Guam, and Commonwealth of Northern Mariana Islands (CNMI). These non–pre-authorization agreement areas are included for completeness, and their inclusion does not signify intent to apply the proposed regulations to those areas. In addition although the Notice of Proposed Rule-Making (NPRM) (67 FR 63331, October 11, 2002) states that the alternatives will address the inland operating environment, this PEIS does not consider the inland operating environment because there are currently no dispersant pre-authorization agreements for the inland operating environment. If dispersant pre-authorization agreements are adopted for the inland operating environment (the U.S. Environmental Protection Agency [USEPA] has primary responsibility for deciding whether a dispersant pre-authorization agreement is appropriate in this operating environment), a supplemental NEPA process would be extended to this operating environment. The decision whether to pre-authorize the use of chemical dispersion and *in situ* burning or to authorize their use in a specific incident is unaffected by these proposed regulations and this PEIS. Those decisions properly remain within the purview of the local area response community and the RRTs in the area at risk.

The baseline environment, to which the alternatives are applied, includes the spilled oil. Since the response alternatives—on-water mechanical recovery, on-water *in situ* burning, and on-water chemical dispersion—are only applied after there has been an oil spill, the assessment of each alternative includes both the impact of the spilled oil and any impacts caused by the response action.

The scope of the PEIS will include a description of the proposed action and the environmental impacts associated with its possible implementation. The PEIS for developing these proposed regulations will examine the possible impacts to the environment on the regional and national levels. Only those environmental and socioeconomic conditions relevant to the project scope and programmatic-level discussion will be assessed, including resources in the physical, biological, and socioeconomic environments.

1.5. ORGANIZATION OF THIS PEIS

Chapter 1 Purpose of and Need for the Proposed Action is a NEPA-required discussion and action overview. It also describes the PEIS content, approach, and scope.

Chapter 2 Alternatives describes oil spill response strategies, the alternative development process, public involvement, alternatives considered in this PEIS including the no action alternative and the preferred alternative, historical spill data, mitigation for the adverse potential environmental impacts associated with a spill, the environmental legal framework applicable to oil spill response operations, and the Endangered Species Act Section 7 consultation.

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[2] *http://www.uscg.mil/vrp/maps/dispmap.shtml*, last updated August 19, 2004

Chapter 3 Affected Environment, also known as the environmental setting, provides a general description of existing conditions or resources for analysis that might be affected by the action in the areas of influence and a brief discussion of the resources dismissed from further analysis.

Chapter 4 Environmental Consequences identifies the consequences of oil spills and on-water response options of the proposed alternatives to each resource in the physical, biological, and socioeconomic environments. Direct and indirect impacts are identified on the broad regional and national scales as appropriate in this PEIS, along with a comparison of the alternatives, unavoidable adverse impacts of the proposed action, irreversible and irretrievable commitment of resources, relationship between the short-term use of man's environment, and the maintenance and enhancement of long-term productivity and cumulative impacts.

CHAPTER 2
ALTERNATIVES

2.1. INTRODUCTION

This chapter summarizes the fate and effects of oil spills in ocean ecosystems; reviews different response technologies[1] available to minimize the effects of those spills; examines the way in which these technologies alter that fate; and briefly describes oil spill response efforts. This chapter also discusses how the response alternatives were selected and reviews those alternatives that are effective, practicable, and retained for detailed analysis in this Programmatic Environmental Impact Statement (PEIS). In addition, this chapter discusses response alternatives considered but eliminated from further analysis. Historical oil spills are analyzed to provide information regarding the potential use of the proposed alternatives for future oil spill incidents.

The proposed alternatives would require the inclusion of equipment and logistics planning for chemical dispersion, *in situ* burning, and aerial tracking in spill response plans by establishing a requirement whereby the regulated planholders would be required to have oil response capability available based on a combination of mechanical recovery, chemical dispersion, and *in situ* burn techniques. However, the proposed alternatives would not require the actual use of any particular response alternative, nor would they dictate the circumstances under which a specific oil spill response strategy should be used for an oil spill incident. The actual use of the response mechanisms would continue to be at the discretion of the Federal On-Scene Coordinators (FOSCs) in accordance with the guidelines for considering spill response alternatives that are outlined in Regional Contingency Plans (RCPs) and local Area Contingency Plans (ACPs), both of which are developed under the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Appendix A provides an overview of the National Response System (NRS), including the federal agencies involved in and general actions of the National Response Team (NRT).

Regional and local representatives of federal, state, and local environmental and response agencies, with full participation of potentially affected communities, prepare RCPs/ACPs. The RCPs/ACPs identify regional and local strategies and tactics to be employed for oil discharge removal and the mitigation or prevention of associated environmental impacts. These plans also identify conditions

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[1] The response options analyzed and discussed in this PEIS—mechanical recovery, *in situ* burning, and chemical dispersion—are for on-water recovery.

and restrictions related to the potential use of specific response alternatives, including chemical dispersion and *in situ* burning. The FOSC and the U.S. Environmental Protection Agency (USEPA) regional representative with jurisdiction over the incident, in consultation with the affected state(s) and the federal natural resource trustees, must approve the potential use of chemical dispersion and *in situ* burning for a given spill incident. Oil spill response decisionmakers—federal, state, and local government agencies; oil-transportation and -handling industries; the oil spill response industry; environmental and other public interest groups; and the general public—are commonly referred to as the local response community.

Oil spilled in the marine environment (see Appendix B) can result in a variety of adverse environmental impacts. The main objective of oil spill response technologies is to reduce and mitigate these adverse impacts on marine ecosystems. Careful consideration of environmental tradeoffs and the selection of appropriate response options through the required planning process will have a positive environmental impact when compared with the impacts associated with an untreated oil spill. A primary objective of the pollution response planning requirements is to ensure the availability of the most favorable response technique based on operational, weather, logistical, and ecological concerns to mitigate or to minimize the environmental impact of the spill.

2.2. OVERVIEW OF OIL SPILL RESPONSE STRATEGIES

There are five major response options to oil spills:

- On-water mechanical recovery
- On-water chemical dispersion
- On-water *in situ* burning
- Shoreline cleanup and other countermeasures
- Natural removal (no cleanup action).

Other options—including gelling agents and enhanced bioremediation—are less widely used or have major limitations. In determining the best possible response option for a specific situation, availability and applicability must be carefully weighed against potential environmental damage and potential removal success. As mentioned in Section 2.1, selecting the response option to be used for a specific oil spill event is at the discretion of the local response community, who has the responsibility for considering which option or combination of options provides the largest benefit and is the most effective in minimizing potential environmental impacts. This process requires appropriately trained personnel who are familiar with each strategy's application, benefits, and tradeoffs.

2.2.1. On-Water Mechanical Recovery

The primary tools for mechanical recovery include barriers (booms) to contain and divert oil, and skimmers to recover or remove the contained oil from the water's surface. Containment booms concentrate spilled oil and divert it to skimmers for collection. They are typically constructed of an oil-resistant polymer, and consist of a flotation chamber that floats on the water surface and a weighted "skirt" that extends down into the water. Since oil usually floats on the water's surface, the chamber and the skirt trap the oil when the oil encounters the barrier, while the water flows under the skirt. Deployment of containment barriers is typically done from boats, and, depending on water depth and current conditions, barriers may be held in place by anchors placed on the bottom, along the shoreline, or by the vessels from which they are deployed. Skimmers, on the other hand, are mechanical devices that are set to operate on the surface of the water in the oil water interface zone. Primary mechanisms for skimmers include gravity feed; suction; or oil adhesion to a rope, mat, or belt. Once oil is collected in the skimmer, it is transferred to a temporary storage device for shipment to shore for recycling or disposal; thus, skimmers usually require pumps and hoses for oil transfer. Some dedicated skimmers are built into the hulls of oil spill response vessels, and many require one or more support vessels to hold them on station at the apex of containment booms. Storage devices usually include floating oil storage bladders, tank barges, or tank ships designed to carry oil. The rate at which oil can be collected (encounter) in open-water, offshore operations is a function of relative speed of advance through an oil slick (generally 1 kt or less) and sweep width of the boom/skimmer combination. Collection rates generally decrease with increasing sea states. Depending on boom characteristics, sea states of 3 to 4 (waves 4 to 8 ft) generally represent the upper limits of boom effectiveness (USCG, 1999).

Mechanical recovery as a response to an oil spill does not require the establishment of a pre-authorization agreement. As stated in 33 CFR 153.305(c), mechanical recovery is a default response option for mitigating adverse impacts of an oil spill when authorized by the FOSC.

2.2.2. On-Water Chemical Dispersion

The objective of chemical dispersion is to transform oil slicks floating on the surface of the water into tiny oil droplets that are "dispersed" throughout the water column. The primary tools for effective chemical dispersion in response to an oil spill include sufficient quantity of a dispersant, appropriate application tools, and capability to monitor the effectiveness of the dispersant. Dispersant application tools include spray booms and nozzles fitted to fixed-wing aircraft or waterborne vessels, fire monitors on waterborne vessels, and specially designed dispersant buckets carried underneath helicopters. Dispersant delivery aircraft may range in size from small, single-engine helicopters or fixed-wing aircraft to large multiengine cargo aircraft. Monitoring may be visual or may involve electronic monitoring devices as determined necessary by the responders.

In marine waters, application by aircraft is often preferred to application by vessel since aircraft traveling in excess of 100 kt can cover a much larger area than a vessel, which is typically limited to speeds of 5 kt or less. The effectiveness of dispersant application is limited by environmental conditions such as fog, darkness, and high winds, so trained personnel and specially outfitted aircraft or vessels are necessary to ensure effective application. Chemical dispersion may be an appropriate response alternative in treating[2] oil on the water surface in an effort to reduce or prevent damage to marine life (including birds, mammals, and other natural resources), fouling of shorelines and boats, and contamination of drinking water supplies.

Effective chemical dispersion requires that the water, into which the oil is dispersed, is sufficiently deep and has sufficient mixing energy to dilute or reduce the volume of oil in the water column to a level that does not produce a significant ecological effect. If the oil

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[2] The terms "removal" and "treatment" are used interchangeably throughout this PEIS. The term "remove" or "removal" is used throughout the PEIS as it is defined by section 311(a)(8) of the Clean Water Act, and refers to containment and removal of oil from the water and shorelines or the taking of such other actions as may be necessary to minimize or mitigate damage to the public health or welfare of the United States (including, but not limited to, fish, shellfish, wildlife, public and private property, and shorelines and beaches) or to the environment. While the use of dispersants, which break an oil slick into small droplets that then disperse into the water column, renders further manual removal attempts infeasible, the use of dispersants increases the opportunity for the oil to undergo natural bioremediation.

is dispersed in a small volume of water with poor circulation, there could be an increase in adverse ecological impacts. Chemical dispersion effectiveness—the percentage of spilled oil that can be dispersed—depends on a number of factors, including the type of oil, the time the oil has been in the water, and weather conditions. In general, oils that are recoverable using mechanical recovery are also chemically dispersible. However, chemical dispersion is only effective during the first 1 to 3 days of the spill, since after that time period the oil becomes too viscous and/or emulsified for the dispersants to be effective.

"Effectiveness monitoring" provides a qualitative indicator of how much oil is being dispersed by monitoring oil concentrations in the water column. The Special Monitoring of Applied Response Technologies (SMART) protocol[3], which was developed by the USCG, USEPA, National Oceanic and Atmospheric Administration (NOAA), and U.S. Centers for Disease Control and Prevention (CDC) as NRT members, provides criteria and guidelines for monitoring both chemical dispersion and *in situ* burning during spill response operations. SMART relies on small, highly mobile teams to deploy to the scene of dispersant applications or *in situ* burn operations. Monitoring teams collect real-time data using portable, rugged, and easy-to-use instruments, and channel the data to the Unified Command (UC), a group made up of representatives from the USCG, the state, and the responsible party. The monitoring data provided by these teams assist the UC in answering the following critical questions:

- When dispersants are used, are the dispersants effective in dispersing the oil?
- When *in situ* burning is used, are particulate concentration trends exceeding the level of concern?

Dispersants must be listed on the NCP Product Schedule, which is maintained by the USEPA, before they can be used in the United States[4]. Criteria for listing a product on the NCP Product Schedule are contained in the NCP. This includes submission by the manufacturer of toxicity and effectiveness test data to the USEPA. The FOSC and the USEPA regional representative with jurisdiction over the incident, in consultation with the affected state(s) and the federal natural resource trustees, must approve the application of dispersants before their potential use. The NCP authorizes and encourages the ACP process to include completion of USEPA and state approvals and consultation with the appropriate federal and state authorities responsible for managing natural resources in advance through a pre-authorization agreement that defines the conditions and restrictions placed on the FOSC for making a dispersant use decision. The NCP prescribes that these pre-authorization agreements allow the FOSC to approve incident-specific chemical dispersion without additional consultation. The reason for establishing pre-authorization agreement areas is to allow timely and, therefore, more efficient dispersion of oil. The timely application of dispersants can reduce spreading of oil on the water surface, thus reducing or eliminating shoreline impacts where the majority of threatened, endangered, or candidate species exist and where human use is high, and reducing impacts to species that are highly susceptible to oiling (e.g., marine and coastal birds). Current dispersant pre-authorization agreements around the country generally extend seaward from 3 nm from shore with the exception of several areas that have dispersant pre-authorization agreements at different distances from shore, including Maine (>0.5 nm), Massachusetts (>2 nm), Puerto Rico (>0.5 nm and >60 ft depth), the

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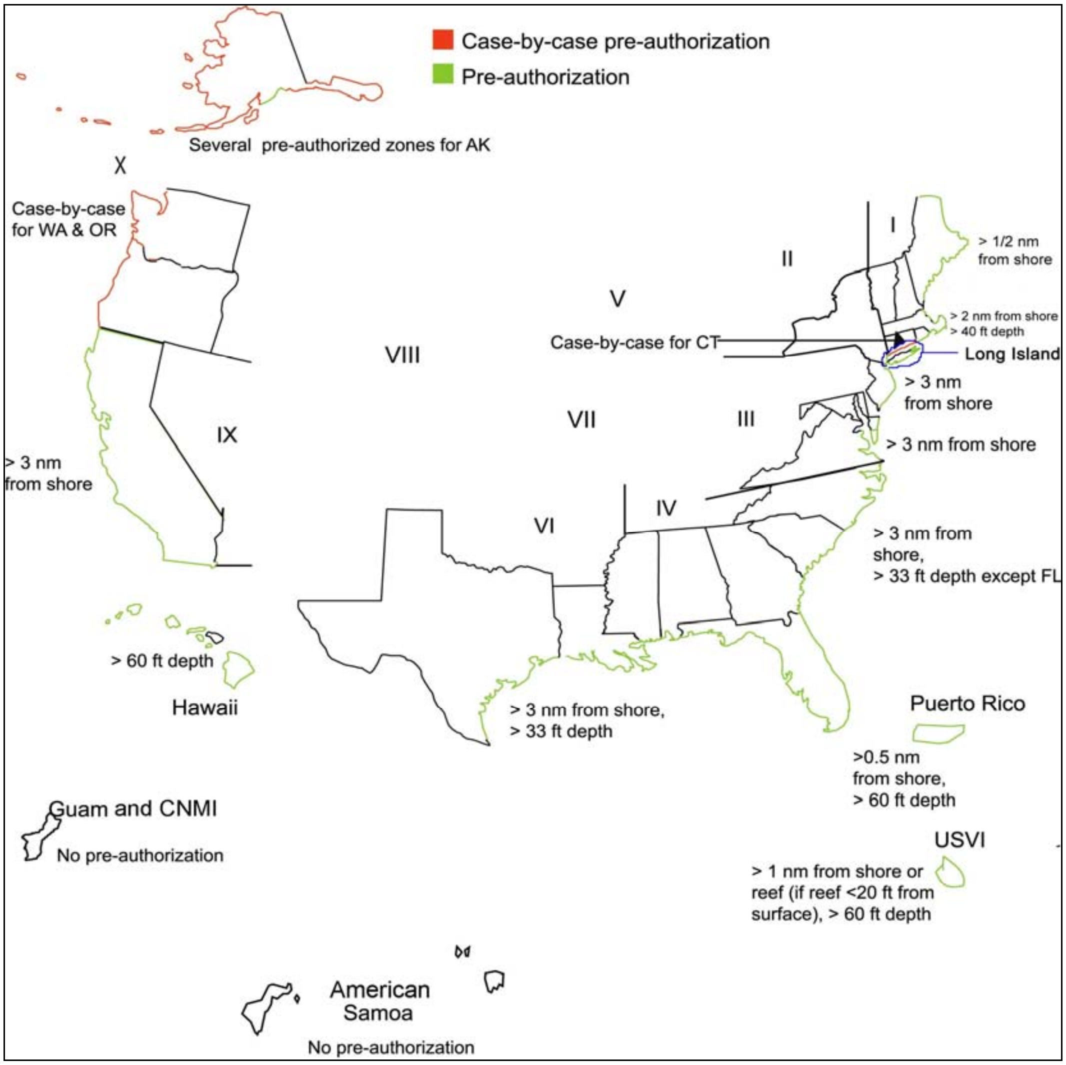
[3] *http://response.restoration.noaa.gov/oilaids/SMART/SMART.html*

[4] Currently there are thirteen different dispersants with varying toxicity and efficacy values on the NCP Product Schedule. More information can be found at *www.epa.gov/oilspill* under NCP Product Schedule and Notebook.

U.S. Virgin Islands (>1 nm from shore or reef, if reef <20 ft from surface and >60 ft depth), and Hawaii (>60 ft depth), as well as areas such as Washington, Oregon, Connecticut, and large portions of Alaska, which have case-by-case pre-authorization agreements[5] (Figure 2.2-1). The underlying rationale for the establishment of dispersant pre-authorization agreements for waters closer than 3 nm from shore is the ability of the environment in these locations to provide reasonable dilution over a shorter distance due to depth and hydrodynamic conditions. This PEIS also addresses waters where dispersant pre-authorization agreements are not currently in place—American Samoa, Guam, and Commonwealth of Northern Mariana Islands (CNMI).

Figure 2.2-1
Summary of Dispersant Pre-Authorization Agreements, 2004



Source: USCG VRP/SOPEP Web site (*http://www.uscg.mil/vrp/maps/dispmap.shtml*, last updated August 19, 2004), with personal communication from LCDR Mark Cunningham, Government Plans Branch, U.S. Coast Guard Headquarters, Washington, D.C., January 2003. For regional information, see Appendix C.

Note: Map is not to scale.

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[5] *http://www.uscg.mil/vrp/maps/dispmap.shtml*, last updated August 19, 2004

2.2.3. On-Water *In Situ* Burning

The primary tools for *in situ* burning include barriers (booms) to contain and concentrate oil, and a means to ignite the oil and sustain the burn. *In situ* burn containment barriers are similar in design and function to those used for mechanical recovery, except that they are constructed of fireproof or fire-resistant materials. This is important to note from a practical standpoint, because it means that *in situ* burn containment barriers are subject to all the same operational limitations discussed for mechanical recovery containment barriers. For example, containment booms usually become ineffective in currents in excess of 1 kt and in waves in excess of 3 to 4 ft. It can also be inferred that the initial number of incidents where *in situ* burning and mechanical recovery are viable as response options is identical.

Oil is gathered in the containment barrier's chamber and trapped in the skirt, while water flows under the skirt. Because of the size and weight of the boom, deployment is typically done from large boats operating in tandem. Once the oil is contained, it is ignited with an ignition device, typically a helitorch delivered by a helicopter. The burn is allowed to continue for as long as ignition can be sustained inside the boom; the fire goes out almost immediately if the containment boom is breached or removed. Most of the oil within the boom is consumed in the fire and is converted to smoke and ash that is carried away by the prevailing winds. *In situ* burning can result in the production of a significant smoke plume that contains particulate matter, which may be harmful to human health and safety. Appropriate precautions must be taken to ensure that smoke plumes will not affect responders and/or the general public. Some small portion of the oil—approximately less than 10 percent—usually will not burn (Allen, 1990[6]) and will remain on the water surface as residue that must be collected by mechanical means and disposed of onshore. Some studies have shown, however, that oil residue from certain types of oil will sink when burned (Buist and Trudel, 1995).

Effectiveness monitoring, carried out for the same purpose as for dispersants, is done visually from spotter aircraft or surface vessels, and is further enhanced through specialized electronic detection devices. In addition, similar to chemical dispersion, *in situ* burning is significantly more effective on recently spilled oil; oil that has been in the water for more than 3 or 4 days typically does not contain enough volatile hydrocarbons to sustain an effective burn.

In situ burning could be an appropriate response alternative for removing oil from the water surface in an effort to reduce or prevent damage to marine life and other natural resources, as well as to prevent fouling of shorelines and boats and contamination of drinking water supplies. In marine waters, it can potentially be used to supplement mechanical recovery when capacity to store oil recovered by skimmers is limited. *In situ* burning is especially beneficial as a response tool in treating oil trapped in icebound waters where conventional mechanical recovery methods are rendered ineffective because of the ice. In general, *in situ* burning is as effective as mechanical recovery since they both depend on boom effectiveness.

The FOSC and the USEPA regional representative with jurisdiction over the incident, in consultation with the affected state(s) and the federal natural resource trustees, must approve the potential use of *in situ* burning for a given spill incident. The NCP authorizes and encourages the ACP process to include completion of USEPA and state approvals

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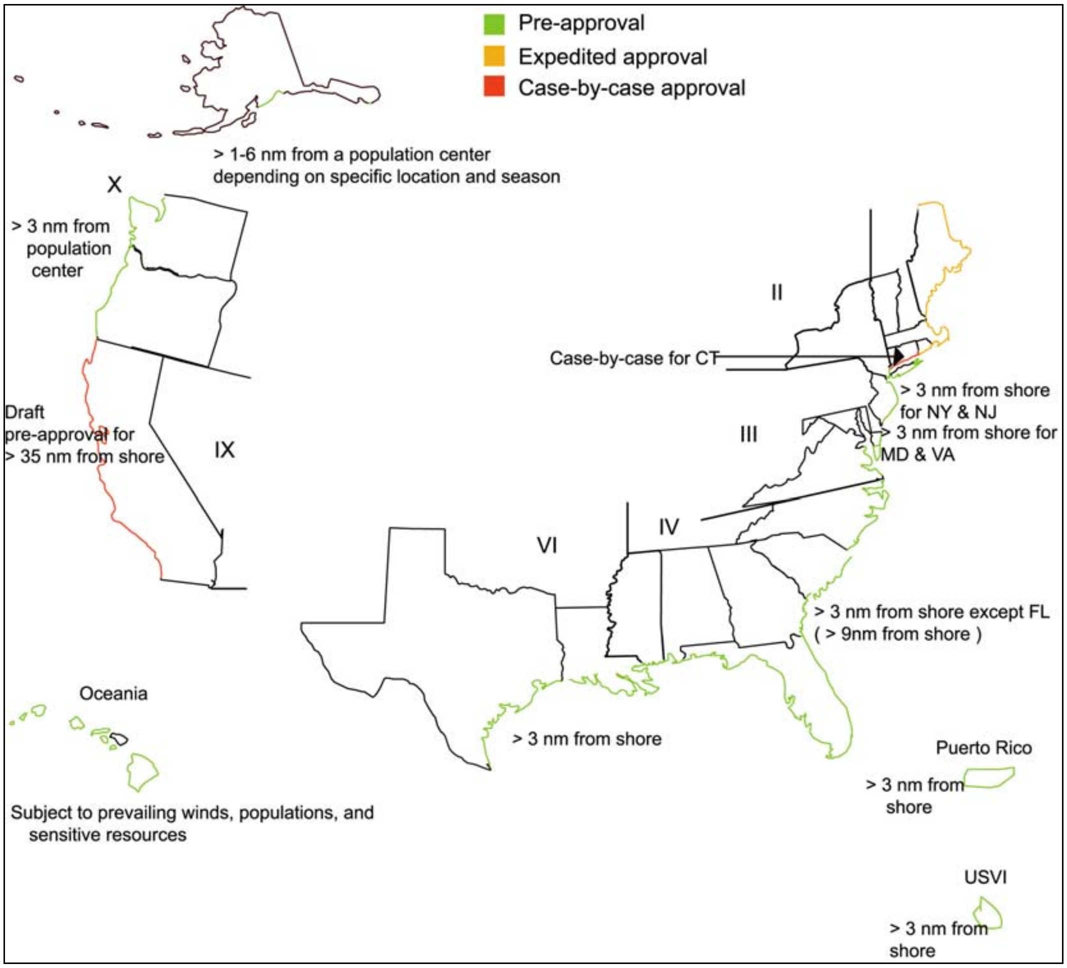
[6] Tests were conducted and reported on during the *EXXON VALDEZ* spill, in which a controlled test burn was conducted on 15,000 to 30,000 gal of Prudhoe Bay crude oil. After the burn approximately 300 gal of taffy-like oil clods remained.

and consultation with the appropriate federal and state authorities responsible for managing natural resources in advance through an *in situ* burn pre-authorization agreement that defines the conditions and restrictions placed on the FOSC for making a decision. The NCP prescribes that these pre-authorization agreements allow the FOSC to approve incident-specific *in situ* burning without additional consultation. Current *in situ* burn pre-authorization agreements are in place in every region of the country and are generally restricted to waters of at least 3 nm from shore (Figure 2.2-2). In no case does the NCP or a pre-authorization agreement empower any responsible party to use *in situ* burning without the incident-specific permission and oversight of the FOSC.

Figure 2.2-2
Summary of *In Situ* Burn Pre-Authorization Agreements, 2004



Source: Adapted from USCG (1999), with personal communication from LCDR Mark Cunningham, Government Plans Branch, U.S. Coast Guard Headquarters, Washington, D.C., January 2003. For regional information, see Appendix C.

Note: Map is not to scale.

2.2.4. Shoreline Cleanup and Other Countermeasures

Shoreline cleanup and other countermeasures include other chemical and biological countermeasures that enhance the removal process. Specifically, these include dispersants, surface-washing agents, surface-collecting agents, bioremediation, and miscellaneous oil spill control agents. Prior to using these countermeasures, chemicals are subject to USEPA review and listing on the NCP Product Schedule, and must be approved by the FOSC, USEPA, and affected state(s) in consultation with the natural resource trustees.

Herding agents push or compress oil on the water surface and can direct the movement of oil to produce a thick oil film and enhance recovery. Emulsion-treating agents include emulsion inhibitors that prevent the formation of emulsions and emulsion breakers that break emulsion into discrete phases. Solidifiers mix and immobilize oil, facilitating removal. Elasticity modifiers impart elasticity to oil by changing the mechanical properties of oil, so that oil remains liquid and can be recovered by skimmers. Oxidation agents enhance the photo-oxidation of oil. Bioremediation agents enhance the natural biodegradation of oil and include fertilizing agents that provide nutrients to stimulate bacterial growth and oil-eating bacteria. Shoreline-cleaning agents increase efficiency of oil removal when water is used to flush the shoreline, and include hydrocarbon solvents that lower oil viscosity by dilution and surface-active agents that make oil float so that it is recoverable rather than dispersed. Oil not removed through natural weathering processes or any on-water recovery strategy described in Sections 2.2.1 through 2.2.3 will eventually be stranded along the shoreline. Techniques involved in removal of stranded oil vary depending on the type of shoreline habitat. For example, cleanup on sandy beaches may involve tractors' scraping oil off the sand's surface and piling it for removal and disposal. It may also involve response personnel raking and shoveling oil along the shoreline. In rocky shorelines, responders may use high- or low-pressure water washers to wash oil back into the water, where it can be recovered using skimming devices. It may also involve using personnel on the shoreline to apply sorbent materials. In marshy areas, fire hoses or similar devices may flush oil out of marshes.

2.2.5. Natural Removal (No Cleanup Action)

Natural removal is "used" when responders determine that the use of any available response options would be ineffective or that the environmental tradeoffs are less favorable when compared to weathering by natural removal. Natural removal relies on the weathering processes described in Appendix B to remove the oil from the environment.

2.2.6. Aerial Tracking of Spilled Oil

Aerial tracking of spilled oil is an auxiliary response strategy that is appropriate for use in conjunction with all on-water response technologies, as it provides responders with oil movement and spill characteristics that allow response managers to more effectively and efficiently deploy the appropriate response resources for removal. As explained in Appendix B, winds and currents tend to spread oil spills quickly over wide areas. Aerial tracking provides the opportunity for responders to track the movement of oil in the ocean environment, and to collect information on several important characteristics of the spill that allow response managers to more effectively and efficiently deploy the appropriate response resources for removal. Aerial tracking also supports effectiveness monitoring efforts by providing indicators of the effectiveness of the removal efforts. Aerial tracking relies on fixed-wing or rotary aircraft capable of sustained operations over water and on trained oil spill monitoring personnel. For more effective response support, aircraft should be equipped with communications equipment that allows continuous communication with response managers and operations personnel on the ground.

2.3. OIL SPILL RESPONSE

As envisioned in the NCP, the NRS is intended to facilitate the reaction of the response community to an oil spill incident to mitigate adverse environmental impacts. The response community includes federal, state, and local government agencies; the oil-transportation and -handling industries; the oil spill response industry; environmental and other public interest groups; and the general public. In carrying out this intent, the NCP assigns specific tasks to various response community members in both the planning and response phases documented within an ACP. Appendix A provides an overview of the NRS, including the federal agencies involved in and general action of the NRT.

In the planning phase, the lead federal response agency in an ACP area (either a USCG or USEPA pre-designated FOSC) chairs an Area Committee responsible for producing the ACP. The ACP provides documentation of community consensus on the response strategies and tactics most appropriate for mitigating oil spill impacts and incorporates them into the planning process. The Area Committee includes federal and state natural resource trustees and invites public participation in assessing oil spill risks and the potential environmental costs and benefits of applying various response options to mitigate those risks. This open and public planning process is intended to satisfy requirements for endangered species and Essential Fish Habitat protection, among other important issues. The Area Committee is ultimately responsible for adopting dispersant and *in situ* burn pre-authorization agreements in a given area. The government-sponsored, community-consensus ACPs dictate which response options will be employed in a given area during a specific response effort. In addition, during the planning phase, the oil-transportation and -handling industries are required to identify the response resources necessary to carry out strategies specified in the ACPs. Each planholder is required to ensure through contract or other approved means the availability of all the resources (up to the limits specified in the regulations) necessary to carry out the ACP strategies as they apply to the planholders operating locations.

When a spill actually occurs, both the FOSC and the responsible party activate their plans. In most spill incidents, the responsible party carries out all response activities under the supervision of the FOSC. If the spill is large enough to represent a significant and substantial harm to the environment, the FOSC will assume control for directing all resources. The primary response tools are on-water mechanical recovery and shoreline cleanup. Whether the responsible party or the FOSC is directing the response, options such as dispersants, *in situ* burning, and other chemical- or biological-mitigating agents are never used unless ordered by the FOSC, under the conditions set forth by the USEPA, affected states, and natural resource trustees.

There are practicable limits to how much oil can be effectively treated by any method. The weathering effects on oil discussed in Appendix B largely govern those practicable limits. Immediately after the spill, the oil is too closely bunched together to allow effective employment of more than one or two mechanical recovery or *in situ* burn systems. Within hours—due to spreading, evaporation, and natural dispersion—the oil is spread in widely separated, thin patches that must be tracked down and corralled using slow-moving skimmers and containment booms or *in situ* burn booms. No matter how much equipment is put on the water, mechanical recovery and *in situ* burn systems are forced to search for smaller and smaller patches of oil spread over wider and wider areas. As discussed in Sections 2.2.1 and 2.2.3 above, mechanical recovery and *in situ* burn booms have essentially the same operational restrictions.

To put it in simpler terms, spill responders can only recover or burn oil on the water that they corral and contain in sufficient quantity using booms to allow for effective recovery or burning. They can recover or burn 10 to 90 percent of the oil they contain in sufficient quantity (Table 5-1 in USCG, 2008), but they only contain at most 30 percent of the total oil spilled. Thus only a limited amount (generally considered to be less than 15 percent) of the oil is likely to be recovered on water using mechanical recovery or *in situ* burning, regardless of how much equipment is employed. In *Coping with an Oiled Sea*, the Congressional Office of Technology reports, "Even under ideal conditions, with equipment and trained personnel nearby, and good weather, it is not realistic to expect to recover more than 30 percent from a major spill. Probably less than half that amount is more likely" (OTA, 1990, p. 16).

Dispersant removal capability is much higher than mechanical recovery and *in situ* burning because application by aircraft treats a much greater portion, up to 100 percent, of the spilled oil. Aircraft are much more mobile than boats used for dispersant application as well as boats used to operate mechanical recovery systems. Aircraft can move quickly to treat even widely scattered patches of oil. Theoretically, dispersant treatment can approach 100 percent, but a more reasonable expectation is 45 to 80 percent (USCG, 2008), given the potential for decreased dispersant efficiency from weathering of oil, misapplication, etc. For the purposes of this PEIS, the USCG has estimated efficiency rates. Appendix D provides the calculated efficiency rates for mechanical recovery, *in situ* burning, and chemical dispersion.

2.4. ALTERNATIVES DEVELOPMENT PROCESS

The preferred environmental option for protecting marine resources from environmental damage associated with oil spills is preventing the oil from reaching the resources of concern (NRC, 1989). The focus of the alternatives development process is similar in that it considers alternative response strategies that would improve the ability of the response community to minimize potential adverse environmental impacts of oil spills by reducing the amount of spilled oil reaching sensitive marine resources. The USCG analyzed the potential effectiveness of all oil spill response strategies, including mechanical recovery, chemical dispersion, *in situ* burning, shoreline cleanup, herding agents, emulsion-treating agents, solidifiers, elasticity modifiers, oxidation agents, bioremediation agents, and shoreline-cleaning agents. Aerial tracking, as a complement to any of the above mentioned response strategies, was also analyzed (USCG, 1999).

As part of USCG's goal to ensure a prompt response and cleanup of oil spills in U.S. marine waters, the USCG published Final Rules for tank vessels on January 12, 1996 (61 FR 1052) and for marine transportation-related (MTR) facilities on February 29, 1996 (61 FR 7890). These regulations required tank vessel and MTR facility planholders to have available, by contract or other approved means, mechanical recovery equipment suitable for removing spilled oil from the environment. Based on the recognition that technological and scientific developments, equipment availability, and general acceptance of certain other response technologies could occur over time, these regulations required the USCG to determine whether the mechanical recovery capability requirements should be increased and whether other response strategies in addition to mechanical recovery were practicable for mitigating the environmental impacts of an oil spill.

The guidelines for considering all spill response strategies are outlined in the NCP and described in detail in local ACPs, which are developed under the NCP. In carrying out the NCP mandates, Regional Response Teams (RRTs) and Area Committees around the country have engaged in intensive examination of the environmental tradeoffs involved in responding to oil spills using all potential oil spill response strategies. These efforts were motivated by the local response community's awareness of the potential benefits and advantages—from technical, operational, and environmental standpoints—that could be rendered by the potential use of any or all of the oil spill response strategies included in the NCP. Based on these local and regional environmental evaluations, almost every RRT and Area Committee has now adopted dispersant and *in situ* burn pre-authorization agreements for oil spill response (USCG, 1999). These agreements represent a consensus understanding by the oil spill response community of the value and limitations of chemical dispersion and *in situ* burning as response strategies. These agreements also detail the circumstances under which each pre-authorized strategy enhances the responders' ability to mitigate potential adverse environmental impacts associated with the spill in an efficient and effective manner.

2.5. PUBLIC INVOLVEMENT

In addition to the alternative development process inherent to the assembly of local ACPs, the USCG has used public scoping as an integral part of its effort to develop the oil response alternatives to be analyzed in this PEIS. Public scoping has been critical to understanding public concerns over the potential operational, economic, and environmental benefits and tradeoffs surrounding different spill response strategies. Public workshops were held in Oakland, California, on July 24, 1998; Houston, Texas, on August 19, 1998; and Washington, D.C., on September 16, 1998. The workshops were widely publicized through a *Federal Register* notice, the USCG vessel response plan (VRP)/shipboard oil pollution plan (SOPEP) Web site[7], trade journals, and written notice to individuals and organizations representing interested members of the public and the response community from around the country. These workshops were intended to elicit input on potential changes to the equipment requirements within the current response plan regulations for mechanical recovery, chemical dispersion, *in situ* burning, shoreline cleanup, herding agents, emulsion-treating agents, solidifiers, elasticity modifiers, oxidation agents, bioremediation agents, and shoreline-cleaning agents.

The workshops served as forums to discuss issues relevant to establishing practicable alternatives to existing spill response equipment capability requirements. Discussions focused mostly on technological, operational, economic, and environmental concerns related to mechanical recovery and chemical dispersion because the USCG perceived these options to be the most promising in rapidly treating large volumes of spilled oil in open-water marine environments. *In situ* burning was also discussed as having significant potential for large-volume oil spill response. In addition, based on the information received during the development of the local ACPs, other response strategies were also discussed, including other chemical and biological strategies such as herding agents, emulsion-treating agents, solidifiers, elasticity modifiers, oxidation agents, bioremediation agents, and shoreline-cleaning agents. The results of the workshops demonstrated that, based on current oil spill response technology, there was significant public, government, and industry support for increasing the on-water mechanical recovery equipment requirements imposed by the current regulations, while also imposing dispersant and *in situ* burn capability requirements. Summary reports of the workshops are available on the USCG VRP/SOPEP Web site[8].

Based on inputs received from the workshops, in 1998 the USCG commissioned an independent study to assess the practicability of spill response requirements. The study focused on the advances in technology, policy, and equipment availability for the removal of on-water oil discharges with the goal of determining whether changes to current removal equipment requirements were warranted. The study concluded with a report—*Response Plan Equipment Caps Review*—published in May 1999, which found that, since 1993, there have been vast technological advancements and considerable improvements in the effectiveness and availability of on-water mechanical recovery equipment, and that local or regional determinations related to chemical dispersion and *in situ*

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[7] *http://www.uscg.mil/vrp*

[8] *http://www.uscg.mil/vrp/reg/response.shtml*

burning have been completed nationwide (USCG, 1999). Therefore, the report recommended that the USCG consider amending the current regulations to require industry to increase its on-water mechanical recovery equipment capability and to establish and maintain both dispersant and on-water *in situ* burn capability.

The report's general conclusions and recommendations (USCG, 1999) found, based on the potential for spills in excess of both current and projected response plan equipment capability requirements and availability in the marketplace and in existing spill response organizations' stockpiles, that it is practicable to consider:

- Increasing the current mechanical recovery capability requirements by 25 percent at this time and again in 5 years;
- Requiring dispersant capability under certain conditions for planholders operating in waters where dispersant pre-authorization agreements are in place;
- Requiring an *in situ* burn capability at this time as a supplement to existing mechanical recovery capability, and possibly considering an offset of mechanical recovery capability under certain conditions;
- Requiring planholders to provide an airborne visual-tracking capability since advances in aerial tracking technology are expected to improve the effectiveness of all three spill response techniques examined in the report.

The complete *Response Plan Equipment Caps Review* (USCG, 1999) and the *Federal Register* Notice of Decision are available on the USCG VRP/SOPEP Web site[9].

On September 1, 2000, the USCG announced the commencement of this PEIS in a Notice of Intent (NOI) (65 FR 53335) and defined several broad alternatives for use in areas where pre-authorization agreements are in place in the waters of the United States. After receiving public comment on the alternatives and considering the historical context of alternatives, the USCG decided to explore public opinion on expanding the scope of the proposed regulations to inland and coastal waters. On October 11, 2002, the USCG published a Notice of Proposed Rule-Making (NPRM) (67 FR 63331) announcement that expanded the alternatives to include chemical dispersion and *in situ* burning in the inland operating environment. Although the NPRM states that the alternatives will address the inland operating environment, this PEIS does not consider the inland operating environment because there are currently no pre-authorization agreements for the inland operating environment. If pre-authorization agreements are adopted for the inland operating environment (the USEPA has primary responsibility for deciding whether a pre-authorization agreement is appropriate in this operating environment), a supplemental NEPA process would be extended to this operating environment.

The Draft PEIS was available for public review and comment for 60 days after the Notice of Availability (NOA) was published. Actions during this public involvement phase included the following:

- A NOA was published in the Federal Register on June 1, 2005, announcing the availability of the Draft PEIS for review and comment. This publication date started the 60-day review period.

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[9] *http://www.uscg.mil/vrp/reg/capsreview.shtml*

- The USEPA published a Notice of Receipt of the Draft PEIS in the Federal Register on May 27, 2005.
- A Notice of Public Hearing was published in the Federal Register on June 15, 2005. The purpose of the Notice of Public Hearing was to state that the U.S. Coast Guard would hold four public hearings to solicit comments on the Draft PEIS. The locations, dates, and times of the public hearings were as follows:

  – Houston, Texas – July 11, 2005 – 12:00 P.M. to 7:00 P.M.

  – Sacramento, California – July 13, 2005 – 12:00 P.M. to 6:00 P.M.

  – Anchorage, Alaska – July 15, 2005 – 12:00 P.M. to 7:00 P.M.

  – Washington, D.C. – July 19, 2005 – 12:00 P.M. to 7:00 P.M.
- The Draft PEIS was mailed to agencies and interested members of the public for review and comment.
- Requests for a national consistency determination pursuant to section 307(c)(1) of the Coastal Zone Management Act (CZMA) were sent to thirty-four State Coastal Zone Management Programs. The U.S. Coast Guard received twelve formal responses concurring with the federal consistency determination. Nonresponses were also considered as concurring with the federal consistency determination.
- A Notice of Availability and Request for Comments was published in the Federal Register on August 5, 2005, announcing that the review and comment period had been extended for an additional 30 days.
- A total of nineteen commenters provided comment on the Draft PEIS. These comments and USCG responses are provided in Appendix H.

The USCG has decided to eliminate the credit for *in situ* burning because allowing such a credit may reduce the amount of mechanical recovery response equipment available in areas where *in-situ* burn pre-authorizations are in place. As these areas are typically more than three miles from shore, there will be no reduction in mechanical recovery equipment available in near shore areas. The Coast Guard acknowledges the limited opportunities to employ *in-situ* burning in open waters. Those limitations are so severe, and the cost of *in-situ* burn equipment so high, that the Coast Guard cannot justify requiring stockpiling of *in-situ* burn equipment in addition to required mechanical recovery stockpiles.

2.6. ALTERNATIVES CONSIDERED IN THIS PEIS

Based on the knowledge and information developed through the Area Committee investigations, public input from workshops, the *Response Plan Equipment Caps Review* study, and responses from the PEIS NOI and the NPRM, the USCG has concluded that mechanical recovery, chemical dispersion, and *in situ* burning meet the criteria for potentially reducing the amount of spilled oil reaching sensitive marine habitat. These response options have the potential to effectively remove large quantities of oil from the water when used in the first several days after a spill incident occurs (NAS, 1989; USCG, 1999). The alternatives proposed in the NOI and refined in the NPRM determined the alternatives that are considered and analyzed in detail in this PEIS. Thus, these alternatives will be analyzed in this PEIS and will be covered in more detail in Chapter 4.

The proposed regulations would increase the oil removal capacity requirements for tank vessels and MTR facilities, and thus would increase the available oil removal capability for oil spills. The reasonable alternatives proposed in the NOI and refined in the NPRM met the purpose and the need that were to be considered and analyzed in detail in this PEIS. This PEIS examines the six refined alternatives (Figure 2.6-1):

- Alternative 1—no action, whereby no change in response plan regulations would be implemented.
- Alternative 2—increase on-water mechanical recovery capability and establish and maintain aerial tracking capability*.
- Alternative 3—increase on-water mechanical recovery capability, establish on-water dispersant application capability (Option A), establish *in situ* burn credit, and establish and maintain aerial tracking capability.
- Alternative 4—increase on-water mechanical recovery capability, establish on-water dispersant application capability (Option B), establish *in situ* burn credit, and establish and maintain aerial tracking capability.
- Alternative 5—maintain on-water mechanical recovery capability at current levels, establish on-water dispersant application capability (Option B), establish *in situ* burn credit, and establish and maintain aerial tracking capability.

- Alternative 6 [Preferred Alternative]—maintain on-water mechanical recovery capability at current levels, establish on-water dispersant application capability (Option B), and establish and maintain aerial tracking capability.

Under all alternatives except Alternative 1, planholders would be required to have aerial tracking capability available by contract or other approved means. Aerial oil spill tracking is routinely used in oil spill incidents and has proven to be very effective in directing on-water response activities; thus, it will not be considered separately but will be analyzed as an integral part of Alternatives 2 through 6.

Implementing proposed Alternatives 3, 4, 5, or 6 would require planholders to have available, by contract or other approved means, dispersant equipment and supplies for responding to a spill incident. In Alternatives 3, 4, and 5, there are two chemical dispersion options, Options A and B, which are defined in Table 2.6-1. Under Option A in a non–Gulf of Mexico region, within the first 12 hours of response, 2,750 gal of dispersant are applied to treat 55,000 bbl of oil. Under Option B in a non–Gulf of Mexico region, a larger volume of dispersant is applied to treat a larger volume of oil. For the Gulf of Mexico region under both Options A and B, larger volumes of dispersant are applied to treat larger volumes of oil as compared with any of the other regions. Under Alternatives 3, 4, and 5, an *in situ* burn credit would be extended to planholders where *in situ* burn pre-authorization agreements currently are in place (Figure 2.2-2). If a planholder opted to establish and maintain an *in situ* burn capability, the planholder would receive credit against their mechanical recovery equipment and would be able to reduce their mechanical recovery capability by an equal amount up to the limit specified in the NPRM and discussed in Section 2.6.3.

The proposed regulations would apply in all areas with dispersant and *in situ* burn pre-authorization agreements (Figures 2.2-1 and 2.2-2). A pre-authorization agreement represents a consensus among the local response community of the circumstances under which the alternative enhances responders' ability to mitigate environmental impacts of an oil spill event. When the conditions—oil type, water temperature, water depth, distance from shore, proximity to environmentally sensitive habitat—specified in the pre-authorization agreement are met, the FOSC can order the use of the response alternative immediately.

Table 2.6-1
Tiers for Effective Daily Application of Dispersant Capability (Options A and B) under the Proposed Regulations

Tier	Response Time for Completed Application (hr)	Dispersant Applies (gal) : Oil Treated (bbl)	
		Gulf of Mexico Region	Non–Gulf of Mexico Regions
1 Option A	12	5,500:110,000	2,750:55,000
1 Option B	12	8,250:165,000	4,125:82,500
2	36	23,375:467,000	23,375:467,000
3	60	23,375:467,000	23,375:467,000

Source: Adapted from FR 67, No. 198, October 11, 2002.

Note: Gulf of Mexico region Tier 1 (Options A and B) are higher than Non–Gulf of Mexico region Tier 1 (Options A and B) because of greater potential spill size and frequency in the Gulf region; it is assumed that dispersant stockpiles would be centralized in the Gulf region. The 1:20 dispersant-to-oil application ratio is a planning assumption that relies on the generally agreed on estimate of the effectiveness of current dispersant formulations.

The baseline environment, to which the alternatives are applied, includes the spilled oil. Since the response alternatives—on-water mechanical recovery, on-water *in situ* burning, and on-water chemical dispersion—are only applied after there has been an oil spill, the assessment of each alternative includes both the impact of the spilled oil and any impacts caused by the response action.

The spilled oil that is not removed by one of the alternatives would be stranded on a shoreline, where it could be removed using mechanical means such as hot or cold water flushing to re-float the oil and recover it with a skimmer, manual pickup, burning, or removing and replacing the affected substrate. Hard surfaces, such as rocks or bulkheads, could be sandblasted or steam cleaned. It is important to consider that, in general, shoreline cleanup is extremely labor intensive, costly, and environmentally damaging to sensitive resources. Oil on beaches tends to be washed throughout the intertidal zone following the tide cycles, resulting in frequent re-oiling of sensitive habitat. As an example, marshes affected by oil spills are frequently left to recover naturally because the impact of human intervention has been found to be sometimes more environmentally damaging than letting the oil disperse by natural processes.

2.6.1. Alternative 1—No Action (No Change in Response Plan Regulations)

Under this alternative, the USCG would not implement any changes to the current regulations. Mechanical recovery equipment requirements would remain at current levels as determined using the calculations for MTR facilities in 33 CFR part 154, Annex C, and for tank vessels in 33 CFR part 155, Annex B. Dispersant and *in situ* burn capability and equipment would not be required, so their potential use as response strategies would continue to be severely limited because most tank vessel and MTR facility planholders do not currently contract for these capabilities. Planholders would not be required to establish and maintain aerial tracking capability although the majority of planholders currently have aerial tracking capability as a standard practice. In addition, as is the current and historical practice, the local response community would continue to determine the actual use of the response capability in an oil spill event.

Responders would continue to use mechanical recovery equipment to remove as much oil from the water's surface as possible. Oil that is not removed by this method would be removed either through natural recovery or shoreline-cleaning methods. Chemical dispersion and *in situ* burning would be approved for use infrequently in areas where pre-authorization agreements are in place. Chemical dispersion would be approved for use almost exclusively in the Gulf of Mexico and Alaska regions (Table 2.6-2).

Table 2.6-2
Response Options for Each Region under Alternative 1

Region	Mechanical Recovery	Chemical Dispersion	*In Situ* Burning
Atlantic	Yes	No	Yes
Caribbean	Yes	No	Yes
Gulf of Mexico	Yes	Yes	Yes
Pacific	Yes	No	Yes
Alaska	Yes	Yes	Yes
Oceania	Yes	No	Yes

Source: Adapted from USCG, 2008.

As required in 33 CFR parts 154 and 155, MTR facility and tank vessel planholders must have contracts with response providers to deliver the specified recovery capability to the scene and be operational within certain time periods. These time periods or tiers allow planholders to maintain a certain level of locally available equipment and to supplement that equipment by importing equipment from other regions over time (Table 2.6-3). Tier 1 for mechanical recovery is the first operational period of a response that begins anytime from 12 to 24 hours after the discovery of the spill, depending on proximity to major port areas. Tier 2 for mechanical recovery is the second operational period that begins anytime from 36 to 48 hours after discovery of the spill, depending on proximity to major port areas. Tier 3 for mechanical recovery is the third operational period that begins anytime from 60 to 72 hours after the discovery of the spill, depending on proximity to major port areas.

Table 2.6-3
Current and Proposed Response Requirements (bbl/d) for Mechanical Recovery Equipment for Tank Vessels and MTR Facilities *

	Current	Proposed			
Tier	Alternative 1	Alternative 2	Alternative 3*	Alternative 4*	Alternative 5*
1	12,500	15,000	15,000 (12,500)	12,500 (10,000)	12,500 (10,000)
2	25,000	30,000	30,000 (25,000)	25,000 (20,000)	25,000 (20,000)
3	50,000	60,000	60,000 (50,000)	50,000 (40,000)	50,000 (40,000)

Source: Current, 65 CFR 710, USCG, 2008; proposed, adapted from USCG, 2008

Note: The current regulations do not require dispersant or *in situ* burn equipment to be maintained anywhere in the United States.

* Response requirements will revert to previous levels if credit is given for *in situ* burning. Reverted levels are shown in parentheses.

Under existing conditions, the Gulf of Mexico and Alaska regions currently have dispersant pre-authorization agreements in place, as well as dispersant capability. *In situ* burn capability currently is available in all regions with pre-authorization agreements. Therefore, in this PEIS the impacts of chemical dispersion for the Gulf of Mexico and

Alaska regions and *in situ* burning for all six regions considered in this PEIS will be part of Alternative 1 (USCG, 1999).

In the current regulations (33CFR 155.1050 (j) and 33 CFR 155.1225(h)) tank vessel planholders, with established dispersant capability and carrying certain oil cargoes are authorized to apply for a credit against their mechanical equipment requirements if:

- The tank vessel operates in an area with year-round pre-authorization agreement for chemical dispersion; and
- The planholder ensures availability of dispersant and dispersant delivery resources by contract or other approved means.

This credit provision allows planholders to reduce mechanical recovery equipment by up to 25 percent.

2.6.2. Alternative 2—Increase On-Water Mechanical Recovery Capability and Establish and Maintain Aerial Tracking Capability

Under this alternative, the USCG would change the current regulations to increase the amount of mechanical recovery equipment that planholders would be required to have available to respond to an oil discharge. Planholders would also be required to establish and maintain aerial tracking capabilities. The current credit for dispersant capability would be removed. No other change to the current regulations would be mandated, so no dispersant or *in situ* burn capabilities would be required. Chemical dispersion and *in situ* burning would continue to be approved for use infrequently in areas where pre-authorization agreements are in place. Chemical dispersion would continue to be approved for use almost exclusively in the Gulf of Mexico and Alaska regions (Table 2.6-2). In addition, as is the current and historical practice, the local response community would determine the actual use of the response capabilities; thus, this alternative would only require the availability of the response capabilities but would not mandate the actual use of any particular capability in response operations.

Implementation of Alternative 2 would result in a 25 percent increase in the amount of mechanical recovery equipment an individual planholder would be required to have available under contract. Realistically, many planholders share the same equipment, and there are stockpiles of equipment well in excess of the current mechanical recovery equipment capability requirements. It was also estimated that a 25 percent increase in mechanical recovery equipment will not result in an increase in recovery efficiency, meaning no additional barrels of oil would be removed from the water (USCG, 2008). Proposed maximum mechanical recovery equipment requirements (USCG, 2008)—the equipment a planholder would be required to have under contract—are listed in Table 2.6-3.

2.6.3. Alternative 3—Increase On-Water Mechanical Recovery Capability, Establish On-Water Dispersant Application Capability (Option A), Establish *In Situ* Burn Credit, and Establish and Maintain Aerial Tracking Capability

Under this alternative, the USCG would change the current regulations to increase the amount of mechanical recovery equipment as required in Alternative 2 and to establish dispersant application capability that tank vessel planholders would be required to have available to respond to an oil discharge. Option A would require planholders to have a dispersant application capability as shown in Table 2-5.1. The planholders would also have the opportunity to apply for an *in situ* burn credit. The dispersant credit in the current regulations would be eliminated. Planholders would also be required to establish and maintain aerial tracking capability. As is the current and historical practice, the local response community would determine the actual use of the response capabilities; thus, this alternative would only require the availability of the response capabilities but would not mandate the actual use of any particular capability in response operations.

The USCG would also amend the current regulations to require the tank vessel planholders to maintain dispersant equipment (Option A) to respond to an oil discharge. This requirement would apply only to owners/operators of tank vessels operating more than 3 nm from shore where chemical dispersion has been pre-authorized[10] in accordance with the NCP. Most MTR facilities would not be required to meet this requirement since they are assumed to be outside areas where pre-authorization agreements are in place. Currently, there is adequate dispersant capability (i.e., dispersant supply and delivery vehicles) in the United States, although only a very limited number of tank vessels and facilities actually have that capability under contract at this time. According to the *Response Plan Equipment Caps Review* (USCG, 1999), current dispersant stockpiles are adequate to meet the levels anticipated in this PEIS. There are numerous aircraft and vessels available that could serve as adequate dispersant platforms. There are also suitable airport and vessel facilities available throughout the coastal United States to allow the establishment and maintenance of effective dispersant capabilities. The proposed regulations would require the uniform availability of dispersant capability in all regions. For the purpose of this PEIS, it is assumed that requiring the regions to have the capability would make them more inclined to consider using these technologies. This would eventually result in the actual use of those response technologies in all regions.

If Alternative 3 were implemented, it is likely that planholders would have to arrange for contracts to share several dispersant stockpiles on the East, West, and Gulf Coasts of the United States, and possibly in Alaska and Hawaii (USCG, 1999). In addition, these operators would have to contract for a number of dedicated small- and medium-sized aircraft (fixed-wing or rotary), stationed at airports around the country and outfitted to transport and apply thousands of gallons of dispersants up to 50 nm offshore (Table 2.6-1). Cost-benefit estimates are described in the *Response Plan Equipment Caps Review* (USCG, 1999) and *Regulatory Analysis for Changes to Vessel and Facility Response Plans* (USCG, 2008).

In addition to the proposal for dispersant capability, this alternative would also amend the current regulations to provide the tank vessel planholders with an opportunity to maintain *in situ* burn equipment to respond to an oil discharge through an *in situ* burn credit (Table 2.6-4). Specifically, if a planholder opted to establish and maintain an *in situ* burn capability, the planholder would receive credit against their mechanical equipment and would be able to reduce their mechanical recovery capability by an equal amount up to the limit specified in Table 2.6-4. This is based on the assumption, discussed above, that the primary limiter is

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[10] With the exception of several areas that have pre-authorization agreements at different distances from shore, including Maine (>0.5 nm), Massachusetts (>2 nm), Puerto Rico (>0.5 nm and >60 ft depth), the U.S. Virgin Islands (>1 nm from shore or reef, if reef < 20ft from surface and >60 ft depth), and Hawaii (>60 ft depth), as well as areas such as Washington, Oregon, Connecticut, and large portions of Alaska, which have case-by-case pre-authorization agreements (*http://www.uscg.mil/vrp/maps/dispmap.shtml*, last updated August 19, 2004).

the same for both *in situ* burning and mechanical recovery—the ability to contain the oil. Therefore, as noted in Alternative 2, the increase in mechanical recovery equipment and/or the addition of credit for *in situ* burn equipment will not increase the amount of oil treated.

Table 2.6-4
Maximum Anticipated *In Situ* Burn Equipment Required under the Proposed Regulations

				Cumulative Equipment Requirements				
Tier	**Response Time for Completed Burning (hr)***	**Estimated Daily Burn Capacity (EDBC) (bbl)†**	**Fireproof Boom (ft)**	**Fire-Resistant Boom (ft)‡**	**Hand/Torch Igniter (no.)**	**OR**	**Heliheld Igniter (no.)§**	**Support Vessel (no.)**
1	24	5,000	500	500	4	OR	1	2
2	48	10,000	1,000	1,500	12		1	2
3	72	10,000	1,000	2,500	20		1	4
Total			**2,500**	**4,500**	**36**		**3**	**8**

Source: Adapted from FR 67, No. 198, October 11, 2002.

* Tiered response times represent the maximum allowable time from the instant that *in situ* burning is authorized by the Federal On-Scene Coordinator (FOSC) to the completion of the operational burning period for that tier.

† EDBC amounts for Tiers 2 and 3 may be applied against the corresponding tiers for on-water mechanical recovery (EDRC) as required to respond to an owner or operator's worst case discharge (WCD).

‡ Assumes fireproof boom is reusable in all tiers. The fire will consume fire-resistant boom; therefore, it will require a replacement at the start of each new operational period.

§ If a heliotorch igniter system is identified and ensured available, on-time igniters are not required. Alternatives may be considered based on submission to the USCG of peer-reviewed scientific evidence of improved capability.

When using *in situ* burn boom, additional deployment of vessels or auxiliary equipment would be required for the implementation of Alternative 3. In addition, in the event that equipment is acquired, costs would be offset to a certain extent by reductions in the amount of mechanical recovery equipment a planholder would need to have available. Cost-benefit estimates are described in detail in the *Response Plan Equipment Caps Review* (USCG, 1999) and *Regulatory Analysis for Changes to Vessel and Facility Response Plans* (USCG, 2008).

2.6.4. Alternative 4—Increase On-Water Mechanical Recovery Capability, Establish On-Water Dispersant Application Capability (Option B), Establish *In Situ* Burn Credit, and Establish and Maintain Aerial Tracking Capability

Under this alternative, the USCG would amend the current regulations to require planholders to increase mechanical recovery capability to the levels required under Alternative 2 or 3 and establish dispersant application capability equipment to respond to an oil discharge. Option B would require planholders to have a dispersant application capability as shown in Table 2-5.1. The planholders would also have the opportunity to apply for an *in situ* burn credit. The dispersant credit in the current regulations would be eliminated. Planholders would also be required to establish and maintain aerial tracking capability. The USCG would also amend the current regulations to require the planholders to maintain dispersant equipment (Option B) to respond to an oil discharge. This requirement would apply only to owners/operators of tank vessels operating more than 3 nm from shore where chemical dispersion has been pre-authorized[11] in accordance with the NCP.

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[11] With the exception of several areas that have pre-authorization agreements at different distances from shore, including Maine (>0.5 nm), Massachusetts (>2 nm), Puerto Rico (>0.5 nm and >60 ft depth), the U.S. Virgin Islands (>1 nm from shore or reef, if

In addition, this alternative would also amend the current regulations to provide the planholders with an opportunity to maintain *in situ* burn equipment to respond to an oil discharge through an *in situ* burn credit (Table 2.6-4). Specifically, if a planholder opted to establish and maintain an *in situ* burn capability, the planholder would receive credit against their mechanical equipment and would be able to reduce their mechanical recovery capability by an equal amount up to the limit specified in Table 2.6-4. This is based on the assumption, discussed above, that the primary limiter is the same for both *in situ* burning and mechanical recovery—the ability to contain the oil. Therefore, as noted in Alternative 1, the increase in mechanical recovery equipment and/or the addition of credit for *in situ* burn equipment will not increase the amount of oil treated.

As is the current and historical practice, the local response community would determine the actual use of the response capabilities; thus, this alternative would only require the availability of the response capabilities but would not mandate the actual use of any particular capability in response operations. These requirements would apply only to the sections of the regulated community operating in areas where dispersants and *in situ* burning has been pre-authorized in accordance with the NCP, so it would apply only to owners/operators of tank vessels operating more than 3 nm from shore. Most MTR facilities would not be required to meet these requirements except for mechanical recovery, since they are assumed to be outside areas where pre-authorization agreements are in place.

When using *in situ* burn boom, additional deployment of vessels or auxiliary equipment would be required for the implementation of Alternative 4. In addition, in the event that equipment is acquired, costs would be offset to a certain extent by reductions in the amount of mechanical recovery equipment a planholder would need to have available. Cost-benefit estimates are described in detail in the *Response Plan Equipment Caps Review* (USCG, 1999) and *Regulatory Analysis for Changes to Vessel and Facility Response Plans* (USCG, 2008).

2.6.5. Alternative 5—Maintain Mechanical Recovery Capability, Establish On-Water Dispersant Application Capability (Option B), Establish *In Situ* Burn Credit, and Establish and Maintain Aerial Tracking Capability

Under this alternative, the USCG would amend the current regulations to require planholders to maintain mechanical recovery capability and establish dispersant application capability (Option B). Option B would require planholders to have a dispersant application capability as shown in Table 2.6-1. The planholders would also have the opportunity to apply for an *in situ* burn credit. The dispersant credit in the current regulations would be eliminated. Planholders would be required to establish and maintain aerial tracking capability. The USCG would also amend the current regulations to require the planholder to maintain dispersant equipment (Option B) to respond to an oil discharge. This requirement would apply only to owners/operators of tank vessels operating more than 3 nm from shore where chemical dispersion has been pre-authorized[12] in accordance with the NCP.

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reef < 20ft from surface and >60 ft depth), and Hawaii (>60 ft depth), as well as areas such as Washington, Oregon, Connecticut, and large portions of Alaska, which have case-by-case pre-authorization agreements (*http://www.uscg.mil/vrp/maps/dispmap.shtml*, last updated August 19, 2004).

[12] With the exception of several areas that have pre-authorization agreements at different distances from shore, including Maine (>0.5 nm), Massachusetts (>2 nm), Puerto Rico (>0.5 nm and >60 ft depth), the U.S. Virgin Islands (>1 nm from shore or reef, if reef < 20ft from surface and >60 ft depth), and Hawaii (>60 ft depth), as well as areas such as Washington, Oregon, Connecticut, and large portions of Alaska, which have case-by-case pre-authorization agreements (*http://www.uscg.mil/vrp/maps/dispmap.shtml*, last updated August 19, 2004).

In addition, this alternative would also amend the current regulations to provide the planholder with an opportunity to maintain *in situ* burn equipment to respond to an oil discharge through an *in situ* burn credit (Table 2.6-4). Specifically, if a planholder opted to establish and maintain an *in situ* burn capability, the planholder would receive credit against their mechanical equipment and would be able to reduce their mechanical recovery capability by an equal amount up to the limit specified in Table 2.6-4. This is based on the assumption, discussed above, that the primary limiter is the same for both *in situ* burning and mechanical recovery—the ability to contain the oil. Therefore, as noted in Alternative 1, the increase in mechanical recovery equipment and/or the addition of credit for *in situ* burn equipment will not increase the amount of oil treated.

As is the current and historical practice, the local response community would determine the actual use of the response capabilities; thus, this alternative would only require the availability of the response capabilities but would not mandate the actual use of any particular capability in response operations. The actual use of the response mechanisms would continue to be at the discretion of the FOSC in accordance with the controlling guidance contained within the RCP and ACP. These requirements would apply only to the sections of the regulated community operating in areas where dispersants and *in situ* burning has been pre-authorized in accordance with the NCP, so it would apply only to owners/operators of tank vessels operating more than 3 nm from shore. Most MTR facilities would not be required to meet these requirements except mechanical recovery, since these facilities are assumed to be outside areas where pre-authorization agreements are in place.

When using *in situ* burn boom, additional deployment of vessels or auxiliary equipment would be required for the implementation of Alternative 5. In addition, in the event that equipment is acquired, costs would be offset to a certain extent by reductions in the amount of mechanical recovery equipment a planholder would need to have available. Cost-benefit estimates are described in detail in the *Response Plan Equipment Caps Review* (USCG, 1999) and *Regulatory Analysis for Changes to Vessel and Facility Response Plans* (USCG, 2008).

2.6.6. Alternative 6—Maintain Mechanical Recovery Capability, Establish On-Water Dispersant Application Capability (Option B), and Establish and Maintain Aerial Tracking Capability [Preferred Alternative]

Under this preferred alternative, the USCG would amend the current regulations to require planholders to maintain mechanical recovery capability and establish dispersant application capability (Option B). Option B would require planholders to have a dispersant application capability as shown in Table 2.6-1. The dispersant credit in the current regulations would be eliminated. Planholders would be required to establish and maintain aerial tracking capability. The USCG would also amend the current regulations to require the planholder to maintain dispersant equipment (Option B) to respond to an oil discharge. This requirement would apply only to owners/operators of tank vessels operating more than 3 nm from shore where chemical dispersion has been pre-authorized[13] in accordance with the NCP. As is the

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[13] With the exception of several areas that have pre-authorization agreements at different distances from shore, including Maine (>0.5 nm), Massachusetts (>2 nm), Puerto Rico (>0.5 nm and >60 ft depth), the U.S. Virgin Islands (>1 nm from shore or reef, if reef < 20ft from surface and >60 ft depth), and Hawaii (>60 ft depth), as well as areas such as Washington, Oregon, Connecticut, and large portions of Alaska, which have case-by-case pre-authorization agreements (*http://www.uscg.mil/vrp/maps/dispmap.shtml*, last updated August 19, 2004).

current and historical practice, the local response community would determine the actual use of the response capabilities; thus, this alternative would only require the availability of the response capabilities but would not mandate the actual use of any particular capability in response operations. The actual use of the response mechanisms would continue to be at the discretion of the FOSC in accordance with the controlling guidance contained within the RCP and ACP. These requirements would apply only to the sections of the regulated community operating in areas where dispersants have been pre-authorized in accordance with the NCP, so it would apply only to owners/operators of tank vessels operating more than 3 nm from shore. Most MTR facilities would not be required to meet these requirements except mechanical recovery, since these facilities are assumed to be outside areas where pre-authorization agreements are in place.

This is the USCG's preferred alternative because it increases the available oil spill capability requirements for tank vessels and MTR facilities, which is the USCG's purpose and intent for these proposed regulations. In addition to increasing the response plan equipment capability requirements for tank vessels and MTR facilities this alternative also meets the objectives of the USCG to protect the marine environment and promote maritime safety at reasonable cost and with substantial benefit. This alternative includes the largest dispersant equipment stockpile and no change in mechanical recovery requirements. As pointed out in the discussion of previous alternatives, making changes to mechanical recovery equipment would not result in increased spilled oil recovery. However, the larger quantity of dispersants would allow for treatment of a larger quantity of oil, should such treatment be determined to be appropriate. The *Regulatory Analysis for Changes to Vessel and Facility Response Plans* (USCG, 2008) found that national benefit is driven by the effectiveness of dispersant application and aerial tracking. Alternatives 4, 5, and 6 are the most beneficial because they include the largest requirements for dispersant application capability. There is essentially no benefit from increasing response requirements for mechanical recovery. The regulatory analysis (USCG, 2008) determined that the cost of Alternative 6 is $91.32 million.

2.6.7. Summary of the Effectiveness of the Alternatives Considered in This PEIS

The following is a summary of the effectiveness of the alternatives:

- Alternative 1 is the baseline or current state and produces no change.
- Alternative 2 would not result in increased efficiency or produce an increase in oil treated compared with Alternative 1. This alternative only increases mechanical recovery equipment. As Section 2.6.2 concludes, adding more mechanical recovery equipment will not increase the amount of oil treated as the additional equipment would not increase the number of opportunities to actually use that equipment. This alternative also includes aerial tracking capability.
- Alternative 3 would produce an increase in oil treated compared with Alternatives 1 and 2 because this alternative adds dispersant equipment requirements. This alternative allows a reduction in mechanical recovery equipment based on the addition of *in situ* burn equipment. Because *in situ* burning is at best as effective as mechanical recovery, adding *in situ* burn equipment to or substituting *in situ* burn equipment for mechanical recovery equipment will not increase the amount of oil treated. This is based on the assumption that the primary limiter is the same for both mechanical recovery and *in situ* burning—the ability to contain the oil. The addition of dispersant

capability, however, results in treating a larger quantity of oil. This alternative also includes aerial tracking capability.

- Alternative 4 would produce an increase in oil treated compared with Alternative 3 because Alternative 3 dispersant Option A (Table ES.5-1) requires slightly less delivery capacity under Tier 1 (0–12 hours) than Alternative 4 dispersant Option B. For the purpose of this analysis, however, the USCG estimated the amount of oil that could be treated during response operations based only on Option B (Appendix D). This was done to simplify the analysis and ensure that the highest potential levels of exposure to dispersants and dispersed oil in the water column were considered. The increase in mechanical recovery equipment will not increase the amount of oil treated because as noted in Section 2.6.2, adding more mechanical recovery equipment would not increase the number of opportunities to actually use that equipment. This alternative allows a reduction in mechanical recovery equipment based on the addition of *in situ* burn equipment, which, as discussed above, is considered at best equivalent in effectiveness to mechanical recovery and will not increase the amount of oil treated. This alternative also includes aerial tracking capability.
- Alternative 5 would produce the same increase in oil treated as Alternative 4 because it requires the same quantity of dispersant application equipment. For Alternatives 4 and 5 dispersant Option B (Table ES.5-1) requires slightly greater delivery capacity under Tier 1 (0–12 hours) than Alternative 3 dispersant Option A. For the purpose of this analysis, however, the USCG estimated the amount of oil that could be treated during response operations based only on Option B (Appendix D). Thus, for the purpose of this analysis, the changes resulting from Alterative 5 are identical to those reported for Alternative 4. Since the increase in mechanical recovery equipment or the credit for *in situ* burn equipment will not increase the quantity of oil treated, requiring those capabilities does not add any value to offset the costs incurred in establishing and maintaining them.

- Alternative 6 would produce the same increase in oil treated as Alternative 5 because it requires the same quantity of dispersant application equipment. For Alternatives 4 through 6, dispersant Option B (Table ES.5-1) requires slightly greater delivery capacity under Tier 1 (0–12 hours) than Alternative 3 dispersant Option A. For the purpose of this analysis, however, the USCG estimated the amount of oil that could be treated during response operations based only on Option B (Appendix D). Thus, for the purpose of this analysis, the changes resulting from Alterative 6 are identical to those reported for Alternative 5. Since the increase in mechanical recovery equipment will not increase the quantity of oil treated, requiring those capabilities does not add any value to offset the costs incurred in establishing and maintaining them

Under all alternatives except Alternative 1, planholders would be required to have aerial tracking capability available by contract or other approved means. Aerial oil spill tracking is routinely used in oil spill incidents and has proven to be very effective in directing on-water response activities; thus, it will not be considered separately but will be analyzed as an integral part of Alternatives 2 through 6.

2.7. ALTERNATIVES CONSIDERED BUT ELIMINATED

The USCG and local Area Committee investigations concluded that, based on current technology and scientific knowledge, herding agents, emulsion-treating agents, solidifiers, elasticity modifiers, oxidation agents, bioremediation agents, and shoreline-cleaning agents are not considered effective in treating oil with the goal of preventing oil from reaching and affecting sensitive marine resources in the event of an oil spill. Some of these strategies were not considered because they are ineffective in treating large quantities of oil in the water, while others—solidifiers and shoreline-cleaning agents—were not considered because they can only be used once the oil has reached the shore, thus conflicting with the NCP's goal of protecting marine-sensitive resources by preventing oil from reaching these resources in the first place. In addition, the chemical and biological substances associated with these strategies are subject to 33 CFR part 400, subpart J, so emergency on-water use would require a pre-authorization agreement or incident-specific approval. The current absence of pre-authorization agreements reflects the lack of consensus on parameters for emergency use at the regional and local levels. Therefore, approval for incident-specific use is complicated and unlikely, rendering consideration of a requirement for industry to stockpile these materials, and their associated application equipment, inappropriate. Thus, the USCG does not intend to require planholders to stockpile any of the materials necessary to conduct response operations using these chemical and biological strategies in advance of a spill.

Therefore, herding agents, emulsion-treating agents, solidifiers, elasticity modifiers, oxidation agents, bioremediation agents, and shoreline-cleaning agents are removed from further analysis as alternatives and will not be considered in this PEIS. However, the USCG will continue to encourage the NRT, RRTs, Area Committees, and planholders to continue to assess potential use of all response options to decide on the best response strategy in an oil spill event.

The NOI of September 1, 2000, solicited public and agency input into the development of the scope of the PEIS, and advised the public that outreach activities conducted by program participants would be considered in the preparation of the PEIS. After the release of the NOI, several comments were received through the U.S. Department of Transportation's (DOT's) electronic document management system and via faxes. These comments suggested that the USCG consider two additional alternatives: one that would require equipment and personnel to arrive on the scene more quickly than is currently required, and another that would require the USCG to offer incentives for preventive actions.

The USCG examined the issue of quicker response times. The current regulations require that initial response resources for an average most probable spill (approximately 50 bbl) be on the scene, ready to deploy within 1 hour of receiving the notification of a discharge. Similar response times are established for bringing in larger quantities of equipment over time. The most likely strategy to reduce these response times would be to require the equipment to be available on board every regulated tank vessel. The USCG investigated this in 1998 in a report on response equipment on tank vessels (USCG, 1998). The research concluded that while it may be technologically feasible to carry and to deploy oil spill response equipment aboard a tank vessel, the practical limitations of such equipment would make it economically, environmentally, and technologically unfeasible to require tank vessels to carry the equipment. Thus, the USCG concluded that tank vessel-carried equipment should not be required onboard tank vessels. The USCG also analyzed the issue of providing credit to a responsible party who responds more quickly than mandated by regulatory standards. The USCG rejected the concept of incentives for faster response because the response times in the current regulations are established as the maximum response time at the mandated tier, and not as a suggested response time. Thus, the USCG expects that in most cases, response will be quicker than established by the current regulations.

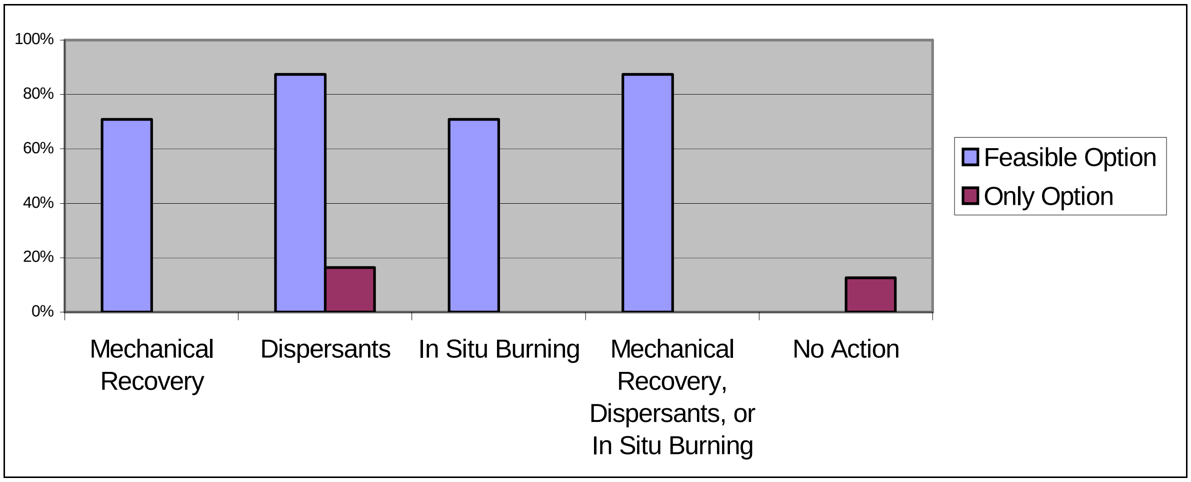
The USCG also considered the issue of incentives for preventive actions. This suggestion was previously considered in the VRP rulemaking process, in which the USCG stated its goal to prepare for response to oil spills to mitigate the environmental effects of oil pollution. Mitigation of oil pollution falls under the prevention category, so all spill response efforts are by nature preventive actions. Further, the USCG position remains that while preventive measures such as double hulls, double bottoms, protective cargo, and ballast pumping could reduce the likelihood of an oil spill, they do not eliminate the possibility of a release, nor do they reduce the total quantity that would be released in the event of a discharge. In addition, a worst case discharge (WCD) is defined as the loss of all oil cargo on a vessel regardless of preventive measures in place, and the response equipment requirements are based on that scenario, independent of reductions in the probability of occurrence. Therefore, incentives in the form of reductions in response standards because of enhanced prevention efforts would not be justified.

2.8. POTENTIAL USE OF RESPONSE OPTIONS IN THE ALTERNATIVES BASED ON HISTORICAL SPILL DATA

The USCG analyzed a period of historical oil spill data to provide a snapshot of information regarding the potential use of the proposed alternatives for future oil spill incidents (USCG, 1999). Since the analysis is based on historical data, the conclusions presented here are only illustrative of potential future spill and response scenarios, and are not derived from any rigorous statistical analysis. The historical USCG spill data set contains information on 231 oil spills that occurred between 1993 and 1998 in U.S. marine waters and were of at least 1,000 gal in size (see Table A-1 in the *Response Plan Equipment Caps Review* [USCG, 1999] for details of these 231 spills). Of these, 79 spills occurred in marine waters at a distance of more than 3 nm from shore (see Appendix E, Table E.1-1 for details of these 79 spills). Only spills larger than 1,000 gal are considered since weathering factors make it unlikely that response actions would be feasible for smaller spills in an open-water marine environment. It was initially planned to consider only spills larger than 1,000 bbl (42,000 gal), since response action using the proposed strategies would be more feasible at this scale. However, there were less than 10 spills in the historical USCG spill data set of that magnitude in U.S. marine waters between 1993 and 1998, providing too small a sample set for analysis.

The specific characteristics of the type of oil spilled and the environmental conditions are critical factors in determining the potential frequency of use for each response alternative. Some of the most important factors that determine the effectiveness of oil spill response strategies include oil density, wind speed, water depth, and distance from shore. These characteristics were established for the historical USCG spill data set to determine the potential effectiveness of oil spill response strategies for similar future spills. In particular, the percentage of historical events where the proposed alternatives would have been potentially useful or the only viable response alternative was determined for the 79 spills occurring more than 3 nm from shore. Only the spills occurring more than 3 nm from shore were considered. Thus, assuming that the historical USCG spill data set is indicative of future spill characteristics (oil type and environmental conditions), Figure 2.8-1 provides information on potential future applications of each oil spill response option.

Figure 2.8-1
Potential Future Applications of Each Oil Spill Response Option
for Oil Spills ≥ 1,000 gal and ≥ 3 nm from Shore



Source: USCG, 2008.

The examination of the historical oil spill data focused on individual spill response options. However, each alternative consists of one or more of these spill response options (see Section 2.6). Alternative 1 is potentially useful in response to 71 percent of all spills occurring beyond 3 nm from shore (Appendix E, Table E.2-1 and Figure 2.8-1), while it would be ineffective in 29 percent of these spills. The *Regulatory Analysis for Changes to Vessel and Facility Response Plans* (USCG, 2008) determined that increased mechanical recovery would not result in increased recovery of oil compared to capabilities mandated in 2000 therefore Alternative 2 would have the same effectiveness as Alternative 1 (71 percent of all spills occurring beyond 3 nm from shore). Dispersants are the only viable alternative for 16 percent of the spills occurring beyond 3 nm offshore (Appendix E, Table E.3-1). Thus, Alternative 3 would increase the effective response capability to 87 percent of all spills, leaving only 13 percent of all spills in the offshore environment for which there is no effective on-water response. Since only mechanical recovery and chemical dispersion offer unique opportunities to treat spilled oil and since there are no spills where *in situ* burning is feasible when mechanical recovery is not, Alternatives 4 and 5 has the same effectiveness as Alternative 3 (87 percent of all spills occurring beyond 3 nm). Overall, the no removal action is the only spill response option for approximately 13 percent of spills beyond 3 nm from shore (Appendix E, Table E.5-1).

2.8.1. Alternative 1—No Action (No Change to Response Plan Regulations)

Alternative 1 would rely on mechanical recovery only. As noted above, mechanical recovery is potentially suitable in 71 percent of all spills of 1,000 gal or greater occurring beyond 3 nm from shore. From 1993 to 1998, there were 79 such spills, so mechanical recovery might have been useful in 56 spill responses around the country, an average of 9.3 oil spill responses per year.

2.8.2. Alternative 2—Increase On-Water Mechanical Recovery Capability and Establish and Maintain Aerial Tracking Capability

As noted in Section 2.6.2, adding more mechanical recovery equipment would not increase the number of opportunities to potentially use that equipment. The *Regulatory*

Analysis for Changes to Vessel and Facility Response Plans (Table 5-1 in USCG, 2008, and Appendix D in this PEIS) also concluded that adding additional mechanical equipment to an individual spill would not result in a measurable increase in the quantity of oil recovered in the incident. Therefore, Alternative 2 would not result in any changes relative to Alternative 1.

2.8.3. Alternative 3—Increase On-Water Mechanical Recovery Capability, Establish On-Water Dispersant Application Capability (Option A), Establish *In Situ* Burn Credit, and Establish and Maintain Aerial Tracking Capability

The *Regulatory Analysis for Changes to Vessel and Facility Response Plans* (USCG, 2008) estimated that a spill size of 40 bbl (1,680 gal) is the lower threshold at which dispersant operations might be considered practicable. Based on that estimate and data in the *Response Plan Equipment Caps Review* (USCG, 1999), from 1993 to 1998 there were a total of 52 oil spill responses around the country (Appendix E, Table E.3-2) where dispersants might have been useful in response, for an average of 8.7 oil spill responses per year.

Of the 52 spills, 32 spills occurred in the Gulf of Mexico or Alaska regions. As indicated in the *Response Plan Equipment Caps Review* (USCG, 1999), dispersant capability is already maintained in these regions at levels similar to those anticipated in the proposed regulations. Therefore, no increase in chemical dispersion is anticipated in these regions as a result of this action, and there will be no increase in dispersant operations or aircraft emissions in these regions over and above Alternative 1. Impacts from chemical dispersion in these regions are estimated as part of Alternative 1.

Under Alternative 3, the key change would be to ensure the uniform availability of dispersant capability in the four regions—Atlantic, Caribbean, Pacific, and Oceania—where appropriate response times cannot currently be met. Alternative 3 requires dispersant Option A (Table 2.6-1), which requires slightly less delivery capacity under Tier 1 (0–12 hours) than Option B. For the purpose of this analysis, however, the USCG estimated how much oil could be treated during response operations based only on Option B (Appendix D). This was done to simplify the analysis and to ensure that exposure to dispersants and dispersed oil in the water column was considered at the highest potential levels.

For Alternatives 3, 4, and 5, there are 20 potentially dispersible spills occurring outside the Gulf of Mexico and Alaska regions, for an average of 3.3 spills per year. The largest of these spills was 25,200 gal, with the average spill size being 6,723 gal.

As noted in Section 2.6.2, adding more mechanical recovery equipment would not increase the number of opportunities to potentially use that equipment. The *Regulatory Analysis for Changes to Vessel and Facility Response Plans* (Table 5-1 in USCG, 2008, and Appendix D in this PEIS) also concluded that adding additional mechanical equipment to an individual spill would not result in a measurable increase in the quantity of oil recovered in the incident.

The *Regulatory Analysis for Changes to Vessel and Facility Response Plans* (USCG, 2008) estimated that a spill size of 563 bbl (23,646 gal) is the lower threshold at which *in situ* burn operations might be considered practicable. Based on that estimate and data in the *Response Plan Equipment Caps Review* (USCG, 1999), from 1993 to 1998 there were a total of four oil spill responses around the country (Appendix E, Table E.4-1) where *in situ* burning capability might have been useful in response, for an average of 0.7 oil spill responses per year.

There are no spills where *in situ* burning is feasible when mechanical recovery is not, as they are applied to the same spill subset. Thus, rather than requiring *in situ* burn equipment to be added, credit (reduction in required mechanical recovery equipment under contract) is offered to planholders operating in areas where *in situ* burning is pre-authorized.

2.8.4. Alternative 4—Increase On-Water Mechanical Recovery Capability, Establish On-Water Dispersant Application Capability (Option B), Establish *In Situ* Burn Credit, and Establish and Maintain Aerial Tracking Capability

Based on the previous sections, only the establishment of on-water dispersant application capability as discussed under Alternative 3 would result in any change to historical use patterns. Thus, the changes resulting from Alterative 4 are identical to those reported for Alternative 3 in Section 2.8.3.

Adding more mechanical recovery equipment, as noted in Section 2.6.2, would not increase the number of opportunities to potentially use that equipment. Despite the addition of *in situ* burn capabilities, there would not be any spills where *in situ* burning is feasible when mechanical recovery is not, as both are applied to the same spill subset. An option to maintain an *in situ* burn credit for planholders operating in areas where *in situ* burning is pre-authorized may result in a reduction in required mechanical recovery equipment under contract; however, the ability to respond to a spill would remain unchanged.

2.8.5. Alternative 5—No Increase in Mechanical Recovery Capability, Establish On-Water Dispersant Application Capability (Option B), Establish *In Situ* Burn Credit, and Establish and Maintain Aerial Tracking Capability

Based on the previous sections, only the establishment of on-water dispersant application capability as discussed under Alternative 3 would result in any change to historical use patterns. Thus, the changes resulting from Alterative 5 are identical to those reported for Alternative 3 in Section 2.8.3.

A spill response situation could arise—for example, in rotten Arctic ice or in certain wetland situations—where, because of physical problems or safety concerns, mechanical recovery might not be possible, but *in situ* burning would be feasible. The option to maintain an *in situ* burn credit for planholders operating in areas where *in situ* burning is pre-authorized may result in a reduction in required mechanical recovery equipment under contract; however, the ability to respond to a spill would remain unchanged.

2.8.6. Alternative 6—No Increase in Mechanical Recovery Capability, Establish On-Water Dispersant Application Capability (Option B), and Establish and Maintain Aerial Tracking Capability [Preferred Alternative]

Based on the previous sections, only the establishment of on-water dispersant application capability as discussed under Alternative 3 would result in any change to historical use patterns. Thus, the changes resulting from Alterative 6 are identical to those reported for Alternative 3 in Section 2.8.3

2.9. MITIGATION

The main goals of response effort are (1) ensuring public and responder safety, (2) securing the spill source, and (3) mitigating actual and potential adverse impacts. Final determination of which response strategy—or combination of alternatives—to use in an oil spill response is made jointly by the FOSC and State On-Scene Coordinators working in cooperation with the responsible party in the UC managing the response effort. This process in itself serves as a mitigation strategy since response actions and decisions are the result of the interaction among response experts, environmental professionals, and natural resource trustees, focusing on mitigating the adverse environmental impact of a specific spill. In addition, as previously described, in most cases chemical dispersion, *in situ* burning, or other chemical countermeasures are specifically prohibited without the incident-specific approval of USEPA and the affected state resource agencies, in consultation with the natural resource trustees. This incident-specific approval requirement process (40 CFR 300.910) is intended as a mechanism to mitigate any potential or actual adverse impacts of the oil spill and the response measure for which approval is being sought.

The NCP recognizes, however, that as with any emergency response activity, advanced planning has the potential to significantly enhance the effectiveness of response actions and thus mitigate potential unintended damages. In doing so, the NCP makes the response community responsible for planning for potential chemical dispersion, *in situ* burning, and other chemical countermeasures in advance of a spill incident. In addition, it charges the response community with pre-planning for the potential use of those alternative response strategies if the natural resource trustees in that community determine that such a pre-authorization agreement could enhance protection of public health and welfare, and the environment (59 FR 178, September 1994). Thus, a pre-authorization agreement represents an endorsement by the technical experts of the local natural resource trustees for the potential use of the pre-authorized strategy in minimizing environmental damage when used in accordance with the procedures of a pre-authorization agreement. On the other hand, absence of a pre-authorization agreement represents evidence that the natural resource trustees have not determined general circumstances in which a particular response alternative is expected to provide significant environmental benefit, as related to endangered species and other environmental concerns.

In addition, the SMART protocol, which was developed by the USCG, USEPA, NOAA, and CDC as members of the NRT, describes a specific methodology for conducting both dispersant and *in situ* burn monitoring activities. These activities are intended to monitor the ongoing effectiveness of individual response strategies in mitigating spill impacts in a specific event. Monitoring the effectiveness of the response alternative could mitigate potential environmental impacts since it allows the response team to evaluate the effectiveness of the response efforts and assess the viability and potential effect of its continued use. This is particularly important for those cases in which response efforts do not produce projected results, and monitoring allows the response team to redirect response efforts accordingly.

Finally, in accordance with the provisions of 40 CFR part 300, the NCP has allowed most regions in the United States to pre-authorize chemical dispersion and *in situ* burning under certain circumstances. As previously mentioned, these pre-authorization agreements are generally restricted to oil spills occurring more than 3 nm from shore and require the dispersant to be listed on the NCP Product Schedule. In addition, all pre-authorization agreements in place within the United States require the use of SMART or similar monitoring protocols to assess the effectiveness of the response alternative in a specific incident (USCG, 1999). In the few regions of the United States where pre-authorization agreements are not in place, the local response officials generally do not actually use dispersants and *in situ* burning, since consensus approval by the response community usually cannot be achieved in a timely fashion to allow for effective use. See Appendix A for more information.

2.10. ENVIRONMENTAL LEGAL FRAMEWORK APPLICABLE TO OIL SPILL RESPONSE OPERATIONS

Oil spill response operations are subject to environmental protection requirements of federal legislation, Presidential Executive Orders, and international treaties that the United States has signed and ratified. Table 2.10-1 briefly summarizes the major international and federal environmental laws and executive orders that the U.S. Coast Guard (USCG) must comply with or implement during oil spill response.

2.11. ENDANGERED SPECIES ACT SECTION 7 CONSULTATION

As required under Section 7 of the Endangered Species Act of 1973 (ESA), the USCG contacted the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) in letters dated April 18, 2002, to determine that the promulgation of the proposed regulations would not affect listed species or designated critical habitat. The letters refer to the 2001 *Inter-Agency Memorandum of Agreement Regarding Oil Spill Planning and Response Activities under the Federal Water Pollution Control Act's National Oil and Hazardous Substances Pollution Contingency Plan and the Endangered Species Act (MOA)*, which was signed by the USCG, USFWS, U.S. Department of the Interior (DOI), NOAA (National Marine Fisheries Service and National Ocean Service), and USEPA, and determines how the agencies intend to work together to fulfill their obligations under the ESA and the NCP.

The MOA is intended to be used at the Area Committee level primarily to identify and incorporate plans and procedures to protect listed species and designated critical habitat during spill planning and response activities. The MOA identifies the roles and responsibilities of each agency during pre-spill planning, spill response, and post-spill response. The potential effects of oil spill response options on listed species and critical habitat will be identified and response plans and countermeasures (response strategies) to minimize or avoid adverse effects will be jointly developed. In the event that oil spill response actions result in effects on listed species or critical habitat, the MOA provides guidance on how to conduct emergency consultation under the ESA. In addition, the MOA encourages the planning committees to pursue informal consultation whenever possible during the planning and response stages.

In a letter dated August 12, 2002, the USFWS concurred that promulgation of the proposed regulations would not affect listed species or designated critical habitat and that any effects to listed species would be evaluated as outlined in the implementing procedures incorporated in the MOA. Likewise, in a letter dated May 22, 2002, NOAA agreed that the regulations, as proposed, would not affect listed species or designated critical habitat.

Table 2.10-1
Major International Treaties, Federal Laws, and Executive Orders Affecting Oil Spill Response Operations

Title of Law (Citation)	Resource Area Affected	Summary
International Laws		
The International Convention for the Prevention of Pollution from Ships, November 2, 1973, London (MARPOL)	Surface water, hazardous materials and waste management, air quality	Establishes an international cooperative regime to prevent marine pollution. Specific standards are addressed in annexes. Implemented by the Clean Water Act (CWA) and the Oil Pollution Act of 1990 (OPA 90).
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, London, December 29, 1972 (London Dumping Convention)	Surface water, hazardous materials, and waste management	Establishes requirements for permit system and prohibitions on listed types of intentional dumping of wastes at sea.
Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, March 24, 1983 (Cartagena Convention)	Surface water, hazardous materials and waste management, land and water use, fisheries, marine mammals	Regional treaty that sets out collaborative framework for Caribbean marine protection. Protocols address combating oil spills and specially protected areas and wildlife.
Federal Laws		
Abandoned Shipwreck Act of 1987 (ASA) (43 U.S.C. 2101–2106)	Cultural and historic resources	Establishes U.S. title to all abandoned shipwrecks on submerged state lands that are either embedded in such lands or included in or determined eligible for the National Register. The act transfers responsibility for these abandoned wrecks to the states, except where the wrecks are in submerged lands administered by a federal agency or American Indian tribe. In cases where these wrecks are embedded in federal agency land, then the agency has responsibility for the abandoned shipwreck. The ASA applies only to formally abandoned shipwrecks.
American Indian Religious Freedom Act of 1978 (42 U.S.C. 1996, 1996a)	Cultural and historic resources	Protects and preserves the rights of American Indians to exercise the traditional religions of the American Indian, Eskimo, Aleut, and Native Hawaiians, including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonies and rites.
Antarctic Marine Living Resources Convention Act of 1984 (16 U.S.C. 2431 *et seq.*)	Fisheries, marine mammals, protected and sensitive habitat	Provides the legislative authority necessary to implement, with respect to the United States, the convention on the Conservation of Antarctic Marine Living Resources. The act prohibits harvesting of Antarctic marine living resources in violation of the convention.
Antiquities Act of 1906 (16 U.S.C. 431–433)	Cultural and historic resources	Protects historic properties on federal lands, allows the establishment of national landmarks, and requires obtaining permits for excavation.

Archaeological and Historic Preservation Act of 1974 (16 U.S.C. 469–469c)	Cultural and historic resources	Amends the Reservoir Salvage Act of 1960 to extend its provisions to protect and preserve historical and archeological data to any alteration of the terrain caused as a result of any federal construction project or federally licensed activity or program. The act directs federal agencies to report to the Secretary of the Interior when their actions may damage archaeological sites, and to conduct or assist in recovering data from such sites.
Archaeological Resources Protection Act of 1979, as amended (16 U.S.C. 470aa–mm)	Cultural and historic resources	Protects archaeological resources and sites on public lands and American Indian lands, and makes it illegal to take or sell artifacts from public land or property.
Clean Air Act Clean Air Act Amendments of 1990 (CAA) (42 U.S.C. 7401–7671q)	Air quality, hazardous materials and waste management	Establishes national ambient air quality standards that states must meet. Federal agencies must determine whether their actions are in “conformity” with states’ efforts to meet standards.
Clean Water Act (CWA)/Federal Water Pollution Control Act (33 U.S.C. 1251–1376)	Surface water, hazardous materials and waste management, land and water use	Sets the basic structure for regulating discharges of pollutants to waters of the United States. States that it is unlawful for any person to discharge any pollutant from a point source into navigable waters unless a permit is obtained under the act.
Coastal Zone Management Act (CZMA) (16 U.S.C. 1451–1465)	Land and water use, surface water	Establishes national program in which states establish coastal management programs. Federal agencies must determine if their actions are “consistent” with state programs.
U.S. Coast Guard Primary Duties (14 U.S.C. 2)	All	Requires the USCG to enforce or assist in enforcing all applicable federal laws on, under, and over the high seas and waters subject to the jurisdiction of the United States. These laws include those that pertain to living marine resource protection.
Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531–1534)	Fisheries, marine mammals, protected and sensitive habitats, sensitive coastal and marine birds	Establishes protection for endangered and threatened species, including a requirement that all federal agencies consult with the U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS), as applicable, before initiating any action that could affect a listed species.
Estuary Protection Act of 1970 (16 U.S.C. 1221–1226)	Land and water use, surface water	Directs the Secretary of the Interior to encourage states and local governments to consider the needs and opportunities for protecting and restoring estuaries.
Historic Sites Act of 1935 (16 U.S.C. 461–467)	Cultural and historic resources	Law to preserve for public use historic sites, buildings, and objects of national significance.
Marine Mammal Protection Act (MMPA) (16 U.S.C. 1361 *et seq.*)	Marine mammals	Prohibits taking marine mammals; that is to harass, hunt, capture, collect, or kill or attempt to harass, hunt, capture, collect, or kill any marine mammal. Requires permits for taking marine mammals and consultations with NMFS if impacts to marine mammals are possible.
Marine Protection, Research, and Sanctuaries Act (33 U.S.C. 1401–1445)	Surface water, hazardous materials and waste management	Establishes regulatory guidelines for marine protected areas and restrictions and permit process for ocean dumping.
Magnuson-Stevens Fishery Conservation and Management Act (16 USC 1801 et. seq.)	Fisheries	Established regional fisheries councils that set fishing quotas and restrictions in US waters. Federal agencies must consult with the NMFS on all actions or proposed actions, authorized, funded, or undertaken by the agency that may adversely affect Essential Fish Habitat.

continued

Table 2.10-1 (*continued*)
Major International Treaties, Federal Laws, and Executive Orders Affecting Oil Spill Response Operations

Title of Law (Citation)	Resource Area Affected	Summary
Federal Laws (*con't*)		
Migratory Bird Treat Act of 1918 (16 U.S.C. 703–712)	Sensitive coastal and marine birds	Protects species or families of birds that live, reproduce, or migrate within or across international borders at some point during their life cycles.
National Environmental Policy Act (NEPA) (42 U.S.C. 4321–4370d)	All	Requires federal agencies to evaluate the environmental impacts of proposed projects, programs, and policies that have the potential for significant impacts on the environment.
National Historic Preservation Act of 1966, as amended (16 U.S.C. 470–470t)	Cultural and historic resources	Provides for the National Register of Historic Places and establishes the Advisory Council on Historic Preservation. The National Register lists sites, districts, buildings, structures, and objects of significance in American history, architecture, archeology, engineering, and culture. National Register resources may be of local, state, or national significance. Section 106 of the act requires federal agencies to take into account the effects of their undertakings on historic properties and to allow the council an opportunity to comment whenever their undertakings may affect eligible or listed resources.
Occupational Safety and Health Act (29 U.S.C. 651–678)	Human health	Establishes standards to protect workers, including standards regarding industrial safety, noise, and health standards. Federal agencies are required to enact implementing guidelines.
Oil Pollution Act of 1990 (OPA 90) Oil or Hazardous Material Pollution Prevention Regulations for Vessels (33 USC 2701–2761)	Surface water, hazardous materials and waste management	Establishes an industry fund to compensate for damages and liability limits for damages resulting from oil pollution. Implements international law, including MARPOL.
Port and Waterways Safety Act (33 U.S.C. 1223 *et seq.*)	Navigation and transportation	As amended by the Port and Tanker Safety Act of 1978 and OPA 90, this act sets vessel operating and towing safety requirements and sets out enforcement provisions.
Federal Executive Orders		
Coral Reef Protection, Executive Order 13089, June 11, 1998	Fisheries, marine mammals	Establishes a U.S. Coral Reef Task Force to provide for federal mapping, conservation, mitigation, and restoration of coral reefs.

Implementation of Section 311 of the Federal Water Pollution Control Act of October 18, 1972, as Amended, and the Oil Pollution Act of 1990	Coastal or ocean waters	Prohibits discharges of oil and hazardous substances into coastal or ocean waters. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) for the removal of oil and hazardous substances is established. In accordance with the NCP, the National Response System is tasked with establishing methods and procedures for removal of discharged oil and hazardous substances; criteria for removal contingency plans; procedures, methods, equipment and other requirements for equipment to prevent and contain discharges of oil and hazardous substances; and criteria for inspection of vessels carrying cargoes of oil and hazardous substances. As part of the NRS, Area Committees and Area Contingency Plans are established and are comprised of members appointed by the President from qualified personnel of Federal, State, and local agencies. Tank vessel and facility response plan regulations are enacted which require an owner or operator of a tank vessel or facility to prepare and submit a plan for responding, to the maximum extent practicable, to a worst case discharge, and to a substantial threat of such a discharge, of oil or a hazardous substance.
Federal Actions to Address Environmental Justice in Minority and Low-income Populations, Executive Order 12898, February 11, 1994	All	Requires federal agencies to identify and address any disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.
Marine Protected Areas, Executive Order 13158, May 26, 2000	Sensitive coastal and marine birds, fisheries, marine mammals, other living marine resources	Requires that federal agencies whose actions affect the natural and cultural resources that are protected by a marine protected area (MPA) shall identify such actions, and, to the extent permitted by law and to the maximum extent practicable, each federal agency in taking such actions shall avoid harm to the natural and cultural resources that are protected by an MPA.
Responsibilities of Federal Agencies to Protect Migratory Birds, January 11, 2001	Sensitive coastal and marine birds	Requires federal agencies to take steps to protect migratory birds that include restoring and enhancing habitat, preventing or abating pollution affecting birds, and incorporating migratory bird conservation into agency planning processes whenever possible.

Source: Adapted from USCG, 2002.

ENDNOTE

[*] By mandate, USCG considered a 1998 response capabilities target of 25 percent increase in mechanical recovery capability above the 1993 levels (OPA 90). The *Response Plan Equipment Caps Review* (USCG, 1998) resulted in the decision for a 25 percent increase for on-water mechanical recovery response capabilities for tank vessel and MTR facility response plans. This decision became effective in 2000 (65 FR 710, January 6, 2000) and represents the current level of mechanical recovery capability. This 2000, 25 percent increase was considered feasible because of the potential to remove more oil from the environment and provide greater environmental protection.

In accordance with this decision and OPA 90, the USCG was also obligated to consider via the regulatory process, an additional 25 percent increase for on-water mechanical recovery capability and requirements for other removal technologies. The USCG regulatory process included a Notice of Proposed Rulemaking (NPRM), a regulatory analysis, and a PEIS, all leading to an appropriate final rule.

The USCG determined that while the regulatory analysis (USCG, 2002) needed to be completed prior to publication of the NPRM, the PEIS only needed to be completed prior to the publication of a final rule. Both the regulatory analysis and PEIS were initiated in 2000 (February and October, respectively), and each used a common set of five alternatives on which to base their analysis.

The regulatory analysis—*Regulatory Analysis for Changes to Vessel and Facility Response Plans*—was completed in February 2002. The analysis of the alternatives in the regulatory analysis concluded that there would not be any benefit to the environment derived from an additional 25 percent increase in on-water mechanical recovery above the current capability. This was based on the conclusion that more oil could not be removed from the environment by requiring a 25 percent increase in mechanical recovery. Thus, the NPRM proposed Alternative 5 as the preferred alternative rather than Alternative 2 based on economic, environmental and practicable operational considerations. The PEIS, which was initiated prior to the NPRM, continued to consider all original alternatives equally from an environmental impacts perspective. Thus, the PEIS considers the impacts to the environment of a 25 percent increase in mechanical recovery capability equal to the current mechanical recovery capability with the addition of aerial tracking. To prevent redundancy in the current alternatives, Alternative 2 also represents the current mechanical recovery capability plus aerial tracking because the scoping process, Area Committee investigations, public input, *Response Plan Equipment Caps Review* (USCG, 1999), and public responses to the NOI were already developed and the preliminary PEIS was already drafted upon obtaining this information.

CHAPTER 3
AFFECTED ENVIRONMENT

3.1. INTRODUCTION

3.1.1. Resources for Analysis

This chapter provides the environmental baseline physical, biological, social, and economic conditions that occur within the regions where the use of the proposed alternatives can be applied[1]. The information in this section provides the basis for potential impact analysis at a programmatic level. Only those environmental and socioeconomic conditions relevant to the programmatic-level discussion are presented—including water resources, air quality, biological resources, cultural resources, marine transportation, and public health and safety—and are analyzed in Chapter 4 for environmental impacts. Although ocean currents and climates are discussed in Chapter 3, these environmental characteristics are not analyzed in Chapter 4.

3.1.2. Resources Dismissed from Analysis

- **Geology—**None of the proposed alternatives would impact geological formations since the majority of response actions would take place on the surface of the water.
- **Soils—**None of the proposed alternatives would impact soils since the majority of response operations would take place on the surface of the water.
- **Visual—**Response operations would take place in marine waters, away from the majority of the viewing public. In addition, these response operations are likely to be short in duration and unlikely to impose long-term visual problems.

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[1] The response options analyzed and discussed in this Programmatic Environmental Impact Statement (PEIS)—mechanical recovery, *in situ* burning, and chemical dispersion—are for on-water recovery.

3.1.3. Areas of Influence

The proposed action could potentially affect all areas in which oil spill response operations could occur, including marine waters of the U.S. Exclusive Economic Zone (EEZ) off the coasts of the continental United States, Alaska, Hawaii, Guam, Puerto Rico, and other U.S. territories (Figure 3.1-1). The proposed regulations that this PEIS supports only apply to waters where dispersant pre-authorization agreement areas exist, which are demarcated as waters in the United States greater than 3 nm from shore with the exception of several areas with dispersant pre-authorization agreements at different distances from shore, including Maine (> 0.5 nm), Massachusetts (>2 nm), Puerto Rico (>0.5 nm and >60 ft depth), the U.S. Virgin Islands (>1 nm from shore or reef, if reef <20 ft from surface and >60 ft depth), and Hawaii (>60 ft depth), as well as areas such as Washington, Oregon, Connecticut, and large portions of Alaska, which have case-by-case pre-authorization agreements[2]. The underlying rationale for the establishment of dispersant pre-authorization agreements closer than 3 nm from shore is the ability of the environment in these locations to provide reasonable dilution over a shorter distance due to depth and hydrodynamic conditions. This PEIS also addresses marine waters where dispersant pre-authorization agreements are not in place—American Samoa, Guam, and Commonwealth of Northern Mariana Islands (CNMI). These areas are included for completeness, and their inclusion does not signify intent to apply the proposed regulations to these areas. In addition although the Notice of Proposed Rule-Making (NPRM) (67 FR 63331, October 11, 2002) states that the alternatives will address the inland operating environment, this PEIS does not consider the inland operating environment because there are currently no pre-authorization agreements for the inland operating environment. If pre-authorization agreements are adopted for the inland operating environment (the USEPA has primary responsibility for deciding whether a pre-authorization agreement is appropriate in this operating environment), a supplemental NEPA process would be extended to this operating environment. The decision whether to pre-authorize *in situ* burning and chemical dispersion or to authorize their use in a specific incident is unaffected by the proposed regulations and this PEIS. Those decisions properly remain within the purview of the local area response community and the Regional Response Team in the area at risk.

To address the substantial differences within different geographical regions and to maintain the programmatic scope of the analysis, the area of influence is delineated into the following regions:

- The Atlantic region covers the waters extending from the Gulf of Maine to the east coast of Florida terminating at the Florida Straits and out to the EEZ.
- The Caribbean region consists of the waters of the Caribbean Sea and Atlantic Ocean and includes Puerto Rico and the U.S. Virgin Islands and out to the EEZ.
- The Gulf of Mexico region covers the waters beginning at the Florida Straits and extends along the west coast of Florida and to the southern border of Texas and out to the EEZ.
- The Pacific region constitutes the waters along California, Oregon, and Washington and out to the EEZ.

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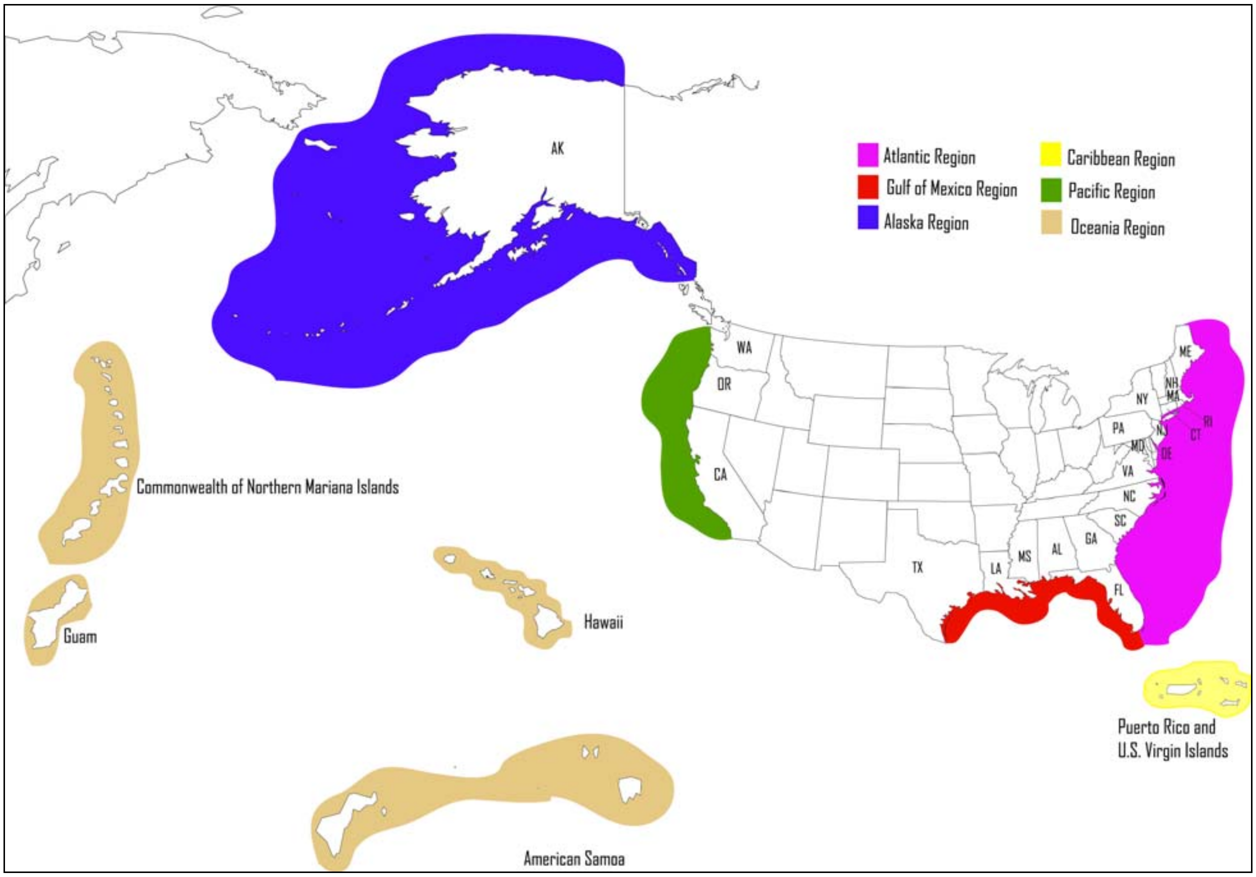
[2] *http://www.uscg.mil/vrp/maps/dispmap.shtml*, last updated August 19, 2004

- The Alaska region covers the waters of Alaska and out to the EEZ.
- The Oceania region consists of the waters surrounding the islands of Hawaii, Guam, CNMI, and American Samoa and out to the EEZ.

Each area of influence is delineated as a defined geographical region that is reasonably unique in terms of environmental conditions.

Figure 3.1-1
Areas of Influence Considered in This PEIS



Note: Map is not to scale. The areas of influence depicted in the map are the six geographic regions considered in this PEIS. In addition, the map shows the breadth of the U.S. Exclusive Economic Zone (EEZ) in each region.

3.1.4. Background on the Aquatic Ecosystem

This section provides a general description of the ecology of aquatic ecosystems to highlight the inherent difficulty in evaluating the potential impacts associated with human activities on marine and coastal resources. Firstly, it describes the structure, function, and dynamics of aquatic ecosystems, highlighting their complexity and dynamic nature. This section also portrays the importance of understanding the interactions among the physical, chemical, and biological components and processes of the system to understand aquatic ecosystem dynamics, and thus the potential impacts associated with anthropogenic influences, such as those caused by oil spills. Lastly, it provides the rationale for the division of resources (within each region analyzed in this PEIS) into physical, biological, and socioeconomic categories to aid in the analysis of the environmental consequences presented in Chapter 4.

Aquatic ecosystems are dynamic in nature, consisting of interdependent relationships among the physical, chemical, and biological components and processes that compose and characterize the system. Analyses of aquatic ecosystems and anthropogenic impacts involve consideration of the structure (species composition and relative abundance) and function (energy flow and nutrient cycling) of these ecosystems, as well as the ecological value and roles played by specific habitats and organisms, and their interactions within the ecosystems. Together, ecosystem structure and function describe the complex processes that define the ecology of a system, including predator–prey relationships, grazing, nutrient cycling, and other interactions of physical, chemical, and biological processes.

Aquatic organisms are not static, isolated units that merely occupy space in the water column and the benthic environment of aquatic ecosystems; they interact with the physical, chemical, and biological environment. Although aquatic ecosystems differ widely in terms of size, complexity, and species composition, they are characterized by the continuous exchange of energy and matter. In simple terms, aquatic plants and chemosynthetic organisms, which obtain energy from the sun and chemicals, respectively, and transform simple inorganic chemicals into food, are grazed by herbivores that are consumed, in turn, by predators. Other types of organisms—principally microbes (fungi and bacteria)—decompose and convert organic tissue into simpler inorganic compounds that can be taken up by aquatic plants in photosynthesis. Microbes may also be consumed as food by other organisms. Microorganisms play a significant role in the aquatic ecosystem, and have been estimated to be greater movers of energy and matter than plankton because of their higher metabolic rates per unit mass (Pomeroy, 1974).

The interaction between aquatic organisms results in the flux of energy and matter through aquatic ecosystems. The recycling of chemical substances among various groups of organisms implies that aquatic ecosystems are basically self-contained from the standpoint of matter. In contrast, the flux of energy is characterized by the input of energy from an external source that must continually be replenished, as it cannot be reused. Unlike matter, which is recycled, energy flows in one direction through the various levels of the ecosystem and is dissipated at each stage as heat. Since most aquatic animals have varied diets and feed at two or more trophic levels, the trophic dynamics of aquatic ecosystems are highly complex and best represented as a food web—a network of interconnected and interdependent food chains. Many species select prey on the basis of size rather than type, are omnivorous, or change food type as individuals grow. There are many organisms that feed on detrital matter from various sources. Food webs are further complicated by trophic "loops" in which a species feeds on organisms normally classified as its consumers. Finally, the diversity in size, behavior, life history, distribution, and habitats of aquatic organisms, makes it difficult to make generalizations about the trophic dynamics within aquatic ecosystems.

Aquatic populations can be affected by action of consumers (top-down control) and by supply of resources (bottom-up control). For example, resources (e.g., nutrients) affect marine producers (e.g., phytoplankton), producers affect consumers (e.g., zooplankton and fish), and consumers alter the abundance of their nutritional resources (e.g., phytoplankton and zooplankton) (Valiela, 1995). The species compositions and relative abundance of species in aquatic environments are determined by a tight intertwining of bottom-up and top-down controls (Valiela, 1995). The relative importance of the controls varies seasonally and depends on changing features of aquatic ecosystems, for example, nutrient supply, abundance of fish and prey organisms, light, temperature, and wave action. Abundance of prey and predators, and their growth rates, are tightly coupled, but are continually changing in response to external variables such as light and temperature and to the natural, evolutionary history of the organisms. An extensively studied example of the complex biological interactions that occur in aquatic ecosystems is provided by the interactions among the kelp forest, sea urchins, and sea otters in the Pacific coast of the United States (Valiela, 1995).

The structure, function, and dynamics of aquatic ecosystems can only be understood by considering biological processes at the level of individual populations acting in concert with processes at the level of the entire community (Mann, 1988). Local processes at the species level permanently change macroscopic properties of the system, which then impose new constraints on the species themselves (Mann, 1988). As described above, biological interactions in aquatic ecosystems are highly complex. An additional layer of complexity to the understanding of the structure, function, and dynamics of aquatic ecosystems results from the close interaction of physical and biological processes, which plays an important role in structuring aquatic biological communities (Daly and Smith, 1993). Physical and biological processes produce and maintain the temporal and spatial patterns of abundance, distribution, and species composition of organisms in aquatic ecosystems, thus directly influencing the processes that determine primary production and the flux of energy and matter in the ecosystem (Daly and Smith, 1993).

Given the spatial and temporal variability of aquatic ecosystems and the complexity and interconnectedness of biological and physical interactions within these systems, human impacts to physical and chemical properties or to specific biological components of the system can have cascading effects throughout aquatic food webs, altering habitat structure, species composition at various trophic levels, energy flow, and nutrient cycling. Thus, an understanding of the interactions among the physical, chemical and biological components and processes that compose and characterize these systems is crucial to understand both the ecology of the system and the potential impacts associated with anthropogenic influences, such as those caused by oil spills.

The waters of the United States are a diverse assemblage of aquatic—marine, estuarine, and freshwater—ecosystems spread over diverse geographical regions. This Programmatic Environmental Impact Statement (PEIS) focuses on the regional- and national-level environmental and socioeconomic implications of oil spills under the alternatives. Oil spill impacts are mostly localized and generally short lived. Thus, the analysis of physical and socioeconomic resources and of specific biological organisms and habitats provides relevant information to determine the potential impacts to marine and coastal resources and ecosystems in the event of an oil spill. In addition, the U.S. regulatory framework focuses on the protection of specific resources—water quality; air quality; threatened, endangered, and candidate species; fisheries; and environmental justice. Therefore, describing U.S. marine and coastal resources by dividing them into the physical, biological, and socioeconomic categories, as presented in Chapters 3 and 4, allows for the evaluation of potential impacts on resources of concern from a regulatory standpoint.

The regional dynamics and functional characteristics of marine and coastal resources are identified and summarized in Sections 3.2 through 3.7. The biological resources presented for each region analyzed in this PEIS are organized according to biological groups that form the functional food web within each habitat. The description of resources provided for each region presents a general discussion of aquatic ecological principles, as well as a description of the basic functional components and regional variations that constitute the aquatic ecosystems of the United States. It includes a general description of the biological structure (organisms) and the basic functional components (food web and habitat interactions) within aquatic ecosystems. It also describes the economic importance of these ecosystems to the U.S. economy, including coastal communities, vessel transportation and ports, archaeological and cultural resources, recreational and commercial fishing, subsistence, coastal tourism, environmental justice, and public health and safety.

3.1.5. Essential Fish Habitat

Congress recognized the importance of fish habitat to the productivity and sustainability of U.S. marine fisheries, and in 1996 added a new habitat conservation provision known as Essential Fish Habitat (EFH) to the Fishery Conservation and Management Act, the federal law that governs U.S. marine fisheries management. The renamed Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA, Public Law 94-265, as amended through October 11, 1996; 16 U.S.C. 1801 *et seq.*) mandated the identification of EFH for all federally managed species for each of their life stages. The statute defines EFH as "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). This definition is further interpreted under the EFH guidelines (50 CFR 600.10).

The act mandates the designation of specific geographic areas as EFH and the subsequent conservation of these areas to minimize adverse effects on habitat caused by fishing and nonfishing activities. In Section 303(a)(7) of the amended MSFCMA, Congress directs the National Marine Fisheries Service (NMFS) and the regional Fish Management Councils, under the authority of the Secretary of Commerce, to

- Describe and identify EFH for all federally managed fisheries species for each of their life stages
- Minimize, to the extent practicable, the adverse effects of fishing on EFH
- Identify other actions to encourage the conservation and enhancement of EFH

EFH designations can be found within each Fishery Management Plan (FMP) developed by the regional Fishery Management Councils (FMCs) and implemented by NMFS. The EFH Web site[3] contains links to pages that present the Secretary-approved council EFH textual descriptions and identifications, and available geographical representations. The life history information provided by these pages will aid federal agency's further understanding of an action's ecological impacts on EFH.

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[3] *http://www.nmfs.noaa.gov/habitat/habitatprotection/efh/fish_manage_c.htm*

3.1.5.1. Habitat Areas of Particular Concern

The EFH regulations encourage regional FMCs to identify Habitat Areas of particular Concern (HAPCs) within areas designated as EFH to focus conservation priorities on specific habitat areas that play a particularly important role in the life cycles of federally managed fish species. The intent of NMFS in encouraging the designation of HAPCs is to help focus conservation efforts on localized areas that are vulnerable to degradation or especially important ecologically. HAPCs should be subsets of the total area necessary to support healthy stocks of fish throughout all of their life stages.

The EFH regulations require that designation of specific HAPCs be based on one or more of the following considerations (50 CFR 600.815(a)(8)):

- The importance of the ecological function provided by the habitat
- The extent to which the habitat is sensitive to human-induced environmental degradation
- Whether and to what extent development activities are or will be stressing the habitat
- The rarity of the habitat type

The location of any HAPCs and the potential impact of oil spill response techniques on these areas should be taken into account when planning or implementing oil spill response strategies. If oil spill response activities should occur within a HAPC, or will likely impact a HAPC, special considerations should be made that reflect the importance of these areas for maintaining sustainable fisheries and those species contribution to a healthy ecosystem.

3.1.5.2. Consulting on Impacts to EFH

Section 1855(b)(2) of the MSFCMA requires federal agencies to consult with NMFS with respect to “any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any Essential Fish Habitat identified under this act.” Adverse effects to EFH are defined further as “any impact that reduces the quality and/or quantity of EFH,” and may include “site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions” (50 CFR 600.810(a). The consultation process allows NMFS to make a determination of the project’s effects on EFH and provide conservation recommendations to the lead agency on actions that would adversely affect such habitat (*see* 16 U.S.C. 1855(b)(4)(A)).

3.2. ATLANTIC REGION

3.2.1. Physical Environment

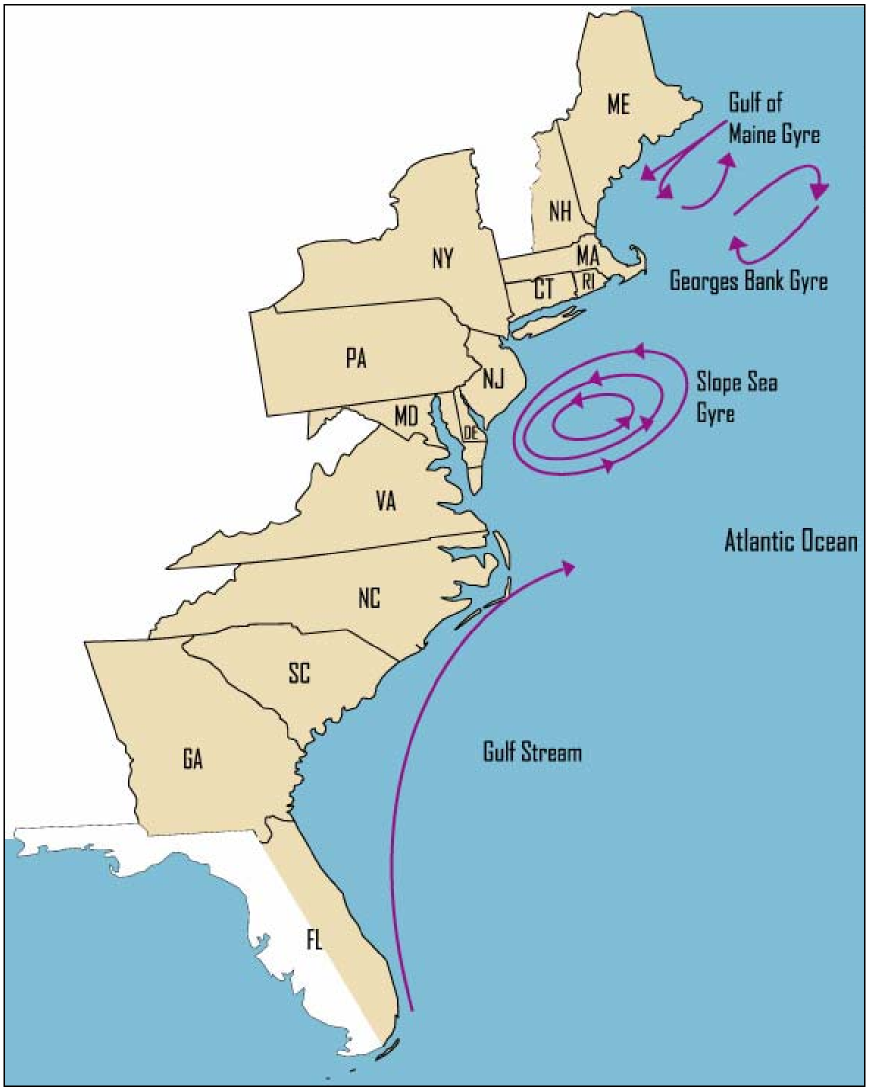
For the purpose of this Programmatic Environmental Impact Statement (PEIS), the Atlantic region will specifically cover the waters extending from the Gulf of Maine to the Florida Straits (Figure 3.1-1). This extensive region comprises the waters of the Gulf of Maine, the estuarine-dominated waters of southern New England and Mid-Atlantic Bight, to the waters off the east coast of Florida. Fifteen states border this region: Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, and the east coast of Florida.

The Gulf of Maine Gyre, with currents that exhibit surface speeds of 0.29 kt, and the Georges Bank Gyre, with currents that exhibit surface speeds of 0.58 kt, influence circulation in the northern section of the Atlantic region (Figure 3.2-1). The Slope Sea Gyre, with currents that have been measured upwards of 0.1 kt, affects the waters further south to the Mid-Atlantic region. This gyre lies off the coast and extends seaward out to the Gulf Stream. The Gulf Stream flows in a northerly direction from southern Florida and veers east off the coast of North Carolina. The Gulf Stream impacts circulation throughout the Atlantic region, with its current's width ranging from 50 to 63 mi and has peak surface velocities of 4 kt (MMS, 1990).

Along the most northern parts of the Atlantic region, salinity is greatly influenced by input from local rivers, resulting in a band of low-salinity water that extends 12 mi or more from the coast. Throughout the rest of the northwestern Atlantic region—Georges Bank, Great South Channel, Cape Cod Bay, and Stellwagen Bank—salinity remains stable at approximately 31 to 33 parts per thousand (ppt), depending on the location. Mid-Atlantic shelf water has relatively low salinity; however, the Delaware Bay is characterized by high salinities, with 28 ppt at the mouth to 8 ppt in the upper boundary (USCG, 1996). The Gulf Stream influences the chemical characteristics of the southwestern Atlantic region shelf water. This area has a general increase in salinity seaward to a maximum of 36 ppt (USCG, 1996).

Atlantic Ocean surface water temperatures vary because of the large geographical distances covered by the area. Annual average temperatures in the northwestern Atlantic Ocean (off the coast of Maine) are between 42.8° and 64.9°F. Temperatures in the southwestern Atlantic Ocean (off the east coast of Florida) average between 78.5° and 84.2°F (NOAA, 2003a).

Figure 3.2-1
Major Currents of the Atlantic Region



Note: Map is not to scale.

3.2.1.1. *Water Quality*

Coastal

The U.S. Environmental Protection Agency (USEPA, 1998a) compiled state assessments of the Atlantic region water quality within estuaries and coastal waters in its 305(b) report. Maine was found to be the state with the highest water quality with greater than 99 percent of all estuaries and coastal waters having good water quality able to fully support aquatic life. Delaware had the lowest water quality, with 86 percent of all estuaries and coastal waters having poor water quality unable to support aquatic life. The remainder of the states within this region varied greatly in the level of water quality exhibited within estuaries and coastal waters.

Primary activities that contribute to the degradation of coastal water quality include those associated with agriculture, urban runoff, septic tanks, storm sewers, industrial plants, and wastewater treatment facilities. Secondary activities include land modifications for flood control, river development, harbors, docks, navigation channels, and pipelines. The resulting environmental degradation may be manifested as diseased fishes, turbid and oily waters, noxious odors, hypoxic conditions, pathogenic contamination of bathing waters and shellfish beds, degraded benthic communities, restricted distributions of fishes, and fish and shellfish tainted with bacteria and hydrocarbons (USEPA, 1998a).

Marine

Marine water quality in the Atlantic region is controlled by ocean circulation that, in the Mid-Atlantic, is dominated by gyres. The water quality in this area generally is good, principally because marine waters are quite a distance from the sources of shore-based pollution and because of the Gulf Stream's influence. For the most part, Gulf Stream water is relatively unpolluted oceanic water; only some slope water, with its higher pollutant load, is entrained by, and becomes part of, Gulf Stream waters. Pollutants that do occur in the Gulf Stream originate from atmospheric rainout and from the discharge of bilges and bunker washings by ships (MMS, 1990). Ambient conditions supporting marine life in the offshore waters are affected to only a small degree from manmade inputs.

The Atlantic region covers a very broad area with several major ports located throughout its coastal area. Maritime vessels transport millions of tons of cargo each year. The large volume of vessel traffic causes marine transport in this region to be responsible for 1.7 percent of all oil spills reported in the United States. In 1999 alone, there were 148 reported oil spills (USCG, 2000a).

3.2.1.2. Meteorology and Air Quality

Climate

Meteorological conditions on the Atlantic coast are dominated by two semipermanent pressure centers: Icelandic Low and Bermuda High. The location of these centers varies by season and they alternate in dominating the pressure and circulation patterns of the region (USCG, 1996). Wind speeds fluctuate depending on the time of year. For example, in the summer months the average wind speed for the region is 4 to 21 nm/hr whereas in the winter the average wind speed increases to 4 to 33 nm/hr (MMS, 1990).

Tropical cyclones (also known as hurricanes), tropical storms, and northeasters are the most significant and powerful meteorological phenomena affecting the Atlantic region. Tropical storms and hurricanes impact the coast on the average of once every 10 years. Strong northeasters impact the coast more frequently than hurricanes and supply much of the rain or snow in late autumn, winter, and spring (NOAA and GaDNR, 1997).

Air Quality

Air quality of coastal counties[4] is measured against National Ambient Air Quality Standards (NAAQS), resulting from the Clean Air Act and its 1977 amendments (40 CFR 50.12), or it is measured against more restrictive adopted state standards. These standards are designed to protect human health. The USEPA requires states to report ambient air quality levels for six major pollutants: particulate matter (10 microns or larger [PM10]), sulfur dioxide, carbon monoxide, nitrogen dioxide, lead, and ozone. NAAQS have been adopted by each of the Atlantic region's states except Florida, which amended these standards to make sulfur dioxide emission levels more restrictive than the federal standard. Appendix F, Table F.1-1 summarizes federal ambient air standards in detail.

All coastal counties of the Atlantic region are considered to be in compliance with the NAAQS attainment levels for sulfur dioxide, nitrogen dioxide, and lead. However, there were many counties that were not in compliance for the remaining three pollutants: sixty-four counties were not in compliance for ozone, seventeen for carbon monoxide, and two for particulate matter (PM10) (USEPA, 2000a).

3.2.2. Biological Environment[5]

3.2.2.1. Marine Mammals

The Atlantic region is expansive and contains a wide variety of environments. These environments allow a diverse group of marine mammals to inhabit the region. A variety of marine mammal species—twenty-three cetaceans (whales, dolphins, and porpoises), five pinnipeds (seals), and one sirenian (manatee) reside or migrate along this coast. There are ninety-one stocks and thirty-nine species of marine mammals in this region, of which the bottlenose dolphin (*Tursiops truncatus*) is the most common cetacean and is found in coastal and offshore environments from the northeastern Atlantic region down to the southeastern tip of Florida (NMFS, 1999). In the north, the minke whale (*Balaenoptera acutorostrata*) is the third most commonly sighted whale along the East Coast of the United States. Appendix F, Table F.2-1 lists twenty-one recognized nonendangered marine mammals in this region.

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[4] The Office of Ocean Resources, Conservation and Assessment (ORCA), National Ocean Service (NOS), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce classifies counties as coastal "because they meet one of the following criteria: (1) at least 15 percent of their total land area is located within the nation's coastal watersheds (as defined by ORCA's Coastal Assessment Framework [*http://spo.nos.noaa.gov/projects/caf/caf.html*], or (2) the county accounts for at least 15 percent of the land area of a coastal cataloging unit (a U.S. Geological Survey-defined drainage basin)" (*http://spo.nos.noaa.gov/projects/population/population.html*). The U.S. Bureau of the Census also uses ORCA's coastal counties list.

[5] Only nonendangered species will be included in Section 3.2.2, Biological Environment. Threatened, endangered, and candidate species will be discussed separately in Section 3.2.3, Threatened, Endangered, or Candidate Species. For this reason, sea turtles will only be discussed in Section 3.2.3, as they are a threatened/endangered species in the Atlantic region.

3.2.2.2. Marine and Coastal Birds

Migrant and resident marine and coastal birds are found throughout the Atlantic region because of extensive habitats. The majority of these species are nearly year-round residents in one or more areas along the coast. In the winter, southern populations of shorebirds are augmented by large numbers of wintering marine, freshwater, or terrestrial birds from more northern ecosystems. A variety of marine and coastal bird species are also identified. At least twenty marine bird species nest regularly in the northern Atlantic region, while nine others irregularly nest there or in the near vicinity (USGS, 1998a). Schneider and Heinemann (1996) completed a recent overview of predominant marine birds inhabiting this region. Gulls, terns, and herons are important species breeding within the ecosystem.

Other species of marine birds that do not breed in the ecosystem are nevertheless important and occupy two ecological regimes within the ecosystem, coastal and pelagic. In the coastal zone, plovers, sandpipers, and other shorebirds are important predators of beach and intertidal invertebrates. Sixty-three nearshore and pelagic birds were found during dozens of birding trips off the coast of Virginia, Maryland, and North Carolina (USGS, 1998a). Twenty-five species of seabirds were observed off east-central Florida (USGS, 1998a).

The presence of six Western Hemisphere Shorebird Reserve Network (WHSRN) sites, seven Ramsar sites, and seventy-nine National Wildlife Refuges in the Atlantic region indicates that large numbers of shorebirds (WHSRN sites) and wetland birds (Ramsar sites) concentrate in the area during migration and/or nesting and wintering. The WHSRN maintains a network of monitoring sites comprising critical habitat for shorebird species. These sites are categorized as hemispheric with an annual count of 500,000 shorebirds or 30 percent of a species flyway population; international with an annual count of 100,000 shorebirds or 10 percent of a species flyway population; and regional with an annual count of 20,000 shorebirds or 5 percent of a species flyway population. The six WHSRN sites in the Atlantic region include one hemispheric, two international, and three regional sites (WHSRN, 2004). The Ramsar Convention on Wetlands designates Ramsar sites as wetlands of international importance. These wetlands are selected based on criteria such as supporting 20,000 or more waterbirds and regularly supporting 1 percent of the individuals in a population of one species or subspecies of waterbird (Wetlands International, 2004). The National Wildlife Refuge sites are established under the National Wildlife Refuge System Improvement Act of 1997 with the aim of protecting wildlife and preserving biological diversity (USFWS, 2004).

Marine birds are showing signs of stress. Probably the most pressing issue regarding the health of bird populations is the continued rapid development of the region due to increased human populations, resulting in the destruction of habitat for both birds and the organisms supporting their food chain.

For the purpose of this PEIS, marine and coastal birds are categorized into five major groups, as detailed in Appendix F, Table F.2-2: seabirds, shorebirds, wading and marsh birds, waterfowl, and raptors.

3.2.2.3. *Plankton and Fish*

Plankton

Plankton are organisms that float at or near the surface of marine waters and are unable to swim against tides, winds, or currents. Plankton species, which represent nearly all major aquatic phyla, can be roughly classified as phytoplankton (microscopic plant life), zooplankton (microscopic animals), and ichthyoplankton (fish eggs and larvae). Because the temperate waters of the Atlantic region provide a sufficient habitat for these organisms, these plankton species are distributed throughout the region from the coastal waters of Maine to the water off the southeastern tip of Florida.

Phytoplankton are microscopic floating algae, which form the base of the food web. They are responsible for approximately one-half of global photosynthesis and play a vital role in stabilizing atmospheric carbon dioxide. These plants can only survive in the shallower, sunlit waters of open-ocean and estuarine areas. Phytoplankton communities in the Atlantic region consist of diatoms, dinoflagellates, and flagellates, which include species such as *Chaetoceros debilis*, *Thalassiosira*, *Skeletonema leptocylindrus*, *Noctiluca scintillans*, *Alexandrium tamarense*, *Phaeocystis poucheti, Skeletonema costatum*, *Cyclotella* spp., *Nitzschia closterium*, *Navicula* spp*., Heterocapsa triquetra*, *Procentrum minimum*, *Amphidinium* and *Gymnodinium* spp., and *Cryptomonads* (Sheppard, 2000).

Zooplankton, which consume phytoplankton, spend either part (meroplankton) or all (holoplankton) of their life cycle as plankton. Their temporal and spatial distributions depend on a number of factors including currents, water temperature, and phytoplankton abundance (Loeb et al., 1983). Zooplankton are a critical link in the transfer of energy from primary producers (phytoplankton) to apex predators, so any process influencing the abundance and distribution of zooplankton can ultimately have an impact on fisheries. The most common classes of zooplankton found in the Atlantic region are Mysida, Amphipoda, Ostracoda, Cumacea, Calanoid, Copepodes, and Hyperids. Included in these classes are *Michteimysis mixta, Neomysis Americana, Pntogeneia inermis, Themisto gaudichaudi, Monoculodes edwardsi, Diastylis polita, Lamprops quadriplicata, Calanus finmarchicus, Pseudocalanus minutus, Acartia longiremis, Hyperia galba, Sida crystallina, Leptodera kind, Conchoceia* spp., *Acartia tonsa, Paracalanus* spp., *Eucalanus* spp., *Oncaea* spp., *Oithona* spp., and *Corycaeus* spp. (Lerman, 1986).

Ichthyoplankton are present year-round within the region; however, the annual distribution and abundance of their eggs and larvae may be highly variable depending on the season and location (Smith et al., 1981). Larvae of commercially and recreationally important estuarine-dependent species, such as spot (*Leiostomus xanthurus*) and Atlantic croaker (*Micropogonias undulates*), are dominant components of the ichthyoplankton community. Generally there are two different kinds of ichthyoplankton denoting different life history types—mesopelagic (marine waters) and estuarine-dependent species. Included in these categories are the families Bothidae, Clupeidae, Gadidae, Gonostomatidae, Myctophidae, Ophidiidae, and Sparidae.

Fish

The New England Fishery Council, Mid-Atlantic Fishery Council, and South Atlantic Fishery Council (see Section 3.2.4) manage the commercial fisheries of the Atlantic region. The commercial yield of fish by weight in the Atlantic region was 685,695 metric tons in 2000 (NMFS, 2003a). Large numbers of groundfish, pelagic, reef fish, several types of tuna and billfishes and shellfish species occur in this area including many migratory and transboundary species, such as Atlantic mackerel (*Scomber scombrus*) and Atlantic menhaden (*Brevoortia tyrannus*). Table 3.2-1 lists the commercially important fish species of the Atlantic region. In addition to fish species, shellfish are an important component to the fisheries industry. From Maine to Cape Cod, Massachusetts, approved shellfish growing areas cover more than 1,000 mi^2 in 1998. Further south, the area from Buzzards Bay, Massachusetts, to Chesapeake Bay, Virginia, has an approved shellfish growing area of approximately 6,300 mi^2. From this area alone, approximately 1.1 billion lbs of seafood were landed in 1989.

Table 3.2-1
Commercially Important Fish Species of the Atlantic Region

Common Name	Scientific Name	Common Name	Scientific Name
Albacore	*Thunnus alalunga*	Red drum	*Sciaenops ocellatus*
American plaice	*Hippoglossoides platessoides*	Red hake	*Urophycis chuss*
Atlantic cod	*Gadus morhua*	Red porgy	*Pagrus pagrus*
Atlantic croaker	*Micropogonias unduatus*	Redfish	*Sebastes* spp.
Atlantic herring	*Clupea harengus*	Scamp	*Mycteroperca phenax*
Atlantic mackerel	*Scomber scombrus*	Scup	*Stenotomus chrysops*
Atlantic salmon	*Salmo salar*	Silver hake	*Merluccius bilinearis*
Atlantic wolffish	*Anarhichas lupus*	Skate	Family Rajidae
Bigeye tuna	*Thunnus obesus*	Skipjack tuna	*Katsuwonus pelamis*
Billfish	*Makaira nigricans, Tetrapturus albidus, Istiophorus platypterus*	Spanish mackerel Spiny dogfish	*Scomberomorus maculatus* *Squalus acanthias*
Black sea bass	*Centropristis striata*	Spot	*Leiostomus xanthurus*
Bluefin tuna	*Thunnus thynnus thynnus*	Striped bass	*Morone saxatilis*
Bluefish	*Pomatomus saltatrix*	Summer flounder	*Paralichthys dentatus*
Butterfish	*Peprilus triacanthus*	Swordfish	*Xiphias gladius*
Cero	*Scomberomorus regalis*	Tilefish	*Lopholatilus chamaeleonticeps*
Cobia	*Rachycentron canadum*	Weakfish	*Cynoscion regalis*
Cusk	*Brosme brosme*	White hake	*Urophycis tenuis*
Dolphin	*Coryphaena* sp.	Windowpane	*Scophthalmus aquosus*
Gag	*Mycteroperca microlepis*	Winter	*Pleuronectes americanus*
Goosefish	*Lophius americanus*	Witch	*Glyptocephalus cynoglossus*
Gray snapper	*Lutjanus griseus*	Wreckfish	*Polyprion americanus*
Haddock	*Melanogrammus aeglefinus*	Yellowfin tuna	*Thunnus albacares*
King mackerel	*Scomberomorus cavalla*	Yellowtail	*Pleuronectes ferrugineus*
Ocean pout	*Macrozoarces americanus*	Yellowtail snapper	*Ocyurus chrysurus*
Pollock	*Pollachius virens*		

Source: Adapted from USCG, 2002.

Commercially important marine arthropods include lobsters, crayfish, crabs and shrimp. Mollusks, or members of the phylum Mollusca, are also important to the region. Mollusks are bilaterally symmetrical invertebrates such as clams, octopuses, and squid.

Fish stocks in the Atlantic region have declined—in some cases severely—over the past 20 years. Pollution, coastal development, and overexploitation have taken a large toll on the fishery stocks of this region (SAFMC, 2002). Improved fishing technology, coupled with habitat-degrading fishing techniques, a high age of breeding maturity for certain species (e.g., cod), and overexploitation of spawning grounds in international waters have had additional detrimental impacts to the fish stocks of the region. As such, there are a variety of species that are managed through permitting and quotas, as well as a series of state and federal management plans geared to increase population levels.

3.2.2.4. *Intertidal Habitats*

Beaches and Coastal Barrier Islands

The Atlantic region has 25,108 mi of shoreline (Good et al., 1998). Parts of the Atlantic coast are lined with barrier islands, with the largest concentration located from the Cape Cod segment of the Massachusetts coast to islands off the coast of Georgia, with a very heavy concentration off the shores of North Carolina. These coastal barriers are elongated landforms consisting of unconsolidated materials (typically sand) that shift frequently and rapidly in response to storms, winds, and tides. These landforms provide important habitat for many species and protect inland areas, wetlands, and estuaries from the brunt of ocean storms (Congressional Research Service Report 97-588 ENR, 1997).

Except for some northern portion of the Atlantic region (such as Maine where only 1 percent of the coastline is sandy beach), much of the region's oceanfront consists of sandy beach-dune areas. Beach areas are particularly important in providing protection from storms, high tides, and wave action for the lagoons, sounds, wetlands, and low ground located landward of most beaches. Natural dune areas found landward of sandy beaches often support seabirds, shorebirds, waterfowl, and a dune grass or shrub community. The coastal beaches are also important for their economic integrity in terms of tourism and recreation. However, because of natural forces and human activities such as seawall and channel jetties, the average shoreline retreat for the Atlantic region seaboard is reported at about 2.0 ft/yr (Heinz Center, 2000).

Estuaries, Wetlands, Mud Flats, and Mangroves

Estuaries are important habitats for both resident and transitory species, providing spawning or nursery habitats and foraging areas for numerous species, including invertebrates, fishes, reptiles, birds, and mammals. High organic productivity, high detritus production, and extensive nutrient recycling characterize estuaries. Some familiar examples of estuaries in the Atlantic region are the Boston Harbor and Chesapeake Bay. Many different habitat types are found in and around estuaries, including wetlands, mud and sand flats, mangroves, and submerged grass beds. Figures 3.2-2 and 3.2-3 show estuary locations in the north and south Atlantic regions, respectively.

Figure 3.2-2
Estuaries in the Atlantic Region—North

Source: Bricker et al., 1999.

Note: Map is not to scale.

Wetland habitats are associated with estuarine areas. These habitats may occupy only narrow bands along the shore, or they may cover larger expanses at the mouths of bays, rivers, or coastal streams. Wetland habitats occurring along the Atlantic coast include salt marshes (colonized by salt-tolerant grasses and bushes), tidal mud flats (areas that are exposed at low tide and are densely packed with shellfish, invertebrates, crabs, and other organisms), freshwater marshes, forests, and shrub lands. Coastal wetlands and estuaries are highly productive, yet fragile, environments that support a great diversity of fish and wildlife species.

The Atlantic region has 22,907 mi^2 of wetlands along the Atlantic seaboard, most of which are located predominantly south of New York because these coastal areas have not been glaciated (Good et al., 1998). The Mid-Atlantic wetlands are composed of two-thirds salt marshes; the majority of the remaining balance is tidal mud flats. Because of widespread urbanization of the Atlantic coastline, the loss of wetland ranges from 31 percent in New England to 47 percent in the southeast Atlantic (Good et al., 1998).

Mud flats and swamps occur in areas of low-wave energy. These areas tend to act as sediment sinks, trapping nutrients that support a variety of plants, fish, birds, and mammals. Mud flats exist along the shores of many of the bays and sounds; the most extensive mud flats are found along the shores of the Delaware and Chesapeake Bays.

Figure 3.2-3
Estuaries in the Atlantic Region—South

Source: Bricker et al., 1999.

Note: Map is not to scale.

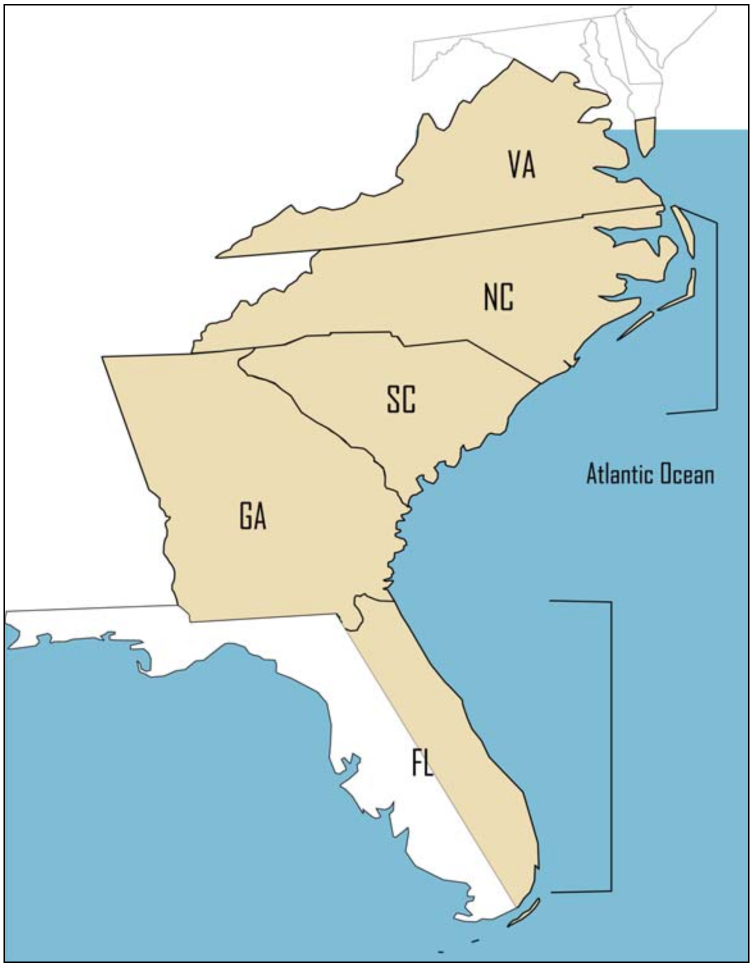
Mangroves are found in tropical and subtropical tidelands in specific areas of the Atlantic region. They primarily grow along the coast of central and southeast Florida, beginning near St. Augustine and continuing down into the Gulf of Mexico. The three most important species of mangroves in this area are red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), and white mangrove (*Laguncularia racemosa*). Mangroves protect habitats and nurseries for fish, crustaceans, and shellfish; provide food for marine species; and provide shoreline protection from wind, waves, and floods. Mangroves are sensitive to cold temperatures and can take 5 to 10 years to reestablish their presence following a freeze. In addition to freezing, several human activities—ditching or impounding for mosquito control, reducing freshwater input, and clearing and filling—lead to the degradation of mangrove quantity and quality.

3.2.2.5. Subtidal Habitats

Submerged Grass Beds

The subtidal (benthic) areas of the Atlantic region consist of either soft or rocky substrates. These areas support a variety of marine life and habitats, including seagrass beds and coral reefs. Seagrass beds provide critical food, shelter, and nursery grounds for many species of waterfowl, shellfish, fish, and other organisms. They also stabilize shifting sediment and generate oxygen. Seagrass communities also support several threatened and endangered species, including sea turtles and manatees. Seagrass beds are found throughout the Atlantic region in shallow coastal areas except Georgia and South Carolina, where freshwater inflow, high turbidity, and tidal amplitude combine to inhibit growth (ASMFC, 1997). Figure 3.2-4 provides the range of submerged grass beds in this region.

Figure 3.2-4
Range of Submerged Grass Beds in the Atlantic Region—South



Source: South Atlantic Fishery Management Council (SAFMC, *http://www.safmc.net/habitat/fmpro?-db=content&-format=default.html&-view*, accessed on March 3, 2003).

Note: Map is not to scale.

Within the Atlantic Region the dominant species are eelgrass (*Zostera marina*), Cuban shoalgrass (*Halodule wrightii*), widgeon grass (*Ruppia maritima*), turtlegrass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), and several species of *Halophila*. The first three species occur primarily from North Carolina northward, while the rest occur predominantly in Florida (Thayer et al., 1997). In one area of the Mid-Atlantic region, seagrass beds cover 200,000 acres (MMS, 1990).

On the east coast of Florida—Bayton Beach to New Smyrna Beach (Ponce de Leon Inlet)—nearshore seagrass coverage is approximately 100,000 acres (Florida Department of Community Affairs, 2000). Increasing human use of coastal areas throughout the Atlantic region has resulted in loss of seagrass beds through construction, recreation, harbor and channel maintenance, and water pollution.

Coral Reefs

Coral reefs are among the most diverse and productive communities on earth. They buffer adjacent shorelines from wave action, thus protecting coastal environments and reducing erosion. Reefs also provide economic benefits in terms of pharmaceutical research, commercial and recreational fisheries, and cost reduction through the mitigation of property damage.

Thirty-nine designated coral reefs, ranging from southern tip of South Carolina to the Upper Florida Keys, are located in this region (Figure 3.2-5). The northernmost reef in this region is Gray's Reef (a designated National Marine Sanctuary), and the southernmost reef in this region is Coffins Patch in the Upper Florida Keys. Gray's Reef is one of the largest nearshore live-bottom reefs of the southeastern United States. Located off the coast of Georgia, it encompasses 17 nm^2 of live-bottom habitat. In the Upper Florida Keys (part of the Florida Keys National Marine Sanctuary), the most common coral reef species are Boulder star coral (*Montastrea annularis*), star coral (*M. cavernosa*), and elkhorn coral (*Acropora palmata*).

Coral reefs are vulnerable to environmental changes, including the impacts of human activities. Environmental influences, such as temperature changes, sea-level fluctuations, and storm events, can negatively impact reefs via coral bleaching, lack of sunlight, and physical damage. Vessel groundings and anchorings, dredging, destructive fishing practices, overfishing, pollution from poor land use, chemical loading, marine debris, and invasive alien species each contribute to the loss of coral reefs. Widespread loss of nearshore and offshore corals in the southern Atlantic Ocean is well documented, as is their replacement with fleshy algae, which are known to flourish in elevated concentrations of phosphate and nitrate.

Figure 3.2-5
Coral Reefs in the Atlantic Region—South

Source: National Oceanic Data Center, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (*http://www.nodc.noaa.gov/col/projects/coral/Coralhome.html*, accessed on June 13, 2002).

Note: The National Oceanic Data Center does not identify any coral reef locations in the Atlantic region—north (ME through MD). Map is not to scale.

* The Upper Florida Keys region consists of the following reefs that are too densely located to show on this scale of map: Fort Lauderdale, John U. Lloyd, Ball Buoy Reef, Miami Beach, Triumph Reef, Biscayne Reef, Star Reef, Schooner Reef, Elkhorn Reef, Dome Reef, Pacific Reef, Turtle Rocks, Carysfort Reef, South Carysfort Reef, Key Largo, Elbow Reef, North North Dry Rocks, North Dry Rocks, Key Largo Dry Rocks, Grecian Rocks, French Reef, White Banks, Three Sisters, Molasses Reef, Pickles Reef, Conch Reef, Davis Reef, Crocker Reef, Hens and Chickens, Cheeca Rocks, Alligator Reef, Tennessee Reef, and Coffins Patch.

3.2.2.6. Areas of Special Concern

Executive Order 13158 ("Marine Protected Areas") defines marine protected areas as "any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein" (65 FR 34909). There are many different types of marine protected areas within and bordering

U.S. waters; some examples include National Marine Sanctuaries, National Seashores, National Parks, National Monuments, National Wildlife Refuges, National Estuarine Research Reserves, and many others (NOAA, 2002a). They have different shapes, sizes, and management characteristics and have been established for different purposes.

The Atlantic region has three National Marine Sanctuaries, eleven National Park units, seventy-nine National Wildlife Refuges, eleven National Estuarine Research Reserves, twelve National Estuary Programs, and two National Estuarine Research Reserve-National Estuary Programs located in coastal or near-coastal areas. For more details regarding history, purpose, and specific site locations pertaining to this region, see Appendix F, Tables F.2-3 through F.2-5 and Figures F.2-1 through F.2-4.

3.2.3. Threatened, Endangered, or Candidate Species

The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have classified eight threatened, seventeen endangered, and seven candidate species within the Atlantic region. These consist of seven marine mammals, nine marine and coastal birds, seven fish species, six sea turtles, one plant species, and two coral species.

Six cetaceans and one sirenian are endangered and reside in and migrate through this region (Table 3.2-2). They are observed frequently in nearshore waters along the U.S. Atlantic coast at different times of year depending on migration and breeding patterns.

Table 3.2-2
Threatened, Endangered, or Candidate Marine Mammals of the Atlantic Region

Scientific Name	Common Name	Status*	Distribution in Region
Balaenoptera musculus	Blue whale	E	Population is highest in spring/summer because of northward migration from subtropics.
Balaenoptera physalus	Fin whale	E	Range from along the continental shelf between Cape Hatteras, NC, to northern ME.
Balaenoptera borealis	Sei whale	E	Range from ME to NC.
Megaptera novaeangliae	Humpback whale	E	Range from ME to NC.
Eubalaena glacialis	Northern right whale	E	Range from ME to the coastal waters along GA and FL.
Physeter macrocephalus	Sperm whale	E	Mostly found in deep waters, but migrate to shallower waters from ME to NC.
Tichechus manatus latirostris	Florida manatee	E	This manatee resides in rivers and coastal waters of peninsular FL and southern GA.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no marine mammals of the Atlantic region have T, C, or X status.

Nine species of threatened and endangered marine and coastal birds reside in selected habitats provided by the Atlantic region (Table 3.2-3). In the winter, the southern Atlantic region's populations of endangered shorebirds are augmented by large numbers of wintering individuals from northern ecosystems. Other endangered species reside temporarily along their route to South America. Bay, estuary, wetland, and coastal beach habitats provide the necessary biological diversity for a variety of protected migratory and indigenous bird species.

Table 3.2-3
Threatened, Endangered, or Candidate Marine and Coastal Birds of the Atlantic Region

Scientific Name	Common Name	Status*	Distribution in Region	Migration Pattern
Pelecanus occidentalis	Brown pelican	E	Atlantic coast from NJ south, Pacific coast, Gulf Coast	Some individuals migrate south in winter, while most are year-round residents of the northeast coast.
Polyborus plancus audubonii	Audubon's crested caracara	T	FL population is threatened and widely separated from the main species range, which extends from extreme southwestern LA, southern TX, and southern AZ to the tip of South America, including Tierra del Fuego and the Falkland Islands.	The FL population of Audubon's crested caracara is geographically isolated from other members of its subspecies.
Aphelocoma coerulescens	Florida scrub jay	T	FL	This is a year-round resident.
Ammodramus maritimus mirabilis	Cape sable seaside sparrow	E	Widely distributed over a large area of south FL; continues to occupy much of its historically known range in Collier, Dade, and Monroe Counties	This is a year-round resident.
Rostrhamus sociabilis plumbeus	Everglade snail kite	E	Previously located in freshwater marshes over a considerable area of peninsular FL; currently restricted to several impoundments on the headwaters of St. John's River; the southwest side of Lake Okeechobee; and the eastern and southern portions of conservation areas	This is a year-round resident.
Charadrius melodus	Piping plover	T	Atlantic coast, Great Lakes, Northern Great Plains, South Atlantic, Gulf Coast, and Caribbean; proposed critical habitat for wintering populations along Atlantic coast from NC south to FL and west along Gulf Coast to TX	The piping plover breeds on sandy beaches in isolated colonies on the northeast coast and Great Lakes regions from March to September, where it spends the summer. It winters along southeastern coast.
Mycteria americana	Wood stork	E	Recent U.S. breeding restricted to FL, GA, and SC; formerly bred in most of the southeastern United States and TX	This is a year-round resident.
Sterna dougallii	Roseate tern	T	Atlantic coast and Caribbean	The roseate tern breeds on islands and protected sand spits on the northeast coast during spring and summer, and migrates south as far as the Caribbean during autumn and winter.

continued

Table 3.2-3 (*continued*)
Threatened, Endangered, or Candidate Marine and Coastal Birds of the Atlantic Region

Scientific Name	Common Name	Status*	Distribution in Region	Migration Pattern
Picoides borealis	Red-cockaded woodpecker	E	Historically, range extended from FL to NJ, as far west as TX and OK, and inland to MI, KY, and TN; today, living in clusters (groups of cavity trees) from FL to VA, and west to southeast OK and eastern TX (representing about 1% of original range)	This is a year-round resident.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no marine and coastal birds of the Atlantic region have C or X status.

Two endangered and five candidate fish species are supported in this region (Table 3.2-4). In eight rivers, the wild Atlantic salmon (*Salmo salar*) is at an all-time low and faces a number of threats that could drive it to extinction. Shortnose sturgeon (*Acipenser brevirostrum*) is distributed as far south as Florida and as far north as New Brunswick, Canada. It once supported a substantial commercial fishery, but like other anadromous species, industrial use of rivers (beginning in the 1800s) and overfishing adversely affect its population. Highly sought after for its valuable caviar, Atlantic sturgeon (*Acipenser oxyrhynchus*) was typically found along the entire East Coast. Because of overfishing, it is now illegal to commercially fish Atlantic sturgeon, and retention as by-catch is prohibited.

Table 3.2-4
Threatened, Endangered, or Candidate Fish of the Atlantic Region

Scientific Name	Common Name	Status*	Distribution in Region
Salmo salar	Atlantic salmon	E	Population is located in the seven rivers along the coast of ME.
Acipenser oxyrhynchus	Atlantic sturgeon	C	Found in thirty-two rivers from ME to GA with spawning occurring in at least fourteen rivers.
Acipenser brevirostrum	Shortnose sturgeon	E	Population is found in brackish and freshwater estuaries of New England.
Epinephelus drummondhayi	Speckled hind	C	Speckled hind inhabit warm, moderately deep waters from NC to Cuba, including Bermuda, the Bahamas, and the Gulf of Mexico.
Rivulus marmoratus	Mangrove rivulus	C	The mangrove rivulus can be found from south-central FL down south through the West Indies to coastal areas of South America.
Carcharhinus signatus	Night shark	C	This shark has been reported in waters from DE south to Brazil, including the Gulf of Mexico.
Carcharhinus obscurus	Dusky shark	C	In the western Atlantic, it extends from southern New England to the Caribbean, and Gulf of Mexico to southern Brazil.

Source: Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (*http://www.nmfs.noaa.gov/pr/species/fish/*, accessed on October 15, 2002); USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no fish of the Atlantic region have T or X status.

Six species of sea turtles have been observed along the entire East Coast (Table 3.2-5). Although sea turtles live most of their lives in the ocean, adult females must return to land to lay their eggs. Most nesting occurs from North Carolina to the middle-west coast of Florida (Dodd, 1995). Their populations have declined because of many factors, but human disturbance is the main cause of the decline of sea turtle numbers. Incidental capture in shrimp trawls, loss of habitat from coastal development, artificial light on coasts causing disorientation of nesting females, and beach sand mining also harm population growth. Many also are lost in storms after being thrown onto beaches entangled in seaweed.

Table 3.2-5
Threatened, Endangered, or Candidate Sea Turtles of the Atlantic Region

Scientific Name	Common Name	Status*	Distribution in Region
Chelonia mydas	Green sea turtle	T / E	This turtle is occasionally sighted from MA south to TX, most commonly in nesting areas of the southeast FL nesting population is listed as endangered.
Eretmochelys imbricata	Hawksbill sea turtle	E	Although more common in tropical and subtropical waters, this turtle has been sighted from along the eastern seaboard as far north as MA, except CT. Sightings north of FL are rare.
Dermochelys coriacea schlegelii	Leatherback sea turtle	E	Range is from Nova Scotia to the southeast; during summer, this turtle is found along the East Coast, from the Gulf of Maine south to the middle of FL.
Caretta caretta caretta	Loggerhead sea turtle	T	Although more common in temperate, tropical, and subtropical waters, this turtle is also found from Newfoundland south. It nests in SC, GA, and FL.
Lepidochelys olivacea	Olive Ridley sea turtle	T	This turtle is more common in southern waters.
Lepidochelys kempii	Kemp's Ridley sea turtle	E	Population occurs mainly in coastal areas of the Gulf of Mexico and the northwestern Atlantic Ocean.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no sea turtles of the Atlantic region have C or X status.

Johnson's seagrass (*Halophila johnsonii*), a threatened plant species, exists in only a few narrowly defined locations along the east coast of Florida, from Northern Virginia Key to Sebastian Inlet (USCG, 2002). It forms extensive meadows of vegetation, which serve as an important food source for grazing marine animals such as the green sea turtle (*Chelonia mydas*) and the Florida manatee (*Trichechus manatus latirostris*). Because of its location, Johnson's seagrass is particularly susceptible to storm surges. In addition, this species is threatened by human trampling attributable to increasing land use, reduced water quality because of nutrient overenrichment from urban and agricultural land runoff, activities related to inlet maintenance, channel dredging, anchor mooring, and vessel traffic with resulting propeller scouring.

There are two species of *Acropora* coral that are in candidate status (Table 3.2-6). A variety of causes have forced a decline in the diversity of coral reefs and the degradation of coral reef habitats: diseases (e.g., white band), natural phenomena (e.g., hurricanes and temperature fluctuations), tourism (e.g., boat anchorings and ship groundings), sedimentation, land clearance, coastal development, and sewage discharges.

Table 3.2-6
Threatened, Endangered, or Candidate Coral of the Atlantic Region

Scientific Name	Common Name	Status*	Distribution in Region
Acropora palmata	Elkhorn coral	C	Elkhorn coral is found on coral reefs in southern FL and the Bahamas, and throughout the Caribbean Sea. Its northern limit is Biscayne National Park, FL, and it extends south to Venezuela.
Acropora cervicornis	Staghorn coral	C	Staghorn coral is found throughout the Florida Keys, Bahamas, and Caribbean islands. The northern limit is on the east coast of FL, near Boca Raton.

Source: Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (*http://www.nmfs.noaa.gov/pr/species/concern/profiles/elkhorn_coral.pdf* for elkhorn coral and *http://www.nmfs.noaa.gov/pr/species/concern/profiles/staghorn_coral.pdf* for staghorn coral, accessed on April 8, 2003).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no coral of the Atlantic region have T, E, or X status.

3.2.4. Essential Fish Habitat

The Fishery Conservation and Management Act of 1976 (FCMA) established eight regional Fishery Management Councils (FMCs), charged with developing Fishery Management Plans (FMPs) to achieve optimum fishery yields within their respective regions. In subsequent years, additional legislation was formulated to increase the effectiveness of this act. Two examples are the NMFS "602 Guidelines" ("Guidelines for the Preparation of Fishery Management Plans under the FCMA," 50 CFR part 602), which provided an official definition of overfishing and required each FMP to include measurable definitions of overfishing for each managed species, and the Sustainable Fisheries Act of 1996 (Public Law 104-297; 16 U.S.C. 1801 *et seq.*), which was passed and integrated into the Magnuson-Stevens Fishery Conservation and Management Act of 1996 (MSFCMA, Public Law 94-265, as amended through October 11, 1996; 16 U.S.C. 1801 *et seq.*). This later act required FMCs and the Secretary of Commerce to identify and describe Essential Fish Habitat (EFH) for species specified under each respective FMP.

There are three regional councils that are responsible for implementing the MSFCMA through FMPs in the Atlantic region: New England Fishery Management Council (NEFMC), Mid-Atlantic Fishery Management Council (MAFMC), and South Atlantic Fishery Management Council (SAFMC). Cumulatively, these three councils have developed twenty-four FMPs covering fish, shellfish, and coral habitats for this region. FMPs contain EFH designations for federally managed species. A list of commercially important fish species in the Atlantic region is contained in Table 3.2-1. It is important to identify habitat areas essential to each life stage of a federally managed species to ensure sustainable fisheries and the ability of managed species to contribute to a healthy ecosystem. EFH designations vary by species life-history requirements and comprise numerous habitat types, including coral, coral reefs, live-/hard-bottom, gravel, cobble, sand, submerged grass beds, and estuarine habitats. NMFS is currently reviewing EFH designation methodology and considering options to revise existing EFH designations, which will be available on-line upon completion[6].

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[6] *http://www.nmfs.noaa.gov/habitat/habitatprotection/efh/fish_manage_c.htm*

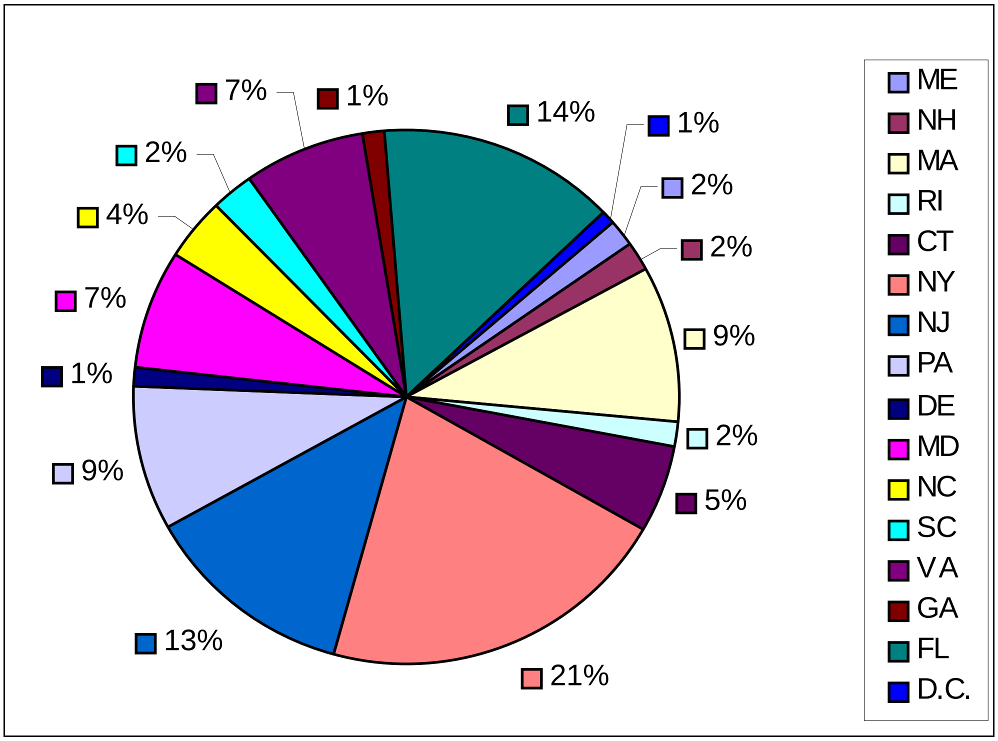
3.2.5. Socioeconomic Environment

3.2.5.1. Coastal Communities, Demography, and Employment

This socioeconomic impact area, based on NOAA's definition of coastal counties, comprises 285 coastal counties in the fifteen states listed in Section 3.2.1 (including the District of Columbia). The coastal counties in the socioeconomic impact area extend from Washington County, Maine, to Miami-Dade County, Florida.

The coastal population of the Atlantic region is 65,615,354 (U.S. Census Bureau, 2000a), which is calculated by combining population statistics for the region's 285 coastal counties, as identified by NOAA. Appendix F, Table F.2-6 lists these coastal counties and their populations. The Atlantic region's coastal population makes up 23 percent of the total U.S. population, of which the majority is located in New York, New Jersey, and Florida (Figure 3.2-6) (NOAA, 2002b; U.S. Census Bureau, 2000a).

Figure 3.2-6
Coastal Population Distribution of the Atlantic Region



Source: NOAA, 2002b; U.S. Census Bureau, 2000a.

The Atlantic region varies substantially in socioeconomic patterns ranging from low-density rural areas to high-density urban centers. The range is from 4,149 people in Tyrrell County, North Carolina, to 2,465,326 people in Kings County, New York. The East Coast of the United States holds some of the largest population centers in the country. Table 3.2-7 lists the most densely populated coastal counties of the Atlantic region.

Table 3.2-7
Highest Populated Coastal Counties of the Atlantic Region

County	Population
Kings, NY	2,465,326
Miami-Dade, FL	2,253,362
Queens, NY	2,229,379
Broward, FL	1,623,018
New York, NY	1,537,195

Source: NOAA, 2002b; U.S. Census Bureau, 2000a.

In 2000, the coastal counties within this region had a total civilian labor force of 35,541,083, with an average unemployment rate of 5.5 percent, compared with the national average of 5.8 percent. Income levels rank on par with the national average of per capita income and higher than the national average of median household income at $21,090 and $44,116, respectively. (The national average per capita and median household incomes are $21,587 and $41,994, respectively.) The levels of income vary throughout the region. For example, Allendale County, South Carolina, the poorest county in the region, has a per capita income of $11,293, while New York County, New York, the wealthiest county in the region, has a per capita income of $42,922 (U.S. Census Bureau, 2000a).

3.2.5.2. Economic Status

There are a variety of sectors that make up the foundation of the Atlantic region's economic system. Major population centers—such as New York, New York; Boston, Massachusetts; and Miami, Florida—provide financial and consumer services, as well as coordination and capital for large-scale wholesale, retail, and manufacturing in other Atlantic coastal areas. Foreign and domestic transportation, commerce, and communications industries are very prominent players in regional income, as are tourism and commercial fishing, which exist in many areas throughout the coast.

All along the Atlantic coast, there are public beaches, boardwalks, amusement parks, hotels, and resort areas for tourists that frequent the area, usually between the months of April and September, with the exception of Florida, which has peak tourism during the colder months of the year. For the Atlantic region, the American Coastal Coalition (ACC, 1998) estimates that the annual average revenue collected for tourism was more than $74 billion.

Commercial fishing activities in the region bring in a large portion of the total U.S. seafood catch. The American lobster catch alone is worth just over $300 million per year with scallops, goosefish, quahogs, and crab bringing in another estimated $360 million (Table 3-2.8). This industry has an extensive onshore service sector, including warehousing and transportation companies, canneries and packaging plants, sales and marketing firms, marine maintenance and support operations, and many other associated services.

Table 3.2-8
Top Commercial Landings for 2000* for the Atlantic Region

Scientific Name	Common Name	Pounds	Dollars
Homarus americanus	American lobster	86,926,003	314,255,145
Placopecten magellanicus	Sea scallop	32,162,513	160,885,844
Callinectes sapidus	Blue crab	109,665,827	95,320,668
Mercenaria mercenaria	Quahog clam	11,123,085	53,603,636
Lophius americanus	Goosefish	45,685,394	53,384,329

Source: NMFS, 2003a.

* Ranked by dollar value.

About 98 percent of the labor force of the region is employed in nonfarm activities (U.S. Census Bureau, 2000a). The largest economic activities in this sector are lodging, health, legal, education, retail and wholesaling, transportation, financial services (includes banking), and entertainment. In many areas, particularly in Connecticut, Maryland, Virginia, and Florida, there are heavy concentrations of U.S. military and government activities.

3.2.5.3. Vessel Transportation and Ports

Commercial, recreational, and federal agency vessels all contribute to vessel traffic along the Atlantic coast of the United States. There are many commercial ports receiving vessels from all over the world that serve as entry and exit points for millions of tons of commercial goods per year. In 1999, there were more than 511,000 vessel trips measured along waterways associated with major ports throughout the region (USACE, 1999a). The Port of New York and New Jersey is the third largest in the nation and the largest port on the East Coast of North America. Table 3.2-9 lists the major ports of the Atlantic region.

Table 3.2-9
Major Ports of the Atlantic Region

State	Port
ME	Portland
NH	Portsmouth
MA	Boston, New Bedford
RI	Providence
CT	New London, New Haven, Bridgeport
NY	New York, Albany
NJ	Newark, Trenton
PA	Philadelphia
DE	Wilmington
MD	Baltimore
VA	Norfolk, Hampton Roads
NC	Wilmington, Morehead City
SC	Charleston
GA	Savannah
FL (east coast)	Jacksonville, Port Everglades, Miami

Source: USACE, 1999a.

In 1999, the Atlantic region received or shipped from its ports more than 605,000 thousand short tons of foreign and domestic cargo: domestic shipping and receiving accounted for 96,164 and 160,025 thousand short tons, respectively, while foreign shipping and receiving accounted for 85,183 and 219,144 thousand short tons, respectively. In addition, there were 45,078 thousand short tons of intrastate waterborne commerce (USACE, 1999a).

The majority of the commodities being transported to Atlantic ports are petroleum based. Ports on the Delaware River receive the highest volume of petroleum products and crude oil on the eastern coast of the United States (Ford et al., 1992). More than 58 percent of all incoming shipments to the Port of New York and New Jersey are petroleum or a petroleum-based derivative (USACE, 1999a). In 1999, there were more than 148 oil spills in the Atlantic region (USCG, 1999a), which accounted for 2.5 percent of all oil spills in U.S. waters.

3.2.5.4. Fisheries

Commercial Fisheries

The commercial fishing sector is an important component of the Atlantic region's economy. During 2000, fisheries off the Atlantic region produced more than 1.5 billion lbs, valued at over $1.25 billion (NMFS, 2003a) that provided nearly 55 percent of all commercial fish landings in the continental United States. Table 3.2-8 lists the top commercial landings for the Atlantic region.

Recreational Fisheries

A major recreational activity is offshore fishing. The most commonly caught species by anglers in the region are Atlantic mackerel, croakers, cod, striped bass, sea bass, summer flounder, and bluefish. Although the number of anglers in certain areas depends on the proximity of population centers to the coast (e.g., Florida), anglers generally can be found throughout the region. In 2001, 6.2 million marine recreational fishing participants took 53 million trips and caught 244 million fish (NMFS, 2002). The eastern coast of Florida accounted for the highest number of trips at 24 percent, while Maine, New Hampshire, Delaware, and Georgia accounted for only a total of 6 percent (NMFS, 2002). For this region in 2001, the economic expenditures due to this fishery were approximately $8.6 billion (ASA, 2002)[7].

3.2.5.5. Subsistence

Information on subsistence use of fish and shellfish in the Atlantic region is limited. While some residents may supplement their diets with these resources, subsistence is not known to be a prominent activity in this area, as compared to Alaska, where Native communities may suffer substantial economic and cultural losses due to contamination of subsistence seafood during an oil spill.

3.2.5.6. Archaeological/Historic Resources

Lowering sea levels at the height of the last glacial epoch resulted in the lower sea levels of today, which exposed large areas of the continental shelf. Prehistoric people were present in the eastern United States as early as 12,000 years ago, at which time sea level along the East Coast was approximately 98 ft

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[7] This includes the total dollar amount from both coasts in Florida.

below present levels. Sea level reached its present stand sometime between 6000 and 3000 years B.P. (Before Present). A literature survey of inundated prehistoric sites in North America indicates that there are at least twelve known prehistoric sites below present sea level along the East Coast between Penobscot Bay, Maine, and Long Island, New York (Stright, 1990). These sites range in age from late Paleo-Indian to Woodland (ca 9000 to 3000 B.P.), and in elevation from 31 ft below present sea level to mean low tide. Many such inundated prehistoric sites may exist on the Atlantic Outer Continental Shelf (OCS) but have not yet been discovered. For any possible prehistoric sites on the OCS to be preserved intact, they would have to have been buried beneath sufficient sediment to protect them from the forces of erosion. Environments capable of such burial include the marsh-lagoon-barrier system and the floodplain-marsh-estuary system. Evidence of the buried remains of these environments has been found offshore New Jersey, Delaware, Maryland, Virginia, South Carolina, and Georgia. For example, of Georgia's nearly 30,000 recorded archaeological sites, less than 2 percent are within 1,000 ft of a shore or coastline, and only 222 sites are submerged cultural resources (GaDNR, 1998).

Most historic sites located in the coastal region are listed on the National Register of Historic Places or eligible for nomination to the register. These are ports, coastal fortifications, historic districts, and lighthouses that are frequently protected from the sea by bulwarks or other barriers.

The thousands of known shipwrecks along the Atlantic coast are concentrated in areas of shoals, historic ports, and areas of major hurricane occurrence. Locations of the vast majority of shipwrecks are only approximations and are listed in general terms, such as "off Cape Hatteras." The state of preservation of shipwreck sites depends on a number of factors, including sea state, water depth, bottom type, nature of adjacent coast, strength and direction of storm waves and currents, and size and type of construction of the vessel. The preservation potential for historic shipwrecks along much of the Atlantic coast is low, primarily because of the strong current and wave regimes. The heavy wave action that often causes ships to wreck also causes damage to the wrecks or destroys the remains. This is especially true of the Georges Bank, Nantucket Shoals, and Cape Hatteras areas where sediments are frequently reworked by strong currents.

3.2.5.7. Recreation and Tourism

The Atlantic region contains the largest population base of the regions in this PEIS, along with one of the longest coastlines. This equates to a major recreational region for the United States, particularly in connection with marine fishing and beach-related activities. Tourists from domestic and foreign locations come to the coastal beaches, barrier islands, estuarine bays and sounds, and tidal marshes. Publicly owned and administered areas (such as national seashores, parks, beaches, and wildlife lands), as well as designated preservation areas (such as historic and natural sites, landmarks, wilderness areas, wildlife sanctuaries, and scenic rivers), attract residents and visitors throughout the year. Commercial and private recreational facilities and establishments, such as resorts, marinas, amusement parks, and ornamental gardens, also serve as primary areas of interest.

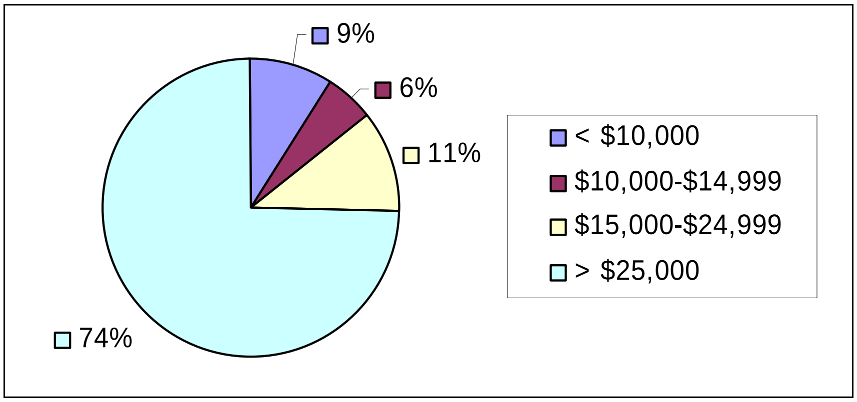
For 1996, the ACC (1998) stated tourism totals for the Atlantic region were $74,871,590,000. In this region, Florida had the highest coastal tourist expenditures at $30,232,090,000, while Rhode Island had the lowest coastal tourist expenditures at $794,300,000.

3.2.5.8. Environmental Justice

Executive Order 12898 ("Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," 59 FR 7629) provides that each federal agency shall make achieving environmental justice part of its mission by identifying and addressing questions regarding environmental and health conditions of impoverished communities.

Low-income communities, which can be found across the Atlantic region, include multiethnic as well as homogenous communities and neighborhoods. Of the 18,246,940 families that live within the coastal counties of this region, 8.5 percent (or 1,561,012) have been classified as living in poverty by the U.S. Census Bureau (2000a). The average per capita and median household incomes of this region are $21,090 and $44,116, respectively. However, 26 percent of households earned less than $25,000 in 1999. Figure 3.2-7 shows the distribution of household income in the Atlantic region.

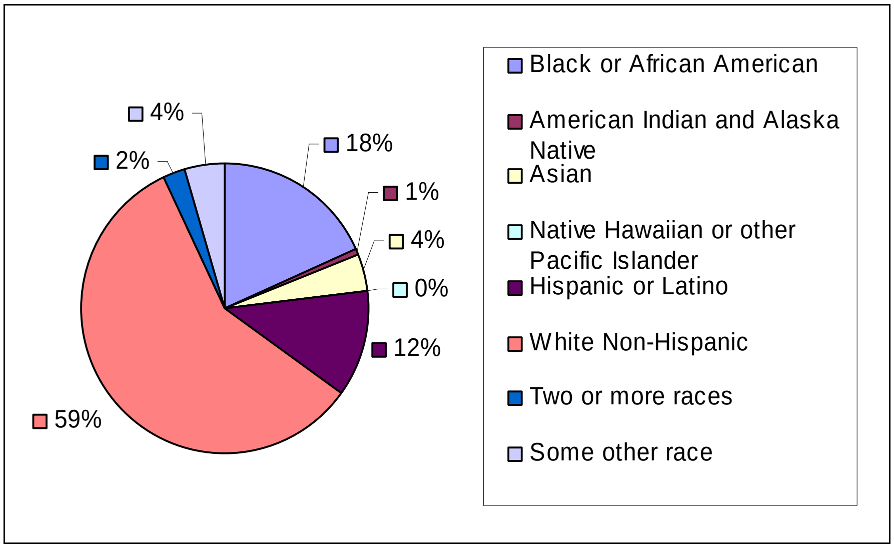
Figure 3.2-7
Distribution of Household Income in the Atlantic Region



Source: U.S. Census Bureau, 2000a.

Minority groups are scattered throughout the Atlantic region. These groups include Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian or other Pacific Islander, or other (Hispanic or Latino, and white Non-Hispanic). Figure 3.2-8 shows the distribution of race in this region.

Figure 3.2-8
Distribution of Race in the Atlantic Region



Source: U.S. Census Bureau, 2000a.

3.2.5.9. Public Safety and Worker Health

Oil spill response is one of the U.S. Coast Guard's (USCG's) many missions. In responding to oil spills, the USCG is aware of public safety and the effects that alternative response technologies—chemical dispersion and *in situ* burning—could have on human health. Under the guidelines established by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), steps have been taken to protect both the public and oil spill responders. Whether compensated workers or volunteers, responders are required to be certified under either the Occupational Safety and Health Administration's (OSHA's) Hazardous Waste Operations and Emergency Response Standard or USEPA's Hazardous Waste Operations and Emergency Response Standard. These standards ensure that responders understand the hazards of oil spill response and how to protect themselves. To assist in public safety, the USCG has the maritime safety authority to establish a safety zone around oil spill cleanup operations. This zone is established to safeguard the public and responders from the hazards associated with cleanup. In addition, USCG standard operating procedures (SOPs) are used to protect responders, as well as the public, from the hazards associated with chemical dispersion and *in situ* burning. These procedures are outlined in SOPs in each Area Contingency Plan's (ACP's) Site Safety Plan. In addition, training exercises such as PREP (Preparedness for Response Exercise Program) and SONS (Spill of National Significance) train USCG response personnel to avoid safety hazards.

Dispersants are a liquid chemical used to disperse oil spills from the ocean surface (see Section 2.2.2). During an oil spill, dispersant application can be done from either an aerial or a shipboard platform. In both cases response personnel have the potential to be accidentally exposed to the dispersant, and in extreme cases exposure to the public could occur. The two types of dispersants with use allowed in the United States have OSHA-established, permissible exposure limits of 50 ppm on skin. The Material Safety Data Sheet (MSDS) for these dispersants makes clear the human health concerns from excess exposure.

In situ burning of an oil spill entails setting contained or boomed oil on fire (see Section 2.2.3). This action has been acknowledged as having potential human health and safety effects. Besides the physical hazards to responders, there is the potential for inhalation of airborne burn products. *In situ* burning emits a plume of black smoke laden with particulates (PM10, soot), the main public health concern. Response personnel working close to the burn may be exposed to levels of gases and particulates that would require them to use personal protective equipment. Occupational standards such as OSHA's Permissible Exposure Limits (PELs) are applicable. For the general public, NOAA (2000a) reported that particulate concentrations in a smoke plume remain the only agent of concern past 1 or 2 mi downwind, with the gases created in a burn dissipating to levels close to background. Public exposure to smoke particulate from the burn is not expected to occur unless the smoke plume travels down to ground level. Since the general public may include sensitive individuals, such as the very young and very old, pregnant women, and people with pulmonary or cardiovascular diseases, this population's tolerance to particulates may be significantly lower than that of the responders. There is little data concerning the effect on humans of particulates from the *in situ* burning of oil. Based on chemical analysis of soot particulates and their physical behavior, the hazard is expected to be similar to that of better-known particulate emissions that are now regulated by the NAAQS. In 1997, the Special Monitoring of Applied Response Technologies (SMART) protocol[8] was created, in part, to address the particulates concerns and to better aid the Federal On-Scene Coordinator (FOSC) in making decisions related to initiating, continuing, or terminating *in situ* burning.

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[8] *http://response.restoration.noaa.gov/oilaids/SMART/SMART.html*

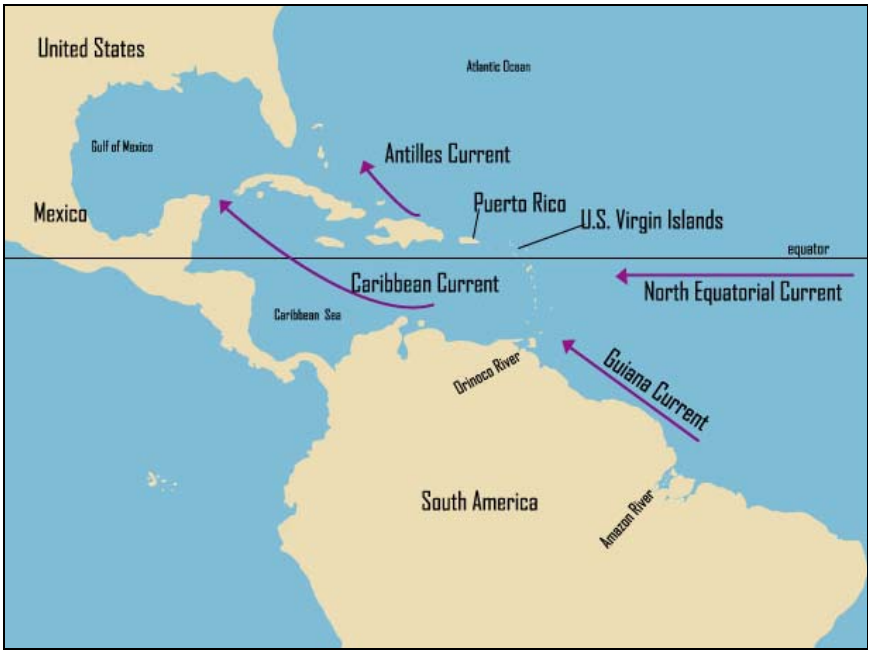
3.3. CARIBBEAN REGION

3.3.1. Physical Environment

For the purpose of this Programmatic Environmental Impact Statement (PEIS), the Caribbean region consists of the tropical waters of the Caribbean Sea and Atlantic Ocean and is enclosed to the south by Venezuela, Colombia, and Panama; to the west by Belize, Honduras, Nicaragua, and Costa Rica; and to the north, it wraps toward the southeast with the Greater and Lesser Antilles Islands, beginning with Cuba and ending with Trinidad and Tobago. The tropical waters of the southwestern Atlantic Ocean are off the north shores of Puerto Rico and the U.S. Virgin Islands (the U.S.-affiliated islands discussed in this section), and the tropical waters of the Caribbean Sea are off their south and west shores (Figure 3.1-1).

The North Equatorial Current, at an average speed of 0.7 kt (NIMA, 2003), is the dominant hydrological driving force in the Caribbean region, entering from the Atlantic Ocean in the east through passages between the Lesser Antilles Islands (Figure 3.3-1). It becomes the Caribbean Current, which travels west, and combines with the Guiana Current, which flows along the northern coast of South America and moves northwest into the Gulf of Mexico (Andrade and Barton, 2000; Murphy et al., 1999). The Guiana Current is highly influenced by the freshwater discharges of the Amazon and Orinoco Rivers. The Amazon River is the largest point source of fresh water entering the Atlantic Ocean (Morrison and Smith, 1990), so variations in riverine contributions may play a major role in altering the Caribbean region's marine water.

Figure 3.3-1
Major Currents of the Caribbean Region



Note: Map is not to scale.

Off the north coast of Puerto Rico and U.S. Virgin Islands, the Antilles Current flows northward from east of the Lesser Antilles Islands and joins the Florida Current past the outer Bahamas. Its waters are concentrated into a strong northward jet approximately 50 to 62 mi wide and centered at about 1,312 ft (Lee et al., 1996). The Caribbean Current is 62 mi to the south and west of the Caribbean region and flows at an average speed of 0.5 to 1.0 kt. Currents in the nearshore areas of Puerto Rico and U.S. Virgin Islands are complex as a result of the interaction among the dominant North Equatorial Current and local winds, waves, tides, coastal configuration, bathymetry, and coastal stormwater discharges (USEPA, 1992a).

One of the factors affecting the chemical characteristics of the marine waters of Puerto Rico and the U.S. Virgin Islands is the large freshwater input to the region from the Orinoco River plume, which originates in Venezuela. This plume can carry high concentrations of suspended particles, unique chemical properties, and biota near the southern coasts of Puerto Rico and the U.S. Virgin Islands. The plume, enriched with nutrients, can be responsible for events of high turbidity and algal blooms that usually occur in the eastern Caribbean basin in October. The result is a large seasonal variation in the surface salinity levels with 36.3 parts per thousand (ppt) in June and 34.1 ppt in September. Coastal surface water temperatures remain fairly constant throughout the year averaging between 79° and 86°F (Steel, 1994).

3.3.1.1. Water Quality

Coastal

The U.S. Environmental Protection Agency (USEPA, 1998a) compiled assessments of the Caribbean region water quality within estuaries and coastal waters in its 305(b) report. Approximately 62 percent of this region's estuaries were surveyed, of which 10 percent were classified as fully supporting use and another 11 percent were classified as having good quality. However, the survey also showed that 27 to 40 percent of the region's ocean shoreline were classified as either threatened or impaired by some form of pollution or habitat degradation for their designated uses (aquatic life, swimming, and fishing). Data gathered by the Caribbean Oil Pollution Database indicates that concentrations of dissolved/dispersed petroleum hydrocarbons are generally low in offshore waters, while relatively high levels are found in enclosed coastal areas (UNEP, 1994).

Primary activities contributing to the degradation of coastal water quality include those associated with metals and wastes from land disposal sites, pathogens from unknown sources, industrial and municipal discharges, collection system failures, spills, marinas and marine waste (cruise ships), urban runoff, human biosolids, and general beach pollution. Although the Caribbean region's water quality is relatively good, it has been declining because of point and non-point source pollution discharges. Municipal wastewater treatment plants pose a particular point source problem to this region because of pipe breakages, efficiency problems, and bad management. Lack of erosion control measures during coastal development, failing septic systems, and urban stormwater runoff are the primary non-point sources of coastal pollution in the region. Heavy metals, chlorinated hydrocarbons, petroleum hydrocarbons, and wastewater discharge products are noticeable problems in a few areas according to the most recent 305(b) reports for Puerto Rico and the U.S. Virgin Islands (USEPA, 1998a).

Marine

One of the factors affecting the chemical characteristics of regional marine water quality is the water advected to the region from the freshwater discharges of the Orinoco and Amazon Rivers. The Orinoco River, with one of the largest discharge zones in the world, has been estimated by the United Nations Environment Programme (UNEP, 1994) to have an average annual sediment discharge of 85×10^6 tons. The Amazon River discharges between 80,000 and 250,000 m^3/s of fresh water, which results in a plume of brackish surface water that extends hundreds of miles seaward and northwest along the coast of South America to the Caribbean Sea (Geyer et al., 1991).

Because of its important location along the Mona and Anegada Passages (key shipping lanes for the Panama Canal and two of the best natural deepwater harbors in the Caribbean), the Caribbean region experiences large amounts of vessel traffic. It is estimated that 25 percent of the world's sea-borne oil travels through this region every year (Roach, 2002). In 1999, this traffic was responsible for seventy-nine spills and 2,939 gal of spilled oil within U.S. territorial waters (USCG, 2000a).

The cruise industry is integral to the Caribbean economy. Hundreds of thousands of tourist arrive every year on cruise ships, with the cruise industry expanding at a steady rate of 8 percent per year (Schmidt, 2000). Cruise ships emit large amounts of point source pollution that has the potential to affect marine water quality in adverse ways. On a 1-week voyage, a typical cruise ship generates an estimated 210,000 gal of sewage and can legally discharge this waste into the water as long as it is beyond the 3-mi limit of U.S. navigable waters. In addition, this cruise ship produces 1,000,000 gal of gray water, which contains detergents, cleaners, oil, grease, metals, pesticides, and medical and dental wastes. According to existing regulations, gray water can be discharged anywhere outside the U.S. Great Lakes (USEPA, 2000a).

3.3.1.2. Meteorology and Air Quality

Climate

Because of their locations in the tropics, Puerto Rico and the U.S. Virgin Islands are highly affected by the predominately easterly trade winds and by the north-south migration of the inter-tropical convergence zone. The trade winds blow consistently from the east (east-south-east, east-north-east) at 10 to 15 kt but can vary in magnitude as the relative strength of the Bermuda High (to the north) and the Equatorial Trough (to the south) varies with the seasons (Steel, 1994). Winter months are designated the dry season, when easterly trade winds are relatively shallow and are generated by relatively weak and cold migratory high-pressure cells that move off the North American continent, displacing the semipermanent Bermuda ridge south of its normal summertime position. The principle air mass during the winter is maritime tropical, with very brief periods of extremely modified continental polar air. Summer months are designated the wet season. Puerto Rico and the U.S. Virgin Islands are in the tropical hurricane region of the eastern Caribbean Sea. As a result, tropical storms and hurricanes, while infrequent, can bring brief heavy rains and winds to this region.

Air Quality

Air quality of the Caribbean region is measured against National Ambient Air Quality Standards (NAAQS), resulting from the Clean Air Act and its 1977 amendments (40 CFR 50.12). These standards are designed to protect human health. The USEPA requires states and territories to report ambient air quality levels for six major pollutants: particulate matter (10 microns or larger [PM10]), sulfur dioxide, carbon monoxide, nitrogen dioxide, lead, and ozone. Appendix F, Table F.1-1 summarizes federal ambient air standards in detail.

Although there are limited numbers of ambient air monitoring stations located in Puerto Rico and the U.S. Virgin Islands, it is generally held that the region has some of the best air quality in the United States because of location and prevailing weather conditions. In 2001, only one U.S.-affiliated island county in the Caribbean region exceeded NAAQS for particulate matter (PM10); none of the remaining federal criteria air pollutants exceeded NAAQS (USEPA, 2000b).

Recent studies have attempted to link blowing dust from the plains of Africa to an increase in asthma and other respiratory disease cases within the Caribbean region. This dust contains beryllium-7, lead 210, elevated mercury, arsenic, and other airborne pollutants that remain within the dust during its trip west across the Atlantic Ocean. This dust has also been associated with Red Tide and amphibian diseases (Ballingrud, 2000).

3.3.2. Biological Environment[9]

3.3.2.1. Marine Mammals

Twenty-three cetaceans (whales and dolphins), two pinnipeds (seals), and one sirenian (manatee) have been spotted in the Caribbean region. Whales and dolphins are an intricate part of the marine and coastal fauna of the northeastern Caribbean Sea, with some of the islands serving as primary habitat for the mating and calving of endangered species. However, the majority of information on marine mammals in this region comes from strandings and opportunistic sightings; as such, data on basic biology, life history, and distribution is lacking (Mignucci-Giannoni, 1998). Appendix F, Table F.3-1 lists nineteen recognized nonendangered marine mammals in this region.

3.3.2.2. Marine and Coastal Birds

The offshore waters, coastal beaches, wetlands, and mangrove areas of the Caribbean region provide habitats for both migrant and resident marine and coastal birds. A combined total of 247 native bird species are located in Puerto Rico (239 species) and the U.S. Virgin Islands (199 species) (USGS, 1998b) although not all occur within the area covered by this PEIS. In addition, thirty-seven nonindigenous species have been introduced to the region, and, in the winter, native populations are augmented by large numbers of migratory wintering birds that arrive from more northern habitats.

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[9] Only nonendangered species will be included in Section 3.3.2, Biological Environment. Threatened, endangered, and candidate species will be discussed separately in Section 3.3.3, Threatened, Endangered, or Candidate Species. For this reason, sea turtles will only be discussed in Section 3.3.3, as they are a threatened/endangered species in the Caribbean region.

The presence of ten Ramsar sites and eight National Wildlife Refuges in the Caribbean region indicates that large numbers of wetland birds concentrate in the area during migration and/or nesting and wintering. The Ramsar Convention on Wetlands designates Ramsar sites as wetlands of international importance. These wetlands are selected based on criteria such as supporting 20,000 or more waterbirds and regularly supporting 1 percent of the individuals in a population of one species or subspecies of waterbird (Wetlands International, 2004). The National Wildlife Refuge sites are established under the National Wildlife Refuge System Improvement Act of 1997 with the aim of protecting wildlife and preserving biological diversity (USFWS, 2004).

For the purpose of this PEIS, marine and coastal birds are categorized into five major groups, as detailed in Appendix F, Table F.3-2: seabirds, shorebirds, wading and marsh birds, waterfowl, and raptors.

3.3.2.3. Plankton and Fish

Plankton

Plankton are organisms that float at or near the surface of marine waters and are unable to swim against tides, winds, or currents. Plankton species, which represent nearly all major aquatic phyla, can be roughly classified as phytoplankton (microscopic plant life), zooplankton (microscopic animals), and ichthyoplankton (fish eggs and larvae). Because of the relatively oligotrophic, or nutrient-poor, marine waters of the Caribbean region, plankton communities are primarily distributed near highly productive coral reefs and estuarine zones.

Phytoplankton are microscopic floating algae, which form the base of the food web. They are responsible for approximately one-half of global photosynthesis and play a vital role in stabilizing atmospheric carbon dioxide. These plants can only survive and produce in the shallower, sunlit waters of open-ocean and estuarine areas. Phytoplankton in the Caribbean region is highly influenced by the advection of the nutrient-rich Orinoco River plume, which increases the abundance and species diversity of the Caribbean Sea's phytoplankton during periods of high outflow (usually August through October). This plume also actively transports coastal diatom populations into the Caribbean Sea, as well as into the immediate waters south of Puerto Rico. In the tropical bays surrounding Puerto Rico and the U.S. Virgin Islands, the phytoplankton community is predominantly composed of diatoms (82 percent) and dinoflagellates (12 percent), with the blue-green algae of the genus *Trichodesmium* and other algae forms making up the other 6 percent (EcoEléctrica, 1996).

Zooplankton, which consume phytoplankton, spend either part (meroplankton) or all (holoplankton) of their life cycle as plankton. Their temporal and spatial distributions depend on a number of factors including currents, water temperature, and phytoplankton abundance (Loeb et al., 1983). Zooplankton are a critical link in the transfer of energy from primary producers (phytoplankton) to predators, so any process influencing the abundance and distribution of zooplankton can ultimately have an impact on fisheries. The most common phylum of zooplankton within the Caribbean region are Coelenterata, Mollusca, Arthopoda, Chaetognatha, and Chordata. Zooplankton communities consist primarily of Cirripod (barnacles), Veliger (gastropods), Penaeoid (shrimp), Caridean (shrimp), and Brachyuran (crab) larvae (EcoEléctrica, 1996).

It has been observed that the highest density of fish eggs and larvae are generally in waters less than 131 ft deep. There are seventy-seven fish families, including at least ninety-five species. Dominant ichthyoplankton groups in the region are Engraulidae (anchovies), Gobiidae (gobies), Clupeiformes (herring-like), Blennidae (blennies), Tripterygiidae, Bragmacerotidae (codlets), and Myctophidae (laternfishes) (EcoEléctrica, 1996).

Fish

Because of the oligotrophic waters of the Caribbean region, most commercially important fish resources are located in or around the highly productive tropical coral reefs or in enclosed bays and estuarine areas. These fish resources consist of reef fish and shellfish. The Caribbean Fishery Management Council manages the fisheries in this region. In 2000, the commercial yield of fish by weight in the Caribbean region was over 2 million lbs (NMFS, 2001). Table 3.3-1 lists the commercially important fish species of the Caribbean region.

Table 3.3-1
Commercially Important Fish Species of the Caribbean Region

Common Name	Scientific Name
Amberjack	*Seriola* spp.
Blackfin tuna	*Thunnus atlanticus*
Blue sharks	*Prionace glauca*
Bluefin	*T. thynnus*
Caribbean spiny lobster	*Panulirus argus*
Dolphinfish	*Coryphaena* sp.
Goliath grouper (jewfish)	*Epinephelus itajara*
Grunts (5 species)	*Pomadasyidae*
Hinds	*Epinephelus* spp.
King mackerel	*Scomberomorus cavalla*
Nassau grouper	*Epinephelus striatus*
Other groupers (4 species)	*Epinephelus*
Pelagic sharks	*Elasmobranchii*
Porbeagle sharks	*Lamna nasus*
Queen conch	*Strombus gigias*
Shrimp (6 species)	*Natantia*
Striped bonito	*Sarda orientalis*
Snapper (10 species)	*Lutanidae*
Wahoo	*Acanthocybium solandri*
Yellowfin	*T. albacares*

Source: Adapted from USCG, 2002.

Because of their close proximity to shore, coupled with their long lives, slow growth, ease of capture, large body size, delayed reproduction, and other factors, reef fish within the Caribbean region are very vulnerable to overfishing and habitat destruction. Spiny lobster populations, which are an important fish resource for both recreational and commercial fisherman in the region, have declined in inshore areas because of the destruction of numerous mangrove estuaries for coastal development, overfishing, and pollution, which has lowered water quality at several lobster nursery sites (Quinn and Kojis, 1997).

3.3.2.4. Intertidal Habitats

Beaches

The Caribbean region has 875 mi of shoreline (Good et al., 1998), containing a mix of sand and gravel beaches, salt ponds, rock cliffs, and mangroves. The coastal beaches are important not only for the ecological systems of the islands, but also for their economic integrity in terms of tourism and recreation. Beaches in the region are threatened by erosion from both manmade and climatic sources. Hurricanes and other weather events have removed sand from some beaches while adding sand to others. Coastline development and bad soil management practices have contributed significantly to erosion in the region. In addition, beach sand and gravel are illegally harvested for construction purposes in Puerto Rico (USGS, 1996).

Estuaries, Wetlands, and Mangroves

Estuaries are important habitats for both resident and transitory species, providing spawning or nursery habitats and foraging areas for numerous species, including invertebrates, fishes, reptiles, birds, and mammals. High organic productivity, high detritus production, and extensive nutrient recycling characterize estuaries. Examples of estuaries in the region are San Juan Bay and Jobos Bay in Puerto Rico. Many different habitat types are found in and around estuaries, including shallow marine waters, freshwater and salt marshes, sandy beaches, mud and sand flats, rocky shores, mangrove forests, tidal pools, and seagrass beds.

Wetland habitats are associated with estuarine areas. These habitats may occupy only narrow bands along the shore, or they may cover larger expanses at the mouths of bays, rivers, or coastal streams. There are 242 mi^2 of wetlands in Puerto Rico and the U.S. Virgin Islands (Good et al., 1998). The prominent types of wetlands in this region include mangrove forests, herbaceous marshes, freshwater swamps, and riverine forests. These wetlands provide habitats that sustain commercial fisheries and many endangered species, as well as reduce the impacts of floods to adjacent areas. Wetlands in the Caribbean region have been reduced by more than 50 percent, mostly from drainage for agriculture, flood control projects, and urban and industrial development (Good et al., 1998).

A significant amount of mangrove forest remains in the Caribbean region; nearly 25 mi^2 of mangrove forest is scattered around Puerto Rico's coastline. While scattered mangrove trees occur along the coast of the U.S. Virgin Islands, mangrove forests have only survived at Salt River, St. Croix, and Jersey Bay, St. Thomas; the larger mangrove areas have been cleared for development (OTA, 1987). Only four of the eighty observed species of mangrove in the world occur in the Caribbean region. They consist of several salt-tolerant tree species, including black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), red mangrove (*Rhizophora mangle*), and buttonwood mangrove (*Conocarpus erectus*). Important to the region are the small islands formed by clumps of red mangrove trees that extend landmasses seaward because of the trees' ability capture sediments and debris. This network of mangrove islands, cays, and channels provide inland areas with an important buffer from the action of stormy seas (EcoEléctrica, 1996). Mangroves also serve as nurseries for many reef and marine fishes, which are economically important commercial species. Mangrove ecosystems of the Caribbean region are also important to birds and other animals that depend on the high concentrations of fishes and invertebrates located in these areas.

Despite their ecological importance, mangrove forests are under intense pressure from human activities. Nearly 75 percent of previously existing mangroves in Puerto Rico and 40 to 50 percent of previous mangroves in the U.S. Virgin islands have been destroyed over the past 50 years (USEPA, 1998b; USVI DPNR, 2001). Because of their high occurrence in protected bays, mangrove forests are ideal sites for marinas and boat facilities. Coastal development has greatly reduced the amount of mangrove forests throughout the region even though they have been protected under law for the last two decades.

3.3.2.5. Subtidal Habitats

Submerged Grass Beds

The subtidal (benthic) areas of the Caribbean region consist of either soft or hard-bottom substrates. These areas support a variety of marine life and habitats, including seagrass beds and coral reefs. Submerged grass beds are highly productive ecosystems that are located extensively throughout the Caribbean region and often occur in close association with shallow-water coral reefs. Submerged grass beds contribute to both the physical and biological aspects of estuarine and nearshore marine habitats and play an important role in reducing coastal erosion by trapping and consolidating bottom sediments with their extensive root and rhizome systems. There is a high level of diversity and abundance among marine species that are associated with submerged grass beds, especially in tropical regions such as the Caribbean. Many vertebrates and invertebrates, including a substantial amount that are of commercial importance, occur in submerged grass beds at some point in their life history (CFMC, 1998). These beds are also important grazing areas for some endangered species, such as the green sea turtle (*Chelonia mydas*) and the West Indian manatee (*Trichechus manatus*).

Within the surrounding coastal waters of the Caribbean region, there are more than 16,358 acres of submerged grass beds. They are highly diverse, consisting of seven different species. These include *Thalassia testudinum* (turtle grass), *Halophila decipiens, H. baillonii, H.engelmannii* (sea vines), *Halodule wrightii* (shoal grass), *Syringodium filiforme* (manatee grass), and *Ruppia maritima* (widgeon grass). Turtle grass, manatee grass, and shoal grass are the three most abundant species (CFMC, 1998).

Among the current threats to submerged grass beds are intensive recreational use, siltation from coastal development, and dredge and fill operations for the creation of ship channels and docking accommodations. Figures 3.3-2 and 3.3-3 show the locations of known submerged grass beds in this region.

Coral Reefs

Coral reefs are the most import ecological (and economic) coastal resources in the Caribbean. They act as barriers to storm waves, provide habitat to a wide variety of marine organisms including most of the economically important species of fish and shellfish, are the primary source of carbonate sand, and serve as the basis for much of the tourism in the Caribbean region.

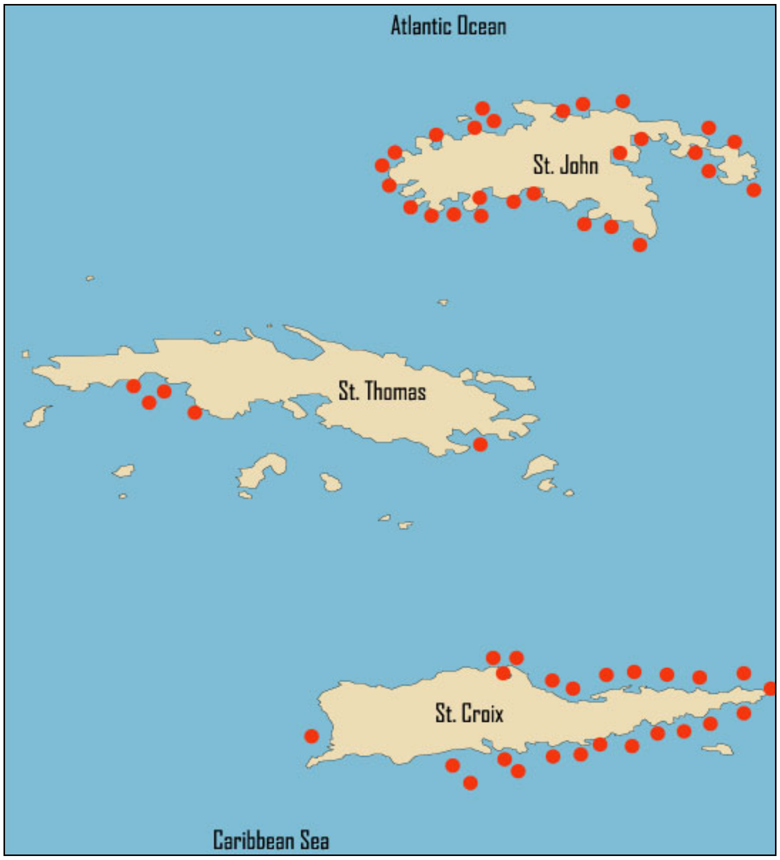
The Caribbean region has 168,032 acres of coral reefs consisting of the Acropora, Montastraea, Porites, Diploria, Siderastera, and Agarica genera. Of these, elkhorn coral (*Acropora palmate*) and Boulder star coral (*Montastraea annularis*) are generally the most numerous species, although in some areas other species such as staghorn coral (*Acropora cervicornis*) may be more common. Almost all coral resources of this region are fringing reefs, except a small barrier reef off St. Croix and several offshore patch reefs and bank structures (Spalding et al., 2001; USEPA 1992b). There are 30,080 acres of reefs in the region that are in protected areas, including Boqueron, Cayos de la Cordillera, Bahia Jobos, Isla Caja de Muerto, Isla Mona, and La Parguera in Puerto Rico (Figure 3.3-4) and Buck Island, Green Cay, Hind Bank, and Virgin Islands National Park in the U.S. Virgin Islands (Figure 3.3-5).

Figure 3.3-2
Locations of Submerged Grass Beds in the Caribbean Region—Puerto Rico

Source: USEPA, 1992a.

Note: Map is not to scale.

Figure 3.3-3
Locations of Submerged Grass Beds in the Caribbean Region—U.S. Virgin Islands



Source: USEPA, 1992a.

Note: Map is not to scale.

Figure 3.3-4
Coral Reefs in the Caribbean Region—Puerto Rico

Source: National Oceanic Data Center, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (*http://www.nodc.noaa.gov/col/projects/coral/Coralhome.html*, accessed on June 13, 2002).

Note: Map is not to scale.

Figure 3.3-5
Coral Reefs in the Caribbean Region—U.S. Virgin Islands

Source: National Oceanic Data Center, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (*http://www.nodc.noaa.gov/col/projects/coral/Coralhome.html*, accessed on June 13, 2002).

Note: Map is not to scale.

Well-known areas of pinnacles are found in southwestern Puerto Rico (specifically to the southeast of Turromote Reef in La Parguera) and are reported for the area south of St. John. These structures submerge and extend from depths of about 16 ft from the surface. Generally associated with these structures are pillar coral (*Dendrogyra cylindrus*) and/or Boulder star coral (*Montastraea annularis*), which are live corals that constitute very attractive sites for recreational diving (CFMC, 1998).

Similar to surrounding areas, the Caribbean region's reefs have been heavily affected by disease, coral bleaching, and manmade disturbances. Diadem (a coral disease) and two coral-bleaching events (1986 through 1989 and 1998) resulted in significant amounts of mortality for the discontinuous reefs along the eastern, western, and southern shores of Puerto Rico. Other negative impacts have been from the clearing of Puerto Rico's mangrove forests along with dredging, agricultural runoff, pollution from untreated sewage, sedimentation from coastal runoff, and oil spills.

The coral reefs of the U.S. Virgin Islands have been affected heavily by disease, hurricanes, and tourism. Hurricanes including the most recent Hugo, Luis, and Marilyn have had various impacts on the surrounding reefs. White band disease has killed many acroporid corals, especially the elkhorn coral (*Acropora palmate*) one of the primary reef-building corals in the Caribbean (USGS, 1998c). Tourism has caused significant harm via boat anchorings and ship groundings. The Virgin Islands National Park on St. John attracts 1 million visitors per year, most of whom arrive on cruise ships or smaller boats adding numerous anchorage impacts in a single year (USGS, 1998c). Other threats include sedimentation, land clearance, coastal development, and sewage discharge from septic systems.

3.3.2.6. Areas of Special Concern

Executive Order 13158 ("Marine Protected Areas") defines marine protected areas as "any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein" (65 FR 34909). There are many different types of marine protected areas within and bordering U.S. waters; some examples include National Marine Sanctuaries, National Seashores, National Parks, National Monuments, National Wildlife Refuges, National Estuarine Research Reserves, and many others (NOAA, 2002a). They have different shapes, sizes, and management characteristics and have been established for different purposes.

There are four National Park units, eight National Wildlife Refuges, one National Estuarine Research Reserve, one National Estuary Program, and one Marine Conservation District. For more details regarding history, purpose, and specific site locations pertaining to this region, see Appendix F, Tables F.3-3 through F.3-5 and Figures F.3-1 through F.3-6.

3.3.3. Threatened, Endangered, or Candidate Species

The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have classified three threatened and thirteen endangered species in the Caribbean region; in addition, they are currently evaluating the status of six candidate species. These consist of seven marine mammals, five marine and coastal birds, four fish species, four sea turtles, and two coral species.

Five cetaceans, one sirenian, and one pinniped are endangered and reside in and migrate through this region (Table 3.3-2). The protected bays and coastal areas of the Caribbean region, with their warmer water temperatures, lure these species and sightings are frequent. The West Indian manatee (*Trichechus manatus*) moves to different areas in the winter and summer depending on the temperature regime; the manatee's breeding cycles, slow mobility, and friendly nature, plus increased human activity within its habitual areas, impact and endanger this species. The Caribbean monk seal (*Monachus tropicalis)* is listed as endangered, but it is believed to be extinct because of a lack of sightings in recent years.

Table 3.3-2
Threatened, Endangered, or Candidate Marine Mammals of the Caribbean Region

Scientific Name	Common Name	Status*	Distribution in Region
Balaenoptera borealis	Sei whale	E	The southern portion of the species' range during spring and summer includes the northern portions of the Atlantic's U.S. Exclusive Economic Zone (EEZ)—Gulf of Maine and Georges Bank.
Balaenoptera physalus	Fin whale	E	Population is common in waters of the U.S. Atlantic EEZ, principally from Cape Hatteras, NC, northward.
Balaenoptera musculus	Blue whale	E	Population has been acoustically detected.
Megaptera novaeangliae	Humpback whale	E	This is a migratory population that uses this region as a reproductive and calving area.
Physeter macrocephalus	Sperm whale	E	Population is abundant in this region.
Trichechus manatus	West Indian (Antillean) manatee	E	Population is found waters surrounding PR and USVI.
Monachus tropicalis	Caribbean monk seal	E / X	This seal is listed as endangered but is believed to be extinct because of a lack of sightings in recent years.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no marine mammals of the Caribbean region have T or C status.

Five species of threatened and endangered marine and coastal birds reside in selected habitats provided by the Caribbean region (Table 3.3-3). In the winter, populations of shorebirds are augmented by large numbers of wintering individuals from northern ecosystems. Other species reside only temporarily along their route to South America. This region's system of mangrove, wetland, estuary, and coastal beach habitats provides the necessary biological diversity for a variety of bird species. In addition, National Wildlife Refuges provide protected habitats for these birds.

There are no threatened or endangered fish species in the Caribbean region; however, four species of reef fish are on the candidate list (Table 3.3-4). Nearly all productive fish habitats are located in nearshore areas associated with coral reefs, submerged grass beds, and estuarine-type environments because of the oligotrophic nature of the offshore water areas of this region. These important nearshore habitats are decreasing because of human exploitation and natural phenomena, the primary reason for the decline in these fish species. The Nassau grouper (*Epinephelus striatus*) was once among the most abundant fishery species in the Caribbean region, but since the 1970s, landings, mean size, and catch per unit of effort have all fallen sharply for both Nassau grouper and Goliath grouper (*Epinephelus itajara*) (NOAA, 1999).

Table 3.3-3
Threatened, Endangered, or Candidate Marine and Coastal Birds of the Caribbean Region

Scientific Name	Common Name	Status *	Distribution in Region	Migration Pattern
Pelecanus occidentalis	Brown pelican	E	Atlantic coast from NJ south, Pacific coast, Gulf coast	This is a year-round resident in the southeast.
Sterna dougallii dougallii	Caribbean roseate tern	E	Atlantic coast and Caribbean	The Caribbean roseate tern breeds on islands and protected sand spits on northeast coast during spring and summer, then migrates south as far as the Caribbean during fall and winter.
Agelaius xanthomus	Yellow-shouldered blackbird	E	Critical habitat areas in southwest island of PR, Roosevelt Roads Naval and USCG Base, and Isla Mona	This is a resident species in island of PR and Isla Mona with a nesting season from April to October.
Caprimulgus noctitherus	Puerto Rican nightjar	E	Island of PR	This year-round resident's nesting occurs from late February through early July, with the peak period from April to June. It does not construct a nest; instead, the eggs are laid directly on leaf litter under vegetation having a canopy 4 to 6 m in height.
Charadrius melodus	Piping plover	T	Atlantic coast, Great Lakes, Northern Great Plains, South Atlantic, Gulf coast, and Caribbean; proposed critical habitat for wintering populations along Atlantic coast from NC south to FL and west along Gulf coast to TX	The piping plover breeds on sandy beaches in isolated colonies on the northeast coast and Great Lakes regions from March to September, where it spends the summer. It winters along southeastern coast.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002*, http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no marine and coastal birds of the Caribbean region have C or X status.

Four threatened or endangered sea turtles are found in the Caribbean region (Table 3.3-5). They require open nesting beaches with no nearshore reef; such beaches are found on the Isla de Culebra and all along the northern shore of the island of Puerto Rico. The submerged seagrass and coral reef areas of the U.S. Virgin Islands provide habitat for juvenile sea turtles until they reach sexual maturity. Populations in the region declined significantly in the last 100 years because of the harvesting of shells and eggs, coastal development, non-point pollution, ingestion of entanglement in marine debris, and as by-catch in other fishing operations.

There are two species of *Acropora* coral that are in candidate status (Table 3.3-6). A variety of causes have forced a decline in the diversity of coral reefs and the degradation of coral reef habitats: diseases (e.g., white band), natural phenomena (e.g., hurricanes and temperature fluctuations), tourism (e.g., boat anchorings and ship groundings), sedimentation, land clearance, coastal development, and sewage discharges.

Table 3.3-4
Threatened, Endangered, or Candidate Fish of the Caribbean Region

Scientific Name	Common Name	Status*	Distribution in Region
Epinephelus itajara	Goliath grouper (formally Jewfish)	C	Historically, Goliath grouper were found in tropical and subtropical waters of the Atlantic Ocean, off both coasts of FL, and from the Gulf of Mexico down to the coasts of Brazil and the Caribbean Sea. Most adults are found in shallow waters, the deepest being about 150 ft. They were abundant in very shallow water along the FL Keys and southwest coast of FL but are no longer abundant in these shallow areas.
Epinephelus striatus	Nassau grouper	C	Nassau grouper is found throughout the islands of the western Atlantic Ocean (including Bermuda and the Bahamas) and southern FL, and along the coasts of central and northern South America.
Epinephelus nigritus	Warsaw grouper	C	Warsaw grouper ranges from NC to the FL Keys and throughout much of the Caribbean Sea and Gulf of Mexico to the northern coast of South America.
Carcharhinus obscurus	Dusky shark	C	In the western Atlantic, it extends from southern New England to the Caribbean, and Gulf of Mexico to southern Brazil.

Source: Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (*http://www.nmfs.noaa.gov/pr/species/fish/*, accessed on October 15, 2002); U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*). Nassau grouper: Heemstra and Randall, 1993; Longley and Hildebrand, 1941; Smith, 1971.

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no fish of the Caribbean region have T, E, or X status.

Table 3.3-5
Threatened, Endangered, or Candidate Sea Turtles of the Caribbean Region

Scientific Name	Common Name	Status*	Distribution in Region
Chelonia mydas	Green sea turtle	T	Population has been recorded around PR and USVI, where primary nesting sites are located.
Eretmochelys imbricata	Hawksbill sea turtle	E	Nesting within the southeastern United States occurs principally in PR and the USVI, the most important sites being Isla Mona, PR, and Buck Island, USVI. Nesting also occurs on other beaches of St. Croix, St. John, and St. Thomas, USVI, and on Isla de Culebra, Isla de Vieques, and mainland PR.
Dermochelys coriacea schlegelii	Leatherback sea turtle	E	Range is from Nova Scotia to the southeast; during summer, this turtle is found along the East Coast, from the Gulf of Maine south to the middle of FL.
Lepidochelys olivacea	Olive Ridley sea turtle	T	This turtle is more common in southern waters.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no turtles of the Caribbean region have T, E, or X status.

Table 3.3-6
Threatened, Endangered, or Candidate Coral of the Caribbean Region

Scientific Name	Common Name	Status*	Distribution in Region
Acropora palmata	Elkhorn coral	C	Elkhorn coral is found on coral reefs in southern FL and the Bahamas, and throughout the Caribbean Sea. Its northern limit is Biscayne National Park, FL, and it extends south to Venezuela.
Acropora cervicornis	Staghorn coral	C	Staghorn coral is found throughout the FL Keys, Bahamas, and Caribbean islands. The northern limit is on the east coast of FL, near Boca Raton.

Source: Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (*http://www.nmfs.noaa.gov/pr/species/concern/profiles/elkhorn_coral.pdf* for elkhorn coral and *http://www.nmfs.noaa.gov/pr/species/concern/profiles/staghorn_coral.pdf* for staghorn coral, accessed on April 8, 2003).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no corals of the Caribbean region have T, E, or X status.

3.3.4. Essential Fish Habitat

The Fishery Conservation and Management Act of 1976 (FCMA) established eight regional Fishery Management Councils (FMCs), charged with developing Fishery Management Plans (FMPs) to achieve optimum fishery yields within their respective regions. In subsequent years, additional legislation was formulated to increase the effectiveness of this act. Two examples are the NMFS "602 Guidelines" ("Guidelines for the Preparation of Fishery Management Plans under the FCMA," 50 CFR part 602), which provided an official definition of overfishing and required each FMP to include measurable definitions of overfishing for each managed species, and the Sustainable Fisheries Act of 1996 (Public Law 104-297; 16 U.S.C. 1801 *et seq.*), which was passed and integrated into the Magnuson-Stevens Fishery Conservation and Management Act of 1996 (MSFCMA, Public Law 94-265, as amended through October 11, 1996; 16 U.S.C. 1801 *et seq.*). This later act required FMCs and the Secretary of Commerce to identify and describe Essential Fish Habitat (EFH) for species specified under each respective FMP.

The Caribbean Fishery Management Council (CFMC) is responsible for implementing the MSFCMA through FMPs in the Caribbean region. EFH is designated under four FMPs in the Caribbean region—spiny lobster, queen conch, reef fish, and coral. The commercially important fish species of the Caribbean region are listed in Table 3.3-1. NMFS is currently finalizing and updated set of EFH designations developed by the CFMC for the region. The updated designations will likely encompass all waters from mean high water to the out boundary of the U.S. Exclusive Economic Zone (EEZ; see Figure 3.1-1), and all substrates from mean high water to 100 fathoms depth (CFMC, 2004). EFH designations for each region are available on-line[10]. It is important to identify habitat areas essential to each life stage of a federally managed species to ensure sustainable fisheries and the ability of managed species to contribute to a healthy ecosystem. EFH in the Caribbean region includes benthic substrates (e.g., mud, sand, shell, rock, and associated biological communities), coral habitats, subtidal vegetation, and adjacent intertidal vegetation (wetlands and mangroves).

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[10] *http://www.nmfs.noaa.gov/habitat/habitatprotection/efh/fish_manage_c.htm*

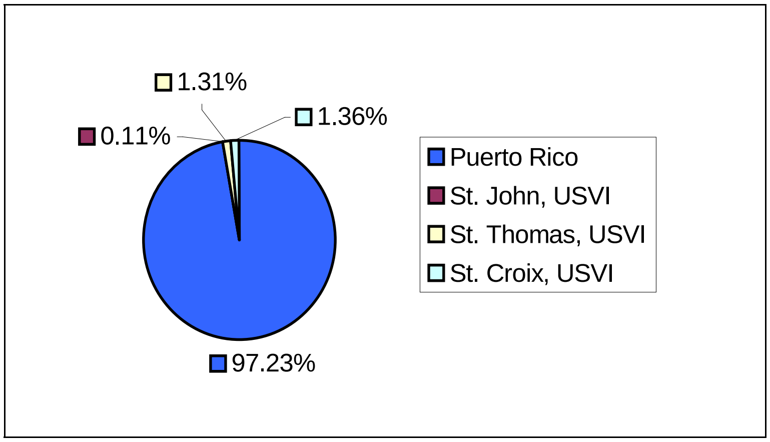
3.3.5. Socioeconomic Environment

3.3.5.1. *Coastal Communities, Demography, and Employment*

The socioeconomic impact area of the Caribbean region comprises Puerto Rico and the U.S. Virgin Islands of St. John, St. Thomas, and St. Croix. Although there are some *municipios* (the equivalent of a county in Puerto Rico) and some subdistricts within the U.S. Virgin Islands that do not fall directly on the coastline, all areas are included in the following analysis because of their economic and social interconnectivity and the small geographic distance between them.

The current coastal population of the Caribbean region is 3,917,222 (U.S. Census Bureau, 2000a), which is calculated by combining population statistics for the region's four islands. Appendix F, Table F.3-6 lists these islands and their populations. Puerto Rico makes up more than 97 percent of the region's population, while the U.S. Virgin Islands make up a little less than 3 percent (Figure 3.3-6) (U.S. Census Bureau, 2000a).

Figure 3.3-6
Coastal Population Distribution of the Caribbean Region



Source: U.S. Census Bureau, 2000a.

Socioeconomic patterns vary across the islands substantially, from low-density, undeveloped rural areas to high-density, highly developed urban centers. Table 3.3-7 lists the most densely populated *municipios* in Puerto Rico.

In 2000, the region had a total civilian labor force of 1,202,796 individuals, with an average unemployment rate of 18.7 percent, compared with the national average of 5.8 percent. Income levels rank well below the national average of both per capita and median household incomes at $13,031 and $23,797, respectively. (The national average per capita and median household incomes are $21,587 and $41,994, respectively.) The levels of income vary throughout the region. For example, Puerto Rico, the poorest island in the region, has a per capita income of $8,185, while the St. John, the wealthiest island in the region, has a per capita income of $18,012 (U.S. Census Bureau, 2000a).

Table 3.3-7
Highest Populated *Municipios* of the Caribbean Region—Puerto Rico

Municipio	**Population**
San Juan	434,374
Bayamón	224,044
Ponce	186,475
Carolina	186,475
Caguas	140,502

Source: U.S. Census Bureau, 2000a.

3.3.5.2. Economic Status

Three primary sectors make up the foundation of the Caribbean region's economic system: tourism, manufacturing and commodity exporting, and petroleum refining. An associated fourth sector provides services to the former three in a variety of capacities including government, sales, communications, and infrastructure.

More than 2 million tourists visit the region every year, expending over $2.0 billion (Commonwealth of Puerto Rico, 2001; USVI BER, 2001). In Puerto Rico, tourism is estimated to be responsible for more than 6.5 percent of the gross domestic product (GDP) and over 40 percent of the GDP for the U.S. Virgin Islands (WTTC, 2001a, b).

Manufacturing surpassed the traditional agricultural-based economy of the region in the past two decades. This is primarily the result of large amounts of foreign direct investment (FDI) coming from the United States. Tax incentives and subsidies established by the U.S. government in the 1950s promoted the development of the region through the establishment of a capital base. The majority of these goods are then exported to the United States or to Europe, Mexico, and South America. The commodities that are produced and then traded on the international market are pharmaceuticals, electronics, apparel, food products, canned tuna, rum, beverage concentrates, medical equipment, watches, and alumina.

There is a large potential for both onshore and offshore oil development within the Caribbean region. Petroleum refining is a large activity for the region; one of the world's largest petroleum refineries is located on St. Croix, making it a large importer of crude oil and exporter of refined petroleum.

3.3.5.3. Vessel Transportation and Ports

The islands of the Caribbean region are located along two very important shipping routes. Puerto Rico is on the Mona Passage, and the U.S. Virgin Islands are on the Anegada Passage. Both these passages are key shipping lanes for the Panama Canal. In 1999, there were 30,637 vessel trips measured along waterways associated with major ports of this region (USACE, 1999a) (Table 3.3-8).

Table 3.3-8
Major Ports of the Caribbean Region

U.S.-Affiliated Island	Port
PR	San Juan, Playa de Ponce, Fajardo, Mayaquez
USVI	St. John
USVI	St. Thomas
USVI	St. Croix

Source: USACE, 1999a.

The ports at San Juan, Puerto Rico, and St. Thomas, U.S. Virgin Islands are some of the best natural deepwater ports in the Caribbean region. In addition, the major ports of the U.S. Virgin Islands are significant debarkation points for the tourist industry. In 2000, almost 2 million cruise ship passengers visited Virgin Island ports (USVI BER, 2001).

In 1999, the Caribbean region received or shipped from its ports close to 75 thousand short tons of foreign and domestic cargo: domestic shipping and receiving accounted for 21,232 and 8,409 thousand short tons, respectively, while foreign shipping and receiving accounted for 2,066 and 40,011 thousand short tons, respectively. In addition, there were 2,698 thousand short tons of intrastate waterborne commerce (USACE, 1999a).

The shipment of crude oil significantly contributes to vessel traffic in the Caribbean region. Extensive refinery operations and easy port access have made this region a large importer of crude oil and one of the largest exporters of refined petroleum. An oil refinery in St Croix, US Virgin Islands is among the largest in the Western Hemisphere. In March 2002, the U.S. Virgin Islands was the largest single regional exporter to the United States (EIA, 2002a). The Caribbean region is becoming the largest single-source region for refined petroleum imported into the United States.

3.3.5.4. Fisheries

Commercial Fisheries

The commercial fishing sector of the Caribbean region is generally small scale and poorly organized, employing lower levels of technology than other regions. Nevertheless, it produced revenues in excess of $8 million in 2001 (NMFS, 2001). Table 3.3-9 lists the top commercial landings for the Caribbean region. A variety of species are caught in Caribbean fisheries.

Recreational Fisheries

A 2001 survey showed that marine recreational fishing in Puerto Rico has 220,000 anglers, who took 1.4 million trips and caught about 2.2 million fish (NMFS, 2001). According to a 1992 report 10,800 residents of the U.S. Virgin Islands were involved in boat-based recreational fishing, involving expenditures of $5.9 million and an estimated annual catch of 54,339 lb; the most frequently harvested species were snappers (Jennings, 1992). Additional data collection by NMFS recently was attempted for U.S. Virgin Islands but was suspended because of logistical problems associated with the survey.

Table 3.3-9
Top Commercial Landings for 2001* for the Caribbean Region

Scientific Name	Common Name	Pounds	Dollars
Panulirus argus	Spiny lobster	313,366	1,754,066
Lutjanus vivanus	Silk snapper	294,715	861,305
Ocyurus chrysurus	Yellowtail snapper	340,097	721,006
Strombus gigas	Conch (meat)	272,151	674,254
Lutjanus synagris	Lane snapper	188,478	408,055

Source: NMFS, 2001.

* Ranked by dollar value.

3.3.5.5. Subsistence

Information on subsistence use of fish and shellfish in the Caribbean is limited. While some residents may supplement their diets with these resources, subsistence is not known to be a prominent activity in this area, as compared to Alaska, where Native communities may suffer substantial economic and cultural losses due to contamination of subsistence seafood during an oil spill.

3.3.5.6. Archaeological/Historic Resources

The Caribbean region is part of a large volcanic island complex that occurs between the junctions of the American and Caribbean plates. Puerto Rico and the U.S. Virgin Islands were formed during the complex sequence of geologic events that took place during the formation of the Caribbean plate and the separation of North and South Americas (Scatena, 1989).

The region was occupied by a variety of different cultures migrating from North and South America between 7,900 and 500 years ago. These were the Mesoindian, Saladoid, and Ostinoid cultures. Evidence of these former cultures has been found at Salt Bay, Krum Bay, and Angostora along the southwestern and northern coasts of Puerto Rico; Isla de Vieques; and the Virgin Islands National Park on St. Thomas and St. John. However, since the majority of these cultures were coastal dwellers, it is believed that, because of sea-level fluctuations, many archeological artifacts are buried underwater in near-coastal areas (NPS, 2001).

The majority of the existing archeological sites within the Caribbean region is from the era of European settlement from 1500 onward. These consist of shipwrecks, forts, tools, and settlements from the Spanish, Dutch, and French. In particular, the Spanish built a fort in 1508 near the current city of San Juan, and the old city wall still exists. In 1650, the French attempted to colonize St. Croix, US Virgin Islands and the Danish West Indies Company colonized the Virgin Islands, the remains of which can be seen at Christensted National Historic Site and the Virgin Islands National Park.

Because of the surrounding nature of its coral reefs and its location near the Mona Passage, the Caribbean region has a large number of nearshore, submerged shipwrecks. It is estimated that there are more than 200 known wrecks within the Puerto Rico area, with many others hidden underneath coral and sand formations (Mir, 1983).

3.3.5.7. Recreation and Tourism

The Caribbean region is a major recreational area of the United States, particularly in connection to coastal and marine activities. Both domestic and foreign tourists come to enjoy the coastal beaches, unique forests, and tropical waters of both the Atlantic Ocean and Caribbean Sea. Publicly owned and administered areas such as the Virgin Islands National Park and Buck Island, which offers an underwater snorkeling trail, are good examples of what the region has to offer. The reliability of the temperature (77° to 85°F), because of the consistency of the trade winds and its latitudinal location, adds to the lure of the region.

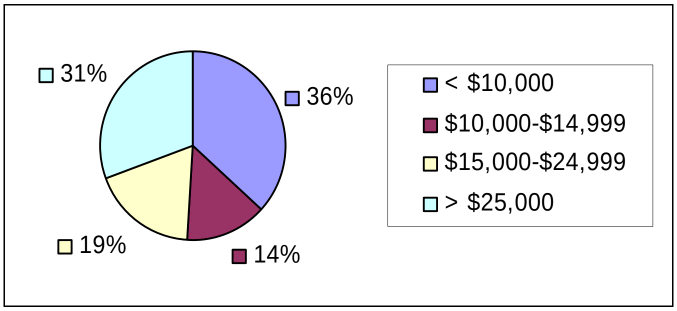
All beaches in the Caribbean region are open to the public. Recreational activities include sightseeing, camping, hiking, beach combing, picnicking, boating, swimming, sunbathing, scuba diving, snorkeling, and sport fishing. Recreational boating—cruise lines, private charters, and privately owned sail- and speedboats—is one of the more popular activities. The Caribbean region derives a substantial portion of its income from recreation- and tourism-related activities. More than 2 million tourists visit the region every year.

3.3.5.8. Environmental Justice

Executive Order 12898 ("Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," 59 FR 7629) provides that each federal agency shall make achieving environmental justice part of its mission by identifying and addressing questions regarding environmental and health conditions of impoverished communities.

Low-income communities, which can be found across the Caribbean region, include multiethnic as well as homogenous communities and neighborhoods. Of the 1,035,191 families that live in this region, 44 percent (or 457,889) have been classified as living in poverty by the U.S. Census Bureau (2000a). The average per capita and median household incomes of this region are $13,031 and $23,797, respectively. However, 69 percent of households earned less than $25,000 in 1999. Figure 3.3-7 shows the distribution of household income in the Caribbean region. Higher rates of poverty occur on the islands of St. Croix and Puerto Rico than elsewhere in the region, with 37 percent of Puerto Rico's households making less than $10,000 a year (U.S. Census Bureau, 2000a).

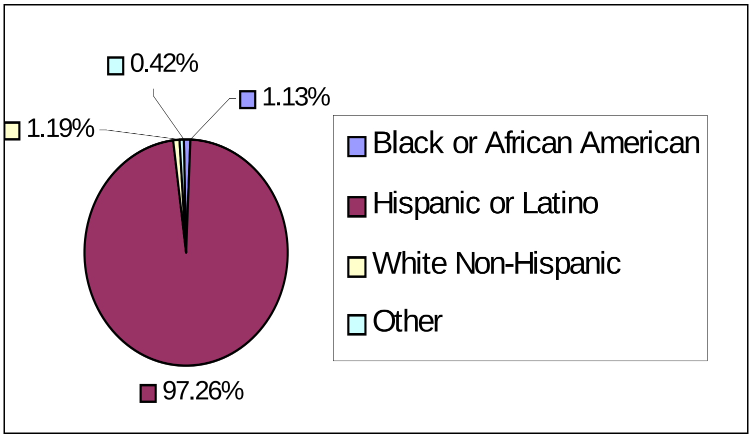
Figure 3.3-7
Distribution of Household Income in the Caribbean Region



Source: U.S. Census Bureau, 2000a.

Minority groups live throughout the Caribbean region. These groups include Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian or other Pacific Islander, or other (Hispanic or Latino, and white Non-Hispanic). More than 96 percent of the population is classified as Hispanic or Latino, almost all of whom (99 percent) live in Puerto Rico. Figure 3.3-8 shows the distribution of race in the Caribbean region.

Figure 3.3-8
Distribution of Race in the Caribbean Region



Source: U.S. Census Bureau, 2000a.

3.3.5.9. *Public Safety and Worker Health*

Oil spill response is one of the U.S. Coast Guard's (USCG's) many missions. In responding to oil spills, the USCG is aware of public safety and the effects that alternative response technologies—chemical dispersion and *in situ* burning—could have on human health. Under the guidelines established by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), steps have been taken to protect both the public and oil spill responders. Whether compensated workers or volunteers, responders are required to be certified under either the Occupational Safety and Health Administration's (OSHA's) Hazardous Waste Operations and Emergency Response Standard or USEPA's Hazardous Waste Operations and Emergency Response Standard. These standards ensure that responders understand the hazards of oil spill response and how to protect themselves. To assist in public safety, the USCG has the maritime safety authority to establish a safety zone around oil spill cleanup operations. This zone is established to safeguard the public and responders from the hazards associated with cleanup. In addition, USCG standard operating procedures (SOPs) are used to protect responders, as well as the public, from the hazards associated with chemical dispersion and *in situ* burning. These procedures are outlined in SOPs in each Area Contingency Plan's (ACP's) Site Safety Plan. In addition, training exercises such as PREP (Preparedness for Response Exercise Program) and SONS (Spill of National Significance) train USCG response personnel to avoid safety hazards.

Dispersants are a liquid chemical used to disperse oil spills from the ocean surface (see Section 2.2.2). During an oil spill, dispersant application can be from either an aerial or a shipboard platform. In both cases response personnel have the potential to be accidentally exposed to the dispersant, and in extreme cases exposure to the public could occur. The two types of dispersants with use allowed in the United States have OSHA-established, permissible exposure limits of 50 ppm on skin. The Material Safety Data Sheet (MSDS) for these dispersants makes clear the human health concerns from excess exposure.

In situ burning of an oil spill entails setting contained or boomed oil on fire (see Section 2.2.3). This action has been acknowledged as having potential human health and safety effects. Besides the physical hazards to responders, there is the potential for inhalation of airborne burn products. *In situ* burning emits a plume of black smoke laden with particulates (PM10, soot), the main public health concern. Response personnel working close to the burn may be exposed to levels of gases and particulates that would require them to use personal protective equipment. Occupational standards such as OSHA's Permissible Exposure Limits (PELs) are applicable. For the general public, NOAA (2000a) reported that particulate concentrations in a smoke plume remain the only agent of concern past 1 or 2 mi downwind, with the gases created in a burn dissipating to levels close to background. Public exposure to smoke particulate from the burn is not expected to occur unless the smoke plume travels down to ground level. Since the general public may include sensitive individuals, such as the very young and very old, pregnant women, and people with pulmonary or cardiovascular diseases, this population's tolerance to particulates may be significantly lower than that of the responders. There is little data concerning the effect on humans of particulates from the *in situ* burning of oil. Based on chemical analysis of soot particulates and their physical behavior, the hazard is expected to be similar to that of better-known particulates emissions that are now regulated by the NAAQS. In 1997, the Special Monitoring of Applied Response Technologies (SMART) protocol[11] was created, in part, to address the particulates concerns and to better aid the Federal On-Scene Coordinator (FOSC) in making decisions related to initiating, continuing, or terminating *in situ* burning.

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[11] *http://response.restoration.noaa.gov/oilaids/SMART/SMART.html*

3.4. GULF OF MEXICO REGION

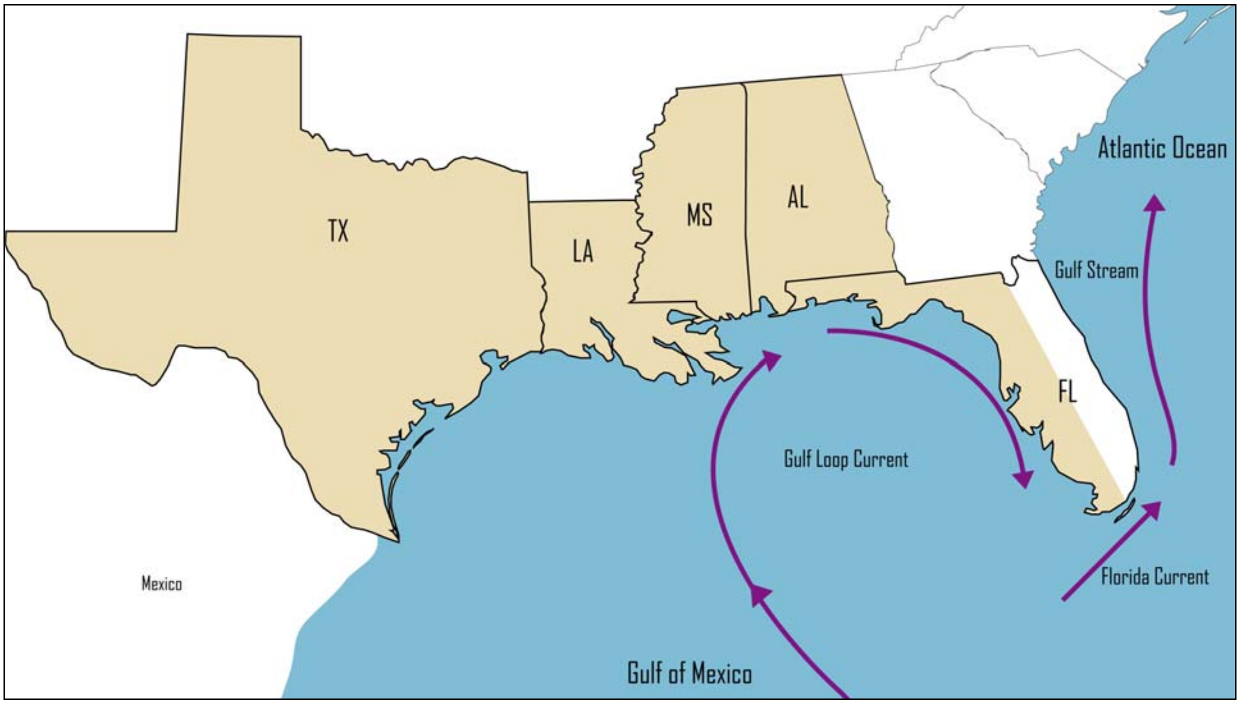
3.4.1. Physical Environment

For the purpose of this Programmatic Environmental Impact Statement (PEIS), the Gulf of Mexico region will specifically cover the waters that lie south and west of the continental United States; east and north of Mexico, and northwest of Cuba. Five states—the west coast of Florida, Alabama, Mississippi, Louisiana, and Texas—border the Gulf of Mexico and are considered in this PEIS (Figure 3.1-1).

Extensive marine waters entering through the Yucatan Channel of Mexico and exiting through the Florida Straits influence this body of water. In addition, fresh water from over two-thirds of the United States, one-half of Mexico, and part of the Guatemalan riverine system of Central America drains into the Gulf (Birkett and Rapport, 1999).

A prominent physical feature of the Gulf of Mexico is the Loop Current (Figure 3.4-1), which is a swift, narrow current that enters the Gulf of Mexico through the Yucatan Channel, turns clockwise, and exits through the Florida Straits to become the Florida Current and eventually the Gulf Stream. Water current velocities associated with the Loop Current can have surface speeds of 2 to 3 kt or more. As the Loop Current extends into the Gulf and widens, surface velocities range between 1.5 to 2.9 kt (Coats, 1992; Nowlin and McLellan, 1967). Circular eddies of water break off from the Loop Current and transport water across the Gulf to the west. These eddies can create short-term, high-velocity currents at the surface as they pass by.

Figure 3.4-1
Major Currents of the Gulf of Mexico Region



Note: Map is not to scale.

The Loop Current also can expand and contract at different times of the year. At one extreme, it has an almost direct path to the Florida Current, causing the shear in the flow to set up a quasi-permanent, clockwise recirculation known as the Cuban Vortex. This feature may initiate Loop Current expansion. At the other extreme, the Loop Current intrudes into the Gulf of Mexico, forming an intense clockwise flow as far north as 29.1°N (latitude) and occasionally reaching as far north as the Mississippi River delta and the Florida continental shelf (NRC, 1990a).

Surface salinities in the Gulf of Mexico vary seasonally. During months of low freshwater input, surface salinities near the coastline range between 29 and 32 parts per thousand (ppt) (MMS, 1997). High-volume freshwater inputs during the spring and summer months result in strong horizontal salinity gradients with salinities less than 20 ppt on the inner shelf. The waters in the open Gulf are characterized by salinities between 36 and 36.5 ppt (MMS, 1997).

Surface water temperatures also vary seasonally. During January, surface temperatures range from 57° to 75°F. During July, sea surface temperatures range from 82° to 86°F (Cochrane and Kelly, 1986; Wallace, 1980).

3.4.1.1. Water Quality

Coastal

In 1998, the U.S. Environmental Protection Agency (USEPA, 1998a) compiled an assessment of the Gulf of Mexico region water quality within estuaries and coastal waters in its 305(b) report. About 78 percent of the region's estuaries were surveyed, and 65 percent of those had good water quality. The remainder was considered "impaired" because of nutrient enrichment, influx of pathogens, increase in oil and grease concentrations, alteration of habitat, salinity, chloride intrusion, siltation, and organic enrichment.

Primary activities that have contributed, or continue to contribute, to the degradation of coastal water quality—often known as the dead zone within the Gulf of Mexico—include those associated with the petrochemical industry, hazardous and oil-field waste, disposal sites, agricultural and livestock farming, power plants, pulp and paper mill plants, fish processing, commercial and recreational fisheries, municipal wastewater treatment, and maritime shipping. Other activities include land modifications for flood control, river development, harbors, docks, navigation channels, and pipelines. The concentration of petrochemical industries along the Gulf coast is the largest in the United States and includes extensive oil and gas development operations both on- and offshore, tanker and barge transport of both imported and domestic petroleum, and petrochemical refining and manufacturing operations (MMS, 2001a).

Marine

The four most predominant factors that affect marine water quality within the Gulf of Mexico region are coastal runoff, oil production, marine transportation, and natural oil seepage. The magnitude of these factors is directly related to the configuration of the basin, which controls the oceanic waters that enter and leave the Gulf, and to the runoff from land, which controls the quantity of freshwater input into the Gulf. For example, there is a higher concentration of chlorinated volatile organic compounds (VOCs) nearshore, while large amounts of petroleum-related VOCs have been detected in offshore areas (Kennicutt and Gallaway, 1985).

In nearshore areas, point and non-point source pollution enters the Gulf via river inputs. The Mississippi River is the largest contributor in that it drains approximately 41 percent of the entire continental United States. A major consequence from this input is nutrient overenrichment, which creates hypoxic (oxygen-depleted) waters. This hypoxic condition has been identified in shallow depths of 13–16 ft nearshore to as far as 8.7 mi offshore (Rabalais et al., 1999).

Offshore, thousands of oil-producing platforms operate within the Gulf of Mexico region. These platforms discharge produced water—that is, the water brought up along with petroleum and oil reserves during exploitation. This produced water is known to contain benzene, arsenic, lead, naphthalene, zinc, and toluene.

More than 100,000 vessels cart millions of tons of cargo across the Gulf of Mexico each year; of these about 45 percent are petroleum and oil related. Spills and dumping via discharged bilge water and lack of segregated ballast tanks during transit are among the chief causes of both marine and coastal debris. Along with on- and offshore platforms, marine transporters located in this region are responsible for 21 percent of all oil spills reported in the United States. In 1999 alone, there were 1,756 reported spills within the Gulf of Mexico region (USCG, 2000a).

The large oil and petroleum resource base of this region also alters water quality via naturally occurring oil seepages. Though insignificant compared with larger manmade oil spills, these small quantities are responsible for some biota kill and can pose an environmental threat to coastal and marine resources.

3.4.1.2. Meteorology and Air Quality

Climate

The Gulf of Mexico region is influenced by a maritime subtropical climate controlled mainly by the clockwise wind circulation around a semipermanent area of high pressure known as the Bermuda High, which alternates between the Azores and Bermuda. This circulation around the western edge of the high-pressure system, aided by the trade winds, results in the predominance of moist, southeasterly winds throughout this region. During the winter months, a persistent high-pressure system over North America results in rare periods of relatively dry, polar continental air over the Gulf. Humidity, cloudiness, visibility, precipitation, and air temperatures over the waters of the Gulf are typical of a maritime climate and show little diurnal or seasonal variation. Winds speeds average 6.5 kt from the south-southeast but are more variable near coastal regions because of the effect of a land-sea breeze circulation system. Tropical storms also affect this area, as hurricanes are expected to influence the area at least once every 2 years (MMS, 2001a).

Air Quality

Air quality of coastal counties[12] is measured against National Ambient Air Quality Standards (NAAQS), resulting from the Clean Air Act and its 1977 amendments (40 CFR 50.12), or it is measured against more restrictive adopted state standards. These standards are designed to protect human health. The USEPA requires states to report ambient air quality levels for six major pollutants: particulate matter (10 microns or larger [PM10]), sulfur dioxide, carbon monoxide, nitrogen dioxide, lead, and ozone. NAAQS have been adopted by each of the Gulf of Mexico region's states except Florida, which amended these standards to make sulfur dioxide emission levels more restrictive than the federal standard. Appendix F, Table F.1-1 summarizes federal ambient air standards in detail.

All coastal counties of the Gulf of Mexico region are considered to be in compliance with the NAAQS attainment levels for PM10, sulfur dioxide, carbon monoxide, nitrogen dioxide, and lead. However, the USEPA identified fifteen counties that are not in compliance for ozone, the primary constituent of smog (USEPA, 2000a).

3.4.2. Biological Environment[13]

3.4.2.1. Marine Mammals

There are a variety of marine mammals—twenty-eight cetaceans (whales and dolphins), one pinniped (sea lion), and two sirenians (manatees)—known to inhabit the Gulf of Mexico region. The common bottlenose dolphin (*Tursiops truncatus*), the most numerous cetacean in the Gulf, is found in all water depths of the Gulf. In deep waters, the pantropical spotted dolphin (*Stenella attenuata*) is the most numerous cetacean species, while sperm whales (*Kogia breviceps* and *simus*) are the most common large whales (MMS, 2000a). At least three additional species—long-finned pilot whale (*Globicephala melaena*), short-beaked common dolphin (*Delphinus delphis*), and long-beaked common dolphin (*Delphinus capensis*)—have been recorded close enough to the boundaries of this region that they may eventually be found in this area (MMS, 2000b). Appendix F, Table F.4-1 lists twenty-three recognized nonendangered marine mammals in this region.

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[12] The Office of Ocean Resources, Conservation and Assessment (ORCA), National Ocean Service (NOS), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce classifies counties as coastal "because they meet one of the following criteria: (1) at least 15 percent of their total land area is located within the nation's coastal watersheds (as defined by ORCA's Coastal Assessment Framework [*http://spo.nos.noaa.gov/projects/caf/caf.html*], or (2) the county accounts for at least 15 percent of the land area of a coastal cataloging unit (a U.S. Geological Survey-defined drainage basin)" (*http://spo.nos.noaa.gov/projects/population/population.html*). The U.S. Bureau of the Census also uses ORCA's coastal counties list.

[13] Only nonendangered species will be included in Section 3.4.2, Biological Environment. Threatened, endangered, and candidate species will be discussed separately in Section 3.4.3, Threatened, Endangered, and Candidate Species. For this reason, sea turtles will only be discussed in Section 3.4.3, as they are a threatened/endangered species in the Gulf of Mexico region.

3.4.2.2. Marine and Coastal Birds

The offshore waters, coastal beaches, and contiguous wetlands of the Gulf of Mexico region provide habitats for migrant and resident marine and coastal birds. More than 230 species of marine and coastal birds have been identified as part- or full-time residents of this region, with the majority being nearly year-round residents (USGS, 1998a). Many species are strongly pelagic and, therefore, rarely seen from shore. The remaining species are found within coastal and inshore habitats. In the winter, populations of shorebirds are augmented by large numbers of wintering marine, freshwater, or terrestrial birds from more northern ecosystems. Recent surveys indicate that the coastal areas of Louisiana and Texas are among the most important in terms of colony sites and total population numbers of nesting marine and coastal birds (MMS, 2000b).

The presence of three Western Hemisphere Shorebird Reserve Network (WHSRN) sites, one Ramsar site, and forty-three National Wildlife Refuges in the Gulf of Mexico region indicates that large numbers of shorebirds (WHSRN sites) and wetland birds (Ramsar site) concentrate in the area during migration and/or nesting and wintering. The WHSRN maintains a network of monitoring sites comprising critical habitat for shorebird species. These sites are categorized as hemispheric, with an annual count of 500,000 shorebirds or 30 percent of a species flyway population; international, with an annual count of 100,000 shorebirds or 10 percent of a species flyway population; and regional, with an annual count of 20,000 shorebirds or 5 percent of a species flyway population. The three WHSRN sites in the Gulf of Mexico region are international sites (WHSRN, 2004). The Ramsar Convention on Wetlands designates Ramsar sites as wetlands of international importance. These wetlands are selected based on criteria such as supporting 20,000 or more waterbirds and regularly supporting 1 percent of the individuals in a population of one species or subspecies of waterbird (Wetlands International, 2004). The National Wildlife Refuge sites are established under the National Wildlife Refuge System Improvement Act of 1997 with the aim of protecting wildlife and preserving biological diversity (USFWS, 2004).

For the purpose of this PEIS, marine and coastal birds are categorized into five major groups, as detailed in Appendix F, Table F.4-2: seabirds, shorebirds, wading and marsh birds, waterfowl, and raptors.

3.4.2.3. Plankton and Fish

Plankton

Plankton are organisms that float at or near the surface of marine waters and are unable to swim against tides, winds, or currents. Plankton species, which represent nearly all major aquatic phyla, can be roughly classified as phytoplankton (microscopic plant life), zooplankton (microscopic animals), and ichthyoplankton (fish eggs and larvae).

Phytoplankton are microscopic floating algae, which form the base of the food web. They are responsible for approximately one-half of global photosynthesis and play a vital role in stabilizing atmospheric carbon dioxide. These plants can only survive in the shallower, sunlit waters of open-ocean and estuarine areas. High production rates are commonly observed at intermediate salinities in the Mississippi discharge plume (Lohrenz et al., 1990). Common types of phytoplankton occurring in the Gulf of Mexico region include diatoms, cyanophytes, protococcaceans, euglenids, and dinoflagellates.

Zooplankton, which consume phytoplankton, spend either part (meroplankton) or all (holoplankton) of their life cycle as plankton. Their temporal and spatial distributions depend on a number of factors including currents, water temperature, and phytoplankton abundance (Loeb et al., 1983). The zooplankton community of the Gulf of Mexico region includes Rotaria eggs, nauplii of cyclopoidids, Cladocerans, Chironomid larvae, V. cyclops, Moira, and Chryodorus. Zooplankton levels drop because of direct mortality, avoidance behavior, and vertical migration when hypoxic conditions occur near the Mississippi discharge plume (MMS, 2001a).

Most fishes inhabiting the Gulf of Mexico, whether benthic or pelagic, have pelagic larval stages (ichthyoplankton). It has been estimated that there are 200 families with more than 1,700 species whose early life stages may occur in the Gulf. In addition to the resident fauna, many eggs, larvae, and juveniles may be advected into the Gulf from the Caribbean Sea via the Loop Current (MMS, 2000b). In a study of the Loop Current front, 237 taxa representing 100 families of ichthyoplankton were identified. Some of the most abundant families in the Gulf are Myctophidae, Gonostomatidae, and Bergmacerotidae (MMS, 2000b).

Fish

The Gulf of Mexico Fisheries Management Council (Section 3.4.4) manages the commercial fisheries in the region. During 2000, total fish landings for commercial fisheries in the Gulf totaled 814,086 metric tons (NMFS, 2004). In the Gulf, the bulk of the commercial fishing landings are from epipelagic fish, which occupy the upper 656 ft of the water column. These include dolphinfish (*Coryphaena hippurus*), Spanish mackerel (*Scomberomorus maclatus*), and bluefin tuna (*Thunnus thynnus*). Some the commercially important fish and lobster species are found in the coral reefs and seagrass beds. These species include groupers (*Mycteroperca* spp.), hinds (*Epinephelu* spp.) red snapper (*Lutjanus campechanus*), and spiny lobster (*Panulirus argus).* Table 3.4-1 lists the commercially important fish species of the Gulf of Mexico region.

Table 3.4-1
Commercially Important Fish Species of the Gulf of Mexico Region

Common Name	Scientific Name	Common Name	Scientific Name
Albacore	*Thunnus. alalunga*	King mackerel	*Scomberomorus cavalla*
Atlantic croaker	*Micropogonias undulatus*	Red drum	*Sciaenops ocellatus*
Bigeye tuna	*Thunnus obesus*	Red porgy	*Pagrus pagrus*
Billfish	*Makaira nigricans, Tetrapturus albidus, Istiophorus platypterus*	Scamp	*Mycteroperca. phenax*
		Skipjack tuna	*Katsuwonus pelamis*
Bluefin tuna	*Thunnus thynnus thynnus*	Spanish mackerel	*Scomberomorus maculatus*
Cero	*Scomberomorus regalis*	Swordfish	*Xiphias gladius*
Cobia	*Rachycentron canadum*	Tilefish	*Lopholatilus chamaeleonticeps*
Dolphin	*Coryphaena* sp.	Wreckfish	*Polyprion americanus*
Gag	*Mycteroperca microlepis*	Yellowfin tuna	*Thunnus albacares*
Gray snapper	*Lutjanus griseus*	Yellowtail snapper	*Ocyurus chrysurus*

Source: Adapted from USCG, 2002.

Because of their location in coastal waters, the fish of hard-bottom habitats have been exploited vigorously and some species, such as the red snapper (*Lutjanus campechanus*), have seen serious population declines. The Gulf coast has approximately 9,000 mi of shellfish growing waters, of which about 42 percent is approved for harvesting. Between 1990 and 1995, the total acreage of approved shellfish-growing waters decreased by 574,000 acres because of habitat degradation and overexploitation (USEPA, 1999).

3.4.2.4. Intertidal Habitats

Beaches and Coastal Barrier Islands

The Gulf of Mexico region has 14,304 mi of shoreline (Good et al., 1998), with coastal barrier islands and beaches found at various locations. The coast from Louisiana to the Florida panhandle and southeast Florida is part of a complex integrated system of beaches, dunes, marshes, bays, tidal flats, and inlets forming part of the extensive barrier island system in the United States. These barrier islands and beaches are constantly migrating, eroding, and building in response to natural processes and human activities. By separating coastal waters from the open ocean, these islands contribute to the amount of available estuarine habitat and protect coastal wetlands. Of all the coastal areas in this region, Louisiana's barrier islands are eroding the most quickly—in some places up to 100 ft of barrier island shoreline is disappearing every year (MMS, 2000b).

Along most of the Gulf, the beaches are composed of sand and other unconsolidated coarse sediments. Coastal beaches are important not only for their ecological habitats (such as for endangered sea turtle nesting) but also for their economic integrity in terms of tourism and recreation. States bordering the Gulf of Mexico have the highest average erosion rates (about 3 ft/yr) in the nation (Heinz Center, 2000). Louisiana has the most rapidly retreating beaches on the continent, with the Louisiana shoreline retreating annually at an average rate of 13.8 ft/yr (MMS, 2000b). The highest reported rates of Louisiana's coastal retreat occurred along the coastal plain of the Mississippi River.

Estuaries, Wetlands, and Mangroves

Estuaries are important habitats for both resident and transitory species, providing spawning or nursery habitat and foraging areas for numerous species, including invertebrates, fishes, reptiles, birds, and mammals. High organic productivity, high detritus production, and extensive nutrient recycling characterize estuaries. Some examples of the largest estuaries in the Gulf of Mexico region are Tampa Bay, Florida; Mobile Bay, Alabama; and Galveston Bay and Corpus Christi Bay, Texas. These estuaries are impacted by anthropogenic activities from nutrient enrichment to habitat modification, plus channelization. Many different habitat types are found in and around estuaries, including shallow marine waters, freshwater and salt marshes, sandy beaches, mud and sand flats, rocky shores, river deltas, mangrove forests, tidal pools, seagrass beds, and wooded swamps. Figure 3.4-2 shows estuary locations in the Gulf of Mexico region.

Figure 3.4-2
Estuaries in the Gulf of Mexico Region

Source: Bricker et al., 1999.

Note: Map is not to scale.

Wetland habitats are associated with estuarine areas. These habitats may occupy only narrow bands along the shore, or they may cover larger expanses at the mouths of bays, rivers, or coastal streams. They support a large number and wide diversity of environmentally and economically important invertebrates, fish, reptiles, birds, and mammals. The extensive coastal wetlands that lie along the Gulf make up approximately half of the total U.S. wetland area (NOAA, 1991). The entire Gulf of Mexico region contains approximately 17,900 mi^2 of wetlands, with Louisiana having the greatest area of coastal wetlands with

5,037 mi^2 (Good et al., 1998). However, over the past several decades, this region has lost close to 50 percent of wetland nursery areas as the result of channelization, river control, subsidence of wetlands, urbanization, and poor water-management practices (Good et al., 1998).

In tropical latitudes, mangroves dominate most wetlands. In this region, they primarily grow along the Gulf coast of southwest Florida. Estimated total area of mangrove forests in Florida ranges from 430,000 to 650,000 acres (Handley, 1995). The three most important species of mangroves in this area are red mangrove (*Rhizophora mangle*), black mangrove (*Avicenna germinans*), and white mangrove (*Laguncularia racemosa*). Mangroves protect habitats and nurseries for fish, crustaceans, and shellfish; provide food for marine species; and provide shoreline protection from wind, waves, and floods. Mangroves are sensitive to cold temperatures and can take 5 to 10 years to reestablish their presence following a freeze. In addition to freezing, several human activities—ditching or impounding for mosquito control, reducing freshwater input, and clearing and filling—lead to the degradation of mangrove quantity and quality.

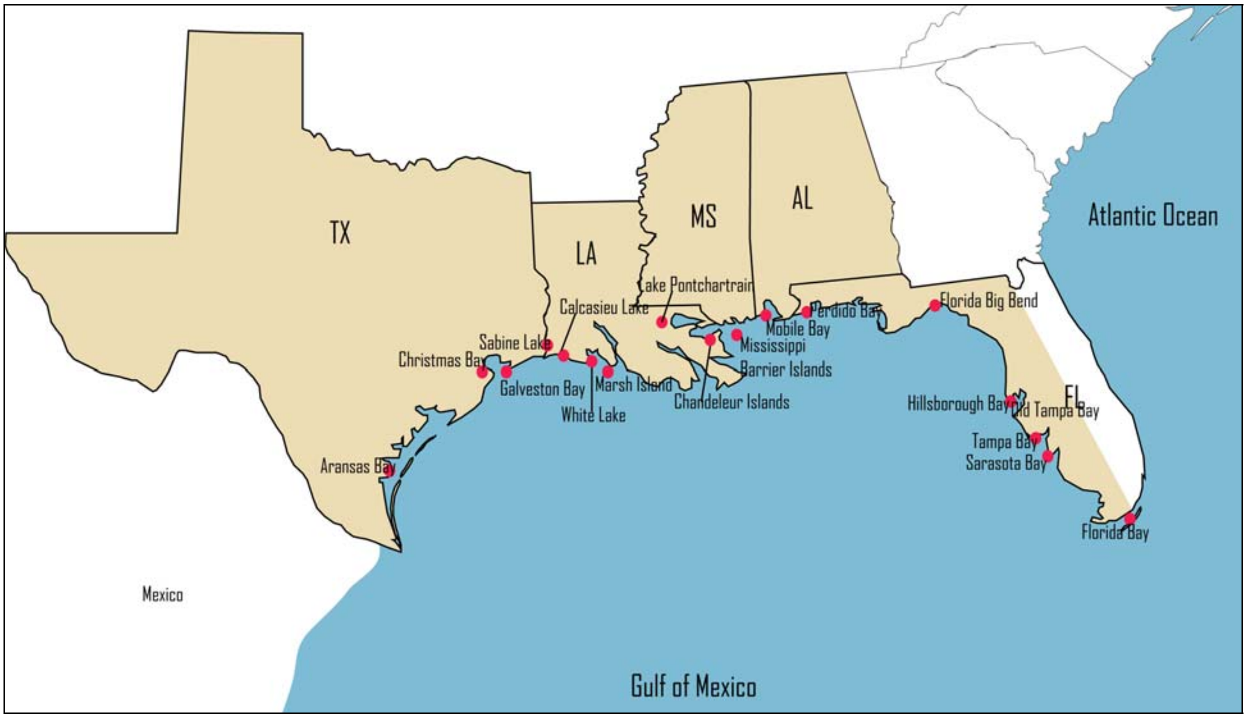
3.4.2.5. Subtidal Habitats

Submerged Grass Beds

The subtidal (benthic) areas of the Gulf of Mexico region consist of either soft or rocky substrates. These areas support a variety of marine life and habitats, including seagrass beds and coral reefs. Seagrass ecosystems are widely recognized as some of the most productive benthic habitats in the Gulf coast's estuarine and nearshore waters. Seagrass meadows provide food for wintering waterfowl plus important spawning and foraging habitats for several species of commercially important finfish and shellfish. The physical structure provided by seagrasses affords juveniles refuge from predation and allows for attachment of epiphytes and benthic organisms. Seagrass communities also support several threatened and endangered species, including sea turtles and manatees. Figure 3.4-3 provides the locations of submerged grass beds in the Gulf of Mexico region.

Although often considered continuous around the entire periphery of the Gulf, seagrasses exist only in isolated patches and narrow bands from Mobile Bay, Alabama, west to Aransas Bay, Texas. They are, however, more extensively developed from Mobile Bay to Florida Bay (see Figure 3.4-3). There are an estimated 7.4 million acres of seagrasses in the Gulf of Mexico region. Approximately 98.5 percent of the seagrass beds in this region are located in the eastern Gulf off the coast of Florida (MMS, 1996a). The coastal waters of Alabama and Mississippi contain approximately 74,000 acres of seagrass growing along the inner edges of the barrier islands of the Mississippi Sound and along prominent bays. To the west, Texas nearshore waters contain 37,000 acres of seagrass beds (MMS, 2000b). Five species of seagrass commonly are found in the Gulf of Mexico region: turtle grass (*Thalassia testudinum*), shoal grass (*Halodule wrightii*), manatee grass (*Syringodium filiforme*), star grasses (*Halophila engelmannii* and *decipiens)*, and widgeon grass (*Ruppia maritima*) (Handley, 1995).

Figure 3.4-3
Locations of Submerged Grass Beds in the Gulf of Mexico Region



Source: Handley, 1995.

Note: Map is not to scale.

Changes in seagrass distribution can reflect the health of a water body, and losses of seagrasses may signal water-quality problems in coastal waters. Losses of seagrasses in the northern Gulf of Mexico region over the last five decades have been extensive—from 20 to 100 percent for most estuaries—with only a few areas experiencing increases in seagrasses. Primary factors believed responsible for theses losses include hurricanes, dredging, dredged material disposal, trawling, water-quality degradation, flood protection levees, saltwater intrusion that moved beds closer inland, and infrequent freshwater diversions from the Mississippi River into coastal areas during flood stages (Handley, 1995).

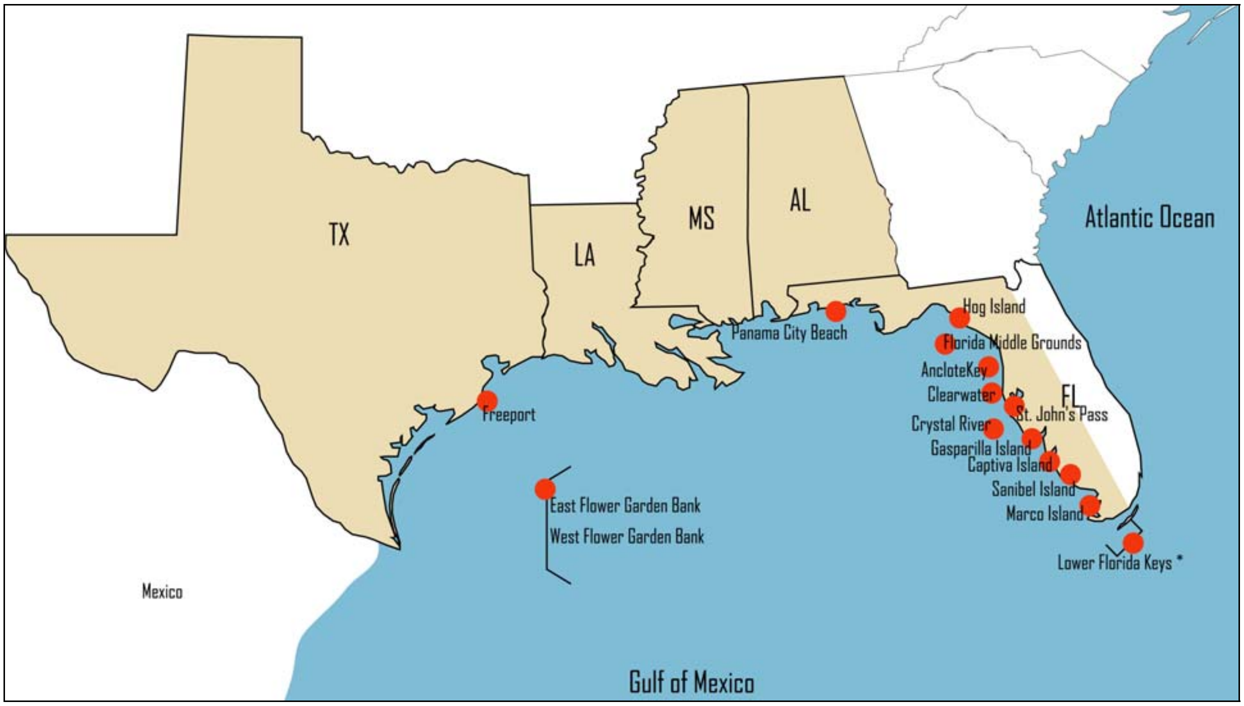
Coral Reefs

Coral reefs are among the most diverse and productive communities on earth. They buffer adjacent shorelines from wave action, thus protecting coastal environments and reducing erosion. Reefs also provide economic benefits in terms of pharmaceutical research, commercial and recreational fisheries, and cost reduction through the mitigation of property damage. For example, approximately 50 percent of all federally managed fisheries depend on coral reefs and related habitats for a part of their life cycle (CoRIS, 2002).

U.S. coral reefs cover about 6,500 mi^2: more than 90 percent is located in the western Pacific; the remainder is located off Florida and Texas, and in the Caribbean Sea. Throughout the Gulf's nearshore, continental slope, and canyon areas, coral exists in both reef communities and solitary stands (Figure 3.4-4).

About 100 mi northwest of Tampa Bay, Florida, and encompassing 379,392 acres, the Florida Middle Grounds—the best-known and most important area on the west coast of Florida in terms of coral communities—consists of two types of large reef structures: mountain-like pinnacles and flattop plateaus. The tops of the structures are in 70 to 90 ft of water, and the structures slope down to depths of 120 to 130 ft. They are covered with dense algae, large sponges, sea whips, and several stony coral species including fire coral (*Millipora* sp.), ten-ray star coral (*Galaxea fascicularis*), and pineapple coral (*Montastrea cavernosa*) (Sakas, 2002).

Figure 3.4-4
Coral Reefs in the Gulf of Mexico Region



Source: National Oceanic Data Center, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (*http://www.nodc.noaa.gov/col/projects/coral/Coralhome.html*, accessed on June 13, 2002).

Note: Map is not to scale.

* The Lower Florida Keys region consists of the following reefs that are too densely located to show at this scale of map: Sombrero Reef, Cosgrove Shoal, Cook Island, Newfound Harbor, Looe Key Reef, Looe Key, Pelican Shoal, Eastern Sambo, Middle Sambo, Middle Sambos Reef, Western Sambo, Nine Foot Stake, Eastern Dry Rocks, Rock Key, Sand Key, Western Dry Rocks, Rebecca Shoal, Fort Jefferson, and Dry Tortugas.

The East and West Flower Garden Banks are two of the most prominent topographic features in the central Gulf. These coral banks rise from surrounding water depths of greater than 328 ft to a depth of 66 ft at the crest. Their crests consist of carbonate rock formed by reef-building corals, coralline algae, and other lime-secreting creatures. The dominant community on the banks is composed primarily of hermatypic corals (*Dendrophylliidae*) consisting of approximately twenty species (MMS, 1999a, b). Additionally, more than 80 species of algae, approximately 250 species of macroinvertebrates, and more than 120 species of fish are associated with these features (MMS, 2001a).

Coral reefs also exist in areas surrounding the Dry Tortugas, an island group about 73 mi west of Key West, Florida. These coral beds form an elliptical-shaped structure dominated by staghorn coral (*Acropora* spp.).

Coral reefs are vulnerable to environmental changes, including the impacts of human activities. Environmental influences, such as temperature changes, sea-level fluctuations, and storm events, can negatively impact reefs via coral bleaching, lack of sunlight, and physical damage. Vessel groundings and anchorings, dredging, destructive fishing practices, overfishing, pollution from poor land use, chemical loading, marine debris, and invasive alien species each contributes to the loss of coral reefs.

3.4.2.6. Areas of Special Concern

Executive Order 13158 ("Marine Protected Areas") defines marine protected areas as "any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein" (65 FR 34909). There are many different types of marine protected areas within and bordering U.S. waters; some examples include National Marine Sanctuaries, National Seashores, National Parks, National Monuments, National Wildlife Refuges, National Estuarine Research Reserves, and many others (NOAA, 2002a). They have different shapes, sizes, and management characteristics and have been established for different purposes.

The Gulf of Mexico region has two National Marine Sanctuaries, seven National Park units, thirty-eight National Wildlife Refuges, three National Estuarine Research Reserves, and seven National Estuary Programs located in coastal or near-coastal areas. For more details regarding history, purpose, and specific site locations pertaining to this region, see Appendix F, Tables F.4-3 through F.4-5 and Figures F.4-1 through F.4-3.

3.4.3. Threatened, Endangered, or Candidate Species

The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have classified six threatened, fifteen endangered, and eleven candidate species within the Gulf of Mexico region. These consist of eight marine mammals, seven marine and coastal birds, thirteen fish species, and four sea turtles.

Six cetaceans and two sirenians are endangered and reside in or migrate through the Gulf of Mexico region (Table 3.4-2). Although whale sightings are less frequent in this region than in the more open areas of the Atlantic or Pacific Oceans, whales are known to breed in more protected tropical waters. As such, the relatively closed off environment of the Gulf, in conjunction with its warmer water temperatures, has the potential to lure these species.

Table 3.4-2
Threatened, Endangered, or Candidate Marine Mammals of the Gulf of Mexico Region

Scientific Name	Common Name	Status*	Distribution in Region
Eubalaena glacialis	Northern right whale	E	Population is found in wintering and calving grounds in coastal waters of the southeastern United States to summer feeding and nursery grounds in New England waters and northward to the Bay of Fundy and the Scotian Shelf.
Balaenoptera musculus	Blue whale	E	This whale has been acoustically detected.
Balaenoptera physalus	Fin whale	E	Population is common in waters of the U.S. Atlantic Exclusive Economic Zone (EEZ), principally from Cape Hatteras, NC, northward.
Balaenoptera borealis	Sei whale	E	The southern portion of the species range during spring and summer includes the northern portions of the U.S. Atlantic EEZ, Gulf of Maine, and Georges Bank.
Megaptera novaeangliae	Humpback whale	E	Migratory population uses this region as a reproductive and calving area.
Physeter macrocephalus	Sperm whale	E	Population is abundant in these seas.
Trichechus manatus latirostris	Florida manatee	E	This manatee resides in rivers and coastal waters of peninsular FL and southern GA. Population was previously recorded in NC, SC, and TX.
Trichechus manatus manatus	West Indian (Antillean) manatee	E	This is a year-round resident whose historic range includes the southeastern United States, Caribbean Sea, and South America.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no marine mammals of the Gulf of Mexico region have T, C, or X status.

Seven species of threatened and endangered marine and coastal birds reside in selected habitats provided by the Gulf of Mexico region (Table 3.4-3). In the winter, populations of shorebirds are augmented by large numbers of wintering individuals from northern ecosystems. Other species reside only temporarily along their route to South America. This region's well-developed mangrove, estuary, wetland, and coastal beach habitats provide the necessary biological diversity for a variety of endangered bird species. National Wildlife Refuges and National Park units across the region also provide sanctuaries.

Variable ecological factors, including salinity, primary productivity, and bottom type, differ widely across this region and between inshore and offshore waters. Therefore, the threatened and candidate fish listed in Table 3.4-4 depend on various environments and are not randomly distributed (e.g., coastal pelagic and reef fish). As such, many threatened and endangered fish species require habitats that provide specific elements. When these environments are altered, usually by human activity, more sensitive fish species can experience rapid population decline. In an effort to protect these critical habitats, the National Oceanic and Atmospheric Administration (NOAA) established the Florida Keys and the Flower Garden Banks National Marine Sanctuaries.

Table 3.4-3
Threatened, Endangered, or Candidate Marine and Coastal Birds of the Gulf of Mexico Region

Scientific Name	Common Name	Status*	Distribution in Region	Migration Pattern
Charadrius melodus	Piping plover	T	Atlantic coast, Great Lakes, Northern Great Plains, South Atlantic, Gulf coast, and Caribbean; proposed critical habitat for wintering populations along Atlantic coast from NC south to FL and west along Gulf coast to TX	The piping plover breeds on sandy beaches in isolated colonies on the northeast coast and Great Lakes regions from March to September, where it spends the summer. It winters along the southeastern coast.
Sterna dougallii	Roseate tern	T	Atlantic coast and Caribbean	The roseate tern breeds on islands and protected sand spits on the northeast coast during spring and summer, and migrates south as far as the Caribbean during autumn and winter.
Polyborus plancus audubonii	Audubon's crested caracara	T	FL population is threatened and widely separated from the main species range, which extends from extreme southwestern LA, southern TX, and southern AZ to the tip of South America, including Tierra del Fuego and the Falkland Islands.	This is a year-round resident.
Pelicanus occidentalis carolinensis	Eastern brown pelican	E	Atlantic coast from NJ south, Pacific coast, Gulf coast	This is a year-round resident in the southeast.
Picoides borealis	Red-cockaded woodpecker	E	Historically, range extended from FL to NJ, as far west as TX and OK, and inland to MI, KY, and TN; today, living in clusters (groups of cavity trees) from FL to VA, and west to southeast OK and eastern TX (representing about 1% of original range)	This is a year-round resident.
Grus americana	Whooping crane	T	Critical habitat on TX coast	The whooping crane winters in the Gulf coast of TX from October to April then migrates north to Canada.
Mycteria americana	Wood stork	E	Recent U.S. breeding restricted to FL, GA, and SC; formerly bred in most of the southeastern United States and TX	This is a year-round resident.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no marine and coastal birds of the Gulf of Mexico region have C or X status.

Table 3.4-4
Threatened, Endangered, or Candidate Fish of the Gulf of Mexico Region

Scientific Name	Common Name	Status*	Distribution in Region
Acipenser oxyrinchus desotoi	Gulf sturgeon	T	Range extends from Lake Pontchartrain and the Pearl River system in LA and MS east to the Suwannee River in FL and the Gulf of Mexico.
Pristis pectinata	Smalltooth sawfish	E	Current distribution is centered in the Everglades National Park, including Florida Bay.
Carcharhinus obscurus	Dusky shark	C	In the western Atlantic, it extends from southern New England to the Caribbean, and Gulf of Mexico to southern Brazil.
Odontaspis taurus	Sand tiger shark	C	In the Western Atlantic, this shark occurs from the Gulf of Maine to FL, in the northern Gulf of Mexico, in the Bahamas, and in Bermuda.
Carcharhinus signatus	Night shark	C	This shark has been reported in waters from DE south to Brazil, including the Gulf of Mexico.
Epinephelus drummondhayi	Speckled hind	C	Speckled hind inhabit warm, moderately deep waters from NC to Cuba, including Bermuda, the Bahamas, and the Gulf of Mexico.
Epinephelus nigritus	Warsaw grouper	C	Warsaw grouper ranges from NC to the Florida Keys and throughout much of the Caribbean Sea and Gulf of Mexico to the northern coast of South America.
Epinephelus striatus	Nassau grouper	C	Nassau grouper is found throughout the islands of the western Atlantic Ocean (including Bermuda and the Bahamas) and southern FL, and along the coasts of central and northern South America. It is not known from the Gulf of Mexico except at Campeche Bank off the coast of the Yucatan, at Tortugas, and off Key West.
Epinephelus itajara	Goliath grouper (formally Jewfish)	C	Historically, Goliath grouper were found in tropical and subtropical waters of the Atlantic Ocean, off both coasts of FL, and from the Gulf of Mexico down to the coasts of Brazil and the Caribbean Sea.
Rivulus marmoratus	Mangrove rivulus	C	Range from south-central FL down south through the West Indies to coastal areas of South America.
Alosa alabamae	Alabama shad	C	Found mostly in the Gulf of Mexico, spawning in large flowing rivers from the Mississippi River to the Suwannee River of Florida.
Menidia conchorum	Key silverside	C	This species is found in the Florida Keys, from Key West north to Long Key.
Fundulus jenkinsi	Saltmarsh minnow	C	The species is endemic to the north-central coast of the Gulf of Mexico of the southern United States, from Galveston Bay, TX, eastward through LA, MS, AL, and parts of western FL. It is believed that specimens can be found in the Perdido, Escambia, and East Bays of FL.

Source: Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (*http://www.nmfs.noaa.gov/pr/species/fish/*, accessed on October 15, 2002); USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*). Nassau grouper: Smith, 1971.

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no fish of the Gulf of Mexico region have E or X status.

Four species of threatened or endangered sea turtles reside in the Gulf of Mexico region (Table 3.4-5). Sea turtles nest along the entire northern Gulf coast and parts of southwest coast of Florida. Adult turtles are apparently less abundant in the deeper waters of the Gulf than they are in waters less than 27 to 50 ft in depth (NRC, 1990b). Because of such factors as water depth, bottom sediments, and prey availability, the relative abundance of sea turtles increases dramatically east of Mobile Bay (MMS, 2000b).

Table 3.4-5
Threatened, Endangered, or Candidate Sea Turtles of the Gulf of Mexico Region

Scientific Name	Common Name	Status*	Distribution in Region
Chelonia mydas	Green sea turtle	T	This turtle is found from FL to TX. Important feeding grounds in FL include the Florida Keys, Florida Bay, Homosassa, Crystal River, and Cedar Key.
Eretmochelys imbricata	Hawksbill sea turtle	E	While most common off Florida, it is usually found in PR and in the USVI (where it nests and feeds).
Dermochelys coriacea	Leatherback sea turtle	E	This turtle is common year-round, and is found in PR and in the USVI (where it nests).
Lepidochelys kempi	Kemp's Ridley sea turtle	E	Population occurs mainly in coastal areas of the Gulf of Mexico and the northwestern Atlantic Ocean.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no sea turtles of the Gulf of Mexico region have C or X status.

3.4.4. Essential Fish Habitat

The Fishery Conservation and Management Act of 1976 (FCMA) established eight regional Fishery Management Councils (FMCs) charged with developing Fishery Management Plans (FMPs) to achieve optimum fishery yields within their respective regions. In subsequent years, additional legislation was formulated to increase the effectiveness of this act. Two examples are the NMFS "602 Guidelines" ("Guidelines for the Preparation of Fishery Management Plans under the FCMA," 50 CFR part 602), which provided an official definition of overfishing and required each FMP to include measurable definitions of overfishing for each managed species, and the Sustainable Fisheries Act of 1996 (Public Law 104-297; 16 U.S.C. 1801 *et seq.*), which was passed and integrated into the Magnuson-Stevens Fishery Conservation and Management Act of 1996 (MSFCMA, Public Law 94-265, as amended through October 11, 1996; 16 U.S.C. 1801 *et seq.*). This later act required FMCs and the Secretary of Commerce to identify and describe Essential Fish Habitat (EFH) for species specified under each respective FMP.

The Gulf of Mexico Fishery Management Council (GMFMC) is responsible for implementing the MSFCMA through FMPs in the Gulf of Mexico region. EFH is designated under seven FMPs in the Gulf of Mexico region—red drum, reef fish, coastal migratory pelagics, shrimp, stone crab, spiny lobster, and coral. The commercially important fish species of the Gulf of Mexico region are listed in Table 3.4-1. NMFS is currently finalizing an updated set of EFH designations developed by the GMFMC for this region. The updated designations will likely encompass all waters extending from the U.S.–Mexico border to the boundary between the areas covered by the GMFMC and the South Atlantic Fishery Management Council (SAFMC) from estuarine waters out to depths of 100 fathoms (GMFMC, 2004). EFH designations for each region are available on-line[14]. It is important to identify habitat areas essential to each life stage of a federally managed species to ensure sustainable fisheries and the ability of managed species to contribute to a healthy ecosystem.

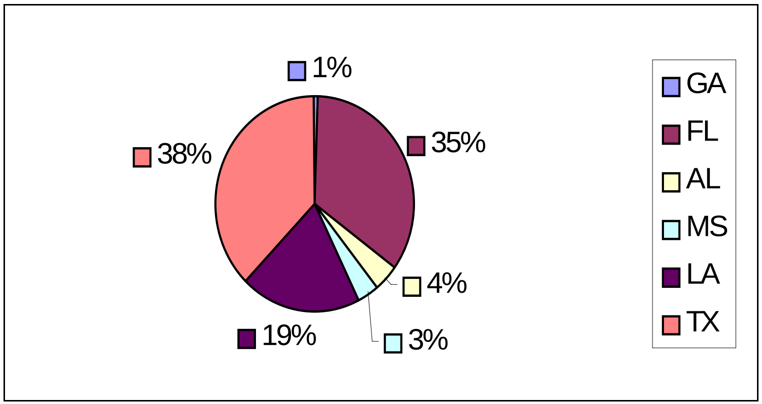
3.4.5. Socioeconomic Environment

3.4.5.1. Coastal Communities, Demography, and Employment

This socioeconomic impact area, based on NOAA's definition of coastal counties, comprises 143 coastal counties (known as parishes in Louisiana) in the five states listed in Section 3.4.1. The coastal counties/parishes in the socioeconomic impact area extend from Monroe County, Florida, to Cameron County, Texas.

The coastal population of the Gulf of Mexico region is 18,002,958 (U.S. Census Bureau, 2000a), which is calculated by combining population statistics for the region's 143 coastal counties/parishes, as identified by NOAA (includes three counties in Georgia). Appendix F, Table F.4-6 lists these coastal counties and their populations. The Gulf of Mexico region's coastal population makes up 6.4 percent of the total U.S. population, of which the majority is located in Florida and Texas (Figure 3.4-5) (NOAA, 2002b; U.S. Census Bureau, 2000a).

Figure 3.4-5
Coastal Population Distribution of the Gulf of Mexico Region



Source: NOAA, 2002b; U.S. Census Bureau, 2000a.

The Gulf of Mexico region varies substantially in socioeconomic patterns ranging from low-density, undeveloped rural areas to high-density, highly developed urban centers. The range varies from 414 people in Kenedy County, Texas, to 3,400,578 people in Harris, Texas. Table 3.4-6 lists the most densely populated coastal counties/parishes of this region.

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[14] *http://www.nmfs.noaa.gov/habitat/habitatprotection/efh/fish_manage_c.htm*

Table 3.4-6
Highest Populated Coastal Counties/Parishes of the Gulf of Mexico Region

County/Parish	Population
Harris, TX	3,400,578
Hillsborough, FL	998,948
Pinellas, FL	921,482
Hidalgo, TX	569,463
Orleans, LA	484,674

Source: NOAA, 2002b; U.S. Census Bureau, 2000a.

In 2000, the coastal counties/parishes within this region had a total civilian labor force of 8,130,780, with an average unemployment rate of 6.39 percent, compared with the national average of 5.8 percent. Income levels rank lower than the national average of both per capita and median household incomes at $16, 276 and $32,573, respectively. (The national average per capita and median household incomes are $21,587 and $41,994, respectively.) For example, Starr County, Texas, the poorest county in the region, has a per capita income of $7,069, while Collier County, Florida, the wealthiest county in the region, has a per capita income of $31,195 (U.S. Census Bureau, 2000a).

3.4.5.2. Economic Status

Three primary sectors make up the foundation of the Gulf of Mexico's economic system: tourism, oil and gas exploration and production, and the seafood industry. An associated fourth sector provides services to the former three in a variety of capacities including government, sales, communications, and infrastructure.

A wide array of natural resources within this region attracts tourists year-round. In 2000, the combined revenue for coastal tourism for the five states of the Gulf of Mexico region exceeded $41 billion. These activities consist of recreational boating (including marinas), beach visits, ecotourism, scuba diving, commercial cruises, amusement parks, and historical sites (ACC, 1998).

This region has one of the highest concentrations of oil and gas activities in the world, the majority of which is located along the coasts of Louisiana and Texas. It is estimated that nearly 25 percent of U.S. crude oil production was produced in this area in 2001, and production is estimated to increase by 5 percent or more in coming years (EIA, 2002b, c). Supporting sectors such as gas processing plants, navigation channels, oil refineries, pipelines and pipeline falls, pipe coating and storage yards, platform fabrication yards, separation facilities, service bases, terminals, and other related industries contribute substantially to the onshore economy.

Commercial fishing activities of the region bring in more than 25 percent of the total U.S. seafood catch. The shrimp catch alone is worth more than $500 million per year with crab, oysters, finfish, lobsters, menhaden, and snappers bringing in another estimated $300 million (NMFS, 2004). Similar to the oil industry, this industry has an extensive onshore service sector, including warehousing and transportation companies, canneries and packaging plants, sales and marketing firms, marine maintenance and support operations, and many other associated service industries.

3.4.5.3. Vessel Transportation and Ports

An extensive domestic and international shipping pattern exists via the marine waters of the Florida Straits, Yucatan Channel, and Bay of Campeche. In addition to this pattern, there also is a substantial amount of domestic waterborne commerce along the Gulf coast that does not always use open Gulf waters. Vessels engaged in this activity generally use the Gulf Intracoastal Waterway, which follows the coastline inshore and through bays and estuaries, and, in some cases, may move offshore. The Gulf Intracoastal Waterway reaches from Fort Myers, Florida, to Brownsville, Texas. The ports of New Orleans, Louisiana, and Houston, Texas, are two of the largest ports serving the United States. In 1999, there were more than 750,000 vessel trips measured along waterways associated with major ports throughout the region (USACE, 1999b). Table 3.4-7 lists the major ports of the Gulf of Mexico region.

Table 3.4-7
Major Ports of the Gulf of Mexico Region

State	Port
FL (west coast)	Tampa, Panama City, Pensacola, Charlotte Harbor, Everglades
AL	Mobile
MS	Biloxi, Gulfport, Pascagoula
LA	Baton Rouge, Lake Charles, New Orleans
TX	Beaumont, Brownsville, Corpus Christi, Freeport, Galveston, Harbor Island, Houston, Matagorda, Port Arthur, Port Isabel, Sabine Pass, Texas City

Source: USACE, 1999b.

In 1999, the Gulf of Mexico region received or shipped from its ports more than 1.1 billion short tons of foreign and domestic cargo: domestic shipping and receiving accounted for 189,430 and 244,724 thousand short tons, respectively, while foreign shipping and receiving accounted for 192,498 and 413,013 thousand short tons, respectively. In addition, there were 109,251 thousand short tons of intrastate waterborne commerce (USACE, 1999b).

The tankering of crude oil is the most significant contribution to vessel traffic in the Gulf of Mexico region. Extensive refinery capacity, easy port access, and a well-developed onshore transportation system contributed to the development of the Gulf coast as an important center for both imported and domestic oil and associated refinery operations. The region receives about 65 percent of all crude oil imported into this country. In 2000, approximately 1.3 billion bbl of crude oil were imported, the majority of which was received from the Organization of Petroleum Exporting Countries (OPEC) (EIA, 2001a).

Of the oil imported into the region, approximately 70 percent enters through the Yucatan Channel, and approximately 12 percent enters through the Florida Straits. Because of the Loop Current, tanker movement is preferentially routed through the Yucatan Channel. Tanker captains use the circulation patterns in the Florida Straits to aid in returning to their ports of origin (MMS, 1996b).

3.4.5.4. Fisheries

Commercial Fisheries

Commercial fisheries are very important to the economics of the states bordering the Gulf of Mexico. The Gulf of Mexico leads all other U.S. regions in fishery production. During 2000, fisheries in this region produced more than 1.79 billion lb, valued at $996 billion, and provided nearly 40 percent of all commercial fish landings in the continental United States (NMFS, 2004). Table 3.4-8 lists the top commercial landings for the Gulf of Mexico region.

Table 3.4-8
Top Commercial Landings for 2000* for the Gulf of Mexico Region

Scientific Name	Common Name	Pounds	Dollars
Penaeus aztecus	Brown shrimp	155,943,193	354,787,761
Penaeus setiferus	White shrimp	108,158,099	252,504,237
Brevoortia patronus	Gulf menhaden	1,303,895,228	80,673,954
Callinectus sapidus	Blue crab	67,967,795	45,193,132
Crassostrea virginica	Eastern oyster	25,742,825	53,083,387

Source: NMFS, 2004.

* Ranked by dollar value.

A variety of species are caught and landed in Gulf of Mexico commercial fisheries, including at least ninety-seven species from thirty-three families, of which the most important species groups are oceanic pelagic fishes, reef fishes, coastal pelagic species, and estuarine-dependent species. The primary estuarine-dependent species targeted are menhaden, penaeid shrimp (brown, white, and pink), and blue crab (MMS, 2001a).

Recreational Fisheries

A major recreational activity in the Gulf of Mexico region is offshore and coastal fishing. It is estimated that more than 40 percent of the nation's marine recreational fishing occurs in the Gulf, with the highest number of anglers fishing in Florida and Texas (USEPA, 1999). According to a 2001 NMFS Marine Recreational Fishery Statistical Survey, over 3 million marine recreational fishing participants took 22.8 million fishing trips and caught approximately 163 million fish excluding Texas (NMFS, 2002). For this region in 2001, the economic expenditures due to this fishery were approximately $8 billion (ASA, 2002)[15].

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[15] This includes the total dollar amount from both coasts in Florida. Recreational fishing information for Texas is unavailable and therefore is not included here.

3.4.5.5. Subsistence

Information on subsistence use of fish and shellfish in the North Texas Shelf is limited. While some residents may supplement their diets with these resources, subsistence is not known to be a prominent activity in this area, as compared to Alaska, where Native communities may suffer substantial economic and cultural losses due to contamination of subsistence seafood during an oil spill.

3.4.5.6. Archaeological/Historic Resources

At the end of the last Ice Age more than 12,000 years ago, the continental shelves in the Gulf of Mexico region were exposed because great amounts of water were frozen into glaciers. The ocean continental shelf of this region was subaerially exposed and habitable by terrestrial flora and fauna, including prehistoric man, who is known to have been in the region since about 12,000 years B.P. (Before Present) (MMS, 2000b). At that time, the sea level would have been approximately 148 ft below present sea level (MMS, 2000b). Therefore, the continental shelf shoreward of the 148-ft bathymetric contour would have potential for prehistoric sites dating subsequent to 12,000 B.P.

Geographic features that have a high probability for associated prehistoric sites in the northwestern and north central Gulf of Mexico region (from Texas to Alabama) include barrier islands and back barrier embayments, river channels and associated floodplains and terraces, and salt dome features. Recent investigations in northwestern Florida around Apalachee Bay area resulted in the discovery of more than 30 archaeological sites. Most of the sites are located between 3 and 9 nm offshore within state waters (MMS, 2000b).

Most historic archaeological resources in the Gulf of Mexico region are shipwrecks. A literature search for reported ship losses and known shipwrecks was conducted as part of the archaeological resources baseline study for the northern Gulf (MMS, 2000b). This study indicated that less than 2 percent of pre-twentieth century ships reported lost in the Gulf and less than 10 percent of all ships reported lost between 1500 and 1945 have known locations (110 out of 1,589). Considering the problems with inaccurate wreck reporting, drift, and breakup of wrecks, and ships that have been lost but never reported, it becomes apparent that very little is known about the locations of historic shipwrecks in this region.

An updated investigation of the initial Coastal Environments, Inc. study identified more than 4,000 potential shipwreck locations in the Gulf, nearly 1,500 of which occur on the Outer Continental Shelf (OCS) (MMS, 2000b). The study also investigated the relationship between factors such as ocean currents, storm tracks, natural navigational hazards, economic history of port development and usage, and distribution of shipwreck patterns. The results of these analyses indicate that many shipwrecks on the OCS occur in clustered patterns related mainly to navigation hazards and port entrances. As a result of this study, a high probability zone for the occurrence of shipwrecks was refined. High concentrations of shipwrecks occur off Florida's west coast from Pensacola and the Apalachicola-Cape San Bias areas (MMS, 2000b).

3.4.5.7. *Recreation and Tourism*

The Gulf of Mexico region is one of the major recreational regions of the United States, particularly in connection with marine fishing and beach-related activities. Tourists from domestic and foreign locations come to the coastal beaches, barrier islands, estuarine bays and sounds, river deltas, and tidal marshes. Publicly owned and administered areas (such as national seashores, parks, beaches, and wildlife lands), as well as designated preservation areas (such as historic and natural sites, landmarks, wilderness areas, wildlife sanctuaries, and scenic rivers), attract residents and visitors throughout the year. Commercial and private recreational facilities and establishments, such as resorts, marinas, amusement parks, and ornamental gardens, also serve as primary areas of interest.

The region's coastal shorefront has many public and private recreation areas. Most of the outdoor recreation activities are associated with accessible beach areas. There are more than 400 public access points to beaches and bays along the coast of Texas (TGLO, 2000). Florida has identified 41 percent, more than 300 mi, of sandy shoreline that is accessible to the public (Florida Department of Community Affairs, 2000). These beaches are a major inducement for coastal tourism, as well as a primary resource for resident recreational activity.

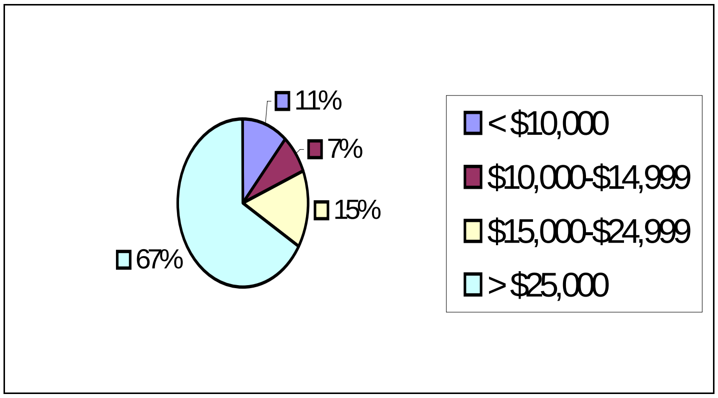
These physical attributes make tourism a prominent industry in the Gulf of Mexico region. Coastal tourist expenditures amounted to more than $41 billion and created more than 640,000 jobs in 1996 (ACC, 1998). Coastal resources (especially beaches), marine and sport fishery resources, and developed coastal tourism infrastructure contribute significantly to Gulf state tourism attractions. Tourism is the leading industry in the state of Florida; in Texas, tourism is second only to the oil and chemical industry. Ecotourism and gambling are the fastest growing components of this tourism sector.

3.4.5.8. *Environmental Justice*

Executive Order 12898 ("Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," 59 FR 7629) provides that each federal agency shall make achieving environmental justice part of its mission by identifying and addressing questions regarding environmental and health conditions of impoverished communities.

Low-income communities, which can be found across the Gulf of Mexico region, include both multiethnic and homogenous communities and neighborhoods. Of the 4,710,703 families that live within the coastal counties/parishes of this region, 12.5 percent (or 588,589) has been classified as living in poverty by the U.S. Census Bureau (2000a). The average per capita and median household incomes of this region are $16,276 and $32,573, respectively. However, 33 percent of households earned less than $25,000 in 1999 (U.S. Census Bureau, 2000a). Figure 3.4-6 shows the distribution of household income in the Gulf of Mexico region.

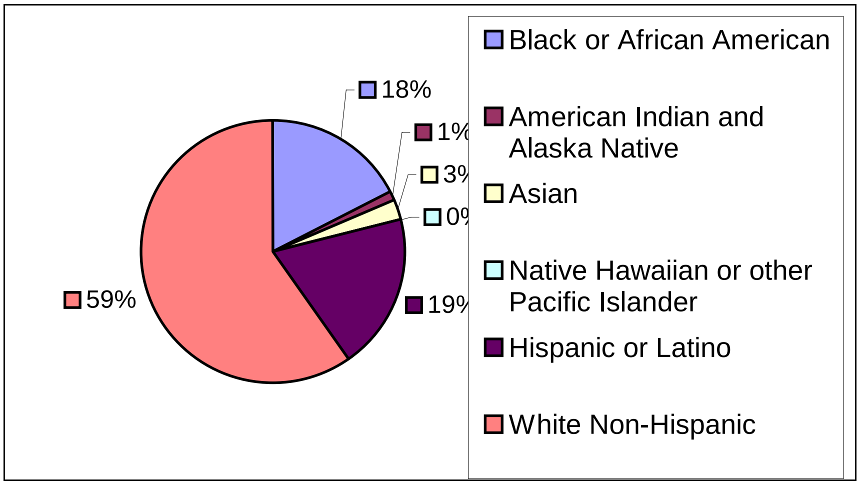
Figure 3.4-6
Distribution of Household Income in the Gulf of Mexico Region



Source: U.S. Census Bureau, 2000a.

Minority groups are scattered throughout the Gulf of Mexico region. These groups include Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian or other Pacific Islander. Figure 3.4-7 shows the distribution of race in the Gulf of Mexico region.

Figure 3.4-7
Distribution of Race in the Gulf of Mexico Region



Source: U.S. Census Bureau, 2000a.

3.4.5.9. *Public Safety and Worker Health*

Oil spill response is one of the U.S. Coast Guard's (USCG's) many missions. In responding to oil spills, the USCG is aware of public safety and the effects that alternative response technologies—chemical dispersion and *in situ* burning—could have on human health. Under the guidelines established by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), steps have been taken to protect both the public and oil spill responders. Whether compensated workers or volunteers, responders are required to be certified under either the Occupational Safety and Health Administration's (OSHA's) Hazardous Waste Operations and Emergency Response Standard or USEPA's Hazardous Waste Operations and

Emergency Response Standard. These standards ensure that responders understand the hazards of oil spill response and how to protect themselves. To assist in public safety, the USCG has the maritime safety authority to establish a safety zone around oil spill cleanup operations. This zone is established to safeguard the public and responders from the hazards associated with cleanup. In addition, USCG standard operating procedures (SOPs) are used to protect responders, as well as the public, from the hazards associated with chemical dispersion and *in situ* burning. These procedures are outlined in SOPs in each Area Contingency Plan's (ACP's) Site Safety Plan. In addition, training exercises such as PREP (Preparedness for Response Exercise Program) and SONS (Spill of National Significance) train USCG response personnel to avoid safety hazards.

Dispersants are a liquid chemical used to disperse oil spills from the ocean surface (see Section 2.2.2). During an oil spill, dispersant application can be from either an aerial or a shipboard platform. In both cases response personnel have the potential to be accidentally exposed to the dispersant, and in extreme cases exposure to the public could occur. The two types of dispersants with use allowed in the United States have OSHA-established, permissible exposure limits of 50 ppm on skin. The Material Safety Data Sheet (MSDS) for these dispersants makes clear the human health concerns from excess exposure.

In situ burning of an oil spill entails setting contained or boomed oil on fire (see Section 2.2.3). This action has been acknowledged has having potential human health and safety effects. Besides the physical hazards to responders, there is the potential for inhalation of airborne burn products. *In situ* burning emits a plume of black smoke laden with particulates (PM10, soot), the main public health concern. Response personnel working close to the burn may be exposed to levels of gases and particulates that would require them to use personal protective equipment. Occupational standards such as OSHA's Permissible Exposure Limits (PELs) are applicable. For the general public, NOAA (2000a) reported that particulate concentrations in a smoke plume remain the only agent of concern past 1 or 2 mi downwind, with the gases created in a burn dissipating to levels close to background. Public exposure to smoke particulate from the burn is not expected to occur unless the smoke plume travels down to ground level. Since the general public may include sensitive individuals, such as the very young and very old, pregnant women, and people with pulmonary or cardiovascular diseases, this population's tolerance to particulates may be significantly lower than that of the responders. There is little data concerning the effect on humans of particulates from the *in situ* burning of oil. Based on chemical analysis of soot particulates and their physical behavior, the hazard is expected to be similar to that of better-known particulates emissions that are now regulated by the NAAQS. In 1997, the Special Monitoring of Applied Response Technologies (SMART) protocol[16] was created, in part, to address the particulates concerns and to better aid the Federal On-Scene Coordinator (FOSC) in making decisions related to initiating, continuing, or terminating *in situ* burning.

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[16] *http://response.restoration.noaa.gov/oilaids/SMART/SMART.html*

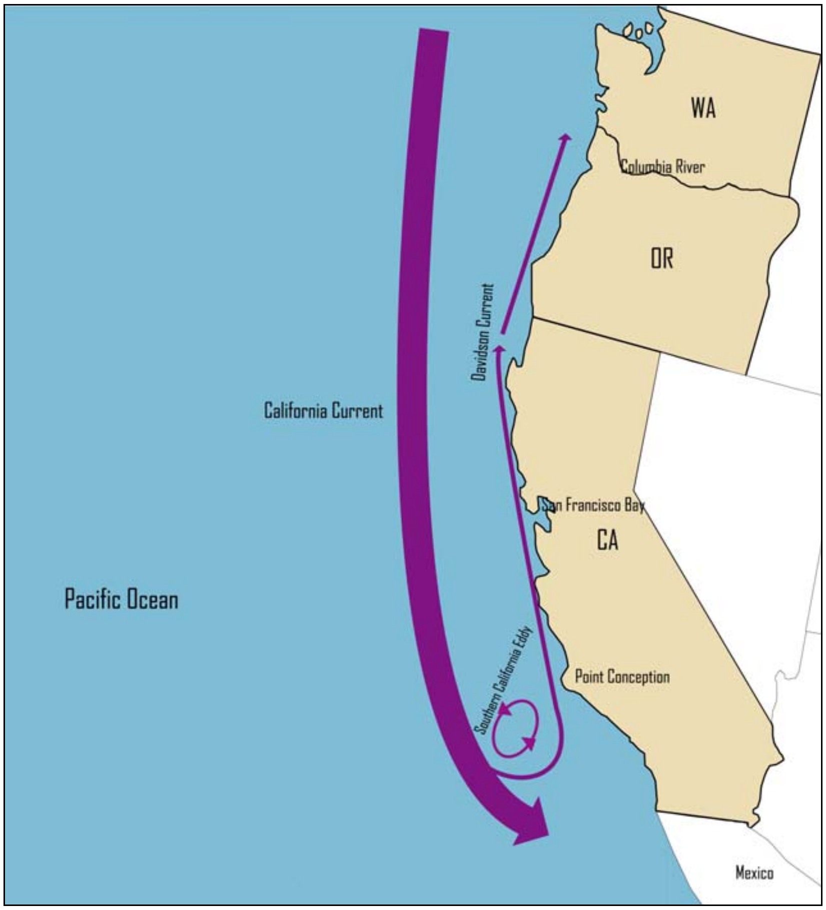
3.5. PACIFIC REGION

3.5.1. Physical Environment

For the purpose of this Programmatic Environmental Impact Statement (PEIS), the Pacific region specifically constitutes the coastal area in which the states of California, Oregon, and Washington border the Pacific Ocean (Figure 3.1-1).

The California Current, low in temperature and salinity flowing southward from the northern latitudes down the Washington-Oregon border to southern California, dominates these 2,134 mi of coastal waters (Figure 3.5-1). The current is strongest at the surface and is approximately 1,000 km wide with a typical velocity of 0.2 kt (NOAA, 2003b). A secondary and seasonal coastal current is the Davidson Current, which flows northward averaging 2 kt along the Pacific region from Point Conception, California, to Washington during the fall and winter season (Barth, 2002). The Southern California Eddy, offshore from Point Conception, forms off the California Current, and is stronger in the summer and autumn and weaker during winter and spring.

Figure 3.5-1
Major Currents of the Pacific Region



Note: Map is not to scale.

The physical oceanographic conditions along the Washington, Oregon, and northern California coast are primarily influenced by the California Current and the input of fresh water from precipitation and river runoff. The Columbia River provides a major source of freshwater to Washington and Oregon coastal waters. Off the coast of central California, the influx of fresh water is from the Sacramento and San Joaquin Rivers through the mouth of San Francisco Bay.

Analysis of surface waters in the California Current shows the seasonal variation of temperature and salinity from 55° to 68°F and 32 to 34 parts per thousand (ppt) (County of Santa Barbara, 2002).

3.5.1.1. Water Quality

Coastal

The U.S. Environmental Protection Agency (USEPA, 1998a) compiled assessments of the Pacific region water quality within estuaries and coastal waters in its 305(b) report. The quality of the estuarine and coastal waters varied from a high of 93 percent of the surveyed estuaries partially supporting aquatic life to a low of 60 percent supporting life.

The coastal waters surrounding areas of low population, industry, and residential development—such as northern California, portions of Oregon, and the northwest coast of Washington—are essentially unpolluted. Few roads, steep rocky cliffs, and restricted access by private owners and Native American tribes make accessibility difficult, contributing to the lack of shoreline development. However, along much of the California coast and developed areas of Oregon and Washington, water is degraded from shipping activities, logging activities, pulp mill wastes, domestic and industrial discharges, and agricultural runoff. These anthropogenic sources impact the coastal waters at various levels.

Marine

Marine water quality in the Pacific region is generally good to excellent (MMS, 1996b). The dilution effect of the Columbia River plume extends offshore of northern California during the summer and as far north as the Strait of Juan de Fuca during the winter. The plume's effect on various water quality parameters is exemplified by studies that have tracked its salinity, alkalinity, productivity, turbidity, and radioactivity far into the sea (MMS, 1996b). The effect of discharge from the Strait of Juan de Fuca on the water masses along the coast of Washington and Oregon is believed to be minimal because of the relatively high salinity caused by tidal mixing in the Strait and the poleward transport of water along the coast of Vancouver Island away from the Washington and Oregon coasts. Approximately 75 percent of the total discharge of rivers into the ocean from Washington and Oregon comes from the Columbia River (MMS, 1996b).

Natural petroleum seepage contributes significant amounts of hydrocarbons, which may have a profound effect on microbial populations, productivity, and metabolic activities of sediments (MMS, 2001b). Most known seepage occurs off the California coast. The four main seepage zones on the mainland shelf are at Point Conception, at Coal Oil Point and Santa Barbara-Rincon in Santa Barbara Channel, and in Santa Monica Bay, which are all in California (MMS, 2001b).

Oil and gas production facilities have been installed in the southern waters of the Pacific region. It has been estimated that each offshore platform discharges hundreds of thousands of gallons of produced water every day (MMS, 2001b). Produced water is water that is brought up along with oil and gas; it contains various toxic pollutants including benzene, arsenic, lead, naphthalene, zinc, toluene, and varying amounts of radioactive pollutants.

The Pacific region covers a very broad area with several major ports located throughout its coastal area. Maritime vessels transport millions of tons of cargo each year. This vessel traffic in this region is responsible for a large portion of all oil spills reported in the United States: during 2000, there were 623 oil spills into the Pacific region, spilling a total volume of 36,301 gal (USCG, 2000a).

3.5.1.2. Meteorology and Air Quality

Climate

The climate in the Pacific region is affected by the cold-water California Current and two pressure systems: the North Pacific High and the Aleutian Low. The North Pacific High air mass in combination with the California Current moderates the Pacific region's coastal weather, resulting in relatively cool summers and warm mild winters.

The Aleutian Low dominates the winter weather along the Washington and Oregon coasts. Winter winds are generally from the west and southwest. During the summer months, the Aleutian Low contracts northward and is replaced by the expanding North Pacific High from the south. Wind directions are primarily northwesterly except in Southern California where the winds are more westerly with average wind speeds from about 8 to 16 kt (MMS, 1996b).

Air Quality

Air quality of coastal counties[17] is measured against National Ambient Air Quality Standards (NAAQS), resulting from the Clean Air Act and its 1977 amendments (40 CFR 50.12), or it is measured against more restrictive adopted state standards. These standards are designed to protect human health. The USEPA requires states to report ambient air quality levels for six major pollutants: particulate matter (10 microns or larger [PM10]), sulfur dioxide, carbon monoxide, nitrogen dioxide, lead, and ozone. NAAQS have been adopted by each of the Pacific region's states except California, which amended these standards to make them more restrictive than the federal standards. Appendix F, Table F.1-1 summarizes federal ambient air standards in detail.

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[17] The Office of Ocean Resources, Conservation and Assessment (ORCA), National Ocean Service (NOS), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce classifies counties as coastal "because they meet one of the following criteria: (1) at least 15 percent of their total land area is located within the nation's coastal watersheds (as defined by ORCA's Coastal Assessment Framework [*http://spo.nos.noaa.gov/projects/caf/caf.html*], or (2) the county accounts for at least 15 percent of the land area of a coastal cataloging unit (a U.S. Geological Survey-defined drainage basin)" (*http://spo.nos.noaa.gov/projects/population/population.html*). The U.S. Bureau of the Census also uses ORCA's coastal counties list.

All coastal counties of the Pacific region are considered to be in compliance with the NAAQS attainment levels for sulfur dioxide, nitrogen dioxide, and lead. However, there were several counties that were not in compliance for the remaining three pollutants: seventeen counties were not in compliance for ozone, three counties were not in compliance for carbon monoxide, and nine counties were not in compliance for particulate matter (PM10) (USEPA, 2000a).

3.5.2. Biological Environment[18]

3.5.2.1. Marine Mammal

The marine and coastal waters of the Pacific region support a large and diverse population of marine mammals that are highly migratory, moving seasonally between northern feeding-breeding grounds and southern wintering grounds. There are a variety of marine mammals—sixteen cetaceans (whales, dolphins, and porpoises), six pinnipeds (seals and sea lions), and one fissiped (sea otter)—known within this region, at least a portion of the year. The common dolphin (*Delphinus delphis*) is the most numerous cetacean and is found in both coastal and offshore waters of the Pacific region (NMFS, 1999). The eastern Pacific Harbor seal (*Phoca vitulina richardsi*) is the most numerous pinniped and is found in coastal waters usually near an inlet, bay, or harbor. Appendix F, Table F.5-1 lists fourteen recognized nonendangered marine mammals of this region.

3.5.2.2. Marine and Coastal Birds

The offshore waters, coastal beaches, bays, and contiguous wetlands of the Pacific region are populated by a large variety of both resident and migratory species of marine and coastal birds. More than 2 million marine birds of twenty-nine species nest along the California, Oregon, and Washington coasts (Carter et al., 1995). Including breeding species, migrants, overwintering birds, and rare vagrants more than eighty species of marine birds have been found in Pacific coast nearshore and pelagic waters (USGS, 1998a). The shorebirds that frequent the coast and shorelines of the region are highly migratory and move seasonally between Alaska's breeding and feeding grounds to the south for overwintering grounds.

The presence of five Western Hemisphere Shorebird Reserve Network (WHSRN) sites, two Ramsar sites, and thirty-one National Wildlife Refuges in the Pacific region indicates that large numbers of shorebirds (WHSRN sites) and wetland birds (Ramsar site) concentrate in the area during migration and/or nesting and wintering. The WHSRN maintains a network of monitoring sites comprising critical habitat for shorebird species. These sites are categorized as hemispheric, with an annual count of 500,000 shorebirds or 30 percent of a species flyway population; international, with an annual count of 100,000 shorebirds or 10 percent of a species flyway population; and regional, with an annual count of 20,000 shorebirds or 5 percent of a species flyway population. The five WHSRN sites in the Pacific region include two hemispheric, one international, and two regional sites (WHSRN, 2004). The Ramsar Convention on

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[18] Only nonendangered species will be included in Section 3.5.2, Biological Environment. Threatened, endangered, and candidate species will be discussed separately in Section 3.5.3, Threatened, Endangered, or Candidate Species. For this reason, sea turtles will only be discussed in Section 3.5.3, as they are a threatened/endangered species in the Pacific region.

Wetlands designates Ramsar sites as wetlands of international importance. These wetlands are selected based on criteria such as supporting 20,000 or more waterbirds and regularly supporting 1 percent of the individuals in a population of one species or subspecies of waterbird (Wetlands International, 2004). The National Wildlife Refuge sites are established under the National Wildlife Refuge System Improvement Act of 1997 with the aim of protecting wildlife and preserving biological diversity (USFWS, 2004).

For the purpose of this PEIS, marine and coastal birds are categorized into five major groups, as detailed in Appendix F, Table F.5-2: seabirds, shorebirds, wading and marsh birds, waterfowl, and raptors.

3.5.2.3. Plankton and Fish

Plankton

Plankton are organisms that float at or near the surface of marine waters and are unable to swim against tides, winds, or currents. Plankton species, which represent nearly all major aquatic phyla, can be roughly classified as phytoplankton (microscopic plant life), zooplankton (microscopic animals), and ichthyoplankton (fish eggs and larvae). Variability in the California Current influences distribution and abundance of plankton. In particular, periodic disruptions of the California Current, often associated with El Niño-Southern Oscillation events, can affect available nutrients and zooplankton. Upwelling caused by southward-blowing winds and earth rotation allows colder, nutrient-rich layers of the bottom to rise to the surface, thus causing periods of increased phytoplankton, and, in turn, zooplankton abundance all along the coast during June and July (County of Santa Barbara, 2002).

Phytoplankton are microscopic floating algae which form the base of the food web. They are responsible for approximately one-half of global photosynthesis and play a vital role in stabilizing atmospheric carbon dioxide. These plants can only survive in the shallower, sunlit waters of the open-ocean and estuarine areas. The distribution of phytoplankton communities in the Pacific region appears to be influenced by local oceanographic conditions with the diatom abundances being associated with coastal upwelling. Phytoplankton in this region primarily consist of dinoflagellates and diatoms, which include the dominant diatoms species *Chaetoceros compressus* and *Skeletonema costatum*.

Zooplankton, which consume phytoplankton, spend either part (meroplankton) or all (holoplankton) of their life cycle as plankton. Unlike the phytoplankton, which are limited to the upper levels of ocean surface zooplankton growth occurs at all depths. Their temporal and spatial distributions depend on a number of factors including currents, water temperature, and phytoplankton abundance (Loeb et al., 1983). Like phytoplankton the distribution of zooplankton is extremely patchy. Zooplankton are a critical link in the transfer of energy from primary producers (phytoplankton) to apex predators, so any process influencing the abundance and distribution of zooplankton can ultimately have an impact on fisheries. Major zooplankton groups off the coastal areas of the Pacific region include copepods, euphausiids, chaetognaths, mollusks, thaliaceans, and fish larvae.

Icthyoplankton are present year-round within the region; however, the annual distribution and abundance of their eggs and larvae may be highly variable depending on the season and location (Smith et al., 1981). In a 1996 study by the California Cooperative Oceania Fisheries Investigation (CalCOFI Atlas No. 33, Moser, 1996) of early stages of fishes of the California Current, more than 500 species of fish larvae and eggs were identified. Off the coast of California, the larval fish assemblage is dominated by Northern anchovy (*Engraulis mordax*); to the north off of Washington and Oregon the coastal zone is dominated by a diverse assemblage of Sebates species, cottids, hexagrammids, and various pleuronectid and paralichthyid species (Doyle et al., 1993).

Fish

The Pacific Fishery Management Council manages a diversity of fish species (see Section 3.5.4). Many of the managed species are targeted for commercial fishing including Pacific Whiting (*Merluccius productus*), Widow rockfish (*Sebastes entomelas*), and Petrale sole (*Eopsetta jordani*). The Pacific region has 455 mi^2 of shellfish growing waters, 30 percent of which are approved for harvesting. In 2000, fish landings in the region's waters totaled over 467,000 metric tons (NMFS, 2003a).

Some fish within the region can generally be classified as anadromous (*Oncorhynchus* spp.). Anadromous fish stocks have declined primarily due to loss of freshwater and estuarine habitats; there has also been increased mortality associated with dam construction and operations, water diversion, and sportfishing activities (MMS, 2001a). Table 3.5-1 lists the commercially important fish species of the Pacific region.

Table 3.5-1
Commercially Important Fish Species of the Pacific Region

Common Name	Scientific Name
Dover sole	*Microstomus pacificus*
Dungeness crab	*Cancer magister*
Hake	*Microgadus proximus*
Jack mackerel	*Trachurus symmetricus*
Market squid	*Loligo opalescens*
Northern anchovy	*Engraulis mordax*
Pacific albacore	*Thunnus germo*
Pacific bonito	*Sarda chiliensis*
Pacific mackerel	*Scomber japonicus*
Pacific sardine	*Sardinops sagax*
Pacific whiting	*Merluccius products*
Pink shrimp	*Penaeus duorarum*
Sablefish	*Anoplopoma fimbria*

Source: Adapted from USCG, 2002.

3.5.2.4. Intertidal Habitats

Beaches and Rocky Shores

The Pacific region has 7,863 mi of shoreline (Good et al., 1998). The region's coastal beaches are important for their ecological and economic integrity in terms of tourism and recreation. Two of the most prominent beach types found in the region are rocky shores and sandy beaches, the latter of which are the most common in the region. Rocky shore habitats are more abundant from central California to southern Oregon, and along the Channel Islands offshore of southern California. For over 305 mi of California coastlines from central California and further south, beaches exhibit the classic beach structure: they are backed either by dunes or cliffs, followed to seaward by the berm, beach flat, trough, and bar (Oakden, 1996). For the state of California, the average rate of coastal erosion is 0.5 to 1 ft/yr (Surfrider Foundation, 2001). The primary reasons for coastal beach degradation and depletion are all human related. The construction of sea walls, roads, beach property, and marinas all play a role, as do the effects from El Niño.

Estuaries and Wetlands

Estuaries are important habitats for both resident and transitory species. They provide spawning or nursery habitats and foraging area for numerous species, including invertebrates, fishes, reptiles, birds, and mammals. High organic productivity, high detritus production, and extensive nutrient recycling characterize estuaries. Some of the important estuaries in the Pacific region include Puget Sound and Willapa Bay, Washington, and San Francisco Bay and Santa Maria River mouth, California. Along the coasts of Washington and Oregon, estuaries are typically larger than those found further south. Many different habitat types are found in and around estuaries, including shallow marine waters, freshwater and salt marshes, sandy beaches, mud and sand flats, rocky shores, river deltas, tidal pools, and seagrass and kelp beds. Figure 3.5-2 shows estuary locations in the Pacific region. A large percentage of bays and estuaries have been altered by anthropogenic activities, such as population growth, pathogen contamination, sedimentation, and pollution runoff.

Wetland habitats are associated with estuarine areas. These habitats may occupy only narrow bands along the shore, or they may cover larger expanses at the mouths of bays, rivers, or coastal streams. Wetland habitats occurring in the Pacific region include salt marshes, eelgrass beds, freshwater and brackish water marshes, and mud flats. San Francisco Bay contains more than half of all wetlands in this region, even though it is estimated to have lost almost 95 percent of its wetlands since the time of its settlement by humans (Nichols, 2002). All totaled, the Pacific region has 3,005 mi^2 of wetlands with a 46 percent wetland loss (Good et al., 1998).

Figure 3.5-2
Estuaries in the Pacific Region

Source: Bricker et al., 1999.

Note: Map is not to scale.

3.5.2.5. Subtidal Habitats

Submerged Grass Beds

The subtidal (benthic) areas of the Pacific region consist of either soft or rocky substrates. These areas support a variety of marine life and habitats, including seagrass beds and kelp forests. Seagrass ecosystems are widely recognized as some of the most productive benthic habitats in the Pacific coast's estuarine and nearshore waters. Seagrass beds are critical nursery areas for many recreational and commercial fishery species. Seagrass meadows provide food for wintering waterfowl plus important spawning and foraging habitats for several coastal bird species. The physical structure provided by seagrasses affords juveniles refuge from predation and allows for attachment of epiphytes and benthic organisms. Seagrass communities also support several endangered and threatened marine species. Figure 3.5-3 provides the locations of submerged grass beds in the Pacific region.

Figure 3.5-3
Locations of Submerged Grass Beds in the Pacific Region

Source: Adapted from Wyllie-Echeverria and Thom, 1994.

Note: Map is not to scale.

Seagrass communities in the Pacific region occur mainly in low-energy subtidal and intertidal habitats along the coast and comprise three species of surfgrass (*Phyllospadix torreyi, P. scouleri,* and *P. serrulatus*) and two species of eelgrass (*Zostera marina* and *Z. japonica*) (Yozzo et al., 2001). Increasing human use of coastal areas has resulted in the loss of seagrass beds because of construction, recreation, harbor and channel maintenance, and water pollution.

Kelp Forests

Kelp is large brown algae (*Phaeophyta*) that attach to rocky substrates and grow to the surface in shallow nearshore waters with depths ranging from about 7 to 98 ft. Kelp forests are composed of large brown algae with an underlayer of various red and brown algae. They are anchored to the rocky sea floor by strong holdfasts and grow upwards. The upper portion of these plants floats on the sea surface and forms dense canopies.

Kelp forests are one of the most productive communities in the sea. Kelp beds provide vertical water-column habitats for many species of invertebrates, fish, birds, marine mammals, and other plants. These beds are found in the photic zone and are sensitive to water temperature changes, nutrient availability, and wave energy. Since kelp forests are variable and dependent on environmental and anthropogenic factors, kelp is found in other habitats such as drift kelp (detached kelp floating far out to sea) and beach wrack (detached kelp deposited on the beach). Kelp beds are dynamic systems that may change in size and species composition over time spans of weeks to years. These fluctuations are a normal part of these ecosystems and are caused by a variety of natural causes, such as warm water periods, sea urchin populations, low nutrient periods, and storms (Santa Monica BayKeeper, 2003).

The Pacific region is home to two types of giant kelp (*Macrocystis integrifolia* and *M. pyrifera*) and bull kelp (*Nereocystis luetkeana*). Giant kelp dominates areas of relatively low water motion in years with relatively calm sea conditions. It is present from Alaska to Baja California, Mexico, often forming canopies on rocky substrata at 20- to 39-ft depths (Van Wagenen, 2001). Bull kelp is more tolerant of high water motion and dominates more exposed areas (NOAA, 2000b). Both are the dominant canopy-forming kelps in this region. In California, mixed canopies of giant kelp and bull kelp run from Sandhill Bluff to Port San Luis, with giant kelp found offshore and bull kelp found inshore (Van Wagenen, 2001).

3.5.2.6. Areas of Special Concern

Executive Order 13158 ("Marine Protected Areas") defines marine protected areas as "any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein" (65 FR 34909). There are many different types of marine protected areas within and bordering U.S. waters; some examples include National Marine Sanctuaries, National Seashores, National Parks, National Monuments, National Wildlife Refuges, National Estuarine Research Reserves, and many others (NOAA, 2002a). They have different shapes, sizes, and management characteristics and have been established for different purposes.

The Pacific region has five National Marine Sanctuaries, five National Park units, twenty-eight National Wildlife Refuges, four National Estuarine Research Reserves, and six National Estuary Programs located in coastal or near-coastal areas. For more details regarding history, purpose, and specific site locations pertaining to this region, see Appendix F, Tables F.5-3 through F.5-5 and Figures F.5-1 through F.5-3.

3.5.3. Threatened, Endangered, or Candidate Species

The U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) classify seventeen threatened, thirteen endangered, and two candidate species within the Pacific region. These consist of nine marine mammals, eleven marine and coastal birds, eight fish, and four sea turtles.

Six endangered cetaceans, two threatened pinnipeds, and one threatened fissiped reside in or migrate through this region (Table 3.5-2). Although whales were once hunted to near extinction in the Pacific, their numbers have steadily increased over the past few years. Whale sightings in the marine waters of the Pacific are becoming more frequent and should continue to increase in the future.

Table 3.5-2
Threatened, Endangered, or Candidate Marine Mammals of the Pacific Region

Scientific Name	Common Name	Status*	Distribution in Region
Balaenoptera borealis	Sei whale	E	This whale is seen only in summer during migration.
Balaenoptera musculus	Blue whale	E	Population is highest in spring because of northward migration from subtropics.
Balaenoptera physalus	Fin whale	E	Population is highest in summer and autumn because of northward migration from subtropics.
Eubalaena japonica	Pacific right whale	E	There have been only two sightings of this whale in southern CA.
Megaptera novaeangliae	Humpback whale	E	Migratory population has peak abundance mainly during summer but also in autumn.
Physeter macrocephalus	Sperm whale	E	Population is rare on continental shelf but abundant in deeper waters.
Arctocephalus townsendi	Guadalupe fur seal	T	The Guadalupe fur seal breeds off Baja California, Mexico.
Eumetopias jubatus	Steller sea lion	T	This is a visitor to the Pacific region from southern breeding grounds.
Enhydra lutris nereis	Southern sea otter	T	Ranges between Half Moon Bay and Point Conception, CA.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no marine mammals of the Pacific region have C or X status.

Eleven species of threatened and endangered marine and coastal birds reside in selected habitats provided by the Pacific region (Table 3.5-3). In the winter, the populations of the shorebirds are augmented by large numbers of wintering individuals from the northern ecosystems. Migratory species reside only temporarily along their route to wintering nesting areas. The Pacific region's well-developed bay, estuary, wetland, and coastal beach habitats provide the necessary biological diversity for a variety of bird species. National Wildlife Refuges and National Park units across the region provide sanctuary to a variety of endangered migratory and indigenous bird species.

Five species of anadromous (Oncorhynchus) Pacific salmon and steelhead trout spawn in and migrate through rivers and streams in this region. Salmonids (including Chinook salmon [*Oncorhynchus tshawytscha*]) on the U.S. West Coast have experienced dramatic declines during the past several decades as a result of human-induced and natural factors. Threats from water diversion and agricultural and development activities have affected stream habitats. In addition, commercial fishing on unlisted healthier stocks has caused adverse impacts to weaker stocks of salmon, and illegal high-seas driftnet fishing in past years also may have been partially responsible for population declines (USCG, 2002). Recreational fishing throughout the salmon range also affects these populations. Nehlsen et al. (1991) identified 214 declining West Coast stocks (California, Oregon coast, Columbia Basin, Washington coast/Puget Sound) of anadromous Pacific salmon and steelhead trout. The stocks noted were those headed toward extinction (high and moderate risk), as well as those of special concern because of habitat loss and disturbance (e.g., population growth, lumber operations, agricultural activities, and hydropower development).

Table 3.5-3
Threatened, Endangered, or Candidate Marine and Coastal Birds of the Pacific Region

Scientific Name	Common Name	Status*	Distribution in Region	Migration Pattern
Polysticta stelleri	Steller's eider	T	AK coast, accidental south to CA; critical habitat in AK	There are accidental sightings in summer in Pacific waters. This bird migrates north to eastern AK.
Polioptila californica californica	Coastal California gnatcatcher	T	Southern CA coast; critical habitat ~513,650 acres in Los Angeles, Orange, Riverside, San Bernardino, and San Diego Counties, CA	This nonmigratory bird inhabits coastal sage scrub from Los Angeles County, CA, south to Baja California, Mexico.
Lanius ludovicianus mearnsi	San Clemente loggerhead shrike	E	San Clemente Island, CA	This is a year-round resident.
Amphispiza belli clementeae	San Clemente sage sparrow	T	San Clemente Island, CA	This is a year-round resident.
Sterna antillarum browni	California least tern	E	San Francisco Bay, CA, to Central America	This bird is found in coastal CA beaches and estuaries during the breeding season; it then migrates south after breeding.
Pelecanus occidentalis californicus	California brown pelican	E	Pacific coast	This bird breeds in southern CA from March to April, and is found from southern Mexico to central CA and occasionally from northern CA to WA.
Rallus longirostris obsoletus	California clapper rail	E	San Francisco Bay Area, CA	This is a year-round resident on the central and southern CA coast.
Rallus longirostris levipes	Light-footed clapper rail	E	Southern CA coast	This is a year-round resident on the central and southern CA coast.
Brachyramphus marmoratus	Marbled murrelet (Pacific population)	T	AK coast south to CA coast; critical habitat not in the Pacific continental waters region	This bird breeds from northern WA to San Francisco, CA, coast and winters along the entire Pacific coast.
Charadrius alexandrinus nivosus	Western snowy plover	T	WA coast south to CA coast; critical habitat in twenty-eight areas along the CA, OR, and WA coasts	This bird summers along Pacific coast and migrates south to Mexico and South America during winter. Some CA populations are residents.
Haliaeetus leucocephalus	Bald eagle	T	WA, OR and CA coast and Santa Catalina Island off the coast of CA	This bird winters along the Pacific coast and inland areas.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no marine and coastal birds of the Pacific region have C or X status.

The white abalone (*Haliotis sorenseni*) located off the California coast is the only shellfish (mollusk) currently listed under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended) by the NMFS, while the black abalone (*Haliotis cracherodii*) in the same location was designated a candidate species in June 1999. Table 3.5-4 lists the eight threatened, endangered, and/or candidate species supported in the Pacific region.

Table 3.5-4
Threatened, Endangered, or Candidate Fish of the Pacific Region

Scientific Name	Common Name	Status*	Distribution in Region
Oncorhynchus tshawytscha	Chinook salmon	T / E	Population is found from Monterey Bay, CA, to Chukchi Sea, AK, and associated freshwater rivers.
Oncorhynchus kisutch	Coho salmon	T	This salmon is found in waters off the coast of Monterey Bay, CA, to north of the Canadian border. It is associated with freshwater rivers.
Oncorhynchus keta	Chum salmon	T	Population s found in Tillamook Bay, OR, to Arctic coast of AK and associated freshwater rivers.
Oncorhynchus nerka	Sockeye salmon	T / E	This salmon is found in northern WA, especially in and around Puget Sound.
Oncorhynchus mykiss	Steelhead trout	T / E / C	West Coast steelhead trout is currently distributed across about 15 degrees of latitude, from approximately 49°N at the U.S.-Canada border south to 34°N at the mouth of Malibu Creek, CA, and Santa Margarita River, San Diego County, CA.
Haliotis sorenseni	White abalone	E	Population is found in deepwater marine areas off the coast of southern CA and Baja California, Mexico.
Haliotis cracherodii	Black abalone	C	Areas of concern are OR, CA, and Baja California, Mexico.
Acipenser medirostris	North American green sturgeon	C	Range in nearshore marine waters from Mexico to the Bering Sea and are commonly observed in bays and estuaries along the coast with large concentrations entering the Columbia River estuary, Willapa Bay, and Grays Harbor in WA.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 et seq., as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no fish of the Pacific region have X status.

Sea turtles nest on beaches in the tropics and subtropics throughout the Pacific region (Table 3.5-5); they have also been sighted in the eastern North Pacific Ocean as far north as the Gulf of Alaska (NOAA, 1993). The Pacific region hosts four species of sea turtles, two of which are listed as both threatened and endangered. The leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), and Pacific (olive) ridley (*Lepidochelys olivacea*) sea turtles are most commonly reported off the West Coast. Factors such as water depth, bottom sediments, and prey availability account for sea turtle distribution in nearshore habitats.

Table 3.5-5
Threatened, Endangered, or Candidate Sea Turtles of the Pacific Region

Scientific Name	Common Name	Status*	Distribution in Region
Dermochelys coriacea schlegelii	Leatherback sea turtle	E	This turtle approaches coastal waters only during breeding season. Nesting occurs throughout the Caribbean, on the northern coast of South America, on the Pacific coast of Central America, and on the east coast of FL.
Chelonia mydas	Green sea turtle	T / E	The breeding populations off FL and the Pacific coast of Mexico are listed as endangered, while all others are listed as threatened. In the eastern North Pacific Ocean, this turtle has been sighted from Baja California, Mexico, to southern AK.
Lepidochelys olivacea	Pacific (olive) Ridley sea turtle	T / E	The breeding populations off the coast of Mexico are listed as endangered, while all others are listed as threatened. This turtle is essentially tropical. In the eastern Pacific Ocean, nesting takes place from southern Sonora, Mexico, south to at least Colombia. Nonnesting individuals occasionally are found in waters of the southwestern US.
Caretta caretta	Loggerhead sea turtle	T	Population is circumglobal, inhabiting continental shelves, bays, estuaries, and lagoons in temperate, subtropical, and tropical waters. In the eastern Pacific Ocean, this turtle has been reported as far north as AK and as far south as Chile. Occasional sightings are also reported from the WA coast, but most records are of juveniles off the CA coast.

Source: U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no sea turtles of the Pacific region have C or X status.

3.5.4. Essential Fish Habitat

The Fishery Conservation and Management Act of 1976 (FCMA) established eight regional Fishery Management Councils (FMCs), charged with developing Fishery Management Plans (FMPs) to achieve optimum fishery yields within their respective regions. In subsequent years, additional legislation was formulated to increase the effectiveness of this act. Two examples are the NMFS "602 Guidelines" ("Guidelines for the Preparation of Fishery Management Plans under the FCMA," 50 CFR part 602), which provided an official definition of overfishing and required each FMP to include measurable definitions of overfishing for each managed species, and the Sustainable Fisheries Act of 1996 (Public Law 104-297; 16 U.S.C. 1801 *et seq.*), which was passed and integrated into the Magnuson-Stevens Fishery Conservation and Management Act of 1996 (MSFCMA, Public Law 94-265, as amended through October 11, 1996; 16 U.S.C. 1801 *et seq.*). This later act required FMCs and the Secretary of Commerce to identify and describe Essential Fish Habitat (EFH) for species specified under each respective FMP.

The Pacific Fisheries Management Council (PFMC) is responsible for implementing the MSFCMA through FMPs in the Pacific region. EFH is designated under four FMPs in the Pacific region—groundfish, salmon, highly migratory species, and coastal pelagic species. The commercially important fish species of this region are listed in Table 3.5-1. NMFS is currently updating EFH designations for this region. EFH designations for each region are available on-line[19]. It is important to identify habitat areas essential to each life stage of a federally managed species to ensure sustainable fisheries and the ability of managed species to contribute to a healthy ecosystem.

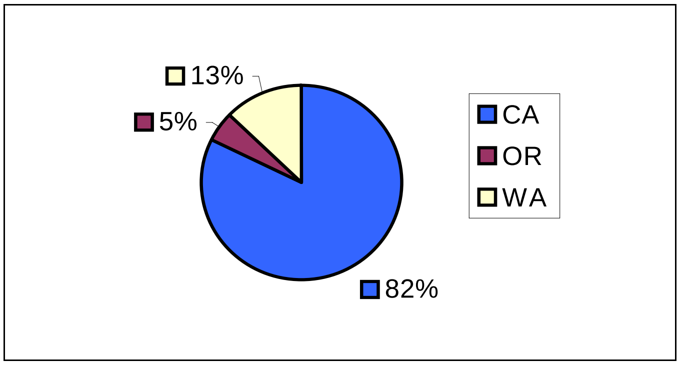
3.5.5. Socioeconomic Environment

3.5.5.1. Coastal Communities, Demography, and Employment

This socioeconomic impact area, based on NOAA's definition of coastal counties, comprises 60 coastal counties located in three states listed in Section 3.5.1. The coastal counties in the socioeconomic impact area extend from Whatcom County, Washington, south to San Diego County, California.

The coastal population of the Pacific region is 36,055,298 (U.S. Census Bureau, 2000a), which is calculated by combining population statistics for the region's 60 coastal counties, as identified by NOAA. Appendix F, Table F.5-6 lists these coastal counties and their populations. The Pacific region's coastal population makes up 12.8 percent of the total U.S. population, of which the majority is located in California (Figure 3.5-4) (NOAA, 2002b; U.S. Census Bureau, 2000a).

Figure 3.5-4
Coastal Population Distribution of the Pacific Region



Source: NOAA, 2002b; U.S. Census Bureau, 2000a.

The Pacific region varies in socioeconomic patterns ranging from low-density, undeveloped rural areas to high-density, highly developed urban centers. The range is from 3,824 people in Wahkiakum County, Washington, to 9,519,338 people in Los Angeles County, California. Table 3.5-6 lists the most densely populated coastal counties of the Pacific region.

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[19] *http://www.nmfs.noaa.gov/habitat/habitatprotection/efh/fish_manage_c.htm*

Table 3.5-6
Highest Populated Coastal Counties of the Pacific Region

County	Population
Los Angeles, CA	9,519,338
Orange, CA	2,846,289
San Diego, CA	2,813,833
King, WA	1,737,034
San Bernardino, CA	1,709,434

Source: NOAA, 2002b; U.S. Census Bureau, 2000a.

In 2000, the coastal counties within this region had a total civilian labor force of 17,333,433, with an average unemployment rate of 6.4 percent, compared with the national average of 5.8 percent. Income levels rank higher than the national average of both per capita and median household incomes at $21,991 and $44,116, respectively. (The national average per capita and median household incomes are $21,587 and $42,834, respectively.) The levels of income vary throughout the region. For example, Del Norte County, California, the poorest county in the region, has a per capita income of $14,573, while Marin County, California, the wealthiest county in the region, has a per capita income of $44,962 (U.S. Census Bureau, 2000a).

3.5.5.2. Economic Status

Four primary sectors make up the foundation of the Pacific's economic system: natural resources, tourism, petroleum, and international commerce. An associated fifth sector provides services to the former four in a variety of capacities including government, sales, communications, and infrastructure.

The coastal areas of northern California, Oregon, and Washington historically have had a resource-oriented economy dependent on agriculture, forestry, and fishing. Although there has been a shift in recent years to diversify that economic base to include manufacturing, food processing, smelting, forestry, and commercial fishing are still the primary economic sectors within the northern Pacific region.

Tourism is a critical segment of the coastal economy, and public recreation facilities, such as national parks and museums, can be found all along the coastline. Although in 1996 the combined revenue for coastal tourism across the three states exceeded $41 billion (ACC, 1998), the tendency of these industries to be cyclical over time and highly seasonal in nature can pose a problem. For example, employment levels drop during the rainy season when tourism drops significantly.

The southern portion of the Pacific region has a large amount of oil and gas activity. Proved reserves of oil and gas off California are estimated to be 3,627 million bbl and 2,681 billion ft^2, respectively, as of December 31, 2001 (EIA, 2002d). In 1992, the offshore oil and gas industry employed approximately 25,600 people and contributed an estimated $850 million to the California economy (California Resources Agency, 1997).

The Pacific region's proximity to the Pacific Rim countries and Mexico provides major access to world markets. As such, international trade represents a significant economic input in the region. In 2000, California businesses exported $130 billion in products (California Technology, Trade and Commerce Agency, 2001), leading the nation in exports and expecting to grow in the future. In addition, the state of Washington ranked fourth in total value of exports among the fifty states in 1999 (Lin and Schmidt, 2000). There is evidence suggesting that more than 40 percent of all Washington exports are moved by water and that almost one out of every four jobs is related to the export industry (Dinsmore, 1997).

3.5.5.3. Vessel Transportation and Ports

An extensive domestic and international shipping pattern exists within the coastal states of the Pacific region and between various ports in Asia, Mexico, Canada, and South America. There are seventeen major ports in the region (Table 3.5-7), with over 500,000 voyages reported every year (USACE, 1999c). The combined Port of Seattle-Tacoma, Washington, is the eleventh largest port in the world, and the Port of Los Angeles, California, is the tenth busiest, bringing in annually over $80 billion dollars worth of goods (USACE, 1999c). Major commodities are automobiles, petroleum products, grain, and a variety of miscellaneous containerized items. In 2002, an estimated 275,740 bbl (approximately 8 percent) of the crude oil entering the United States came through ports in the Pacific region (EIA, 2003).

Table 3.5-7
Major Ports of the Pacific Region

State	Port
CA	Humboldt Harbor, San Francisco Bay and Harbor, Oakland Harbor, Richmond Harbor, Port Hueneme, Los Angeles, Long Beach, San Diego
OR	Portland, Coos Bay
WA	Bellingham, Seattle, Tacoma, Port Angeles, Port Townsend, Grays Harbor, Vancouver

Source: USACE, 1999c.

In 1999, the Pacific region received or shipped from its ports more than 318 thousand short tons of foreign and domestic cargo: domestic shipping and receiving accounted for 20,928 and 69,047 thousand short tons, respectively, while foreign shipping and receiving accounted for 86,247 and 107,891 thousand short tons, respectively. In addition, there were 34,588 thousand short tons of intrastate waterborne commerce (USACE, 1999c).

3.5.5.4. Fisheries

Commercial Fisheries

With the recent decline in revenues from the coastal timber industry, the importance of commercial fishing and ancillary activities to the local economies of the Pacific region has increased substantially. Fisheries are located throughout the coast, with important catches consisting of sardines, squid, anchovies, salmon, albacore, tuna, sablefish, Pacific whiting, rockfishes, Pacific cod and halibut, rex and petrale sole, crabs, oysters, scallops, clams, and kelp seaweed. During 2000, fisheries off the Pacific coast produced nearly 640 million lb, valued at $217 million (NMFS, 2003b), which provided nearly 13 percent of all commercial fish landings in the continental United States. Table 3.5-8 lists the top commercial landings for the Pacific region.

Table 3.5-8
Top Commercial Landings for 2000* for the Pacific Region

Scientific Name	Common Name	Pounds	Dollars
Cancer magister	Dungeness crab	35,416,765	75,728,638
Loligo opalescens	California market squid	262,132,781	27,242,467
Crassostrea gigas	Pacific oyster	8,439,111	22,068,500
Panopea abrupta	Pacific geoduck clam	1,144,877	15,489,041
Strongylocentrotus franciscanus, S. droebachiensis, and *S. purpuratus*	Red sea urchin, green sea urchin, and purple sea urchin	15,194,252	15,051,588

Source: NMFS, 2003b.

* Ranked by dollar value.

Recreational Fisheries

Recreational fishing is an important activity throughout the Pacific region. Many tourists are attracted to the region for oceanic salmon fishing and numerous other species. There are six different kinds of sportfishing in the region: shore, pier, commercial passenger vessel (party boat), skiff, diving, and clamming. Based on a 2001 NMFS Marine Recreational Fishery Statistical Survey, 2.5 million marine recreational fishing participants took 9.6 million trips and caught a total of 35 million fish (NMFS, 2002). Sixty-five percent of the trips were made in California, 23 percent in Washington and 12 percent in Oregon (NMFS, 2002). In 2001, the economic expenditures in this region due to this fishery were approximately $2.5 billion (ASA, 2002).

3.5.5.5. Subsistence

In the Pacific region, Native American subsistence gathering, although not previously well documented, may involve several thousand individuals and can account for a major portion of the total subsistence for some Native American families (MMS, 2001b). Subsistence gathering along the Oregon and Washington coasts involves both foodstuff and traditional medicines, such as herbs and teas. The taking of salmon and shellfish make up the largest portion of the subsistence economy in the area. Shellfish have recently replaced salmon as the leading subsistence crop for Native American tribes in the state of Washington. The annual subsistence and commercial harvest for the region is approximately 757,000 lb of clams, 2.8 million lb of oysters, 4 million lb of crab, and 500,000 lb of shrimp (MMS, 2001b).

The Makah, a Washington State Native American tribe, also harvested marine mammals such as the gray whale. Historically, the types of resources taken have been very extensive and have included salmon, skate, mussels, cod, sculpins, porpoise, seal, halibut, deer, elk, duck, geese, herring, sturgeon, gulls, puffins, crabs, cormorants, roots, berries, and eels. Currently, the types of resources taken are far fewer than was common in historic times; however, subsistence gathering is an extremely important part of life for the contemporary Native American tribes in Oregon and Washington. Ocean resources are also used in an extensive barter system, exchanging salmon and other ocean resources for inland resources (such as deer and elk). The resources also are sold for cash as a means of supplementing their income (MMS, 2001b).

In California, the Bureau of Land Management (BLM) and other agencies have primarily documented gathering for subsistence and ceremonial purposes. The distribution of the subsistence and hunting activities in California varies. In northern California, activities tend to be very similar to those in Oregon and Washington, while in southern California, the intertidal zone is the object of intensive food-gathering activities by members of various ethnic groups. The traditional subsistence gathering of Native Americans in southern California has been reduced in recent years because of a decrease in the supply of traditional plant and animal foods (MMS, 2001b).

3.5.5.6. Archaeological/Historic Resources

The Minerals Management Service (MMS, 1996b) conducted two archaeological baseline studies that cover the entire coastal Pacific region: the California, Oregon, and Washington Archaeological Resource Study that ran from Morro Bay, California, north to the Canadian border, and the Archaeological Resource Study that ran from Morro Bay to the Mexican border. This report revealed that the onshore coastal areas of the Pacific region contain numerous prehistoric and historic archaeological sites. Many of these sites are the cultural remains of early coastal Native American populations. The baseline study for northern California, Oregon, and Washington compiled information on 2,762 known prehistoric archaeological sites within a narrow strip of land along the coast. The baseline study for southern California documented 1,681 known prehistoric archaeological sites along the coastal area south of Morro Bay to the Mexican border. These prehistoric archaeological sites represent only the sites that have been recorded to date; it is likely that there are thousands of additional undocumented sites. Although no submerged prehistoric archaeological sites have been recorded offshore of northern California, Oregon, or Washington, there have been numerous finds of ground-tone artifacts offshore of southern California. Most of the artifacts are indicative of the Milling Stone Cultural Horizon (MMS, 1996b).

Onshore historic sites are numerous and are listed in such inventories as the National Register of Historic Places and the State Register of Historic Places. Offshore historic sites (submerged resources) can include several categories of resources, such as sunken ships and aircraft. An MMS archaeological baseline study for northern California, Oregon, and Washington identified a total of 3,850 shipwrecks for the area from Morro Bay north to the Canadian border (MMS, 1996b). The baseline study for southern California identified a total of 916 shipwrecks for the area from Morro Bay south to the Mexican border (MMS, 1996b). These shipwrecks represent only those shipwrecks that have been documented through literature searches (MMS, 1996b).

3.5.5.7. *Recreation and Tourism*

The Pacific region's coastline is extremely diverse and varies from rugged, wind-blown cliffs to flat, sandy beaches backed by wide, meandering river valleys to fully developed urban areas. Recreational activities along the coast include sightseeing, camping, clam digging, hiking, beachcombing, picnicking, boating, swimming, wading, sunbathing, diving, surfing, and sportfishing. Sightseeing and beachcombing are enjoyed along the entire coast and are mainly dependent on the aesthetic aspect of the area.

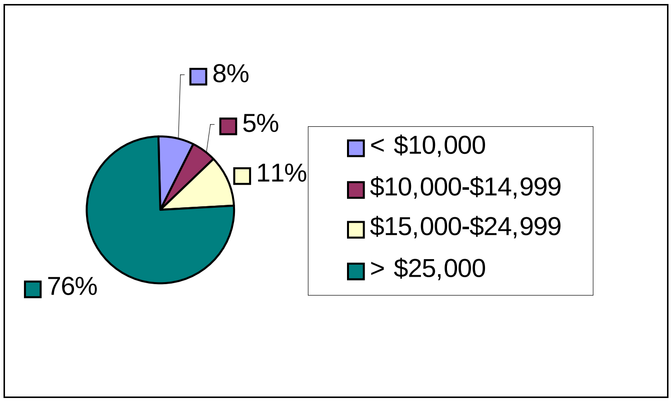
Each of these recreational activities depends on an accessible and unpolluted marine environment. Most of these activities occur at established shoreline parks, recreation sites, beaches, or public access sites. The most intense use of available recreational resources generally is found near the major coastal population centers. The American Coastal Coalition (ACC, 1998) reported that coastal tourist expenditures for the Pacific region totaled $41,092,240 and supported 575,000 jobs.

3.5.5.8. *Environmental Justice*

Executive Order 12898 ("Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," 59 FR 7629) provides that each federal agency shall make achieving environmental justice part of its mission by identifying and addressing questions regarding environmental and health conditions of impoverished communities.

Low-income communities, which can be found across the Pacific region, include multiethnic as well as homogenous communities and neighborhoods. Of the 8,487,203 families that live within the coastal counties of this region, 9.6 percent (or 813,505) have been classified as living in poverty by the U.S. Census Bureau (2000a). The average per capita income and median household incomes for this region are $21,991 and $44,116, respectively. However, 24 percent of households earned less than $25,000 in 1999. Figure 3.5-5 shows the distribution of household income in the Pacific region.

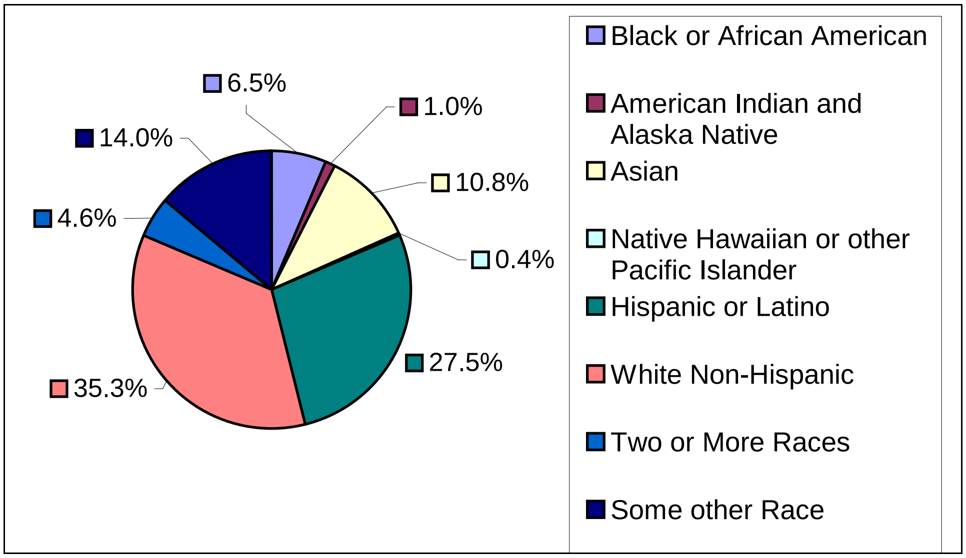
Figure 3.5-5
Distribution of Household Income in the Pacific Region



Source: U.S. Census Bureau, 2000a.

Minority groups are scattered throughout the Pacific region. These groups include Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian or other Pacific Islander, or other (Hispanic or Latino, and white Non-Hispanic). Figure 3.5-6 shows the distribution of race in the Pacific region.

Figure 3.5-6
Racial Distribution of the Pacific Region



Source: U.S. Census Bureau, 2000a.

3.5.5.9. Public Safety and Worker Health

Oil spill response is one of the U.S. Coast Guard's (USCG's) many missions. In responding to oil spills, the USCG is aware of public safety and the effects that alternative response technologies—chemical dispersion and *in situ* burning—could have on human health. Under the guidelines established by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), steps have been taken to protect both the public and oil spill responders. Whether compensated workers or volunteers, responders are required to be certified under either the Occupational Safety and Health Administration's (OSHA's) Hazardous Waste Operations and Emergency Response Standard or USEPA's Hazardous Waste Operations and Emergency Response Standard. These standards ensure that responders understand the hazards of oil spill response and how to protect themselves. To assist in public safety, the USCG has the maritime safety authority to establish a safety zone around oil spill cleanup operations. This zone is established to safeguard the public and responders from the hazards associated with cleanup. In addition, USCG standard operating procedures (SOPs) are used to protect responders, as well as the public, from the hazards associated with chemical dispersion and *in situ* burning. These procedures are outlined in SOPs in each Area Contingency Plan's (ACP's) Site Safety Plan. In addition, training exercises such as PREP (Preparedness for Response Exercise Program) and SONS (Spill of National Significance) train USCG response personnel to avoid safety hazards.

Dispersants are a liquid chemical used to disperse oil spills from the ocean surface (see Section 2.2.2). During an oil spill, dispersant application can be from either an aerial or a shipboard platform. In both cases response personnel have the potential to be accidentally exposed to the dispersant, and in extreme cases exposure to the public could occur. The two types of dispersants with use allowed in the United States have OSHA-established, permissible exposure limits of 50 ppm on skin. The Material Safety Data Sheet (MSDS) for these dispersants makes clear the human health concerns from excess exposure.

In situ burning of an oil spill entails setting contained or boomed oil on fire (see Section 2.2.3). This action has been acknowledged as having potential human health and safety effects. Besides the physical hazards to responders, there is the potential for inhalation of airborne burn products. *In situ* burning emits a plume of black smoke laden with particulates (PM10, soot), the main public health concern. Response personnel working close to the burn may be exposed to levels of gases and particulates that would require them to use personal protective equipment. Occupational standards such as OSHA's Permissible Exposure Limits (PELs) are applicable. For the general public, NOAA (2000a) reported that particulate concentrations in a smoke plume remain the only agent of concern past 1 or 2 mi downwind, with the gases created in a burn dissipating to levels close to background. Public exposure to smoke particulate from the burn is not expected to occur unless the smoke plume travels down to ground level. Since the general public may include sensitive individuals, such as the very young and very old, pregnant women, and people with pulmonary or cardiovascular diseases, this population's tolerance to particulates may be significantly lower than that of the responders. There is little data concerning the effect on humans of particulates from the *in situ* burning of oil. Based on chemical analysis of soot particulates and their physical behavior, the hazard is expected to be similar to that of better-known particulates emissions that are now regulated by the NAAQS. In 1997, the Special Monitoring of Applied Response Technologies (SMART)[20] protocol was created, in part, to address the particulates concerns and to better aid the Federal On-Scene Coordinator (FOSC) in making decisions related to initiating, continuing, or terminating *in situ* burning.

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[20] *http://response.restoration.noaa.gov/oilaids/SMART/SMART.html*

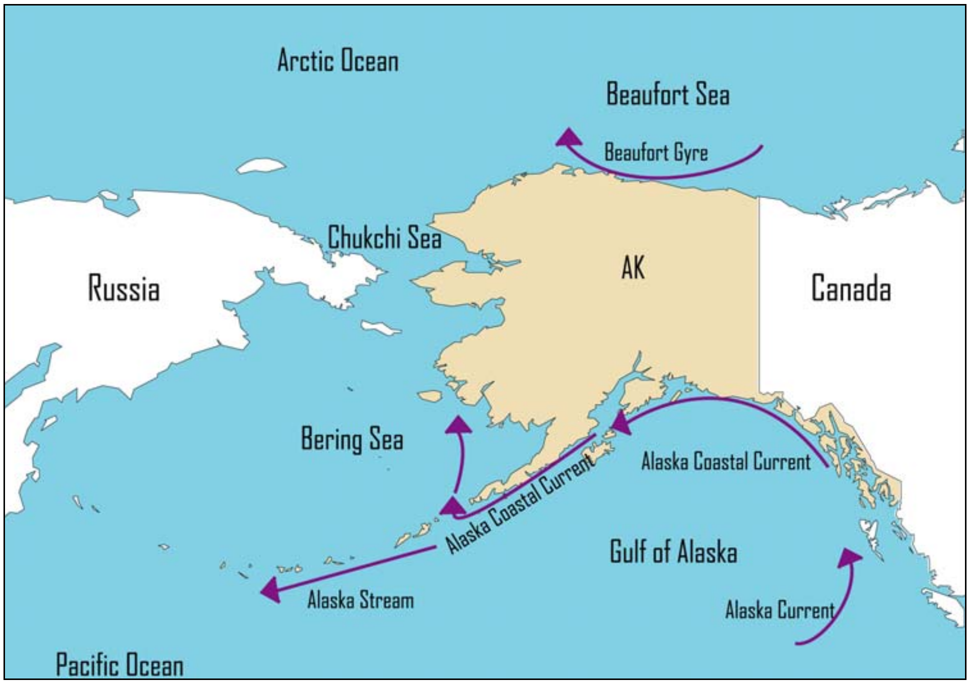
3.6. ALASKA REGION

3.6.1. Physical Environment

The coastal shoreline of Alaska measures about one-third of the total shoreline of the United States and its possessions. Because of the Alaska region's immense size, a range of information primarily from the Gulf of Alaska (GOA) and Beaufort Sea will provide a discussion about this region for the purpose of this Programmatic Environmental Impact Statement (PEIS). Beginning south of the state, the body of water bordering the state's southern coastline and Canada's west coast is the GOA. Traveling counterclockwise, these far-reaching waters adjoin the Bering and Chukchi Seas; finally, the Beaufort Sea is located along the north coast of Alaska (Figure 3.1-1). Each of these marine environments differs through various surface currents and physical inputs from Alaskan rivers.

Three surface currents affect the GOA: Alaska Current, Alaska Stream, and Alaska Coastal Current (Figure 3.6-1). The eastward-flowing Alaska Current in the northern GOA flows into the southward-moving Alaska Stream. This stream then flows along the Alaskan Peninsula. Closer to shore flows the Alaska Coastal Current. All three currents characterize the circulation of the GOA. Speed and salinity vary between each of these systems and depend on prevailing winds and seasonal fluctuations. Current speeds average 0.4 to 3.6 kt. Mean monthly sea-surface temperatures range from about 38°F in March to about 57°F in August. Surface salinities range from a maximum of approximately 31 parts per thousand (ppt) in late winter to a minimum of 25 ppt in August (*EXXON VALDEZ* Oil Spill Trustee Council, 2002).

Figure 3.6-1
Major Currents of the Alaska Region



Note: Map is not to scale.

The surface circulation of the Beaufort Sea is dominated by a clockwise gyre in the Arctic basin. The prevailing current moves water and ice shoreward throughout most of the year, with velocities ranging from 2 to 4 in/s. For 9 months of the year (typically from November through July), marine waters are covered with ice. In late summer and fall, easterly and offshore winds produce surface currents countering the prevailing Arctic gyre, which results in a variable period of relatively ice-free waters (ADNR, 1999). Salinity and temperature in the Beaufort Sea also depend on the change of seasons. Seawater temperatures are cold throughout the year, ranging from 28° to 30°F in winter under the ice, to just above freezing in the summer. The salinity in the Beaufort Sea varies both geographically and seasonally from 28 to 32 ppt (ADNR, 1999).

3.6.1.1. Water Quality

Coastal

Alaska is a remote, sparsely populated landmass with little or no industrial activity, which causes one to assume that the water quality should be near pristine. However, turbidity, dissolved oxygen, trace metals, and hydrocarbons are introduced into the marine environment through river runoff, glaciation, coastal erosion, natural oil seeps, atmospheric deposition, mining activities, oil and gas activities, and past oil spills. Anthropogenic impacts from concentrated population areas include seafood processing, discharge, and municipal waste. The U.S. Environmental Protection Agency (USEPA, 1998a) compiled an assessment of 1 percent of Alaska's estuarine waters in its 305(b) report. Of these, most were classified as impaired for overall use. It should be noted that this assessment reflects waters with known impairments. Efforts are underway to assess other waters across the state.

Marine

The general water quality of offshore marine waters is pristine. There is, however, some impact from major river inputs (sediments) that flow beyond coastal waters and into offshore waters. Waste discharge from petroleum-producing platforms, commercial fishing vessels, oil tankers, and cruise ships also contaminate marine waters. For example, it was estimated that during a typical 7-day cruise, 1,109,523 gal of graywater was discharged into Alaskan coastal waters from 3,000 passengers and crewmembers (AMSEC LLC, 2000). Accidental oil spills normally result from collisions and groundings of vessels. In 1999, there were 800 oil spills in and around the coast of Alaska (USCG, 2000a).

3.6.1.2. Meteorology and Air Quality

Climate

The climate of Alaska is varied because of the large differences in latitude and geography. Three semipermanent atmospheric pressure patterns largely affect the climate over Alaska: Siberian High, Aleutian Low, and East Pacific High (*EXXON VALDEZ* Oil Spill Trustee Council, 2002). The Siberian High influences the continental, arctic, polar air mass and is generally characterized by average low annual temperatures and low precipitation. Maritime polar air masses are influenced by two pressure patterns—Aleutian Low and East Pacific High. The Aleutian Low creates moderate temperatures and moderate moisture; this low-pressure system dominates control over much of Alaska's weather in the winter. The second pressure pattern influencing polar air mass is the East Pacific High, which controls much of Alaska's weather in the summer.

Arctic coastal wind speeds of 30 to 50 kt are common during winter months. The average wind speed is 10.6 kt at Barrow (ADNR, 1999). Winds along the coastal areas of the GOA are strongly influenced by local topography. They mostly blow parallel to nearby mountain ranges, with a prevalent wind direction from the east averaging between 12 and 18 kt (MMS, 2001a).

Air Quality

Air quality is measured against National Ambient Air Quality Standards (NAAQS), resulting from the Clean Air Act and its 1977 amendments (40 CFR 50.12), or it is measured against more restrictive adopted state standards. These standards are designed to protect human health. The USEPA requires states to report ambient air quality levels for six major pollutants: particulate matter (10 microns or larger [PM10]), sulfur dioxide, carbon monoxide, nitrogen dioxide, lead, and ozone. NAAQS have been adopted by the state of Alaska. Appendix F, Table F.1-1 summarizes federal ambient air standards in detail.

All coastal counties of the Alaska region are considered to be in compliance with the NAAQS attainment levels for sulfur dioxide, nitrogen dioxide, lead, and ozone. There were only a few counties that were not in compliance with the remaining two pollutants: one county was not in compliance for carbon monoxide, and two counties were not in compliance for particulate matter (PM10) (USEPA, 2000a).

Alaska has the lowest air emissions of all states in the nation because there are few industrial emission sources and, other than Anchorage or Fairbanks, no sizable population centers. Primary emissions are associated with oil and gas production, power generation, small refineries, paper mills, and mining. During winter and spring, pollutants are transported across the Arctic Ocean from industrial Europe and Asia to arctic Alaska (Rahn, 1982), causing a phenomenon known as arctic haze. The haze has been thoroughly analyzed, and it consists of sulfate (up to 90 percent), soot, and sometimes dust (AMAP, 1997). Concentrations of this aerosol haze are similar to those over large portions of the continental United States. Despite this seasonal, long-distance transport of pollutants into the Arctic, regional air quality is still far better than specified by the NAAQS and by state standards (BLM, 1998).

3.6.2. Biological Environment[21]

3.6.2.1. Marine Mammals

The Alaska region is home to a diverse group of marine mammals living in both arctic and subarctic environments throughout the coastline. All coasts north of the Bering Strait are bordered by sea ice every winter, with pack ice often just offshore every summer; marine mammals that occur here are rare or nonexistent south of the Bering Sea (USCG, 2002). A variety of marine mammal species—sixteen cetaceans (whales and porpoises), eight pinnipeds (seals and walruses), and two fissipeds (sea otters)—are known to inhabit Alaskan waters. Polar bear, seal and walrus also inhabit Alaska's waters for at least part of the year (USCG, 2002).

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[21] Only nonendangered species will be included in Section 3.6.2, Biological Environment. Threatened, endangered, and candidate species will be discussed separately in Section 3.6.3, Threatened, Endangered, or Candidate Species.

Many of these species face unique pressure from human activities such as oil exploration, subsistence hunting, and intense seasonal fisheries and are, therefore, protected under the Marine Mammal Protection Act of 1972 as amended (Neff et al., 2001). Appendix F, Table F.6-1 lists fifteen recognized nonendangered marine mammals in this region.

3.6.2.2. Marine and Coastal Birds

The Alaska region is an important breeding area for migratory waterfowl and shorebird species. About 100 million seabirds reside in the marine waters of Alaska during some time of the year. Conceivably half of this population is composed of fifty species of nonbreeding residents, visitors, and breeding species that use marine habitats only seasonally (Hatch and Piatt, 1995). Another thirty species include 40 to 60 million birds that breed in Alaska and spend most of their lives in U.S. territorial waters (Hatch and Piatt, 1995). Alaskan populations account for more than 95 percent of the breeding seabirds in the continental United States; eight species nest nowhere else in North America (Hatch and Piatt, 1995). These birds populate the offshore waters, coastal shores, and wetlands of the Alaska Region. Many species are strongly pelagic and are, therefore, rarely seen from shore. The remaining species are found within coastal and inshore habitats.

The presence of five Western Hemisphere Shorebird Reserve Network (WHSRN) sites, one Ramsar site, and eight National Wildlife Refuges in the Alaska region indicates that large numbers of shorebirds (WHSRN sites) and wetland birds (Ramsar site) concentrate in the area during migration and/or nesting and wintering. The WHSRN maintains a network of monitoring sites comprising critical habitat for shorebird species. These sites are categorized as hemispheric, with an annual count of 500,000 shorebirds or 30 percent of a species flyway population; international, with an annual count of 100,000 shorebirds or 10 percent of a species flyway population; and regional, with an annual count of 20,000 shorebirds or 5 percent of a species flyway population. The five WHSRN sites along the Alaska coastline consist of one hemispheric, one international, and three regional sites (WHSRN, 2004). The Ramsar Convention designates Ramsar sites as wetlands of international importance. These wetlands are selected based on criteria such as supporting 20,000 or more waterbirds and regularly supporting 1 percent of the individuals in a population of one species or subspecies of waterbird (Wetlands International, 2004). The National Wildlife Refuge sites are established under the National Wildlife Refuge System Improvement Act of 1997 with the aim of protecting wildlife and preserving biological diversity (USFWS, 2004).

For the purpose of this PEIS, marine and coastal birds are categorized into five major groups, as detailed in Appendix F, Table F.6-2: seabirds, shorebirds, wading and marsh birds, waterfowl, and raptors.

3.6.2.3. Plankton and Fish

Plankton

Plankton are organisms that float at or near the surface of marine waters and are unable to swim against tides, winds, or currents. Plankton species, which represent nearly all major aquatic phyla, can be roughly classified as phytoplankton (microscopic plant life), zooplankton (microscopic animals), and ichthyoplankton (fish eggs and larvae). In the GOA, dramatic differences are observed between pelagic communities in the deep ocean and those communities in shelf, coastal, and inside waters (sounds, fjords, and estuaries). Specifically, the euphotic zone seaward of the shelf edge is dominated year-round by very small phytoplankters, which are tiny diatoms. In contrast, shelf, coastal, and inside waters host a more traditional plankton community, in which large and small diatoms and dinoflagellates support a copepod-dominated grazing assemblage (*EXXON VALDEZ* Oil Spill Trustee Council, 2002; Sheppard, 2000).

Phytoplankton are microscopic floating algae, which form the base of the food web. They are responsible for approximately one-half of global photosynthesis and play a vital role in stabilizing atmospheric carbon dioxide. These plants can only survive in the shallower, sunlit waters of open-ocean and estuarine areas. Off the Alaskan coast, phytoplankton blooms occur over areas of upwelling; these areas are widespread, particularly at the edges of the various water domains on the shelf and shelf break (e.g., heads of submarine canyons, edges of gullies on the continental shelf, within passages between the Aleutian Islands, around submerged seamounts) (USGS, 1998a). In the Beaufort Sea, plankton numbers are very low, and phytoplankton bloom less frequently than in southern waters (ADNR, 1999). Quantities do increase a modest amount during and after ice breakup and are most abundant in late July and early August, when sunlight is strongest. Phytoplankton species include diatoms, dinoflagellates, and flagellates. The diatom *Chaetoceros* spp. is most abundant (ADNR, 1999).

Zooplankton, which consume phytoplankton, spend either part (meroplankton) or all (holoplankton) of their life cycles as plankton. Their temporal and spatial distributions depend on a number of factors including currents, water temperature, and phytoplankton abundance (Loeb et al., 1983). The zooplankton community on the GOA shelf is dominated by a combination of oceanic and neritic herbivorous and omnivorous copepod stocks. The major oceanic species include *Neocalanus plumchrus*, *N. flemingeri*, *N. cristatus*, *Eucalanus bungii*, and *Metridia pacifica*. Nereitic taxa are dominated by *Pseudocalanus* spp. and *Calanus marshallae*, with lesser amounts of *Acartia* spp., *Centropages abdominalis*, and *Calanus pacificus*. In addition to copepods, a number of micro-nektonic species contribute substantially to the overall density of forage for fish on the GOA shelf. The euphausiid species primarily include *Thysanoessa inermis*, *T. spinifera*, and *Euphausia pacifica*, with lower densities of *T. raschii*, *T. longipes*, *T. inspinata*, *Tessara branchion oculatum*, and *Euphausia pacifica*. Amphipods include *Cyphocaris challengeri*, *Parathemisto pacifica*, and *Primno macropa* (Sheppard, 2000).

Ichthyoplankton consume zooplankton either continuously or until they become mature fishes. The Alaskan Fisheries Science Center has identified 291 of 636 (45.8 percent) of larvae species in regional waters. The major families identified are Scorpaenidae, Cottidae, Hemitripteridae, Liparidae, Stichaeidae, and Pleuronectidae (Busby et al., 2000).

Fish

The Alaska region contains some of the most productive waters on earth. Almost all commercially important fish species are found here, including King salmon (*Oncohynchus tshawytscha*), Alaska halibut (*Hippoglossus stenolepis*), pollock, and Pacific cod (*Gadus macrocephalus*). The major commercial fisheries species in the western GOA are King crab (*Limulus polyphemus*) and Tanner crab (*Chionoecetes bairdi*). In 2000, commercial fisheries in Alaska grossed a total of 2,025,758 metric tons of fish landings (NMFS, 2003a). The North Pacific Fishery Management Council manages the Alaska Fisheries (see Section 3.6.4). Table 3.6-1 lists the most commercially important fish species of the Alaska region.

Table 3.6-1
Commercially Important Fish Species of the Alaska Region

Common Name	Scientific Name
Alaskan halibut	*Hippoglossus stenolepis*
Alaskan shrimp	*Pandalus* spp.
Arrowtooth flounder	*Asteresthes stomas*
King crab	*Limulus polyphemus*
King salmon	*Oncorhynchus tshawytscha*
Pacific cod	*Gadus macrocephalus*
Pacific Ocean perch	*Sebastes alutus*
Pink salmon	*Oncorhynchus gorbuscha*
Sablefish	*Anoplopoma fimbria*
Tanner crab	*Chionoecetes bairdi*
Walleye pollock	*Theragra chalcogramma*

Source: Adapted from USCG, 2002.

Because of problems associated with excess exploitation, many fish species are heavily managed by both state and federal agencies. In particular, the Alaska Department of Fish and Game (ADFG) regulates salmon stocks through a strict permitting and quota system. Through these and similar efforts, fish stocks in the Alaska region are slowly increasing to more sustainable levels.

3.6.2.4. Intertidal Habitats

Beaches and Coastal Barrier Islands

Alaska has the longest shoreline in the United States—33,904 mi, including the Aleutian Islands (Good et al., 1998). Located in the Beaufort Sea area are barrier islands, which are so numerous that they nearly equal the amount of barrier islands in the Gulf of Mexico region. These barrier islands are constantly migrating, eroding, and building in response to natural processes such as severe storms. Marine mammals and migratory seabirds use these islands as important haul-out and nesting habitats.

Along the GOA shoreline, the dominant habitats in the Alaska region are sheltered and exposed rocky shores, wave-cut platforms, and beaches with varying mixtures of sand, gravel, cobble, and boulders (*EXXON VALDEZ* Oil

Spill Trustee Council, 2002). Fine- and coarse-grained sand beaches represent a small portion of the GOA shoreline. Gravel and sand beaches dominate the coast on the Beaufort Sea. Strong storm waves and ice action cause the erosion rate in the Beaufort Sea to reach 9.8 ft/yr in some locations (USACE, 1998).

Estuaries and Wetlands

Estuaries are important habitats for both resident and transitory species, providing spawning or nursery habitats and foraging areas for numerous species, including invertebrates, fishes, reptiles, birds, and mammals. High organic productivity, high detritus production, and extensive nutrient recycling characterize estuaries. In the Alaska region, there are numerous and extensive estuaries along the coast from the Cook Inlet-Shelikof Strait on the south-central coast to the Colville River delta in the Beaufort Sea. Many different habitat types are found in and around estuaries, including shallow marine waters, freshwater and salt marshes, mud flats, rocky shores, river deltas, tidal pools, and seagrass and kelp beds.

Wetland habitats are associated with estuarine areas. These habitats may occupy only narrow bands along the shore, or they may cover larger expanses at the mouths of bays, rivers, or coastal streams. Wetland habitats are important habitats for marine mammals, salmon species, and other anadromous fish populations. The Alaska region has approximately 26,230 mi^2 of wetlands comprising 43 percent of the surface area of the state; as a comparison, the remainder of the United States contains 42,713 mi^2 of wetlands (ADEC, 2002; Good et al., 1998). Over the last 50 years, it has been estimated that Alaska lost less than 1 percent of its wetlands from human activities and natural erosion (Good et al., 1998).

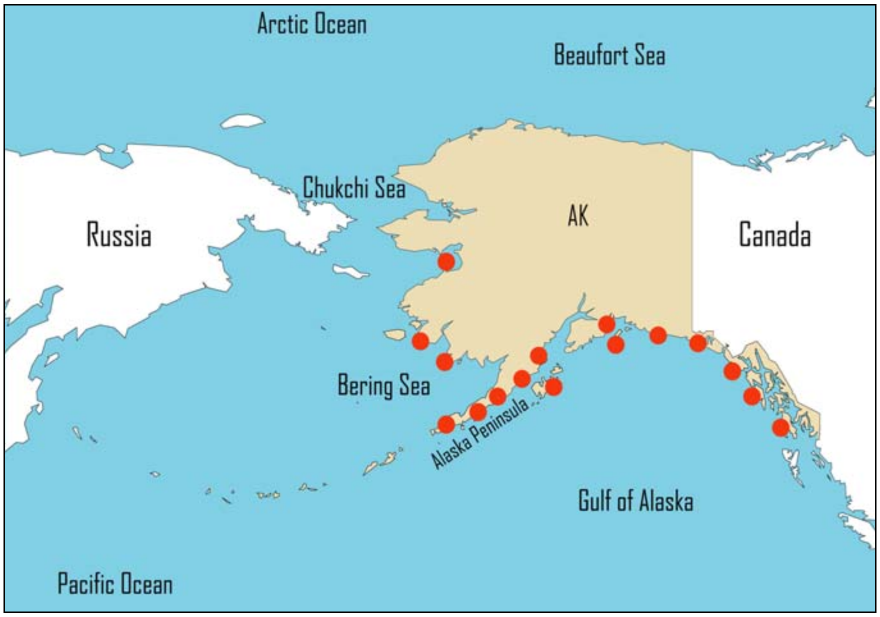
Well-developed salt marsh communities are unusual along Alaska's arctic coast, and those that exist tend to be only a few meters in extent because of low tidal range and sea-ice action along the generally unstable and erosion-prone shoreline (Macdonald, 1977; Viereck et al., 1992). The most extensive salt marsh habitats occur in the deltas of major rivers and a few protected bays. For example, the Copper River delta covers approximately 70,750 acres along the south-central coast of Alaska, just east of Prince William Sound; the delta contains the largest contiguous area of coastal wetland on the Pacific coast of North America (MMS, 2001a). Mud flats are predominantly found in southern Alaska, in particular near Kachemak Bay.

3.6.2.5. Subtidal Habitats

Submerged Grass Beds

The subtidal (benthic) areas of the Alaska region consist of either soft or rocky substrates. These areas support a variety of marine life and habitats, including seagrass beds and kelp forests. Seagrass beds provide food for wintering waterfowl and provide important spawning and foraging habitats for several species of commercially important finfish and shellfish. The physical structure provided by seagrasses affords juveniles refuge from predation and allows for attachment of epiphytes and benthic organisms. Figure 3.6-2 provides the locations of submerged grass beds in the Alaska region.

Figure 3.6-2
Locations of Submerged Grass Beds in the Alaska Region



Source: Adapted from Wyllie-Echeverria and Thom, 1994.

Note: Map is not to scale.

Two species of seagrass thrive in the Alaskan region: eelgrass (*Zostera marina*) and surfgrass (*Phyllospadix serrulatus*). Eelgrass is distributed in the northern Pacific Ocean and is the only seagrass north of the Arctic Circle. Unlike kelp, eelgrass is a flowering, marine vascular plant found in intertidal and subtidal zones in extensive meadows. Surfgrass is also located in the northern Pacific Ocean; however, the GOA is its most northern habitat. Surfgrass occurs on rocky, surf-beaten coasts (NOAA, 2001).

The Beaufort Sea coastline is subject to severe erosion and experiences tides of small fluctuation. Subsequently, coastal salt marshes are smaller and less common than on the southern coast (Viereck et al., 1992). These salt marshes are characterized by dense growth of salt-tolerant sedges (primarily *Carex ramenkii* and *C. subpathacea*).

Kelp Forests

Kelp forests perform important ecological functions, namely as nurseries and feeding grounds for juveniles of several marine species. Kelp provides food materials and protection from predators. The GOA supports three genera of kelp—*Agarum*, *Laminaria*, and *Nereocystis*—that form dense beds along a large portion of the coast.

The largest kelp community in the Alaska region occurs in Stefansson Sound and is appropriately entitled the boulder patch, an area of cobbles and boulders with attached kelp and invertebrate organisms located between barrier islands and the Sagavanirktok Delta along the coast of the Beaufort Sea (Dunton, 1984; Dunton and Schonberg, 1981; Dunton et al., 1982). The boulder patch only occurs in this area of Alaska and has been found nowhere else in the Beaufort Sea or in the Arctic. It contains unique communities of macrophytic algae (large seaweeds or kelp), benthic microalgae, bacteria, and diverse benthic invertebrates, including soft coral, sea anemones, hydroids, jellyfish, and many other organisms. In general, macrophytes are most likely to occur in areas not subjected to ice gouging or landfast ice and where hard substrates occur. The locations of other kelp beds in the eastern Beaufort Sea are portrayed near Stockton Island, Flaxman Island, and Demarcation Bay (Dunton et al., 1982).

3.6.2.6. Areas of Special Concern

Executive Order 13158 (“Marine Protected Areas”) defines marine protected areas as “any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein” (65 FR 34909). There are many different types of marine protected areas within and bordering U.S. waters; some examples include National Marine Sanctuaries, National Seashores, National Parks, National Monuments, National Wildlife Refuges, National Estuarine Research Reserves, and many others (NOAA, 2002a). They have different shapes, sizes, and management characteristics and have been established for different purposes.

Two-thirds of the entire National Park system (nearly 55 million acres) lie in Alaska (NPCA, 2002). The Alaska region has ten National Park units, ten National Wildlife Refuges, and one National Estuarine Research Reserve (Kachemak Bay, the largest reserve in the federal system [NOAA, 2003c]) located in coastal or near-coastal areas. In addition, Alaska is the only region in this PEIS with designated National Forests (two) in coastal or near-coastal areas. For more details regarding history, purpose, and specific site locations pertaining to this region, see Appendix F, Tables F.6-3 through F.6 6 and Figures F.6-1 through F.6-4.

3.6.3. Threatened, Endangered, or Candidate Species

The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have classified nine threatened, ten endangered, and three candidate species within the Alaska region. These consist of eleven marine mammals, six marine and coastal birds, and three fish species.

Seven cetaceans are endangered and reside in and migrate through this region; in addition, there is one candidate cetacean (Table 3.6-2). One pinniped and one fissiped are threatened, while the Northern sea otter (*Enhydra lutris kenyoni*) was designated a candidate species on November 9, 2000. The remainder of marine mammals, although not listed as endangered or threatened, receives special protection under the Marine Mammal Protection Act of 1972 as amended. Although Alaskan waters are not as heavily used as coastal waters in the lower forty-eight states, many species face unique pressures from human activities such as oil exploration, subsistence hunting, and intense seasonal fisheries.

Table 3.6-2
Threatened, Endangered, or Candidate Marine Mammals of the Alaska Region

Scientific Name	Common Name	Status *	Distribution in Region
Balaenoptera mysticetus	Bowhead whale	E	Population occurs in the regions of Spitsbergen, Davis Strait, Hudson Bay, Okhotsk, and western Arctic.
Balaenoptera musculus	Blue whale	E	Population occurs from the Gulf of Alaska (GOA) to the Aleutian Islands.
Balaenoptera physalus	Fin whale	E	Population occurs in high densities in the northern GOA and southeastern Bering Sea from May to October, with some movement through the Aleutian Islands into and out of the Bering Sea. In the GOA, population appears to congregate in the waters around Kodiak Island and south of Prince William Sound.
Balaenoptera borealis	Sei whale	E	This whale has been reported primarily south of the Aleutian Islands, in the Shelikof Strait and waters surrounding Kodiak Island, in the GOA, and inside waters of southeast AK; it is occasionally reported from the Bering Sea, with low numbers on the central Bering Sea shelf.
Megaptera novaeangliae	Humpback whale	E	Two populations occur, distinguished by different summer grounds: Bering Sea and Aleutian Islands for one population and Southeast Alaska and Prince William Sound for the other population.
Eubalaena glacialis	Northern right whale	E	The winter distribution and migration pattern is poorly understood; current population estimates range from 100–200.
Physeter macrocephalus	Sperm whale	E	Population is distributed from Bering Sea north to Cape Navarin; in summer, mature males move north into the Aleutian Islands, GOA, and Bering Sea, generally remaining offshore in the GOA and Bering Sea.
Delphinapterus leucas	Beluga whale	C	Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere and are closely associated with open leads and polynyas (areas of open water surrounded by sea ice) in ice-covered regions. During winter, beluga whales occur in offshore waters associated with pack ice; during spring, they migrate to warmer coastal estuaries, bays, and rivers for molting and calving. Some, if not all, of the Cook Inlet stock may inhabit Cook Inlet year-round, while the other stocks winter in the Bering Sea.
Eumetopias jubatus	Steller sea lion	T / E	Population is distributed around North Pacific rim, northward to Bering Sea, and along eastern shore of Kamchatka Peninsula, GOA, and Aleutian Islands. Population east of 144°W is listed as threatened, while population west of 144°W is listed as endangered.
Enhydra lutris nereis	Southern sea otter	T	This otter lives in shallow waters along the shores of the North Pacific.
Enhydra lutris kenyoni	Northern sea otter	C	Population is found in the Aleutian Islands.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*). Beluga whales: NMML, 2002.

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16 U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no marine mammals of the Alaska region have X status.

Four threatened, one endangered, and one candidate species of marine and coastal birds reside in selected habitats provided by the Alaska region (Table 3.6-3).

Table 3.6-3
Threatened, Endangered, or Candidate Marine and Coastal Birds of the Alaska Region

Scientific Name	Common Name	Status*	Distribution in Region	Migration Pattern
Phoebastria albatrus	Short-tailed albatross	C	Open Pacific Ocean, from AK to CA	The short-tailed albatross is a summer visitor that migrates south in fall. It breeds in Japan, Midway Is., and HI.
Somateria fischeri	Spectacled eider	T	AK coast	Population breeds on the AK coast on the Bering Sea and Arctic Ocean. It migrates south for the winter, but winter range is unknown.
Polysticta stelleri	Steller's eider	T	AK coast, accidental south to CA; critical habitat at Kuskokwim Shoals in northern Kuskokwim Bay, Seal Islands, Nelson Lagoon (including portions of Port Moller and Herendeen Bay), and Izembek Lagoon on the north side of the AK Peninsula, and intertidal zone lands between the Askinuk Mountains and Nelson Island in the Yukon-Kuskokwim Delta	Population breeds in eastern Arctic coast of AK and migrates south and west to Aleutian Islands and western AK coast.
Numenius borealis	Eskimo curlew	E		The Eskimo curlew no longer occurs in AK.
Branta canadensis leucopareia	Aleutian Canadian goose	T	Breeding on AK coast; migration and winter south to CA	During spring and summer, population is found on the Aleutian Islands chain off the AK coast. It winters in CA and OR, and also has been seen as far south as Mexico.
Brachyramphus marmoratus marmoratus	Marbled murrelet	T	AK coast south to CA; critical habitat in Bering Sea between St. Lawrence and St. Matthew Islands, in Norton Sound east of Nome, in Ledyard Bay between Cape Lisburne and Icy Cape, and on the coastal fringe of parts of the Yukon-Kuskokwim Delta	Population summers from Kenai Peninsula, Barren Islands, and Aleutian Islands south along the coast of North America. It may leave northernmost areas during winter.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no marine and coastal birds of the Alaska region have X status.

The Bering Sea, Aleutian Islands, and GOA contain some of the most productive waters on earth (USCG, 2002). Three species of fish are listed as either endangered or threatened species, depending on the population's location (Table 3.6-4).

Table 3.6-4
Threatened, Endangered, or Candidate Fish of the Alaska Region

Scientific Name	Common Name	Status*	Distribution in Region
Oncorhynchus nerka	Sockeye salmon	E	Population is found in marine, river, and lake environments from the Columbia River and its tributaries north and west to the Kuskokwim River in western AK.
Oncorhynchus mykiss	Steelhead trout	T / E	Population in Snake River Basin, Lower Columbia River, Upper Willamette River, and Middle Columbia River is listed as threatened, while population in Upper Columbia River is listed as endangered.
Oncorhynchus tshawytscha	Chinook salmon	T / E	Population in Snake River during spring, summer, and autumn; Puget Sound; Lower Columbia River; and Upper Willamette River is threatened, while population in Upper Columbia River during spring is endangered.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq*., as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no fish of the Alaska region have C or X status.

Salmonids (including Chinook salmon [*Oncorhynchus tshawytscha*]) on the U.S. West Coast have experienced dramatic declines during the past several decades as a result of human-induced and natural factors. Threats have resulted from water diversion and agricultural and development activities that affect stream habitats. In addition, commercial fishing on unlisted, healthier stocks has caused adverse impacts to weaker stocks of salmon, and illegal, high-seas driftnet fishing in past years also may have been partially responsible for population declines (USCG, 2002). Recreational fishing throughout the salmon range also affects these populations.

Sources of disturbance to the steelhead trout (*Oncorhynchus mykiss*) along the coast include commercial, recreational, and tribal fishing of streams and oceans, plus ocean conditions. Sources of disturbance to the species inland include stream water diversions and obstructions, and land-use activities such as logging and road construction, urban development, agriculture, grazing, mining, and fishing (USCG, 2002).

3.6.4. Essential Fish Habitat

The Fishery Conservation and Management Act of 1976 (FCMA) established eight regional Fishery Management Councils (FMCs), charged with developing Fishery Management Plans (FMPs) to achieve optimum fishery yields within their respective regions. In subsequent years, additional legislation was formulated to increase the effectiveness of this act. Two examples are the NMFS "602 Guidelines" ("Guidelines for the Preparation of Fishery Management Plans under the FCMA," 50 CFR part 602), which provided an official definition of overfishing and required each FMP to include measurable definitions of overfishing for each managed species, and the Sustainable Fisheries Act of 1996 (Public Law 104-297; 16 U.S.C. 1801 *et seq.*), which was passed and integrated into the Magnuson-Stevens Fishery Conservation and Management Act of 1996 (MSFCMA, Public Law 94-265, as amended through October 11, 1996; 16 U.S.C. 1801 *et seq.*). This later act required FMCs and the Secretary of Commerce to identify and describe Essential Fish Habitat (EFH) for species specified under each respective FMP.

The North Pacific Fishery Management Council (NPFMC) is responsible for implementing the MSFCMA through FMPs in the Alaska region. EFH is designated under five FMPs in the Alaska region—Bering Sea–Aleutian Islands groundfish, GOA groundfish, salmon, crab, and scallop. The commercially important fish species of this region are listed in Table 3.6-1. NMFS is in the process of finalizing the EFH designations for this region through their EFH Environmental Impact Statement (NPFMC, 2005). EFH designations for each region are available on-line[22].

3.6.5. Socioeconomic Environment

3.6.5.1. Coastal Communities, Demography, and Employment

This socioeconomic impact area comprises twenty-four coastal counties within the state of Alaska. The coastal counties extend from the North Slope Borough in the very north, down the coast (including the Aleutian Islands) to the Prince of Wales, outer Ketchikan Census Area in the southeastern corner of the state.

The coastal population of the Alaska region is 529,474 (U.S. Census Bureau, 2000b), which is calculated by combining population statistics for the region's twenty-three coastal boroughs/census areas/municipalities, as identified by NOAA as coastal counties[23]. Appendix F, Table F.6-7 lists these coastal counties and their populations. The Alaska region's coastal population makes up less than 1 percent of the total U.S. population, of which over 49 percent is located in the Anchorage Municipality (Figure 3.6-3) (NOAA, 2002b; U.S. Census Bureau, 2000b).

The Alaska region varies substantially in socioeconomic patterns. The vast majority of the coastline is made up of low-density, undeveloped rural areas. There are several developed areas along the southern coast, with Anchorage being the most highly populated and highly developed urban center. The range is from 808 people in Yakutat City and Borough to 260,283 people in Anchorage Municipality. Table 3.6-5 lists the most densely populated coastal boroughs/census areas/municipalities of the Alaska region.

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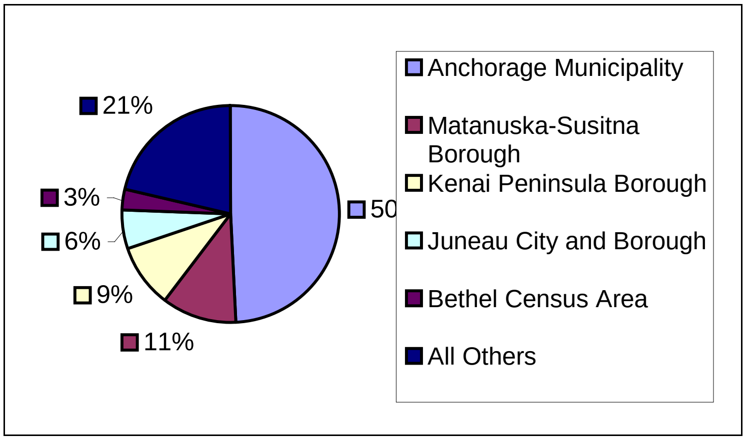
[22] *http://www.nmfs.noaa.gov/habitat/habitatprotection/efh/fish_manage_c.htm*

[23] The Office of Ocean Resources, Conservation and Assessment (ORCA), National Ocean Service (NOS), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce classifies counties as coastal "because they meet one of the following criteria: (1) at least 15 percent of their total land area is located within the nation's coastal watersheds (as defined by ORCA's Coastal Assessment Framework [*http://spo.nos.noaa.gov/projects/caf/caf.html*], or (2) the county accounts for at least 15 percent of the land area of a coastal cataloging unit (a U.S. Geological Survey-defined drainage basin)" (*http://spo.nos.noaa.gov/projects/population/population.html*). The U.S. Bureau of the Census also uses ORCA's coastal counties list.

Figure 3.6-3
Coastal Population Distribution of the Alaska Region



Source: NOAA, 2002b; U.S. Census Bureau, 2000c.

Table 3.6-5
Highest Populated Boroughs/Census Areas/Municipalities of the Alaska Region

Borough/Census Area/Municipality	Population
Anchorage Municipality	260,283
Matanuska-Susitna Borough	59,322
Kenai Peninsula Borough	49,691
Juneau City and Borough	30,711
Bethel Census Area	16,006

Source: NOAA, 2002b; U.S. Census Bureau, 2000c.

In 2000, the coastal counties had a total civilian labor force of 262,330, with an average unemployment rate of 8.7 percent, compared with the national average of 5.8 percent. Income levels rank on par with the national average of per capita income and higher than the national average of median household income at $20,635 and $47,948, respectively. (The national average per capita and median household incomes are $21,587 and $41,994, respectively.) Income levels fluctuate throughout the Alaska region. For example, Wade Hampton Census Area is the poorest with a per capita income of $8,717, while Skagway-Hoonah-Angoon Census Area is the wealthiest with a per capita income of $27,769 (U.S. Census Bureau, 2000c).

3.6.5.2. *Economic Status*

Three primary sectors make up the foundation of the Alaska region's economic system: oil and gas, tourism, and commercial fisheries. An associated fourth sector provides services to the former three in a variety of capacities including government, sales, communications, and infrastructure.

The oil industry, which is the largest economic sector in the state, provides approximately 85 percent of the state budget (Alaska Department of Community and Business Development, 2001). Alaska remains a leading U.S. supply source of crude oil, ranking second in crude oil reserves and third in crude oil production worldwide. Per day, 970,000 million bbl are produced, with proved reserves of 4.9 billion bbl, accounting for 23 percent of the U.S. total. There are 1,852 oil-producing wells and 8 operational rotary rigs, located primarily on state lands in the North Slope. After the oil is produced, it is shipped to the port of Valdez via the Alyeska Pipeline (EIA, 2002e).

Tourism is the second largest industry in Alaska, and it is responsible for employing one-eighth of the workforce, which is primarily driven by small businesses. In 1999, 1.4 million tourists visited, spending $1.36 billion (approximately $970 per visitor). Approximately 32 percent of Alaska's visitors come by cruise ship and 53 percent by air (ATIA, 2002).

Commercial fishing activities in 2000 employed 65,710 individuals, or 25 percent of the Alaska region's civil labor force. The same year the commercial fisheries of the region caught $942 million worth of seafood products and generated $58,961,200 in tax revenues for the state. This region is the world's largest producer of wild salmon, in addition to catching a variety of shellfish, groundfish, and herring (ADFG, 2002).

3.6.5.3. Vessel Transportation and Ports

An extensive domestic and international shipping pattern exists in the marine waters of the Pacific Ocean and Bering Sea. Domestic trade occurs between Alaska and western states, and internationally with Canada and countries in east and south Asia. Marine traffic in northern areas is largely limited to a 60-day summer open-water season. Transport of marine freight to arctic communities/work camps is accomplished by lighters that ferry cargo directly from a freighter anchored offshore or by shallow-draft barges. The largest natural deepwater port is in the Ketchikan Gateway Borough, which is located near the southernmost point of this region. In 1999, 10,614 trips were recorded for vessels entering and departing these major Alaskan ports[24]: Ketchikan, Juneau, Valdez, Homer, Seward, Anchorage, Kodiak, and Unalaska Bay (USACE, 1999c).

Within this region, a large volume of both crude oil and petroleum products are transported between land-based terminals and storage facilities at ports by tanker and barge. Large amounts of oil extracted in the North Slope Borough are shipped via the Alyeska Pipeline and then stored at the Alyeska Terminal in Valdez, at the head of Prince William Sound. From there, approximately 500 annual crude-carrier departures occur by tankers that vary in size from 250,000- to 2.6-million-bbl carriers. The oil exported from the port at Valdez accounts for approximately 17 percent of total U.S. domestic oil production (Alyeska Pipeline Company, 2003; EIA, 2001b; NRC, 1998).

In 1999, the Alaska region received or shipped from its ports more than 71 thousand short tons of foreign and domestic cargo: domestic shipping and receiving accounted for 51,839 and 2,614 thousand short tons, respectively, while foreign shipping and receiving accounted for 11,174 and 1,375 thousand short tons, respectively. In addition, there were 4,167 thousand short tons of intrastate waterborne commerce (USACE, 1999c).

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[24] Arctic Alaska has no major ports; the most extensive marine facilities are the industrial docks associated with the Prudhoe Bay industrial complex.

3.6.5.4. *Fisheries*

Commercial Fisheries

The Alaskan commercial fishing sector is an important component of the Alaska region's economy. During 1999, fisheries in the Alaska region produced 5.6 billion lb, valued at $1.3 billion, which provided approximately 55 percent of all commercial fish landings in the continental United States (ADFG, 2000, 2001a). A variety of species are caught and landed in Alaska's commercial fisheries. They include scallops, cucumbers, urchins, geoducks, clams, shrimp, crabs (Dungeness, Tanner, and King), cod, rockfish, sablefish, halibut, herring, salmon (seven varieties), perch, lingcod, and walleye pollock. Walleye pollock (*Theragra chalcogramma*), Pacific Cod (*Gadus macrocephalus*), and Sockeye salmon (*Oncorhynchus nerka*) are the most important species in terms of revenue for this region. Table 3.6-6 lists the top commercial landings for the Alaska region.

Table 3.6-6
Top Commercial Landings for 2000* for the Alaska Region

Scientific Name	Common Name	Pounds	Dollars
Theragra chalcogramma	Walleye Pollock	1,182,436	160,524,764
Oncorhynchus nerka	Sockeye Salmon	92,953	155,747,023
Gadus macrocephalus	Pacific Cod	240,254	141,941,773
Hippoglos-sus stenolepis	Pacific Halibut	32,535	134,824,754
Anoplopoma fimbria	Sablefish	16,131	80,177,917

Source: NMFS, 2003b.

* Ranked by dollar value.

Recreational Fishing

One of the major recreational activities in the Alaska region is offshore marine recreational fishing. In 2001, more than 420,000 anglers fished off coastal waters (ASA, 2002). A large portion of the anglers are tourists, allured by a wide range of fishing expeditions throughout the state, varying from low to high adventure. Preferred target species are salmon, Pacific cod (*Gadus macrocephalus*), walleye pollock (*Theragra chalcogramma*), and a variety of shellfish. In 2001, the total catch for marine recreational fisheries was 3,078,100 fish, with an estimated $537 million spent by U.S. residents on fishing trips and equipment in Alaska (ADFG, 2001b, c).

3.6.5.5. *Subsistence*

The term subsistence refers to the hunting, fishing, and gathering activities that constitute the traditional way of life for Alaska's native people. Subsistence continues to flourish in many areas of the Alaska region. Before the mid-eighteenth century arrival of the first nonnatives, subsistence was the only form of economic production by which the indigenous populations fed, clothed, and housed themselves.

Conducted in seasonal cycles by small, seminomadic communities and kinship groups within recognized territories, indigenous people utilized traditional, small-scale technologies for hunting, harvesting, and preserving foods. These foods were then distributed through networks of communal sharing and bartering. Wide disparities existed among the subsistence practices of native societies depending on the different climatic and biological areas of Alaska—from the marine mammal cultures of the high Arctic, through the land mammal and fishing groups of the interior river systems, to the resource-abundant coastal communities of the southeastern rain forests (ADFG, 1999). Subsistence remains economically and culturally important for many Alaskan families and communities.

The Alaska Subsistence Fisheries 1999 annual report defines *subsistence fishing* as the taking of fish, shellfish, or other fisheries resources by Alaska residents for subsistence uses. *Subsistence uses* of wild resources are defined as "noncommercial, customary, and traditional uses" for a variety of purposes: direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; making and selling handicraft articles out of nonedible by-products of fish and wildlife resources taken for personal or family consumption; and customary trade, barter, or sharing for personal or family consumption (ADFG, 1999). In 1985, commercial fisheries harvested about 908,500,000 lb of salmon, halibut, herring, and shellfish. (There was an additional commercial groundfish harvest of about 2.99 billion lb.) For comparison, according to statistics provided by the Alaska Department of Fish and Game, subsistence harvesting composes only 4 percent (by weight) of all fish and game harvested in the state, with sport uses and commercial uses comprising 1 percent and 95 percent, respectively (Wolfe and Bosworth, 1990).

3.6.5.6. Archaeological/Historic Resources

Archaeological and historic resources are the remains of the material culture of past generations. They are also basic to, and have implications for, the nonmaterial culture such as beliefs, knowledge, art, customs, property systems, and other social aspects of culture. Prehistoric and historic peoples occupied the northern and southern onshore and offshore coastal areas of most of the Alaska region. Some archaeological sites reveal prehistoric subsistence resources such as the remains of sea and land mammals, fishes, shells, sea urchins, and birds. These sites contain information on the wide variety of species used by ancient people.

The Alaska region's archaeological resources date to about 6,000–6,500 B.C. The surrounding continental shelf and onshore area have been inhabited by prehistoric and historic people for thousands of years and contain valuable known and undiscovered archaeological resources. Over 1,000 prehistoric sites have been documented throughout the GOA. Most of these sites lie next to the shore and consist of subsistence resource-gathering sites, and many of them are listed on the National Register of Historic Places. The predominant types of prehistoric resources found on the shores are housepits containing household and subsistence artifacts (e.g., stone lamps, sinkers, arrowheads) of early people. Historic sites consist of early Russian houses, churches, roadway inns, fish and mining camps, downed World War II aircraft, and other World War II artifacts. The approximately 997 shipwrecks that occurred offshore in the Alaska region are archaeological resources that, if found, would add considerable information about marine culture (MMS, 1996b).

3.6.5.7. Recreation and Tourism

Major recreational and tourist activities include fishing, boating, hunting, hiking, sightseeing, and camping. Some of these activities are water-oriented and often water-dependent. The wilderness quality and beautiful vistas on most of the coastline are attractive components for all these activities. Some of the highest quality tourist and recreational opportunities take place in the National Park units, National Wildlife Refuges, and National Forests along the Alaskan coast.

Tour ships from the lower forty-eight states regularly traverse southeast Alaska, and many independent travelers use the Alaska Maritime Highway (ferry) system to access the region. Helicopter and small aircraft sightseeing tours have developed locally, along with a generally robust tourism sector that includes a fleet of small regional tour ships, river jet-boat tours, and fishing charters (MMS, 2001a).

In northern Alaska, most nonresident recreational activity takes the form of tour groups, primarily visiting Barrow or Deadhorse. Hikers and river rafters also visit the Arctic National Wildlife Refuge (ANWR) and other areas (MMS, 2001a). Because of the limited population and transportation infrastructure, and its remoteness, the number of residents and tourists who might enjoy these environs is few.

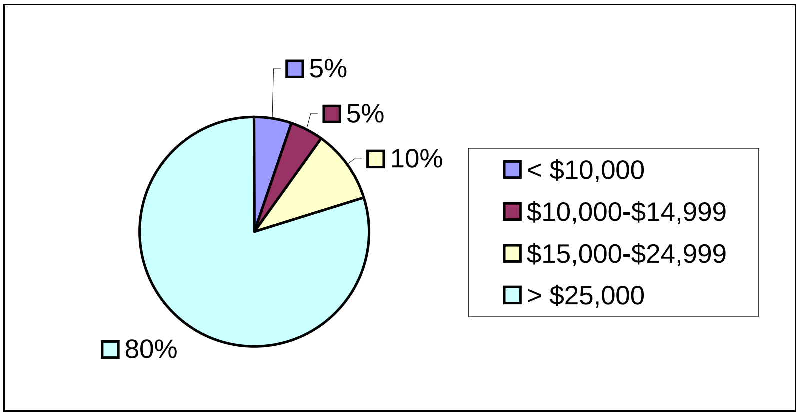
The American Coastal Coalition (ACC, 1998) reported that coastal tourist expenditures for the Alaska region totaled $1.364 billion and supported approximately 26,000 jobs.

3.6.5.8. Environmental Justice

Executive Order 12898 (“Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” 59 FR 7629) provides that each federal agency shall make achieving environmental justice part of its mission by identifying and addressing questions regarding environmental and health conditions of impoverished communities.

Low-income communities, which can be found across the Alaska region, include multiethnic as well as homogenous communities and neighborhoods. Of the 128,516 families that live in this region, 6.7 percent (or 8,545) have been classified as living in poverty by the U.S. Census Bureau (2000b). The average per capita and median household incomes of this region are $20,635 and $47,948, respectively. However, 20 percent of households earned less than $25,000 in 1999. Figure 3.6-4 shows the distribution of household income in the Alaska region.

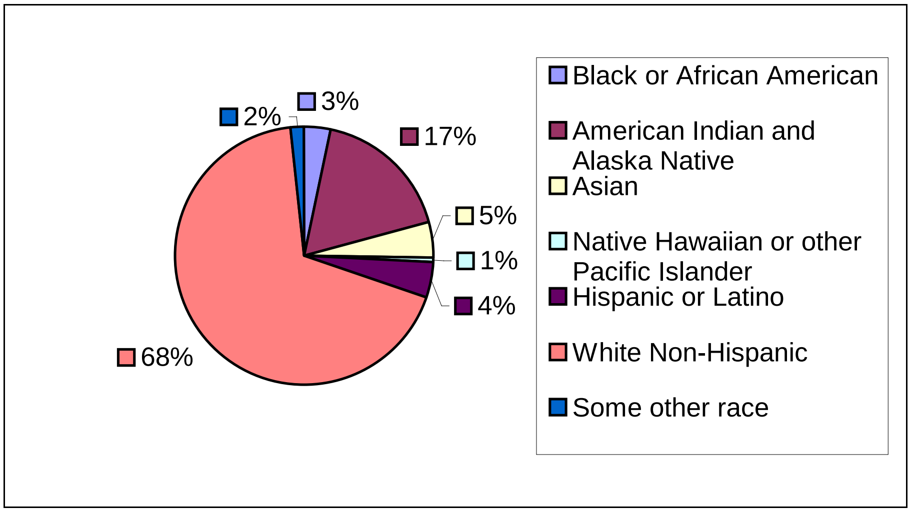
Figure 3.6-4
Distribution of Household Income in the Alaska Region



Source: NOAA, 2002b; U.S. Census Bureau, 2000c.

Minority groups are scattered throughout the region, but the primary population center is the Anchorage Municipality. These groups include Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian or other Pacific Islander, or other (Hispanic or Latino, and white Non-Hispanic). Figure 3.6-5 shows the distribution of race in the Alaska region.

Figure 3.6-5
Distribution of Race in the Alaska Region



Source: NOAA, 2002b; U.S. Census Bureau, 2000c.

Within Alaska there are several federally recognized tribal lands. Alaska Natives include the Tlingit, Haida, Yupik, Inupiat, Metlakatla, Eyak, Tanana, Ahtna, and Tanaina. Maps and other location information regarding these groups can be obtained from the U.S. Department of the Interior, Bureau of Indian Affairs[25].

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[25] *http://www.doi.gov/bureau-indian-affairs.html*

3.6.5.9. Public Safety and Worker Health

Oil spill response is one of the U.S. Coast Guard's (USCG's) many missions. In responding to oil spills, the USCG is aware of public safety and the effects that alternative response technologies—chemical dispersion and *in situ* burning—could have on human health. Under the guidelines established by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), steps have been taken to protect both the public and oil spill responders. Whether compensated workers or volunteers, responders are required to be certified under either the Occupational Safety and Health Administration's (OSHA's) Hazardous Waste Operations and Emergency Response Standard or USEPA's Hazardous Waste Operations and Emergency Response Standard. These standards ensure that responders understand the hazards of oil spill response and how to protect themselves. To assist in public safety, the USCG has the maritime safety authority to establish a safety zone around oil spill cleanup operations. This zone is established to safeguard the public and responders from the hazards associated with cleanup. In addition, USCG standard operating procedures (SOPs) are used to protect responders, as well as the public, from the hazards associated with chemical dispersion and *in situ* burning. These procedures are outlined in SOPs in each Area Contingency Plan's (ACP's) Site Safety Plan. In addition, training exercises such as PREP (Preparedness for Response Exercise Program) and SONS (Spill of National Significance) train USCG response personnel to avoid safety hazards.

Dispersants are a liquid chemical used to disperse oil spills from the ocean surface (see Section 2.2.2). During an oil spill, dispersant application can be from either an aerial or a shipboard platform. In both cases response personnel have the potential to be accidentally exposed to the dispersant, and in extreme cases exposure to the public could occur. The two types of dispersants with use allowed in the United States have OSHA-established, permissible exposure limits of 50 ppm on skin. The Material Safety Data Sheet (MSDS) for these dispersants makes clear the human health concerns from excess exposure.

In situ burning of an oil spill entails setting contained or boomed oil on fire (see Section 2.2.3). This action has been acknowledged as having potential human health and safety effects. Besides the physical hazards to responders, there is the potential for inhalation of airborne burn products. *In situ* burning emits a plume of black smoke laden with particulates (PM10, soot), the main public health concern. Response personnel working close to the burn may be exposed to levels of gases and particulates that would require them to use personal protective equipment. Occupational standards such as OSHA's Permissible Exposure Limits (PELs) are applicable. For the general public, NOAA (2000a) reported that particulate concentrations in a smoke plume remain the only agent of concern past 1 or 2 mi downwind, with the gases created in a burn dissipating to levels close to background. Public exposure to smoke particulate from the burn is not expected to occur unless the smoke plume travels down to ground level. Since the general public may include sensitive individuals, such as the very young and very old, pregnant women, and people with pulmonary or cardiovascular diseases, this population's tolerance to particulates may be significantly lower than that of the responders. There is little data concerning the effect on humans of particulates from the *in situ* burning of oil. Based on chemical analysis of soot particulates and their physical behavior, the hazard is expected to be similar to that of better-known particulates emissions that are now regulated by the NAAQS. In 1997, the Special Monitoring of Applied Response Technologies (SMART) protocol[26] was created, in part, to address the particulates concerns and to better aid the Federal On-Scene Coordinator (FOSC) in making decisions related to initiating, continuing, or terminating *in situ* burning.

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[26] *http://response.restoration.noaa.gov/oilaids/SMART/SMART.html*

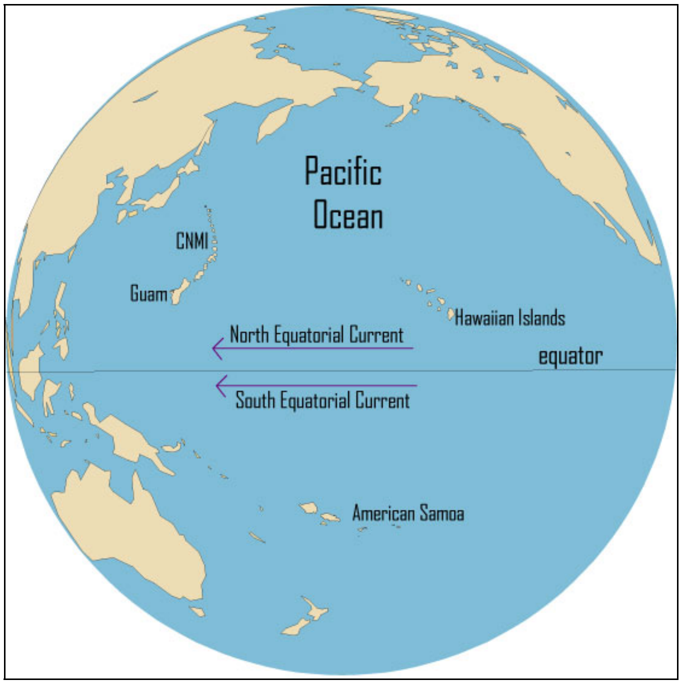
3.7. OCEANIA REGION

3.7.1. Physical Environment

Oceania is a collective name used for the islands scattered throughout most of the Pacific Ocean. In its broadest sense, the term embraces the entire insular region between Asia and the Americas. For the purpose of this Programmatic Environmental Impact Statement (PEIS), all references to the Oceania region will specifically cover the tropical waters surrounding the islands of Hawaii, Guam, Commonwealth of Northern Mariana Islands (CNMI), and American Samoa (Figure 3.1-1). Midway, Jarvis, and Wake Islands are also included in some of the analysis.

The westward-flowing North Equatorial Current influences the waters surrounding Hawaii and all U.S.-affiliated islands of the Oceania region except American Samoa, which is south of the equator and is affected by the broad, western-flowing South Equatorial Current (Figure 3.7-1). Both currents flow at a rate between 1 and 2 kt (Sheppard, 2000).

Figure 3.7-1
Major Currents of the Oceania Region



Note: Map is not to scale.

Hawaii, Guam, and CNMI are in warm, temperate, subtropical and tropical waters north of the equator. American Samoa is solely in warm, southern, tropical waters. Both types vary in surface seawater temperatures of 41° to 95°F with surface salinity averaging between 28 and 37 parts per thousand (ppt) (NOAA, 1994). These areas are generally affected by a diurnal tide cycle, which encompasses one low and one high tide per tidal period.

3.7.1.1. *Water Quality*

Coastal

Quality of coastal water in the Oceania region is not widely known because of the lack of comprehensive coastal monitoring. Though data are limited, the 305(b) reports of the U.S. Environmental Protection Agency (USEPA, 1998a) show that coastal waters are impacted by anthropogenic sources, such as sedimentation from shore development, stormwater and agricultural runoff, nutrients, industrial effluent, and sewage outfalls. Data from the 305(b) reports also suggest that 10 percent of Hawaii's coastal shoreline area is impaired by some form of pollution or habitat degradation, and, of the 14 mi assessed (of 117 mi of shoreline) in Guam, all 14 mi were identified as impaired for swimming. CNMI's most recent USEPA 305(b) report on water quality stated that the 52 mi of coastal water surrounding Saipan is rated poor for swimming.

Marine

The 305(b) reports (USEPA, 1998a) for Guam, CNMI, and American Samoa lacked significant amounts of marine water-quality information. Complicating matters further is the nature of the location of the region. Because of the Pacific Ocean's large, deep expanses, plus the distance between each location, it is difficult to obtain aggregate numbers without speculative estimation. However, marine monitoring programs are expected to increase in the future.

Domestic sources of pollution are most likely the largest contributor to marine pollutant loads. Contaminants of concern associated with domestic sources include nutrients, biochemical oxygen demand, solids, and microbial pollution. Agricultural activities that contribute pollutants to marine and coastal waters are the application of agricultural chemicals, erosion of exposed soils with naturally occurring nutrients, and runoff containing concentrated animal wastes.

The vast majority of exports and imports in the Oceania region are via waterborne shipping. For instance, the state of Hawaii imports about 80 percent of what it consumes; approximately 97 percent of that enters the state through the commercial harbor system (State of Hawaii, 2001). This large dependency on maritime traffic increases the potential for environmental impacts in the form of oil spills. In 1999, there were 229 oil spills totaling 5,582 gal in waters in and surrounding Hawaii (USCG, 2000a).

3.7.1.2. *Meteorology and Air Quality*

Climate

With the exception of American Samoa, which is in the southern hemisphere, the whole of the Oceania region lies in the northern Pacific Ocean above the equator. The North Pacific High pressure system and the Intertropical Convergence Zone (ITCZ, an equatorial trough of low pressure) influence the climate of the northern part of the Oceania region. The shifting of the North Pacific High pressure system and ITCZ during the year is accompanied by seasonal changes in the direction and intensity of the winds. Northeast and southeast trade winds prevail in this area, with winter trade winds being weak and summer trade winds being persistent in the 15- to 20-kt range. American Samoa falls in a tropical marine climatic region that is affected by the South Pacific Convergence Zone, with relatively consistent southeasterly trade winds for 9 months out of the year and northwesterly trade winds for the remaining 3 months. Tropical storms such as typhoons are known to frequent the area (NOAA, 2003d).

Air Quality

Air quality of the islands in the Oceania region is measured against National Ambient Air Quality Standards (NAAQS), resulting from the Clean Air Act and its 1977 amendments (40 CFR 50.12), or it is measured against more restrictive adopted state standards. These standards are designed to protect human health. The USEPA requires states to report ambient air quality levels for six major pollutants: particulate matter (10 microns or larger [PM10]), sulfur dioxide, carbon monoxide, nitrogen dioxide, lead, and ozone. Appendix F, Table F.1-1 summarizes federal ambient air standards in detail.

Hawaii and all U.S-affiliated islands within the region are considered in compliance with NAAQS attainment levels (USEPA, 2000a). Compliance is mainly due to the region's geographical location in the Pacific Ocean: constantly blowing westerly winds, coastal location of large cities, and a limited amount of heavy industry. For example, Hawaii has been rated as having the best air quality in the nation and is not impacted by pollution from neighboring states (USEPA, 2000a). The localized air pollution that can occur is primarily due to concentrated urban centers by way of auto emissions and small industry. In addition, there are also some natural pollutants from active volcanoes and geothermal energy production in the form of hydrochloric and sulfuric acids and glass fragments.

3.7.2. Biological Environment[27]

3.7.2.1. Marine Mammals

A variety of marine mammals—twenty-two cetaceans (whales and dolphins), one sirenian (dugong), and one pinniped (seal)—are known to occur in the Oceania region. Humpback whales (*Megaptera novaeangliae*) are one of the most abundant marine mammals in the region, and the Hawaiian Islands are an important breeding ground for the species (USCG, 2002). In both coastal and offshore environments, several different species of whales can be found in the region. At least four species of dolphins—Pacific bottlenose (*Tursiops truncatus*), rough-toothed (*Steno bredanensis*), spotted (*Stenella attenuata*), and spinner (*Stenella longirostris*)—are known to occur in all water depths throughout the region (USGS, 1998d). Appendix F, Table F.7-1 lists the sixteen recognized nonendangered marine mammals in this region.

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[27] Only nonendangered species will be included in Section 3.7.2, Biological Environment. Threatened, endangered, and candidate species will be discussed separately in Section 3.7.3, Threatened, Endangered, or Candidate Species. For this reason, sea turtles will only be discussed in Section 3.7.3, as they are a threatened/endangered species in the Oceania region.

3.7.2.2. Marine and Coastal Birds

The Oceania region provides habitats for both migrant and resident marine and coastal birds; however, migration is rare in the area. Over 100 species of marine and coastal birds have been identified as part- or full-time residents of this region (USGS, 1998d). Of these, the majority are nearly year-round residents. Many species are endemic to specific island locations within the region.

The offshore waters, coastal beaches, tropical forests, and existing wetlands are populated by both resident and migratory species of marine and coastal birds. Many species are strongly endemic, and, therefore, only seen on specific islands. The remaining species are found within coastal and offshore habitats. Despite having the world's highest proportion of endemic species per unit of land area or number of human inhabitants, the biological diversity of the Pacific islands is among the most critically threatened in the world (USGS, 1998d).

The presence of ten National Wildlife Refuges in the Oceania region indicates that large numbers of waterbirds concentrate in the area during migration and/or nesting and wintering. The National Wildlife Refuge sites are established under the National Wildlife Refuge System Improvement Act of 1997 with the aim of protecting wildlife and preserving biological diversity (USFWS, 2004).

For the purpose of this PEIS, marine and coastal birds are categorized into five major groups, as detailed in Appendix F, Table F.7-2: seabirds, shorebirds, wading and marsh birds, and waterfowl.

3.7.2.3. Plankton and Fish

Plankton

Plankton are organisms that float at or near the surface of marine waters and are unable to swim against tides, winds, or currents. Plankton species, which represent nearly all major aquatic phyla, can be roughly classified as phytoplankton (microscopic plant life), zooplankton (microscopic animals), and ichthyoplankton (fish eggs and larvae). Distinct populations of planktonic and micronektonic marine organisms appear to be maintained around islands. These include populations of mesopelagic fishes, larval fishes, and zooplankton. The tropical Pacific Ocean, like other tropical ocean regions, contains warm, clear water. The water is clear because of the near absence of plankton and suspended particles, with the exception of highly productive coastal and reef areas.

Because there is little plankton in the tropics, tropical ocean water is nearly sterile in comparison with the fertile waters of temperate oceans. This contrasts the popular misconception that tropical ocean regions are very high in biological productivity. The reason for these low levels of biological productivity is due to the relatively oligotrophic, or nutrient-poor, marine waters of the Oceania region. As such, the majority of plankton found in the Oceania region are located near reef structures or in areas where ground water runoff and surface water run-off from the islands that are rich in nutrients can elevate nearshore primary production (plankton) (Sheppard, 2000).

Phytoplankton are microscopic floating algae, which form the base of the food web. They are responsible for approximately one-half of global photosynthesis and play a vital role in stabilizing atmospheric carbon dioxide. These plants can only survive in the shallower, sunlit waters of open-ocean and estuarine areas. There are over ninety species of diatoms and forty species of dinoflagellates in the Oceania region. Commonly identified species include *Cyclotella* spp., *Thalassiosira* spp., *Planktoniella* spp., *Biddulphia* spp., *Chaetoceros* spp., *Triceratium* spp., *Diatoma* spp*., Mastogloia* spp., *Eunotia* spp., *Asterionella* spp., *Navicula* spp., *Peridinium* spp., *Ceratium* spp., and *Dinophysis* spp. (Smith, 2002).

Zooplankton, which consume phytoplankton, spend either part (meroplankton) or all (holoplankton) of their life cycle as plankton. Their temporal and spatial distributions depend on a number of factors including currents, water temperature, and phytoplankton abundance (County of Santa Barbara, 2002). Detailed vertical distribution data for zooplankton around the islands of the Oceania region are lacking, so that the degree to which vertical distribution can affect the ability of zooplankton to be retained around islands cannot be assessed. Coastal species, which have been identified around Hawaii, include the coastal calanoid *Undinula vulgaris* and pontellid *Labidocera madurae*, and two oceanic calanoids*, Cosmocalanus darwinii* and *Scolecithrix danae* (USGS, 1998d).

Larval fishes (ichthyoplankton) around the islands of the Oceania region are typically a combination of open-ocean and shorefish species. Few surveys have examined the distribution of ichthyoplankton near oceanic islands. A 1996 report on ichthyoplankton off the coast of Oahu, Hawaii, identified a total of 155,390 fish larvae in 375 taxa; the dominant larvae families were Gobiidae, Myctophidae, Gonostomatidae, Phosichthyidae, and Schindleriidae (Boehlert and Mundy, 1996).

Fish

The Western Pacific Fishery Management Council (WPFMC) (see Section 3.7.4) manages fisheries in the Oceania region, which includes Hawaii, Guam, American Samoa, and CMNI. In 2000, fishing landings for this region were over 2.9 million pounds (NMFS, 2001b). Some of the important fish are snappers, tuna, and dolphinfish. Table 3.7-1 lists the most commercially important fish species of the Oceania region.

Table 3.7-1
Commercially Important Fish Species of the Oceania Region

Common Name	Scientific Name
Bigeye tuna	*Thunnus obesus*
Blue shark	*Prionace glauca*
Marlin	*Makaira* spp.
Swordfish	*Xiphias gladius*
Yellowfin tuna	*Thunnus albacares*

Source: Adapted from USCG, 2002.

Because of the generally oligotrophic tropical waters of the Oceania region, the majority of fish species are found near reef structures, sea mounts, or estuarine areas, or in relatively nearshore areas. Reef fish are found in and around coral and rock reefs and can range from shallow tidal pools to areas over 200 ft in depth. In offshore areas, there are some commercially feasible deepwater dwelling species such as tuna and sharks. The majority of the fish stocks located in this region have a wide distribution; however, as is the case for many Hawaiian fish species, some are only found near their particular habitats and conduct little migration (NMFS, 2001b).

Fish stocks have been declining significantly for the last 20 years. Recent shifts from traditional, small-scale fishing practices to more intensive commercial fishing have had a large impact on local fish stocks. Further, destructive fishing practices such as dynamiting and chlorine application destroy breeding habitats and reduce reproductive rates. Human population pressure has also taken a toll: nursery areas are destroyed during road construction and coastal building projects; coral is smothered and blocked from sunlight by the sediment from harbor dredging and faulty land management. The destruction of estuarine, wetland, and mangrove areas also negatively impacts fish stock. Finally, coral blocks are either taken as souvenirs or used as building materials (NMFS, 2001b).

3.7.2.4. *Intertidal Habitats*

Beaches

The Oceania region has 1,494 mi of shoreline (Good et al., 1998). Coastal beaches are important not only for the ecological systems of the islands, but also for their economic integrity in terms of tourism and recreation. Hawaii's beaches consist of either white or black (volcanic) sand. Approximately one-third of Guam's 36 mi of shoreline consists of coastal beaches, and CNMI's island of Saipan has widespread sandy beaches on its western side for recreation (USEPA, 1998a). There are few beaches on the American Samoa's main island of Tutuila because the majority of its coastline is made up of rocky cliffs.

Beach erosion is a serious problem in Hawaii, with a typical erosion rate ranging from 0.5 to 1 ft/yr (Surfrider Foundation, 2002). Nearly one-quarter of the area of the Hawaiian Islands has been significantly degraded over the last 50 years, and all shorelines have been affected to some extent. In Oahu, Hawaii's most populated island, over 24 percent (17 mi) of coastal beaches has been lost or significantly narrowed over the last century (Surfrider Foundation, 2002). The primary reasons for coastal beach degradation and depletion are all human related: construction of sea walls, roads, beach property, and marinas, as well as the destruction of natural barriers such as coral reefs.

Estuaries, Wetlands, and Mangroves

Estuaries are important habitat for both resident and transitory species, providing spawning or nursery habitat and foraging area for numerous species, including invertebrates, fishes, reptiles, birds, and mammals. High organic productivity, high detritus production, and extensive nutrient recycling characterize estuaries. Examples of estuaries in the region are Kane'ohe Bay, Hawaii, and Leone Bay, American Samoa. Some estuaries have been affected by anthropogenic activities such as population growth, pathogen contamination, sedimentation, and pollution runoff. Many different habitat types are found in and around estuaries, including shallow marine waters, freshwater and salt marshes, sandy beaches, mud and sand flats, rocky shores, mangrove forests, tidal pools, and seagrass beds.

Wetland habitats are associated with estuarine areas. These habitats may occupy only narrow bands along the shore, or they may cover larger expanses at the mouths of bays, rivers, or coastal streams. Some 180 mi^2 of wetlands in the Oceania region consist of coastal freshwater, saltwater, and brackish water marshes, and reed swamps (Good et al., 1998). These wetlands provide habitats that sustain commercial fisheries and many endangered species. Guam has considerably more wetlands and a wider variety of types than any of the other islands in the Mariana chain (Wiles and Ritter, 1993). Cumulative wetland loss over the last few decades has been substantial in some areas, such as CNMI with a 64 percent loss, while Hawaii has lost only 12 percent and Guam, 23 percent (Good et al., 1998). This loss is mostly due to agriculture, urban expansion, and aquaculture. Past expansion of the U.S. military port facility in Apra Harbor, Guam, has also caused extensive loss to wetland habitats.

All islands in the Oceania region have mangroves, with the boundary for naturally occurring mangroves being American Samoa; mangroves are not found naturally much to its east. Mangroves were introduced on the Hawaiian Islands of Oahu and Molokai in the early 1900s. The most common species of mangroves in the region include red (*Rhizophora mangle*)*,* large leaf orange (*Bruguiera gymnorhiza)*, and cannon ball (*Xylocarpus moluccensis)*. The largest mangrove section in the region is at Pala Lagoon (Nu'uuli Pala) (148.6 acres) on Tutuila, American Samoa (Volk, 2001). Mangrove ecosystems are a useful buffer between the land and the sea. Their primary function is to provide a "sink" for sediments, nutrients, and other contaminants to maintain coastal water quality, thus promoting coral and seagrass growth offshore. Further, they protect the land from marine inundation during storms and from rising sea levels, and protect habitats and nurseries for fishes, crustaceans, and shellfish. However, through human activities such as clearing and filling, most mangrove forests have been reduced in size over the past century.

3.7.2.5. Subtidal Habitats

Insular Shelves

The subtidal (benthic) areas of the Oceanic region consist of either soft or hard-bottom substrates. These areas support a variety of marine life and habitats, including insular shelves, seagrass beds, coral reefs, and seamounts. One of the main characteristics of the Oceania region's coastal environment is the general absence of the broad, shallow shelves that are found in most U.S. coastal regions. Comparatively narrow coral shelves sitting on steep island slopes characterize these coasts. It is common to find depths of over 9,000 ft within 1.2 mi of shore. These deeper-water habitats have unique biota. The steep shelves provide a habitat for coastal species whose range extends into deeper waters, and provide shelter to permanent biological communities such as the Pen Shell Beds. Further, humpback whales (*Megaptera novaeangliae*) use island slopes during critical moments in their life cycles. With the exception of fisherman who exploit some of the larger species of these areas, the biological resources of insular shelves are most likely not under threat from habitat damage or ecological degradation (USGS, 1998d).

Submerged Grass Beds

Seagrass beds are less widespread in the Oceania region than in other regions. Unlike temperate seagrasses, most tropical species are small with rapid growth rates. They are usually found in less then 33 ft of water, but in some circumstances can exist in depths of up to 164 ft (USGS, 1998d). Much of the seagrass growth in the western Pacific Ocean is made possible by the sheltering effect of barrier reefs. The algae associated with seagrasses contribute to the productivity.

There are two known seagrass species in Hawaii, both a marine (*Halophila ovalis)* and an estuarine (*Ruppia maritima*). Seagrasses are most diverse in the western Oceania region, with seven species in Guam and three species in CNMI. In Guam, seagrass (*Halodule uninervis*) stands cover about 9 percent of the fringing and barrier reefs. In CNMI, seagrasses are found primarily on the leeward side of Saipan within an extensive lagoon system (*Enhalus acoroides, Halodule uninervis,* and *Halophila minor*). America Samoa has virtually no seagrasses.

Seagrass ecosystems are vital for fish and invertebrates (including shellfish), mammals, sea turtles, and waterfowl. However, currently they are declining in most U.S. coastal regions—destroyed by dredging, propeller scouring, and disease; poisoned by pesticides and herbicide runoff; and denied sunlight by increased turbidity of water. The turbidity of water, because of blooms of microalgae, is often compounded by increased loads of suspended materials such as sand, silt, and clay from activities like boating or coastal construction. Further, runoff from fertilizer and sewage can stimulate large algal formations that have the potential to stunt seagrass growth through competition for nutrients and sunlight.

Coral Reefs

Coral reefs are one of the most important and extensive ecosystems in the Oceania region. About 94 percent of the coral reefs under U.S. jurisdiction are located within the region and cover a 9,272 mi^2 area (NOAA, 2002c).

Coral reefs are very diverse ecosystems that provide many benefits to humankind. They build atolls, protect island shores from coastal erosion and wave damage, support fisheries of cultural and economic value, and provide a natural medicine cabinet for traditional healing and biomedical research (WPRFMC, 2001).

The National Oceanic Data Center (NODC)[28] has identified sixty-five different reefs within the Oceania region, of which over half are within the Hawaiian Island chain. The majority of these sixty-five reefs are located near the coastlines of their respective islands, but there are five outlying banks paralleling Guam and CNMI to the west, as well as two banks located a few miles

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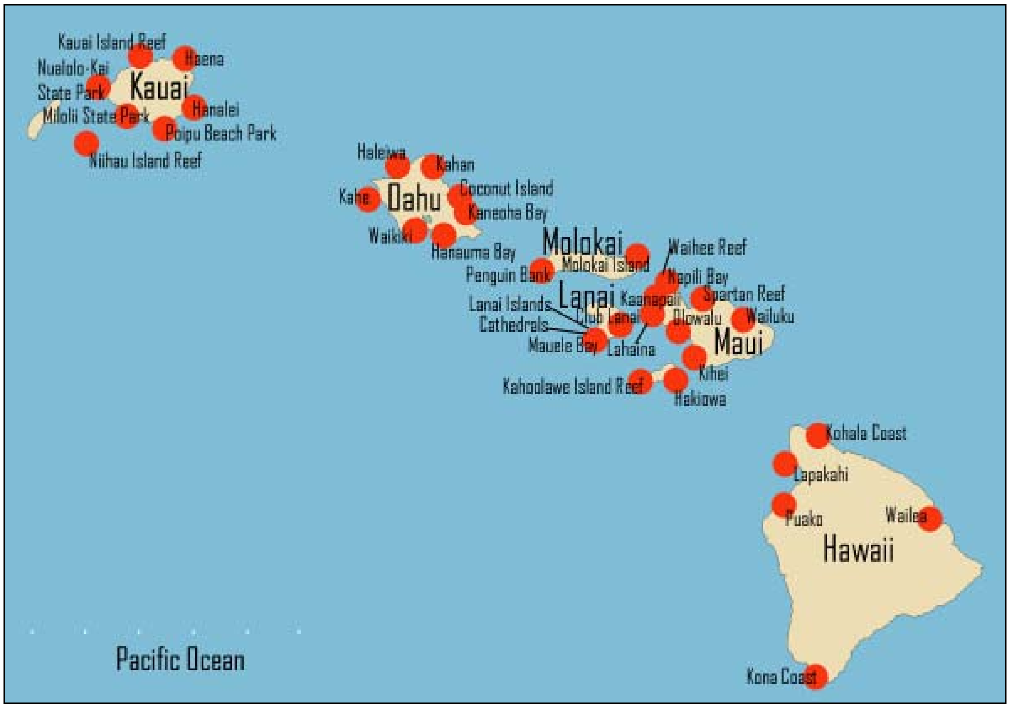
[28] *http://www.nodc.noaa.gov/col/projects/coral/Coralhome.html*

northwest of Saipan, CNMI. Several forms of coral reef development can be found in the Oceania region: barrier reefs around Guam and Saipan, CNMI; fringing reefs around Hawaii and American Samoa; and patch and submerged reefs, banks, and shoals throughout the region, particularly abundant in the Northwestern Hawaiian Islands and within the U.S. Exclusive Economic Zone (EEZ) of the CNMI (WPRFMC, 2001).

The Hawaii Island reefs (Figure 3.7-2 and 3.7-3) are not noted for high levels of coral, fish, or other reef species. However, their fauna consists of endemic species, a manifestation of near-continuous geographic isolation over a long time period (Bryant et al., 1998). By virtue of its isolated position in the Pacific Ocean, Hawaii has relatively few species of coral (about fifty species in seventeen genera) and, more importantly, lacks most of the branching or tabletop *Acropora* species, which form the majority of reefs elsewhere in the Pacific Ocean.

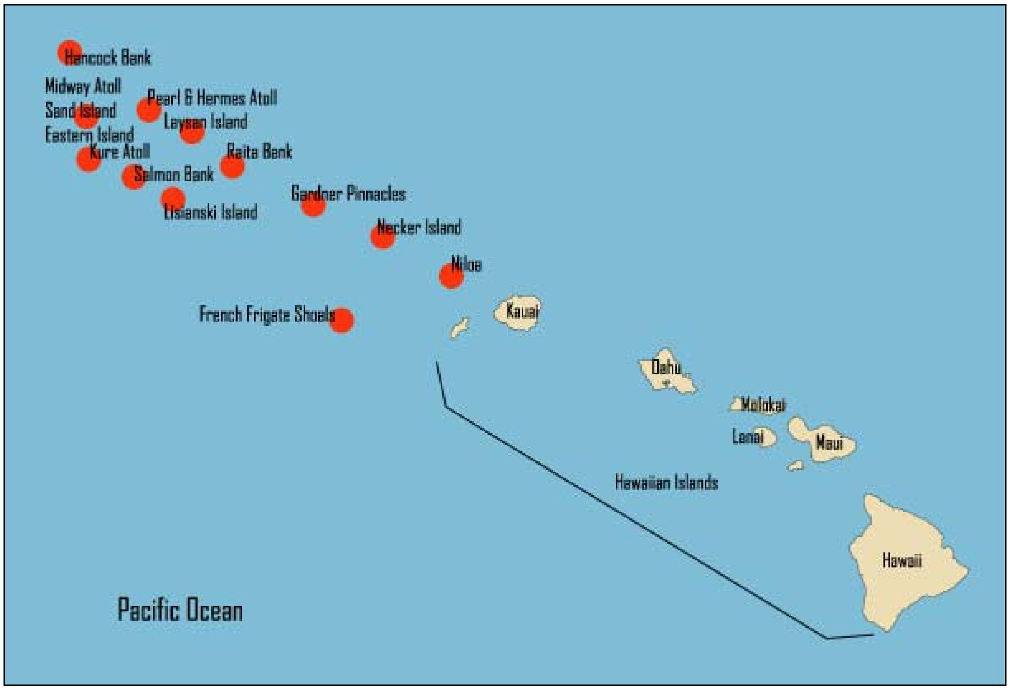
Figure 3.7-2
Coral Reefs in the Oceania Region—Hawaiian Islands



Source: National Oceanic Data Center, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (*http://www.nodc.noaa.gov/col/projects/coral/Coralhome.html*, accessed on June 13, 2002).

Note: Map is not to scale.

Figure 3.7-3
Coral Reefs in the Oceania Region—Northwestern Hawaiian Islands



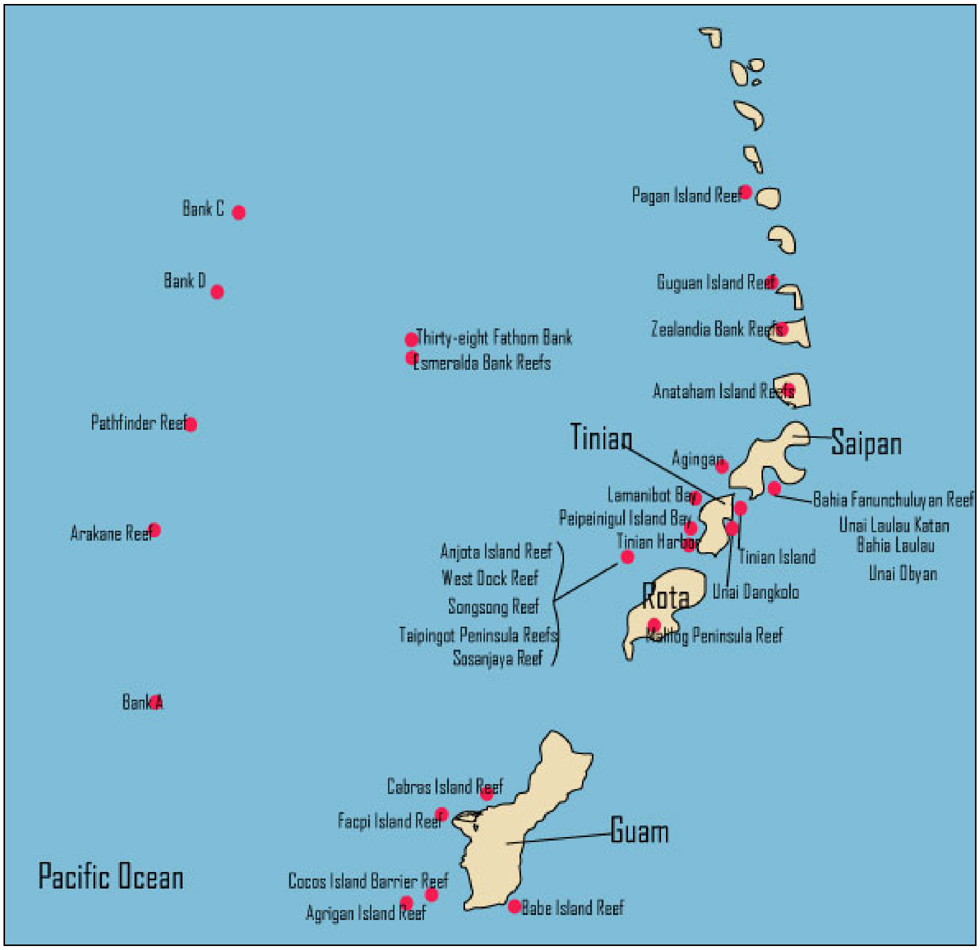
Source: National Oceanic Data Center, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (*http://www.nodc.noaa.gov/col/projects/coral/Coralhome.html*, accessed on June 13, 2002).

Note: Map is not to scale.

Guam has fringing reef flats, submerged formations, a barrier reef, and offshore banks (Birkeland et al., 2000; Gulko et al., 2000) (Figure 3.7-4). The fringing reef flats vary from 33 ft wide on the windward side to well over 328 ft. This reef system contains approximately 270 species of hard coral and 220 species of benthic marine algae (Birkeland et al., 2000; Gulko et al., 2000). In CNMI, the southern islands (Rota, Aguijan, Tinian, Saipan, and Farallon de Medinilla) have well-developed coral reefs on the western coasts with about 253 species (56 genera) of reef-building (hermatypic) coral. The northern islands (nine islands from Anatahan to Farallon de Pajaros) have less developed coral reefs but still have approximately 159 species (56 genera) of coral (Grigg and Birkeland, 1997).

Although they are not cataloged to the same extent as coral reefs in Hawaii, Guam, and CNMI, most of American Samoa's coral beds consist of narrow fringing reefs (85 percent) growing up against the steep slopes of the main islands, a few offshore banks (12 percent), and two atolls (3 percent) (NOAA, 2002c) (Figure 3.7-5). These coral reefs are currently recovering from a series of natural disturbances over the past two decades.

Figure 3.7-4
Coral Reefs in the Oceania Region—Guam and Commonwealth of Northern Mariana Islands



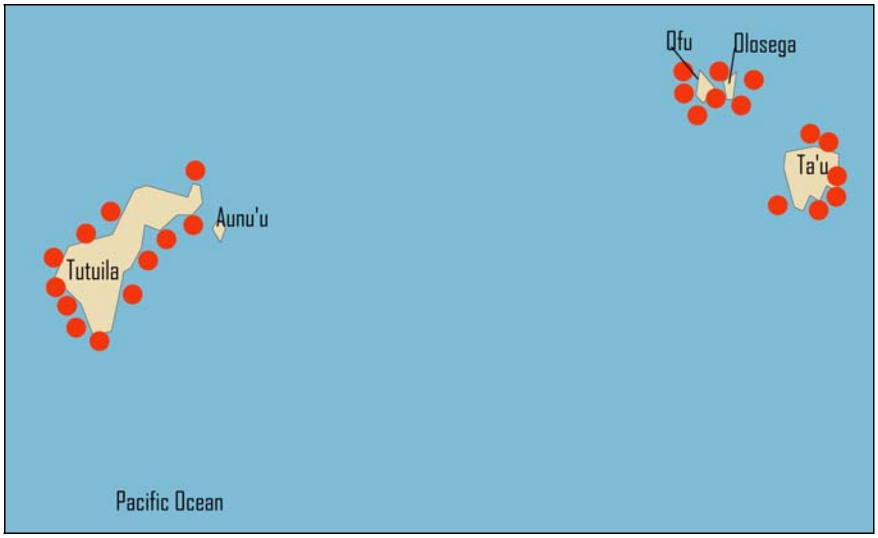
Source: National Oceanic Data Center, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (*http://www.nodc.noaa.gov/col/projects/coral/Coralhome.html*, accessed on June 13, 2002).

Note: Map is not to scale.

A healthy, functioning coral reef is a necessary habitat requirement for reef fishes. Habitat destruction through dredging, blasting, and chlorine fishing can destroy these important sanctuaries and may eliminate important fish species from these areas. Tourism and increased temperatures significantly impact the coral reefs of the Oceania region. Increased social and economic demands place new levels of stress on Pacific corals; for example, with low-impact tourism, tourists crowd coastal coral reefs to view the tropical array of fish species that exist within the region. The World Bank (2000, p. 8) observed that:

> Coastal areas in the Pacific are increasingly threatened. Overfishing, pollution, mining, and poor coastal planning are leading to the depletion of fisheries and to coastal degradation, undermining livelihood of coastal communities. The decline of mangroves and coral reefs is increasing the islands' exposure to cyclones and storm surges. The degradation of coastal areas is imposing significant economic and social costs, leaving coastal communities in need of urgent assistance.

Figure 3.7-5
Locations of Coral Reefs in the Oceania Region—American Samoa



Source: WPRFMC, 2001.

Note: Map is not to scale.

Seamounts

Seamounts are undersea peaks in the ocean floor; they are widely scattered throughout the Pacific Ocean. Within the Oceania region, they are concentrated near the Hawaiian Islands and CNMI. The seamounts appear to support a high diversity of life both on their surfaces and in surrounding waters. Although these seamounts and their inhabitants are located in very deep and remote waters, they have been threatened by overfishing.

3.7.2.6. Areas of Special Concern

Executive Order 13158 ("Marine Protected Areas") defines marine protected areas as "any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein" (65 FR 34909). There are many different types of marine protected areas within and bordering U.S. waters; some examples include National Marine Sanctuaries, National Seashores, National Parks, National Monuments, National Wildlife Refuges, National Estuarine Research Reserves, and many others (NOAA, 2002a). They have different shapes, sizes, and management characteristics and have been established for different purposes.

There are two National Marine Sanctuaries, ten National Park units, eighteen National Wildlife Refuges, one Coral Reef Ecosystem Reserve, and three Special Management Areas located in coastal or near-coastal areas. For more details regarding history, purpose, and specific site locations pertaining to this region, see Appendix F, Tables F.7-3 through F.7-5 and Figures F.7-1 through F.7-6.

3.7.3. Threatened, Endangered, or Candidate Species

The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have classified five threatened and thirty-four endangered species within the Oceania region. These consist of eight marine mammals, twenty-six marine and coastal birds, and five sea turtles.

Six cetaceans, one sirenian, and one pinniped are endangered and reside in or migrate through the Oceania region (Table 3.7-2). The waters off the coast of the Hawaiian Islands constitutes one of the world's most important North Pacific humpback whale (*Megaptera novaeanglia*) habitats, and the only place in U.S. coastal waters where humpbacks reproduce. Pacific right (*Eubalaena glacialis*), sperm (*Physeter macrocephalus*), blue (*Balaenoptera musculus*), and finback (*Balaenoptera physalus*) whales have been sighted in waters surrounding Hawaiian Islands, Guam, CNMI, and American Samoa.

Table 3.7-2
Threatened, Endangered, or Candidate Marine Mammals of the Oceania Region

Scientific Name	Common Name	Status*	Distribution in Region
Megaptera novaeangliae	North Pacific humpback whale	E	Population occurs throughout the main seven-island chain of HI from January through April.
Balaenoptera musculus	Blue whale	E	Population is thought to occur in deeper offshore waters.
Balaenoptera physalus	Fin whale	E	Population occurs in deeper offshore waters.
Balaenoptera borealis	Sei whale	E	Although population is found worldwide, distribution and movements during much of year are poorly known. In the eastern North Pacific, population is migratory transient from coast of Mexico to Gulf of Alaska (GOA).
Eubalaena glacialis	Pacific right whale	E	These whales are most likely stray individuals from more northern populations.
Physeter macrocephalus	Sperm whale	E	Population occurs in deeper offshore waters or off the northeastern shores of the main seven-island chain of HI.
Dugong dugong	Dugong	E / C	There is spotty distribution in fairly large range in the Indo-West Pacific. Status is poorly known in many areas. Dugong is a candidate species in Palau.
Monachus schauinslandi	Hawaiian monk seal	E	Population is most common northwest of the main seven-island chain of HI and is most abundant on Kure Atoll; Pearl and Hermes Reef; Lisianski, Laysan, Necker, and Nihoa Islands; and French Frigate Shoals.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*). Sei whale: NatureServe (*http://www.natureserve.org/explorer/servlet/NatureServe?searchName=Balaenoptera+borealis*, accessed on October 29, 2002).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq*., as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no marine mammals of the Oceania region have T or X status.

The endangered Hawaiian monk seal (*Monachus schauinslandi*) inhabits the main seven-island chain of Hawaii. Current estimates indicate that this population is declining. These seals breed primarily at Laysan Island, Lisianski Island, and Pearl and Hermes Reefs (USCG, 2002).

The Oceania region provides habitat for twenty-six threatened or endangered marine and coastal birds (Table 3.7-3). Because of their location in the Pacific, there are few migratory species (except interisland), with only two species coming from Alaska and northern Canada each year. The majority of the wildlife sanctuaries in the region—Laysan, Howland, Baker, and Jarvis Islands, and Midway Atoll—provide habitats for the endangered birds of the region, as well as for local state and territorial conservation programs. In spite of this isolation, the bird population of the Oceania region is one of the most diverse in the world. It has been estimated that, with the exception of protected areas, diversity dropped dramatically in the last 100 years because of exotic species and human settlement in nesting areas.

Table 3.7-3
Threatened, Endangered, or Candidate Marine and Coastal Birds of the Oceania Region

Scientific Name	Common Name	Status*	Distribution in Region	Migration Pattern
Anas laysanensis	Laysan duck	E	Laysan, HI	This is a year-round resident.
Anas wyvilliana	Hawaiian duck	E	Pearl Harbor, HI	This is a year-round resident.
Branta (Nesochen) sandvicensis	Hawaiian goose	E	Known only to be on Hawaii, HI. In large numbers, with a few hundred on three islands; found in scrubland, grassland, and sparsely vegetated slopes	This is a year-round resident on selected HI Islands.
Buteo solitarius	Hawaiian hawk	E	Found only in Hawaii, HI	This is a year-round resident.
Chasiempis sandwichensis ibidis	Oahu elepaio	E	Endemic to and local on Oahu, HI	This is a year-round resident.
Corvus hawaiiensis	Hawaiian crow	E	Endemic to Hawaii, HI; favors the upland forests on Hualalai and west slopes of Mauna Loa	This is a year-round resident.
Fulica Americana alai	Hawaiian coot	E	HI coasts	This is a year-round resident.
Gallinula chloropus sandvicensis	Hawaiian common moorhen	E	Restricted to Kauai and Oahu, HI	This is a year-round resident.
Himantopus mexicanus knudseni	Hawaiian stilt	E	HI coasts	This is a year-round resident.
Phoebastria albatrus	Short-tailed albatross	T	Marine range over most of northern Pacific Ocean; some records in the Sea of Okhotsk but not recently in the Sea of Japan; outside the breeding season, along the coasts of eastern Russia, South Korea, China, Taiwan, AK, and HI	There are breeding colonies in Japan.
Pterodroma phaeopygia sandwichensis	Hawaiian dark-rumped petrel	E	Pacific Ocean around HI	This petrel is found on the HI Islands from May to mid-November during breeding, with a range up to 621 ft offshore. It wanders throughout the central Pacific from mid-November through April.

continued

Table 3.7-3 (*continued*)
Threatened, Endangered, or Candidate Marine and Coastal Birds of the Oceania Region

Scientific Name	Common Name	Status*	Distribution in Region	Migration Pattern
Puffinus auricularis newelli	Newell's Townsend's shearwater	E	Pacific Ocean around HI	Population is found on Kauai, HI, from April through September during breeding and on the open ocean from October to April.
Telespiza cantans	Laysan finch (honeycreeper)	E	Laysan Island, Pearl and Hermes Reef, HI	This is a year-round resident.
Telespiza ultima	Nihoa finch (honeycreeper)	E	Nihoa Island, HI	This is a year-round resident.
Myiagra freycineti	Guam broadbill	E / X	Guam	This is a year-round resident.
Halcyon cinnamomina	Guam Micronesian kingfisher	E / X	Endemic to Guam and CNMI; in captivity since extinct in the wild	This is a year-round resident.
Megapodius laperouse	Micronesian megapode	E	Relatively large numbers on smaller, mostly uninhabited northern islands of Anatahan, Sarigan, Guguan, Pagan, Maug, Alamagan, Ascuncion, and possibly Agrihan	This is a year-round resident.
Monarcha takatsukasae	Tinian monarch (old-world flycatcher)	T	Known to occur in CNMI	This is a year-round resident.
Acrocephalus luscinia	Nightingale reed warbler (old-world warbler)	E	Known to occur in CNMI	This is a year-round resident.
Corvus kubaryi	Mariana crow	E	Known to occur in Guam and CNMI	This is a year-round resident.
Anas oustaleti	Mariana mallard	E	Endemic to Guam and the islands of Tinian, Saipan, and Rota, CNMI	This is a year-round resident.
Gallinula chloropus guami	Mariana common moorhen	E	Only remaining wetland bird species CNMI primarily at freshwater, manmade, and natural wetlands, both seasonal and permanent	This is a year-round resident.
Rallus owstoni	Guam rail	E	Endemic and local on Guam	This is a year-round resident.
Aerodramus vanikorensis bartschi	Mariana gray swiftlet	E	Known to occur in CNMI	This is a year-round resident.
Zosterops rotensis	Rota bridled white-eye	E	Known to occur on Rota, CNMI	This is a year-round resident.

Source: USCG, 2002; U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*). Rota bridled white-eye: 50 CFR part 17 (69 FR 3022).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 *et seq.*, as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no marine and coastal birds of the Oceania region have C status.

Five species of sea turtles have been observed in the Oceania region, and all are classified as threatened or endangered (Table 3.7-4). Sea turtles have been known to nest in larger numbers in CNMI and American Samoa but also nest throughout the region. The green sea turtle (*Chelonia mydas*) is considered the most abundant sea turtle in Hawaiian waters. Hawksbills (*Eretmochelys imbricata*) are considered uncommon, and a small number nest on the islands of Hawaii and Molokai each year. Adult leatherbacks (*Dermochelys coriacea schlegelii*) are commonly sighted near the Hawaiian archipelago. Most records of olive ridleys (*Lepidochelys olivacea*) are from entanglements and strandings (USCG, 2002).

Table 3.7-4
Threatened, Endangered, or Candidate Sea Turtles of the Oceania Region

Scientific Name	Common Name	Status*	Distribution in Region
Chelonia mydas	Green sea turtle	T	In the central Pacific Ocean, green sea turtles can be found at most tropical islands. They are found around most of the HI islands and also in the CNMI.
Eretmochelys imbricata	Hawksbill sea turtle	E	In the HI Islands, nesting occurs on the main islands, primarily on several small sand beaches on the Hawaii and Molokai. Two of these sites are at a remote location in the Hawaii Volcanoes National Park.
Dermochelys coriacea	Leatherback sea turtle	E	Leatherbacks are commonly seen by fishermen in HI offshore waters, generally beyond the 100-fathom curve but within sight of land. Sightings often take place off the north coast of Oahu and Kona coast of HI. North of the HI Islands, a high-seas aggregation of leatherbacks is known to occur at 35°–45°N, 175°–180°W.
Caretta caretta	Loggerhead sea turtle	T	Population is circumglobal, inhabiting continental shelves, bays, estuaries, and lagoons in temperate, subtropical, and tropical waters. In the eastern Pacific Ocean, loggerheads are reported as far north as AK and as far south as Chile. Loggerheads migrate through western Pacific waters.
Lepidochelys olivacea	Olive Ridley sea turtle	T	This turtle is essentially tropical. In the western Pacific Ocean, it is scarce everywhere, although widespread low-density nesting occurs.

Source: Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (*http://www.nmfs.noaa.gov/prot_res/PR3/Turtles/turtles.html*, accessed on October 25, 2002); U.S. Fish and Wildlife Service (Threatened and Endangered Species System [TESS], U.S.-Listed Vertebrate Animal Species Report by Taxonomic Group as of March 3, 2002, *http://ecos.fws.gov/servlet/TESSWebpageVipListed?code=V&listings=0#A*).

* Status for threatened (T) and endangered (E) refers to federal status under the Endangered Species Act of 1973 (ESA, Public Law 93-205, 16. U.S.C. 1531 et seq., as amended). Status for candidate (C) refers to proposed federal status under the ESA. X stands for those species presumed to be extinct. Currently, no sea turtles of the Oceania region have C or X status.

3.7.4. Essential Fish Habitat

The Fishery Conservation and Management Act of 1976 (FCMA) established eight regional Fishery Management Councils (FMCs), charged with developing Fishery Management Plans (FMPs) to achieve optimum fishery yields within their respective regions. In subsequent years, additional legislation was formulated to increase the effectiveness of this act. Two examples are the NMFS "602 Guidelines" ("Guidelines for the Preparation of Fishery Management Plans under the FCMA," 50 CFR part 602), which provided an official definition of overfishing and required each FMP to include measurable definitions of overfishing for each managed species, under the Sustainable Fisheries Act of 1996 (Public Law 104-297; 16 U.S.C. 1801 *et seq.*), which was passed and integrated into the Magnuson-Stevens Fishery Conservation and Management Act of 1996 (MSFCMA, Public Law 94-265, as amended through October 11, 1996; 16 U.S.C. 1801 *et seq.*). This later act required FMCs and the Secretary of Commerce to identify and describe Essential Fish Habitat (EFH) for species specified under each respective FMP.

The Western Pacific Regional Fishery Management Council (WPRFMC) is responsible for implementing the MSFCMA through FMPs in the Oceania region. EFH is designated under five FMPs for this region—pelagics, bottomfish, coral reef ecosystems, precious corals, and crustaceans (shellfish). The commercially important fish species of the Oceania region are listed in Table 3.7-1. NMFS is currently reviewing the EFH designations for this region to determine if changes are necessary. Those habitats currently designated as EFH in the Oceania region are listed in Table 3.7-5. EFH designations for each region are available on-line[29].

Table 3.7-5
Essential Fish Habitat of the Oceania Region

Group	Designated Essential Fish Habitat
Adult, juvenile, eggs, and larva bottomfish	Water column and all bottom habitats extending from the shoreline to the outer Exclusive Economic Zone (EEZ) limit to a depth of 1,312 ft
Adult seamount groundfish	All water and bottom habitats encompassing the Hancock Seamount and part of the northern extent of the Hawaiian Ridge, located 1,500 mi northwest of Honolulu
Pelagic species	Lower bound at 3,281 ft depth above seamounts
Pelagic eggs and larvae	Epipelagic zone of 656 ft depth from the shoreline to the outer limit of the EEZ
Crustaceans (spiny lobster larvae)	Water column from the shoreline to the outer limit of the EEZ, down to a depth of 492 ft
Juvenile and adult spiny lobster	Bottom habitat from the shoreline to a depth of 328 ft
Precious coral	Six known coral beds surrounding the Hawaiian Islands

Source: WPRFMC, 1998.

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[29] *http://www.nmfs.noaa.gov/habitat/habitatprotection/efh/fish_manage_c.htm*

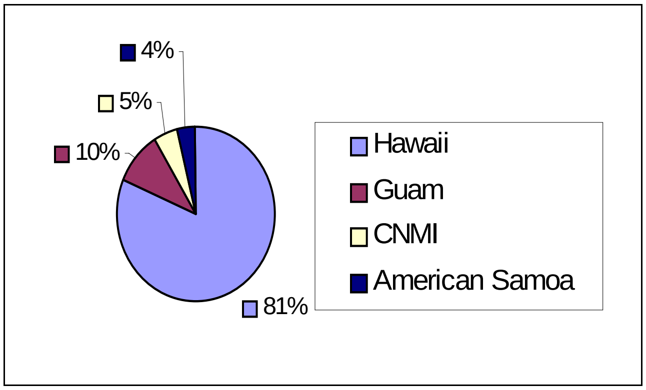
3.7.5. Socioeconomic Environment

3.7.5.1. Coastal Communities, Demography, and Employment

The socioeconomic impact area of the Oceania region comprises thirty-seven coastal districts and twenty coastal counties over the twenty-six islands consisting of Hawaii, Guam, CNMI, and American Samoa. The socioeconomic impact area extends from the island of Kauai, Hawaii, to the western Pacific at Farallon de Pajaros Island, CNMI, and southeast to Tutuila Island, America Samoa.

The population of the Oceania region is 1,492,854 (U.S. Census Bureau, 2000), which is calculated by combining population statistics for the region's fifty-seven counties/districts. Appendix F, Table F.7-6 lists these counties/districts and their populations. The Hawaiian Islands are the most populated in the region, making up 81 percent of the total population (Figure 3.7-6).

Figure 3.7-6
Population Distribution of the Oceania Region



Source: U.S. Census Bureau, 2000.

The Oceania region varies substantially in socioeconomic patterns ranging from low-density, undeveloped rural areas to high-density, highly developed urban centers. The range is from 6 people in the Northern Islands1 Municipality District, CNMI, to 876,156 people in Honolulu County, Hawaii. Table 3.7-6 lists the most densely populated counties/districts of the Oceania region.

Table 3.7-6
Highest Populated Counties/Districts of the Oceania Region

County/District	Population
Honolulu County, HI	876,156
Hawaii County, HI	148,677
Maui County, HI	128,094
Kauai County, HI	58,463
Dededo District, Guam	42,980

Source: U.S. Census Bureau, 2000.

In 2000, the region had a total civilian labor force of 700,339, with an average unemployment rate of 6.6 percent, compared with the national average of 5.8 percent. In addition, 1.29 percent (or 8,463) of those employed were engaged in some kind of subsistence activity. Income levels rank well below the national average of both per capita and median household incomes at $11,939 and $32,564, respectively. (The national average per capita and median household incomes are $21,587 and $41,994, respectively.) The levels of income vary throughout the region. For example, American Samoa, the poorest island group, has a per capita income of $4,357, while Hawaii, the wealthiest island group, has a per capita income $21,525 (U.S. Census Bureau, 2000).

3.7.5.2. Economic Status

Five primary sectors make up the foundation of the Oceania region's economic system: tourism, U.S. government and territorial expenditure, U.S. military, agriculture, and manufacturing. In addition, there is a small commercial seafood sector as well as associated service sectors—sales, communications, transportation, warehousing, and infrastructure—supporting the five primary sectors.

On average over 6 million tourists visit the Oceania region every year (Bank of Hawaii, 1997, 1999, 2003a, b); however, tourism is still very small in American Samoa because of its limited land area to support a critical mass of tourist infrastructure. Tourism accounts for 50 percent of the workforce in CNMI, and over $10 billion in visitor expenditures for Hawaii (Bank of Hawaii, 1999, 2003a). From 1985 to 1997, tourism expenditures multiplied throughout the region's economy and resulted in a large construction boom in which hotels and other tourist-related structures were in high demand. In the past 3 years, however, the tourism industry has declined, due to the economic fallout from the September 11, 2001 event and the SARS (severe acute respiratory syndrome) epidemic. It is also highly dependent on the well-being of Asian economies. In particular, the uncertain state of the Japanese economy has had a particular impact in that it is estimated that over 90 percent of all tourism revenues comes from Japanese visitors (Bank of Hawaii, 1997, 1999, 2003a, b).

The Oceania region depends highly on indirect and direct U.S. funding. Total grants, wage payments, and procurements to Guam in 1998 from the United States amounted to over $1 billion, and it was responsible for the well-being and employment of approximately 22 percent of the total Oceania population via welfare and direct project assistance (Bank of Hawaii, 1997, 1999, 2003a, b). The special relationships between the United States and Guam, CNMI, and American Samoa make the United States responsible for a certain amount of annual financial assistance. In the past 10 years, these revenues have started to decline as local tax revenues have increased.

The U.S. military is actively involved in Hawaii, Guam, and CNMI. Hawaii is the headquarters for the U.S. Navy, Pacific Fleet, and is home to a variety of Air Force, Army, Coast Guard, and Marine bases. Guam also has a variety of air, naval, and army bases along with supporting infrastructure. A large portion of Tinian, CNMI, is leased to the U.S. Department of Defense. Industry and services associated with the military are an integral part of the livelihood of many Oceania residents as these sectors earn billions of outside dollars every year. The large role of the U.S. military in the regional economy was heavily noticed during the military downsizing of the 1990s that created large fiscal deficits and high unemployment rates during the transition. Unless there becomes an increased need for military deployments in the region in the near future, Hawaii, Guam, and CNMI will need to look for alternate sources of revenue.

The agricultural and food products of the Oceania region consist of coconuts, breadfruit, sugarcane, pineapples, tomatoes, melons, tuna, and a variety of smaller fish. In Hawaii, pineapples and sugarcane remain the largest commercial crops. In Guam and CNMI, subsistence and commercial fishing are the largest food production sectors. There are two tuna canning factories on American Samoa that account for 33 percent of employed labor force and provide 25 percent of all canned tuna consumed in the United States (Craig et al., 1993).

Manufacturing began increasing in the past 15 years primarily through tariff-free trade zones established with the United States. Hawaii has a small manufacturing sector and relies more on the associated transportation and warehousing services because of its advantageous location to, and political inclusion with, the United States. Manufacturing has increased in Guam, as the local government began to encourage alternatives to tourism and the U.S. military. There are now thirty-one garment producing factories in the CNMI employing over 12,000 employees and producing goods worth over $1 billion (CIA, 2001). With the exception of two tuna plants, there is no substantial manufacturing in American Samoa.

3.7.5.3. Vessel Transportation and Ports

Because of their location in the Pacific Ocean, the islands of the Oceania region are highly dependent on ships for the import and export of goods. The majority of the food consumed in the region is imported (98 percent of all freight arrives by ship), and almost all bulk export commodities are shipped by sea. Since the region is spread out across the Pacific Ocean, the islands serve as a transshipment point to a variety of locations including the United States, Samoa, eastern and southern Asia, Japan, South America, and smaller islands of the South Pacific. There is also a large amount of U.S. naval traffic in the region. In 1999, over 15,000 vessel trips measured along the waterways were associated with major ports throughout the region (USACE, 1999c). Honolulu Harbor is the largest in the region and contains large-scale facilities for the on- and offloading of containers and support operations. In 1998, 2,752 vessels called on Guam's port in Apra. Table 3.7-7 lists the major ports of the Oceania region.

Table 3.7-7
Major Ports of the Oceania Region

State/U.S.-Affiliated Islands	Port
Hawaii	Hilo Harbor, Kawaihae Harbor, Kahului Harbor, Barbers Point, Honolulu Harbor, Nawiliwili Harbor, Pearl Harbor
Guam	Apra Harbor
CNMI	Charlie Dock (Saipan), West Harbor, Tinian Harbor
American Samoa	Pago Pago Harbor

Source: U.S. Department of the Interior, Office of Insular Affairs (*A Report on the State of the Islands 1999, http://www.doi.gov/oia/pdf/islands.pdf*).

In 1999, the Hawaiian Islands received or shipped from their ports more than 21 thousand short tons of foreign and domestic cargo: domestic shipping and receiving accounted for 1,164 and 5,136 thousand short tons, respectively, while foreign shipping and receiving accounted for 609 and 6,548 thousand short tons, respectively. In addition, there were 7,852 thousand short tons of intrastate waterborne commerce (USACE, 1999c). There is a lack of detailed waterborne commerce data for Guam, CNMI, and American Samoa. Aggregate shipping and receiving, without knowing if the totals are domestic or foreign, for these islands are as follows: Guam, 31,000 and 250,000 thousand short tons (USACE, 1999c); CNMI, 205,851 and 851,794 revenue tons (Commonwealth Development Authority, 2000)[30]; and American Samoa, 182,720 and 614,017 tons (American Samoa Department of Treasury, 2002)[31].

3.7.5.4. Fisheries

Commercial Fisheries

The Oceania region serves as an important transshipment center for commercial fisheries based in both domestic and international waters. The majority of commercial catch is undertaken by international tuna fleets, which lease fishing rights within certain areas of the region's EEZ. During 1999, fisheries produced more than 28 million lb (valued at greater than $200 million (NMFS, 2001b). In particular, tuna species are highly abundant in the tuna fisheries located in the EEZ of Hawaii, Guam, CNMI, and American Samoa. Pago Pago, American Samoa, received 208,300 tons of tuna worth $200 million, making it the leading U.S. port in terms of dollar value and fish landings (NMFS, 2001b).

A variety of species is caught and landed in the region's commercial fisheries, including yellowfin (*Thunnus albacares*), albacore (*Thunnus alalunga*), skipjack (*Katsuwonus pelamis)*, and bigeye (*Thunnus obesus*) tuna; marlin; sharks; rabbitfish; emperors (*Lethrinus amboinensis* and *L. rubrioperculatus*); swordfish (*Xiphias gladius*); parrotfish; wahoo; and mahi mahi (*Coryphaena hippurus* and *C. equiselis*). Of these, tuna is the most important to the region economically. Table 3.7-8 lists the top commercial landings for the Oceania region.

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[30] These numbers are for 1998 in revenue tons from the Commonwealth Development Authority. Short ton information was not available.

[31] The numbers for American Samoa are estimates based off total inbound and outbound cargo (in tons) as denoted by the American Samoa Department of Treasury, Customs and Excise Tax Division.

Table 3.7-8
Top Commercial Landings for 2000* for the Oceania Region

Scientific Name	Common Name	Pounds	Dollars
Thunnus obesus	Bigeye tuna	6,170,906	21,445,144
Xiphias gladius	Swordfish	6,521,184	12,794,362
Thunnus albacares	Yellowfin tuna	4,808,084	12,611,257
Katsuwonus pelamis	Skipjack tuna	1,653,920	2,061,350
Lutjanus campechanus	Red snapper	420,815	1,959,380

Source: NMFS, 2003b.

* Ranked by dollar value.

Recreational Fisheries

Recreational fishing occurs throughout the region but is predominant in Hawaii and Guam. Small-scale fishing operations in CNMI and American Samoa are primarily for subsistence and direct consumption purposes defined largely by tradition and culture.

According to the MSFCMA, fish caught but not sold are classified as "recreational." The WPRFMC estimated recreational participant numbers for bottomfish (2,550), pelagic (64,722)[32], and coral reef (8,050) fisheries[33]. Although charter vessels occur in large numbers throughout the region (particularly in Hawaii and Guam), the fishing statistics—total catch of 2,265,217 lbs valued at $5,292,579—associated with this sector are not considered specifically recreational since the majority of the total catch may be sold commercially[29]. Blue marlin (*Makaira nigricans*), skipjack tuna (*Katsuwonus pelamis*), mahi mahi (*Coryphaena hippurus* and *C. equiselas*), yellowfin tuna (*Thunnus albacares*), wahoo, and shortnose spearfish constitute the majority of the recreational catch in the region.

3.7.5.5. Subsistence

The Oceania region has depended on coastal marine food sources for thousands of years as an important source of protein and nourishment because of limited space for agriculture and a general lack of land mammals. Yet, even though the population's survival is no longer dependent on these resources, subsistence fishing continues to have important traditional and cultural impacts. Over time, local communities developed a close, emotional, as well as utilitarian, association with the marine environment, which has had a large impact on their social organization. Communal disbursement of the catch is still a common practice throughout the Oceania region and its diverse people, as well as the traditional format in which it is conducted. Subsistence fishing is even now conducted in some rural areas of Niihau, Hawaii; CNMI; and American Samoa; combined, the subsistence fisheries production for these three areas is 889 tons, with a nominal value of about $3.5 million (UNEP, 2000). (A survey indicated that at least 40 percent of American Samoa's households exploit the nearshore fisheries for part of their food [OTA, 1987].) The catch consists of shellfish, crustaceans, echinoderms, and other small pelagic fish species.

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[32] This number does not include the number of recreational participants in pelagic fisheries in Hawaii. At the time of this PEIS, this information was unavailable.

[33] Personal communication from Marcia Hamilton, Western Pacific Regional Fishery Management Council, Honolulu, HI, 2002.

3.7.5.6. Archaeological/Historic Resources

Many locations on the Oceania region's islands are identified as culturally or archaeologically sensitive areas and include burial sites, historic properties, and shrines. However, most of the islands have yet to complete thorough archeological surveys, and those completed tend to occur only prior to development. For example, it is estimated that only 10 percent of Hawaii and 8 percent of American Samoa are adequately surveyed (USCG, 1999b, 2000b). Traditional cultural places are only just beginning to be identified. Further, the number of identified areas is substantial—Hawaii alone has 20,000 to 30,000 known sites—and it will take immense resources to compile a list of sites and locations (USCG, 1999b).

Hawaii contains a wide variety of historic properties that well reflect the diverse character of its population. A large number of sites remain that relate to the approximately 1,700-year occupation of the islands by native Hawaiians (SHPD, 2001), prior to European contact in 1778 A.D. (USCG, 1999b, 2000b). Sites range from residential landscapes to temporary habitations and agricultural fields, such as the extensive wetland agricultural fields or the sacred summit region of Mauna Kea. Many of these historic sites are still used today and remain culturally significant (SHPD, 2001).

Numerous significant historic sites are also found along Hawaii's entire coastline. The reason for this coastal patterning is that these areas are where the bulk of the prehistoric population lived. Though more rare, some sites extend below the high-water line, such as fishponds, petroglyphs (rock art) cut into reef rock, circular holes for grinding bait (bait cups), and anchor holes. Shipwrecks (the *USS ARIZONA*) and trains (e.g., in Ewa on Oahu) are also more rare among the modern Hawaiian sites and relatively few significant sites are known in open, offshore waters.

Guam is a mix of Chamorro, Micronesian, American, and Asian cultures. Noteworthy examples of historic sites are petroglyphs (cave paintings) and latte stones (pillars that supported ancient structures and houses). Sites such as these provide insight into the lives of Chamorro people in their earliest times. Below the marine waters of Guam are five shipwrecked galleons.

The ancient Chamorros, the earliest known inhabitants of CNMI, were of Mayo-Polynesian descent originating from Southeast Asia as early as 2,000 B.C. (Government of Guam, 2002). Examples of the Spanish period (1668–1899) are present in two shipwrecks, *CONCEPCION* and *SANTA MARGARITA*. Both were Acapulco-bound galleons that wrecked off Saipan and Rota, respectively, in the early part of the seventeenth century. There is evidence to suggest that additional Spanish-period shipwrecks may be present within CNMI waters. There are remnants of World War II in this region today; offshore in shallow coastal waters are the remains of combat aircraft, patrol boats, and merchant ships (CMNI, 1999).

There are 401 recorded historic archaeological and cultural sites for the major islands of American Samoa. Nine major categories of sites have been identified: star mounds, quarries, U.S. military sites, prehistoric forts, legendary sites, villages, petroglyphs, National Register sites, and terraces. Only 8 percent of the

401 American Samoa sites are being surveyed. The likelihood that archaeological sites are present in areas that would be used during a response to an oil spill is high (USCG, 2000b).

3.7.5.7. Recreation and Tourism

With its unique location in the tropical Pacific, its proximity to Asia, and its relatively constant and enjoyable climate, the Oceania region receives millions of tourists every year. In 2000, nearly 7 million tourists visited the state of Hawaii alone, with expenditures of $10.9 million. The American Coastal Coalition (ACC, 1998) reported that coastal tourism supported 172 thousand jobs.

Tourists come for a variety of recreational activities including scuba diving, sportfishing, surfing, sailing, using the beach, snorkeling, hiking, camping, and observing natural phenomena. Publicly owned and administered areas (national seashores, parks, beaches, wildlife lands) as well as designated preservation areas (historic and natural sites, landmarks, wilderness areas, and wildlife sanctuaries) attract residents and visitors throughout the year. Commercial and private recreational facilities and establishments, such as resorts, marinas, gambling casinos (CNMI), shopping centers, and ornamental gardens, also serve as primary areas of interest.

The region's coastal shorefront has many public and private recreation areas, as well as a variety of government-sponsored mountain nature reserves. There are miles of ocean shoreline within the region that are composed of sandy beaches, rocky outcroppings, and cliffs. Mountain nature reserves usually consist of valley waterfalls, tropical rain forests, and natural phenomena like volcanoes. These areas are a major inducement for coastal tourism, as well as being a primary resource for resident recreational activity. In addition, cruise ships constitute an important part of the tourism industry, particularly in Hawaii, but they also account for large numbers of tourists in Guam and CNMI.

With the exception of American Samoa, the economy of the Oceania region is highly dependent on tourism revenues, which account directly or indirectly for over 30 percent of the employment opportunities within the region (Bank of Hawaii, 1997). It is the number one industry in terms of revenue earnings for Guam and CNMI, yet the state of Hawaii is the highest earner in tourism revenue at over $13 billion (ACC, 1998). The region's heavy reliance on tourism expenditures, the bulk from Asia, has caused economic difficulty in the last few years as the financial situation of Japan, Korea, and Southeast Asia has declined.

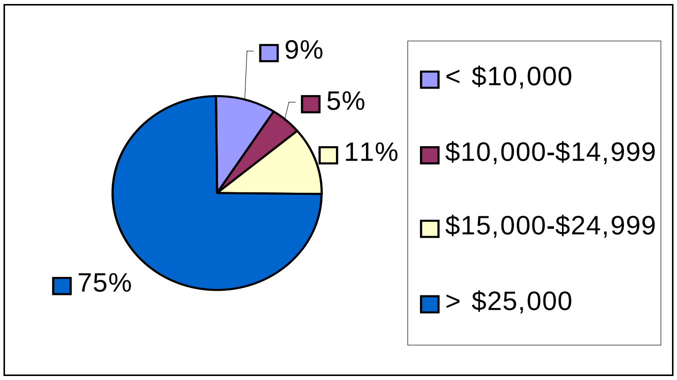
Ecotourism is growing rapidly throughout the region, particularly in American Samoa where a new effort is being undertaken by the government to encourage the tourism industry. It is widely accepted as an environmentally sustainable activity and is especially appealing due to its similarities with the region's traditional ideals of environmental stewardship. Ecoparks (both private and public) are beginning to appear throughout the region and are expected to become very popular in the next decade.

3.7.5.8. Environmental Justice

Executive Order 12898 ("Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," 59 FR 7629) provides that each federal agency shall make achieving environmental justice part of its mission by identifying and addressing questions regarding environmental and health conditions of impoverished communities.

Low-income communities, which can be found across the Oceania region, include multiethnic as well as homogenous communities and neighborhoods. Of the 339,492 families that live within the counties/districts of this region, 10.7 percent (or 36,515) have been classified as living in poverty by the U.S. Census Bureau (2000). The average per capita and median household incomes of this region are $11,939 and $32,564, respectively. However, 25 percent of households earned less than $25,000 in 1999. Figure 3.7-7 shows the distribution of household income in the Oceania region.

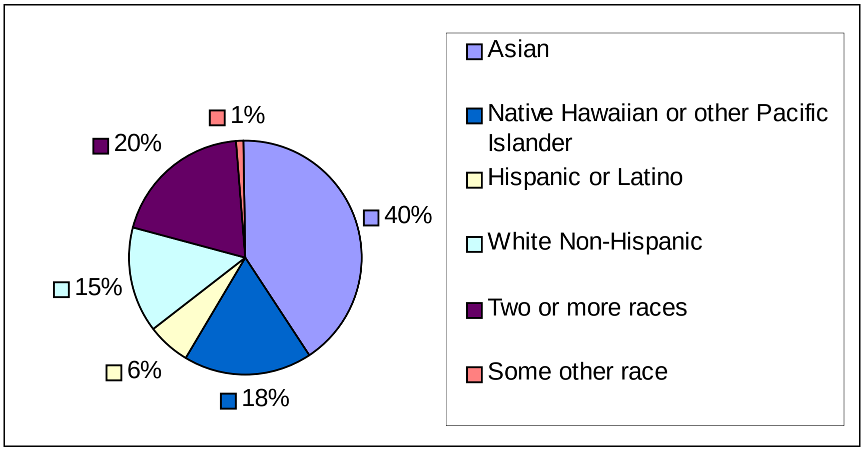
Figure 3.7-7
Distribution of Household Income in the Oceania Region



Source: U.S. Census Bureau, 2000.

Minority groups are scattered throughout the region. These groups include Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, Hispanic or Latino, and Non-Hispanic White. The Oceania region is unique in that it is a melting pot of many different races from Asia, the Pacific Islands, and the United States. The groups that fall under the category "Native Hawaiian or other Pacific Islander" include Carolinian, Chamorro, Chuukese, Kosraean, Marshallese, Palauan, Pohnpeian, Yapese, Tongan, Samoan, Niuean, Tokelauan, Fijian, and other smaller groups of Micronesian people. Niihau, Hawaii, is reserved for and inhabited by (by design of the Bishop Estate) only people of Native Hawaiian decent. Figure 3.7-8 shows the distribution of race within the Oceania region.

Figure 3.7-8
Distribution of Race in the Oceania Region



Source: U.S. Census Bureau, 2000.

3.7.5.9. Public Safety and Worker Health

Oil spill response is one of the U.S. Coast Guard's (USCG's) many missions. In responding to oil spills, the USCG is aware of public safety and the effects that alternative response technologies—chemical dispersion and *in situ* burning—could have on human health. Under the guidelines established by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), steps have been taken to protect both the public and oil spill responders. Whether compensated workers or volunteers, responders are required to be certified under either the Occupational Safety and Health Administration's (OSHA's) Hazardous Waste Operations and Emergency Response Standard or USEPA's Hazardous Waste Operations and Emergency Response Standard. These standards ensure that responders understand the hazards of oil spill response and how to protect themselves. To assist in public safety, the USCG has the maritime safety authority to establish a safety zone around oil spill cleanup operations. This zone is established to safeguard the public and responders from the hazards associated with cleanup. In addition, USCG standard operating procedures (SOPs) are used to protect responders, as well as the public, from the hazards associated with chemical dispersion and *in situ* burning. These procedures are outlined in SOPs in each Area Contingency Plan's (ACP's) Site Safety Plan. In addition, training exercises such as PREP (Preparedness for Response Exercise Program) and SONS (Spill of National Significance) train USCG response personnel to avoid safety hazards.

Dispersants are a liquid chemical used to disperse oil spills from the ocean surface (see Section 2.2.2). During an oil spill, dispersant application can be from either an aerial or a shipboard platform. In both cases response personnel have the potential to be accidentally exposed to the dispersant, and in extreme cases exposure to the public could occur. The two types of dispersants with use allowed in the United States have OSHA-established, permissible exposure limits of 50 ppm on skin. The Material Safety Data Sheet (MSDS) for these dispersants makes clear the human health concerns from excess exposure.

In situ burning of an oil spill entails setting contained or boomed oil on fire (see Section 2.2.3). This action has been acknowledged as having potential human health and safety effects. Besides the physical hazards to responders, there is the potential for inhalation of airborne burn products. *In situ* burning emits a plume of black smoke laden with particulates (PM10, soot), the main public health concern. Response personnel working close to the burn may be exposed to levels of gases and particulates that would require them to use personal protective equipment. Occupational standards such as OSHA's Permissible Exposure Limits (PELs) are applicable. For the general public, NOAA (2000a) reported that particulate concentrations in a smoke plume remain the only agent of concern past 1 or 2 mi downwind, with the gases created in a burn dissipating to levels close to background. Public exposure to smoke particulate from the burn is not expected to occur unless the smoke plume travels down to ground level. Since the general public may include sensitive individuals, such as the very young and very old, pregnant women, and people with pulmonary or cardiovascular diseases, this population's tolerance to particulates may be significantly lower than that of the responders. There is little data concerning the effect on humans of particulates from the *in situ* burning of oil. Based on chemical analysis of soot particulates and their physical behavior, the hazard is expected to be similar to that of better-known particulates emissions that are now regulated by the NAAQS. In 1997, the Special Monitoring of Applied Response Technologies (SMART) protocol[34] was created, in part, to address the particulates concerns and to better aid the Federal On-Scene Coordinator (FOSC) in making decisions related to initiating, continuing, or terminating *in situ* burning.

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[34] *http://response.restoration.noaa.gov/oilaids/SMART/SMART.html*

CHAPTER 4
ENVIRONMENTAL CONSEQUENCES

4.1. INTRODUCTION

This section presents the potential direct, indirect, and cumulative environmental impacts of the alternatives. The significance of these potential impacts is discussed, as well as possible options to mitigate or reduce any possible adverse impacts. The alternatives included in the evaluation are based on the proposed regulations that could, potentially, affect the nature and effectiveness of marine oil spill response. As discussed in Chapter 2, the proposed regulations (or any alternative other than Alternative 1) would establish a requirement for the regulated community (tank vessels and MTR facilities planholders) to have certain oil spill response capabilities available to them, but would not mandate the actual use of any particular response option[1].

For this PEIS, the focus of the assessment is compounded by the environmental considerations of this proposed program. While a direct assessment of the environmental impacts of the response options—on-water mechanical recovery, on-water *in situ* burning, and on-water chemical dispersion—is discussed in Section 4.2.1, these response options will not be utilized under normal circumstances for their intended purposes unless there is an oil spill. Therefore, a thorough assessment of the response options must incorporate the impact of an oil spill under the influence of different response alternatives.

The first step in the evaluation of the alternatives was to refine the scope of the analysis to identify the issues to be analyzed and discussed (Section 4.2). When that was completed, an analytical strategy was selected to evaluate the potential consequences associated with these issues. The approach was to first summarize the available research and field observations concerning oil spills (Section 4.3) and then to place these effects into a regional context for each of the alternatives (Sections 4.5 through 4.9), based on an evaluation of the anticipated effects at selected locations. The analytical approach, explained in Section 4.4, includes a state-of-the-art oil spill fate and effects model, used to predict oil fate and effects at five representative locations around the country based on the response options in the alternatives. The basis for the selection of these areas and the modeling and analytical protocols are summarized in Sections 4.4.1 and 4.4.2. The ecological results from the modeling scenarios were analyzed using a risk assessment methodology

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[1] The response options analyzed and discussed in this PEIS—mechanical recovery, *in situ* burning, and chemical dispersion—are for on-water recovery.

that emphasizes the relative environmental costs and benefits of the various response options under each of the alternatives, as described in Section 4.4.3. The results of this risk assessment were used to refine and to document the anticipated impacts in each geographic region as described in Chapter 3 under each alternative.

A risk assessment approach, described in detail in Section 4.4.3.1, was selected to analyze ecological effects. Risk assessment offers the best method to compare the relative consequences of each of the response options under the various alternatives within and between regions. Once oil has been spilled on the water, the potential for relative risk reduction through the use of various response options becomes much more significant than absolute effects. This is true because some adverse consequences are inevitable and the only appropriate goal is to minimize the potential risks and consequences. Socioeconomic effects, on the other hand, could not be defined using the same risk scales used for ecological effects, and instead the assessment examined the relative change between response options, as described in Section 4.4.3.2.

To deal with the inherent complexity of this evaluation, the analysis examines the probable impacts of a small (200-bbl), medium (2,500-bbl), and large (40,000-bbl) oil spill. U.S. Coast Guard (USCG) regulations (33 CFR 155.1020) define various spill sizes, and the volumes given above were developed from these definitions. The regulations define the worst case discharge (WCD) as the loss of all cargo from a tank vessel. On that basis, the "large" volume is the loss of cargo from two storage tanks, which is approximately 40,000 bbl. The 40,000-bbl limit was used since it is the largest volume of oil that could be dispersed under the Notice of Proposed Rule-Making (NPRM) dispersant-load maximum. The maximum most probable discharge (MMPD) is defined as 2,500 bbl, and this volume represents a "medium" spill. Finally, the regulations define the average most probable discharge as 50 bbl. To make a conservative estimate of the potential impacts from such spills, a volume four times larger, or 200 bbl, is used. The relative frequency of such events varies around the country, but the small spill is representative of the more common "average" spill sizes, while the medium or large spills happen only rarely and represent extreme events (see Section 2.8 and Appendix E for a discussion of the relative size and frequency of oil spills). The use of these three different spill volumes allows for a more accurate assessment of the potential consequences of events that may be of concern.

The modeling results for the five representative locations of the six geographic regions in this Programmatic Environmental Impact Statement (PEIS) are described in Section 4.4.4 and summarized in the technical report (French McCay et al., 2004). All this material is based on the modeling effort, the detailed results of which appear in a six-part technical report prepared in support of this project (French McCay et al., 2004). The potential impacts of the various alternatives are compared in Section 4.10. In Sections 4.11 through 4.14 the subject matter discussed includes unavoidable adverse impacts of the proposed action; irreversible and irretrievable commitment of resources; relationship between the short-term use of the human environment and the maintenance and enhancement of long-term productivity; and cumulative impacts; respectively.

The context of this PEIS is response to spills in dispersant pre-authorization agreement areas, generally 3 or more nm from shore with the exception of several areas with dispersant pre-authorization agreements at different distances from shore, including Maine (>0.5 nm), Massachusetts (>2 nm), Puerto Rico (>0.5 nm and >60 ft depth), the U.S. Virgin Islands (>1 nm from shore or reef, if reef <20 ft from surface and >60 ft depth), and Hawaii (>60 ft depth), as well as areas such as Washington, Oregon, Connecticut, and large portions of Alaska, which have case-by-case pre-authorization agreements[2]. The underlying rationale for the establishment of dispersant pre-authorization agreements closer than 3 nm from shore is the ability of the environment in these locations to provide reasonable dilution over a shorter distance due to depth and hydrodynamic conditions. On this basis, the average modeling results and general conclusions presented in this chapter for an oil spill release based on the 3 nm limit would be applicable to these areas as well. A state-of-the-art oil spill fate and effects model was used to predict the impact of oil spills on the selected physical environment resources. The area that was modeled had boundaries of 3 and 12 miles from shore, with statute miles instead of nautical miles due to default options in the computer-modeling program. These oil spills, especially larger ones, are rare events. Response modes are mechanical recovery, dispersants, and *in situ* burning, and the option(s) selected depend on the timing and the location and conditions at the time of the spill, as well as the type of oil, the time it has been on the water, and the ecological resources of concern. Frequently, the "no action" response option will be used when spills are this far from shore. Of the possible options, mechanical recovery is the most often considered, but its effectiveness begins to decline as wave heights grow beyond approximately 3 ft. *In situ* burning was tested during the *EXXON VALDEZ* spill response, but has never been used for an actual spill response in the United States. These issues were analyzed in detail in the *Response Plan Equipment Caps Review* (USCG, 1999) and in Chapter 2 of this PEIS.

4.2. REFINEMENT OF SCOPE

The intent of the proposed action (as described in Chapter 1) is to improve domestic marine oil spill response capability. All of the response technologies addressed by the alternatives are already in use in the United States, and as a consequence the relative availability of response equipment may change in some locations, but no new technologies will be implemented. This section briefly describes the response technologies under consideration and the potential environmental effects associated with them, to explain what issues will be analyzed in detail and which ones will be omitted from further consideration, and why.

It is a matter of public policy that spilled oil requires a response, and that the Coast Guard should examine all reasonable and potential response options to reduce the potential for environmental effects. There are five major options for response (Section 2.2):

- On-water mechanical recovery
- On-water chemical dispersion
- On-water *in situ* burning
- Shoreline cleanup and other countermeasures
- Natural removal (no cleanup action)

In all cases involving active oil spill response, the goal is to mitigate or to minimize the potential for environmental damage, based on what would occur if no cleanup action were undertaken. Because this assessment relates to alternatives affecting on-water response options, shoreline cleanup is not considered. Natural removal is part of the recovery process addressed in the risk evaluation, but it is not included here as a response option.

It is assumed that mechanical recovery and *in situ* burn capabilities are currently available in all six geographic regions. However, in the Gulf of Mexico and Alaska regions, dispersant capabilities are assumed to be available and their use for response operations feasible (USCG, 1999). Dispersant capability will only be discussed for these two regions because appropriate response times cannot currently be met in the Atlantic, Caribbean, Pacific, and Oceania regions.

The proposed alternatives have the potential to influence the availability of equipment related to three response options: mechanical recovery, chemical dispersion, and *in situ* burning. The capability to use all three response options currently exists throughout the United States, but only mechanical recovery can be used without geographic restrictions. Dispersant pre-authorized agreement areas exist in all six geographic regions (Figure 2.2-1), but appropriate response times for chemical dispersion cannot currently be met in the Atlantic, Caribbean, Pacific, and Oceania regions. Dispersant and *in situ* burn use is restricted by decisions made at the Regional Response Team (RRT) level (see Sections 2.2.2 and 2.2.3, respectively), and their use is essentially restricted to areas 3 or more nm from shore[3]. As defined in Chapter 2, dispersant capability is available only in the Gulf of Mexico and Alaska regions, while the other options are available nationwide.

4.2.1. Response Operations

For this PEIS, the focus of the assessment is compounded by the environmental considerations of this proposed action. While a direct assessment of the environmental impacts of the response options—on-water mechanical recovery, on-water *in situ* burning, and on-water chemical dispersion—is discussed briefly below, these response options will not be utilized under normal circumstances for their intended purposes unless there is an oil spill. Therefore, a thorough assessment of the response options must incorporate the impact of an oil spill under the influence of different response alternatives.

The following sections review the environmental issues associated with each of the response options. The effectiveness of each of the options is influenced by environmental conditions. Mechanical recovery and *in situ* burning achieve efficiencies generally considered to be less than 15 percent (NRC, 2005; OTA, 1990). Only chemical dispersion offers the opportunity to treat[4] large volumes of oil (see Section 2.3).

4.2.1.1. On-Water Mechanical Recovery

Mechanical recovery is the gathering and spatial concentration of oil (by booming) and its physical removal (by skimming) from the water. It is the only response option that removes oil from the marine environment and places it back under containment. While the subsequent disposal of recovered oil may have environmental consequences, these are subject to a controlled decision process and are not addressed in the assessment of the alternatives. Other potential adverse consequences include hydrocarbon emissions from operating equipment, physical damage to the habitat or organisms as a direct result of removal activities, and noise effects on species sensitive to such disturbances. Relative to the hydrocarbon emissions from spilled oil, operation of recovery equipment is a minimal concern. Physical damage can be an issue when recovery equipment is operated in shallow water, but is not a significant concern in the offshore scenarios considered here. Finally, noise effects from response operations are a concern around sensitive organisms, particularly marine mammals, coastal and marine birds, and sea turtles. Nesting areas, rookeries, and haulout areas are of particular concern and must be considered during response operations. The level of concern is not expected to change significantly under any of the alternatives. Under Area Contingency Plans, guidance on minimizing noise effects on sensitive organisms should be included. Consequently, the potential adverse impacts of mechanical recovery are minimal or can be controlled, and both the modeling and discussion of the relevant alternatives are focused on the direct effects of removing the spilled oil, thereby modifying its fate and effects in the environment.

4.2.1.2. On-Water Chemical Dispersion

Dispersant application involves the storage, handling, and delivery of commercial dispersants by either aircraft or vessels. The benefit is that oil is treated on the water surface by breaking it into small droplets that mix into the water column, rapidly dilute, and then undergo biological degradation. The potential adverse effects include hydrocarbon emissions from operating equipment, noise impacts on species sensitive to such disturbances, and potential biological impacts from exposure to dispersants alone or in combination with oil. As with mechanical recovery, the potential hydrocarbon emissions from equipment and the potential noise impacts are minor and not considered further.

The potential environmental impacts of exposure to dispersants alone are much less significant than those from exposure to dispersed oil, but are often a concern and need to be addressed because of concerns regarding overspraying or spraying beyond the area of floating oil. Since these do not vary between regions, they are discussed independently in Appendix G. The summary conclusions of the evaluation are that, while dispersants can cause adverse environmental impacts, these impacts are limited in extent, very short term, and minimal in comparison to the potential effects of the dispersed oil. The primary reasons for this conclusion are that the amount of dispersant used is relatively small (for planning purposes 5 gal or less per acre based on a ratio of 1 part dispersant to 20 parts crude oil at an average thickness of 0.1 mm), and it is not intentionally sprayed away from the oil; therefore, the risk of exposure to dispersant alone is low. While dispersants do show a low level of toxicity in the laboratory, any dispersant that is accidentally sprayed on the water away from the oil is rapidly diluted to levels that are below the levels necessary to cause toxicity. Accidental spraying of marine mammals and birds is a concern because of the possibility of affecting their thermoregulatory capability, but there are spill response protocols in place to avoid areas where such animals concentrate. Consequently, both the modeling and discussion of alternatives focus on the beneficial and adverse impacts related to dispersed oil.

4.2.1.3. On-Water **In Situ** *Burning*

This response option involves the use of booms to contain and concentrate oil, and a means to ignite the oil. Burning is sustained as long as the oil thickness is sufficient. Boom used in this option is similar to that used for mechanical recovery operations, except that it is fire resistant. The same vessels and ancillary equipment are also used. As a consequence, unless oil is actually burned, the impacts of routine operations are equivalent to those of mechanical recovery. Burning oil causes air quality concerns and may result in residue that can sink. These impacts were modeled and are discussed for the alternatives under consideration.

4.2.2. Storage and Maintenance of, and Training with, Response Equipment

Oil spill response equipment must be uniformly available, and there are stockpiles throughout the United States. These repositories are mostly located at or near high-volume ports and high-traffic areas. Current stockpiles include mechanical recovery equipment, a wide range of booms (both for on-water recovery and shoreline protection), *in situ* burn booms, dispersant application equipment, trucks and vehicles, miscellaneous ancillary equipment, and stockpiles of dispersant.

These repositories are located in industrial areas in various ports or, in the case of some dispersant stockpiles, at or near airports. They generally include warehouses of various sizes to store equipment that must be in a protected environment, as well as equipment yards for the storage of larger items and vehicles that can be kept outside. In addition, in areas where aerial dispersant capabilities are presently in place, aircraft and associated application equipment are maintained on standby status at airports.

Various response organizations or cooperatives and their subcontractors are responsible for these repositories and also provide the manpower to respond to oil spills. Full-time staff may be supplemented at the time of a spill, depending on circumstances. These organizations also conduct periodic training exercises for all their response capabilities. These exercises can involve the deployment and operation of equipment.

The current levels of procurement, storage, maintenance, and use of mechanical recovery, *in situ* burn, and dispersant equipment for facilities and vessels would not need to be changed as a result of the proposed action, except local repositioning of dispersant aircraft and associated resources might occur. Any repositioning would utilize existing facilities and equipment. The overall number and detail of spill response exercises is expected to remain consistent with the current levels. Based on these conclusions, potential additional impacts related to the storage and maintenance of response equipment and its use in training exercises are not expected to occur and are therefore not analyzed in this PEIS.

4.3. ANTICIPATED CONSEQUENCES OF OIL SPILLS AND ON-WATER RESPONSE OPTIONS

The impacts of marine oil spills have been the subject of intense study for decades. Four major reviews have been prepared by the National Academy of Sciences (NRC, 1975, 1985, 2003, 2005) and hundreds of scientific studies have been prepared. A recent study (NRC, 2005) finds that sufficient information exists to support open-water dispersant use, which this rulemaking would help support. It also recognizes the viability and importance of the regional-local ecological risk assessment processes that are used to compare the various tradeoffs associated with mechanical recovery and dispersant use, both in nearshore and offshore environments. This section presents a summary of the likely consequences of an oil spill with respect to each of the resources described in Chapter 3, and examines how the use of on-water response options (Section 4.2.1) could affect these concerns. This material is used in the evaluation of alternatives to establish a baseline for interpretation of the location-specific modeling results. Each section begins with a discussion of the effects of oil without any response operations and then addresses the changes with mechanical recovery, dispersants, and *in situ* burning. When appropriate, the impacts from the response option are included. In addition to these concerns, each section also addresses two additional issues:

- What are the general thresholds that determine the consequences for the resource?
- What is the recovery window for this resource, given the exposures anticipated?

4.3.1. Consequences to the Physical Environment

4.3.1.1. Water Quality

Oil spills are not considered to cause long-term degradation to water quality in the water column of marine and open coastal environments. Based on events at actual spills, measurable levels of concern usually occur only near the surface (down to perhaps 20 to 30 ft), even under the worst case weather conditions (Coelho et al., 1995; French McCay, 2002, 2003; Kingston, 1999; NRC, 1989). Historically, most oil spills have affected water quality only for short periods (days to weeks) after the release has stopped. Typically, more than 95 percent of the hydrocarbon components of oil are insoluble in water, limiting the effects of oil on water quality. Even large spills may not significantly affect water quality in marine waters. For example, concentrations of petroleum hydrocarbons in Prince William Sound and the Gulf of Alaska following the *EXXON VALDEZ* spill in 1989 were reported to be less than the state of Alaska standards for aromatic hydrocarbons in marine waters and concentrations shown to be toxic or causing sub-lethal effects in marine animals (Neff and Stubblefield, 1995). The ultimate fate of the oil hydrocarbons in the water is to evaporate, degrade, or be taken up by organisms and sediments, not to remain in the water (see Part A of the technical report [French McCay et al., 2004]). Thus, water-quality impacts are short in duration unless there is a continuous source of contamination to the water.

Greater effects on water quality may occur if a medium or large spill occurs in or migrates to enclosed embayments, estuaries, or wetlands. This can be either directly from the slick or from subsequent leaching from oiled shorelines. In such confined or low-energy water bodies, the spilled oil is likely to be more concentrated because of the decreased mixing and dilution. The 1969 barge *FLORIDA* spill of West Falmouth, Massachusetts, is an example where spilled oil entered an area of shallow protected waters and severely affected the water quality and benthos for months to years after the spill (Teal and Howarth, 1984). Physical dispersion of oil droplets during storms may significantly affect the magnitude of the impacts. During the 1996 *NORTH CAPE* oil spill, which occurred on the south coast of Rhode Island during a severe winter storm, most of the No. 2 fuel oil was mixed into the water column by the heavy surf, resulting in high concentrations of polynuclear aromatic hydrocarbons (PAHs) in the shallow water for weeks after the spill (technical report [French McCay et al., 2004]; French McCay, 2003).

The severity of water-quality impacts resulting from crude oil spills depends, in part, on the chemical composition of the oil. While the chemical composition of crude oil varies, all crude oils contain a combination of hydrocarbon and non-hydrocarbon components. The hydrocarbon components typically compose the bulk of the oil, with some crude oils having more than 95 percent hydrocarbons (NRC, 1985). The principal types of hydrocarbons found in crude oil are alkanes, cycloalkanes, and aromatic hydrocarbons. Among these groups, the lower molecular weight aromatic hydrocarbons (i.e., 1-to 4-ring aromatics) are the most soluble, and specifically the 2- to 4-ring PAHs are considered to cause the most toxic effects on marine life via the water pathway because they are semisoluble, evaporate relatively slowly, and so are more persistent than the soluble and highly volatile 1-ring aromatics (see Part A, Section A.2 of the technical report [French McCay et al., 2004]). Higher molecular weight, less soluble PAHs (greater than 4-ring) are also toxic to marine organisms; however, exposure to these insoluble components is primarily via direct contact with oil or oiled sediments. Non-hydrocarbon components of crude oil include sulfur, nitrogen, oxygen, and a variety of trace metals. While all these components might be of concern to water quality, the components of most concern are the PAHs because they have the greatest potential to affect marine organisms and contaminate their tissues, which may be consumed by other organisms and humans.

The chemical and physical properties of spilled oil change with time as the oil "weathers" or ages (see Appendix B). Generally, the longer spilled oil is weathered, the fewer ecologically damaging constituents it will contain (because the constituents of most concern evaporate). However, a small percentage (typically 1 to 5 percent) of the spilled oil can dissolve into the water column as part of the weathering process. This dissolution represents the most significant impairment to water quality associated with oil spills, but it is generally much less significant than evaporation, which acts to limit water-quality concerns. The importance of dispersion is increased when chemical dispersants are used, as discussed in subsequent sections.

Sedimentation, which removes oil from the water column, is important in nearshore areas where the concentration of suspended particulate material is high. In this process, oil is adsorbed onto the particles and carried to the bottom as the particles settle. Interactions between oil and particulate matter can play a major role in the disposition of petroleum (Payne et al., 1987).

In addition to evaporation, dissolution, and sedimentation, photo-oxidation and the activity of naturally occurring microbes will degrade some of the oil. Photo-oxidation produces highly soluble end products that are found in the water column below the slick, although at very low concentrations. This process and wave action are the major processes that promote dissolution of the soluble hydrocarbons into the water column. Subsequent microbial breakdown occurs in the water column, in the sediments, and on the shorelines where oil is stranded. A complete discussion of oil fate and water column toxicity issues may be found in Part A, Section A.2 of the technical report (French McCay et al., 2004).

Effects of On-Water Mechanical Recovery

No additional adverse impacts on water quality are expected to occur from additional mechanical recovery components. Water-quality impacts will be reduced by the additional amount of oil recovered.

Effects of On-Water Chemical Dispersion

The proposed regulations apply only to waters where pre-authorization agreement areas exist, which are generally demarcated as waters in the United States greater than 3 nm from shore[5]. Since dispersants will not be applied outside pre-authorization areas, dispersants will not be applied in shallow coastal waters and such actions are not analyzed as part of the proposed action. Coastal water quality will likely benefit from chemical dispersion in pre-authorization agreement areas, as the volume of floating oil that subsequently migrates to the nearshore areas will be reduced by the amount dispersed in marine waters.

When effective, chemical dispersion in pre-authorization agreement areas will promote a temporary increase in the initial amounts of hydrocarbons that are dispersed and dissolved into the water column. This will to some extent delay the water column's return to background hydrocarbon concentration levels. However, the dilution volume in offshore waters is very large, quickly mitigating this effect.

Effects of On-Water In Situ *Burning*

Open-ocean *in situ* burning of spilled oil will create burn residue materials and leave a percentage of the oil spill unburned. Water column quality impacts from unburned oil will be the same as discussed above, but will be reduced by the amount of oil that is burned, as some of the burned oil would have entered the water column either as oil droplets or as dissolved components if the burning did not occur.

Physical properties of burn residues depend on burn efficiency and oil type. Efficient burns of heavy crude oils generate brittle, solid residues (like peanut brittle). Residues from efficient burns of other crude oils are described as semisolid (like cold roofing tar). Inefficient burns generate mixtures of unburned oil, burned residues, and soot that are sticky, taffy-like, or semiliquid. Depending on water density, initial density of the spilled oil, oil slick thickness, and efficiency of the *in situ* burning, burn residues may either sink or float. For example, 300 gal of stiff, taffy-like burn residue that could be picked up easily remained floating after a controlled test burn of between 15,000 to 30,000 gal of Prudhoe Bay crude oil during the *EXXON VALDEZ* spill (Allen, 1990), while Iranian heavy crude burn residues sank (which makes them difficult or impossible to recover) during the 1991 *HAVEN* explosion and burning off Genoa, Italy (NOAA, 2000a). Burn residues may also stay afloat while warm but sink as they cool off, as shown by Buist (1995) in a series of Prudhoe Bay, Alaska, test burns.

Generally, burn residues have less volatile hydrocarbons with low boiling points, are denser and more viscous than unburned oil, and show relative enrichment in metals and the higher molecular weight PAHs. Environment Canada coordinated a series of studies to determine if *in situ* burning caused water column toxicity beyond that attributable to allowing the slick to remain on the surface of the water. While these studies centered on the Newfoundland *in situ* burn field trials conducted in August 1993, they also included laboratory tests to investigate potential effects in a more controlled environment (Daykin et al., 1994). Results from the laboratory and field studies indicated that, although toxicity to test organisms was higher in water samples collected beneath oil burning on water than for control samples, this increase was generally no greater than that caused by the presence of an unburned oil slick on water. Chemical analyses performed along with the biological tests reflected low hydrocarbon levels in the water samples. If burn residue is not collected, it could gradually leach hydrocarbons into the water. However, laboratory tests on burn residue from the Newfoundland *in situ* burn field trials indicated that toxic compounds were not leaching from the residue and the limited amount of burn residue produced would not be sufficient to noticeably affect water quality (Blenkinsopp et al., 1997).

Thresholds and Recovery Patterns

Water-quality standards criteria exist for a number of constituents known to be present in spilled oil and dispersants. The U.S. Environmental Protection Agency (USEPA, 1999) maintains a list of National Recommended Water Quality Criteria for priority toxic pollutants and non-priority pollutants. Depending on the pollutant, numerical criteria may exist for the Criterion Maximum Concentration (CMC) and Criterion Continuous Concentration (CCC) in fresh water, the CMC and CCC in salt water, and/or the concentrations for which the post-consumption carcinogenic risk to humans is greater than the human health threshold criterion of 10^{-6}. The CMC is an estimate of the highest concentration in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. The CMC is developed based on acute toxicity bioassays and endpoints, such as LC50 (lethal concentration to 50 percent of exposed organisms) and EC50 (effects concentration causing a 50 percent reduction in a measured function such as growth rate). The CCC is an estimate of the highest concentration in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. Thus, the CCC applies to situations of chronic exposure.

States also maintain water-quality criteria for pollutant constituents in their waters. In some cases, state criteria may be more stringent than federal criteria. States may also have site-, water body-, or designated use-specific criteria for certain pollutants that vary from site to site within the state. Finally, some states may have numerical criteria for groups of pollutants rather than for individual pollutants. For pollutant constituents in water subsequent to an oil spill, the thresholds of concern are essentially the water-quality standards for those pollutants. Since the CMC criteria are based on short-term exposure, they are the most relevant to oil spill impacts.

Table 4.3-1 lists the USEPA saltwater and human health risk water-quality criteria that are available for pollutant constituents in oil and dispersants. The saltwater-quality standards from some coastal states for the same constituents can be more stringent, as Table 4.3-2 shows. While metals are present in oil, their concentrations in the source oil are generally low. Given the insolubility of oil and the rapid dilution that occurs in the water column, the metal concentrations in the receiving water resulting from an oil spill would not exceed water-quality standards. Thus, metals are not considered further.

Table 4.3-1
U.S. Environmental Protection Agency Saltwater and Human Health Risk Water-Quality Standards for Some Pollutants Commonly Associated with Oil Spills

	Salt Water		**Human Health**		**Concentration in Crude Oil**
Pollutant	**CMC (mg/L)**	**CCC (mg/L)**	**Water (mg/L)**	**Fish (mg/kg)**	**Alaska North Slope* (mg/L)**
Benzene	—	—	1.2	71	3,698
Toluene	—	—	6,800	200,000	9,040
Ethylbenzene	—	—	3,100	29,000	1,689
PAHs	†	†	—	—	8,108
Cadmium	42	9.3	—	—	< 0.5
Copper	4.8	3.1	1,300	—	< 0.6
Lead	210	8.1	—	—	< 3.0
Mercury	1.8	0.94	0.05	0.051	< 15.0

Source: USEPA, 1999.

Note: CMC, Criterion Maximum Concentration; CCC, Criterion Continuous Concentration; PAHs, polynuclear aromatic hydrocarbons.

* Environment Canada (Jokuty et al., 1996).

† Under development (DiToro et al., 2000).

Table 4.3-2
Saltwater Oil Spill Pollutant Water-Quality Standards for Some Coastal States

	CA		FL		LA		VA	
Pollutant	**CMC (mg/L)**	**CCC (mg/L)**	**CMC (mg/L)**	**CCC (mg/L)**	**CMC (mg/L)**	**CCC (mg/L)**	**CMC (mg/L)**	**CCC (mg/L)**
Benzene	—	5.9	—	71.28	2,700	1,350	—	—
Toluene	—	—	—	—	950	475	—	—
Ethylbenzene	—	4.1	—	—	8,760	4,380	—	—
Cadmium	10	4	—	4.42	45.35	10	34	9.3
Copper	30	12	2.9	—	3.63	3.63	5.9	3.8
Lead	20	8	5.6	—	209	8.08	240	9.3
Mercury	0.4	0.16	0.025	—	2	0.025	2.1	0.025

Source: CSWRCB, 1990; FDEP, 2001; LDEQ, 2000; VDEQ, 1997.

Note: CMC, Criterion Maximum Concentration; CCC, Criterion Continuous Concentration.

The constituents of concern where there are water-quality standards are the monoaromatic hydrocarbons (MAHs, such as benzene, toluene, and ethylbenzene). These compounds rapidly evaporate from oil spills. While water-quality criteria do not yet exist for PAHs, they are more significant for interpreting impacts. The approach used by DiToro et al. (2000), which is being used by the USEPA to develop water-quality criteria for PAHs, as well as the thresholds that result, are equivalent to the development of water column thresholds of concern described in Part A of the technical report (French McCay et al., 2004) and summarized below. The PAH threshold is 6 μg/L (ppb [parts per billion]) averaged over at least 4 days. For brief exposures, analogous to the CMC, the PAH threshold is 100 μg/L (Part A, Table A.3-5 of the technical report [French McCay et al., 2004]).

In evaluating potential impacts of MAHs to water quality, the lowest water standards were used to establish a threshold of concern to be conservative. Thus, the threshold of concern is 1 mg/L (ppm [parts per million]). The modeling of water column toxicity thresholds (described below and in Part A, Section A.3.4 of the technical report [French McCay et al., 2004]) indicates the threshold for the most sensitive species, given 4 days or more of exposure, is 0.4 mg/L.

Water column recovery time is directly related to spill size. Modeling of potential contact areas and contaminant residence times for spills greater than 1 bbl was performed for marine water and marsh water environments (MMS, 1995). Spills were classified into Size 1 (8,000 m^2), Size 2 (80,000 m^2), and Size 3 (1,000,000 m^2) categories, depending on the area of either surface water or marsh that was affected.

Deterioration of open-water quality is expected only during the time that the oil slicks remain on the surface of the water. It is expected that most slicks will dissipate within 10 days and that all oil sheen will be gone within 6 weeks. In a previous assessment of the potential duration of water-quality impacts after an oil spill, water column concentrations in open coastal waters were expected to reach background levels within 6 months to 2 years (MMS, 1995). However, marine water column contamination lasting this long has never been documented in any spill, even for the worst case U.S. spill documented to date for water column contamination—the *NORTH CAPE* spill off Rhode Island in 1996. The modeling results described in Parts A through F of the technical report (French McCay et al., 2004) also indicate that these estimates are conservatively long. Water column concentrations in open coastal waters (i.e., not inclusive of shallow subtidal areas) would be expected to reach background levels within days to weeks, even after large spills.

Concentration impacts on coastal marsh waters are expected to result in disturbances significant enough to degrade water quality in localized areas adjacent to the oiled marsh for up to 10 years for Size 3 spills, up to 5 years for Size 2 spills, and up to 6 months for Size 1 spills. The areal extent of this contamination will decrease significantly over these time periods and depends on proximity to oiled vegetation and sediments that were assumed to gradually release oil to the adjacent water column (MMS, 1995).

4.3.1.2. Air Quality

The effects of an oil spill on air quality may involve all volatile components of the oil. The MAHs, PAHs, and other volatile organic compounds (VOCs) could evaporate into the air. Many of these compounds have the potential to affect human health and wildlife via air exposure. Criteria have been established to determine what concentrations of these chemicals in the air are harmful to human health. Table 4.3-3 lists regulatory thresholds for various chemicals and compounds.

Oil spills are not a major source of air pollutants relative to other hydrocarbon sources (NRC, 2003). Except for the very largest spills, the presence of volatile compounds is localized and of short duration. Most evaporation occurs within the first 24 hours after a spill (see Appendix B) and mixing in the air rapidly reduces concentrations with distance from the slick (Scholz et al., 1999).

Effects of On-Water Mechanical Recovery

Mechanical recovery removes oil from the water surface. As a result of the decreased amount of oil on the surface, less oil will volatize, causing lower concentrations of MAHs, PAHs, and VOCs in the air. Air quality impacts will be reduced by the amount of oil recovered. Relative to the evaporation from the oil slick, emissions from response vessels are a minor concern.

Effects of On-Water Chemical Dispersion

Dispersant application treats oil on the water surface by enhancing the formation of small droplets. As a result, volatilization could be reduced or slowed, depending on how long after the spill dispersant is applied. If dispersant application occurred very early in the spill, more volatile compounds would be present in the dispersed droplets. These volatiles would also eventually enter the atmosphere but would be dispersed over a wider area. This would result in lower concentrations of MAHs, PAHs, and VOCs in the air. Thus, air quality impacts will be reduced if oil is dispersed. Relative to the evaporation from the oil slick, emissions from vessels or aircraft that are applying dispersant are a minor concern.

Effects of On-Water In Situ *Burning*

In situ burning of oil spills as a response option has been proposed and debated for more than 30 years but has achieved only limited acceptance in the oil spill response community. The primary obstacle to incorporating it as a cleanup option is the concern over atmospheric emissions, in particular combustion by-products. Analysis of emissions is difficult and only studied by a few investigators, but more than a decade of intensive laboratory testing in addition to improved technology has yielded an inventory of the key compounds produced during oil burning (Fingas et al., 2001; Thornborough, 1997).

The following is a summary of Fingas et al. (2001), which includes extensive sampling data from over forty-five experimental burns in outdoor test tanks with various crude oils and diesel fuel. The experimental oil burns and emission measurement tests began in Mobile, Alabama, in 1991, with several controlled burns designed to measure a series of physical parameters as well as emissions. Further tests were conducted in 1992, 1993, 1997, and 1998. The emphasis on sampling was at typical receptor heights for humans, usually 1 m. Sampling locations were typically placed at downwind stations, at upwind stations, and in the smoke plume. A full analysis of emissions from an oil burn entails measuring a number of components, including the smoke plume, particulate matter precipitating from the smoke plume, combustion gases, unburned hydrocarbons, organic compounds produced during the burning process, and residue left at the burning pool site. Soot particles also have a variety of chemicals absorbed and adsorbed (Fingas et al., 2001).

Fingas et al. (2001) identified ten substances of possible concern to human and environmental health: particulates, PAHs, VOCs, dioxins and dibenzofurans, carbonyls, carbon dioxide, carbon monoxide, sulphur dioxide, other gases (oxides of nitrogen), and “hidden” compounds. They summarized the measured concentration data from the mesoscale test burns for 150 specific compounds and also calculated safe distances from the burn site for these compounds for various burn sizes.

Table 4.3-3
Air Quality Standards

	NIOSH IDLH (ppm)*			NIOSH TWA (ppm)†			USEPA NAAQS (µg/m³)‡	
Substances	**(ppm)**	**(mg/m³)**	**Conversion ppm to mg/m³ (1 ppm = x mg/m³)**	**ACGIH TLV**	**OSHA PEL**	**NIOSH REL**	**Primary Standard (µg/m³)**	**Secondary Standard (µg/m³)**
Total Particulates								
10-um particle							150 (24-hr average), 50 (annual mean)	150 (24-hr average), 50 (annual mean)
2.5-um particle							65 (24-hr average), 15 (annual mean)	65 (24-hr average), 15 (annual mean)
Fixed gases								
Sulphur dioxide	100		2.62	2	5	2	80 (annual mean), 365 (24-hr average)	1,300 (3-hr average)
Carbon dioxide	40,000		1.8	5,000	5,000	5,000		
Carbon monoxide	1,200		1.15	25	50	35	10,000 (8-hr average), 40,000 (1-hr average)	
Carbonyls								
Acetaldehyde	2,000		1.8	100	200			
Acetone	2,500		2.38		1,000	250		
Formaldehyde	20		1.23		0.75	0.016		
PAHs								
Benzo(a)pyrene		80						
Biphenyl		100	6.31		0.2	0.2		
Chrysene		80						
Naphthalene	250		5.24		10	10		
Phenanthrene		80						
Pyrene		80						
1,2,4-Trimethylbenzene			4.92					
1,2-Diethylbenzene			5.33			10		
VOCs								
1,2,3-Trimethylbenzene			4.92	25		25		
1,3,5-Trimethylbenzene			4.92			25		
1,4-Diethylbenzene			5.33			10		
2,2-Dimethylbutane			3.53					
2,3-Dimethylbutane			3.53					
Benzene	500		3.19	10	1	0.1		

Butane		2.38			800
Cyclohexane	1,300	3.44	300	300	300
Cyclopentane		2.87	600		600
Ethylbenzene	800	4.34	100	100	100
Heptane	750	4.1		500	85
Isobutane (2-Methylpropane)		2.38			800
m,p-xylene	900	4.34	100	100	100
Methylcyclohexane	1,200	4.02		500	400
Naphthalene	250	5.24		10	10
Nonane		5.25	200		200
Octane	1,000	4.67		500	75
o-Xylene	900	4.34	100	1,00	100
Pentane	1,500	2.95		1,000	120
Propane	2,100	1.8		1,000	1,000
iso-Propylbenzene	900	4.92		50	50

Note: Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

ACGIH, American Conference of Governmental Industrial Hygienists; IDLH, immediate danger to life and health; NAAQS, National Ambient Air Quality Standards; NIOSH, National Institute for Occupational Safety and Health; OSHA, Occupational Safety and Health Administration; PAHs, polynuclear aromatic hydrocarbons; PEL, permissible exposure limit; REL, recommended exposure limit; TLV, threshold limit value; TWA, time weighted average; USEPA, U.S. Environmental Protection Agency; VOCs volatile organic compounds.

[*] CDC-NIOSH, 2002a.

[†] CDC-NIOSH, 2002b.

[‡] USEPA, 1990.

Fingas et al. (2001) also draws on the results of the Newfoundland Offshore Burn Experiment (NOBE), conducted 42 km east of St. John's, Newfoundland (Fingas et al., 1995a, b), and the U.K. *in situ* burn trials conducted 40 km offshore Lowesoft (Thornborough, 1997). The NOBE project was, by far, the most extensive *in situ* burn field study ever conducted and examined two controlled spills of approximately 50 m^3 of crude oil. Numerous vessels and aircraft were stationed throughout the 34-km^2 area with equipment to sample the fire and smoke plume (Fingas et al., 1995 a, b). The U.K. burn experiment also studied two controlled spills in a 25-mi^2 area, but the emphasis was on determining the operational practicalities of *in situ* burning as a cleanup option, with only peripheral emphasis on emission sampling (Thornborough, 1997). A summary of the emissions data from these studies is in Part A, Section A.5 of the technical report (French McCay et al., 2004).

All burns, particularly those of diesel fuel, produce a substantial amount of particulate matter. The PM-10 smoke particulate (less than 10 microns in diameter) is the combustion product most likely to be a health concern. Small particle sizes are less likely to settle out of a plume and may be carried much further from the burn site than larger particles. Analysis of smoke plumes shows that these small particles with diameters less than 10 μm constitute 70 to 90 percent of all particulate matter created by *in situ* burning.

In the analysis of the data from the Mobile, Alabama, tank experiments, Fingas et al. (2001) concluded that concentrations of particulates from diesel were four times that for similar-sized crude oil burns. Fingas et al. (1998) showed that concentrations at 1-m height resulting from diesel burns of a small burn area (~5 m^2) were above normal occupational health limits between 30 and 50 m downwind from the burn site. A typical contained fire would have an exceedence area 10 to 100 times this size.

In analyzing the results of the NOBE project, which only involved crude oils, Fingas et al. (1995a, b) found that the particulate levels were only a matter of concern very close to the fire and under the plume. Fingas et al. (2001) determined that the concentration of particulates and other components of the smoke plume may not be a concern past 1,000 m downwind from the burn site for typical crude oil burns. They concluded that safe distances are at least 1 km for crude oil burns and much farther for diesel.

Overall, more PAHs, which are produced by combustion, are destroyed by fires than are created by them. Burning crude oil yields particulates contaminated by PAHs downwind of the fire, but the concentration on the particulate matter is often significantly (at least a factor of ten) smaller than the concentration in the initial oil. Based on the NOBE project, Fingas et al. (1995a, b) concluded that *in situ* crude oil fires do not produce significant amounts of PAHs. The PAHs in crude oils are largely destroyed in combustion (Fingas et al., 1995a, b). Burning diesel results in more pyrogenic PAHs of larger molecular sizes, which are created by the fire (Fingas et al., 2001). However, the net production of PAHs from burning would be less than those produced by evaporation.

VOCs in emissions are in similar concentrations for crude and diesel burns. While not a primary concern, their concentrations can rise close to concern levels very near a fire. VOC concentrations are three times higher when the oil is just evaporating and not burning than when it is burning (Fingas et al., 2001). The NOBE study concluded that no exotic or highly toxic compounds are generated as a result of the combustion process, but that VOC concentrations are well above concern levels within 150 m of the fire (Fingas et al., 1995a, b).

Measurement of dioxins and dibenzofurans indicated that they were not being produced by crude or diesel fires (Fingas et al., 2001). The NOBE study indicated that the concentrations were at background levels (Fingas et al., 1995a, b). Carbonyls from diesel fuel fires are slightly higher than those produced from crude oil burns, but the low levels detected would not be a health concern (Fingas et al., 2001).

Carbon dioxide is the end result of combustion. Levels near a burn can be 500 to 800 ppm, which are higher than normal atmospheric levels of 300 ppm, but do not present a hazard to human health. Near a burn, carbon dioxide levels are highest at 1-m height and fall to background levels at 4 m (Fingas et al., 2001). During a burn, carbon monoxide levels are usually at or below the lowest detection level of the instruments and do not pose any hazard to humans. Carbon monoxide has only been detected during an inefficient burn (Fingas et al., 2001).

Sulphur dioxide and sulphuric acid, its product formed by reaction with water, were not detected at significant levels (Fingas et al., 2001). In the NOBE study, emitted sulphur dioxide was found in an acid aerosol form (Fingas et al., 1995a, b). Attempts to measure oxides of nitrogen that might be the result of combustion were unsuccessful (Fingas et al., 1995a, b, 2001).

A major concern regarding oil burning is the production of any “hidden” compounds that may not be typically expected but could still be hazardous. A “total” analysis of soot and residue samples identified several hundred compounds, but none were found to be of any environmental concern (Fingas et al., 2001).

Thresholds and Recovery Patterns

Thresholds of concern (Table 4.3-3) were compiled from several sources: National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), American Conference of Governmental Industrial Hygienists (ACGIH), and USEPA. The NIOSH thresholds values are: immediate danger to life and health (IDLH) and the recommended exposure limit-time weighted average (REL-TWA). The IDLH values represent a level at which the concentration of the chemical is high enough to immediately cause danger to human health if exposed for 30 minutes. The REL-TWA is the recommended exposure limit for a time-weighted average of 10 hours. PEL-TWA is the permissible exposure limit-time weighted average for air contamination for 8 hours according to OSHA. TLV-TWA is the threshold limit value-time weighted average for 8 hours according to the ACGIH. The ACGIH TLV-TWA is usually more restrictive than the OSHA PEL or NIOSH REL.

The USEPA values are National Ambient Air Quality Standards (NAAQS). NAAQS values are provided by the USEPA for several time periods, from 1-hr averages to annual means and as both primary and secondary standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The recovery time for air quality is very short, on the order of hours to a few days. Volatile chemicals are released as oil weathers for at most a few days, with most release occurring in the first 24 hours. The air quality would be affected over the period of time that volatization is occurring, plus the time necessary to dilute any concentrations of concern. For *in situ* burning of oil, air quality would be affected over the duration of the burn. According to Fingas et al. (2001), the duration of the burn would be on the order of 1 to 2 hours. Thus, recovery time is on the order of hours to days.

4.3.2. Consequences to the Biological Environment

4.3.2.1. Marine Mammals

There are two major pathways of oil exposure for marine mammals: (1) physical oiling of fur, skin, or mucous membranes; and (2) ingestion. Marine mammals such as seals, manatees, whales, and dolphins are vulnerable to oil on the water surface since they spend considerable time at the surface swimming, breathing, feeding, and resting. This enhances the possibility of contact with a surface slick or water-in-oil emulsion. Certain species such as seals and sea otters are often found nearshore, which can increase their exposure. In species such as fur seals and sea otters, contact may lead to fouling of pelage (fur). This fouling of fur interferes with the animal's thermoregulation and buoyancy. Oil has less of a tendency to adhere to the surface of smooth-skinned marine mammals with relatively little or no pelage, such as whales, dolphins, manatees, and some seals (Geraci and St. Aubin, 1990).

Pinnipeds (true seals, sea lions, and fur seals, and walruses) are very vulnerable to floating oil because they spend considerable time at the surface. Additionally, these animals are at risk when hauling out onto shorelines (Dyrynda and Symberlist, 1998). Marine mammals with fur thermoregulate by trapping air in the deeper layers of pelage. If the fur is fouled with spilled oil, the fur will allow the critical air and fur layer to collapse and it will no longer perform its proper function. Fouled animals then run the risk of either hypo- or hyperthermia depending on their environment. Sea otters must maintain a layer of warm, dry air in their dense underfur to insulate against the cold; they are the marine mammals most sensitive to the effects of oil contamination. Even partial fouling of 30 percent of an otter's body surface could result in death (Pierson, 2000a).

Some marine mammals such as walruses, harbor seals, and sea lions rely on blubber to stay warm. Newborn pups are not yet protected by a layer of blubber and do not enter the water until a few days after birth. There is a concern that when a seal pup's protective fur coat becomes oiled there will be increased likelihood of death from hypothermia (USEPA, 2000). The air trapped in deeper layers of fur also aids in natural buoyancy. Fouled animals will lose this buoyancy and could drown (Geraci and St. Aubin, 1990; Pierson, 2000a; USEPA, 2000).

Risks for pinnipeds and other marine mammals are not limited to the effect of oil on fur. The most sensitive tissues exposed to the environment are mucous membranes that surround the eyes and line the oral cavity, respiratory surfaces, and anal and urogenital orifices. Petroleum hydrocarbons, particularly volatile aromatics and short-chain fractions, are irritating to these delicate tissues (Geraci and St. Aubin, 1990). The tissues around the eyes are especially susceptible to oil fouling. Experiments have shown that marine mammals can develop severe conjunctivitis within 24 hours of exposure. They have been found to return to normal after being returned to clean water. However, continued exposure would most likely cause permanent damage. Pinnipeds, with their large protruding eyes, are especially vulnerable (Dyrynda and Symberlist, 1998; Geraci and St. Aubin, 1990; Pierson, 2000a; USEPA, 2000).

Risks to marine mammals also exist when they ingest oiled food. Ingestion of petroleum hydrocarbons has been implicated in the deaths of a number of stranded gray and harbor seals in the United States and abroad. Sea otters, which groom themselves regularly as a means of maintaining their insulating properties, may also ingest oil. Ingested hydrocarbons can irritate or destroy epithelial cells that line the stomach and intestine, thereby affecting digestion and absorption of nutrients, and may also facilitate the direct movement of hydrocarbons to the bloodstream. Chronic ingestion of subtoxic quantities of petroleum may have subtle effects that would only become apparent through long-term monitoring. All pinnipeds examined to date have the enzyme systems necessary to convert absorbed hydrocarbons into polar metabolites that can be excreted in urine. However, some portion of the nonpolar fractions will be deposited in the lipid-rich tissues, particularly blubber (Geraci and St. Aubin, 1990). Therefore, in addition to direct ingestion, marine mammals may be at risk when they feed on animals that have bioaccumulated hydrocarbons elsewhere (Dyrynda and Symberlist, 1998).

Breathing high concentrations of hydrocarbon vapors can be toxic to all marine mammals. The vapors penetrate the epithelium of the respiratory tract and enter the bloodstream. Depending on the vapor concentrations present and the animal's immediate response to stress, exposures to these vapors may be fatal. A panic reaction may cause the animal to breathe rapidly, increasing the amount of vapors inhaled. Depending on the health of the animal, a sudden release of adrenaline may cause death (Geraci and St. Aubin, 1990). This risk is low except in very large spills, because evaporation is high only in the 12 to 24 hours immediately following the spill and the fumes are rapidly diluted. As discussed below, this risk is often difficult to separate from other routes of exposure.

In 1989, during the *EXXON VALDEZ* oil spill in Alaska, many sea otters wre exposed to oiled waters and were fouled. More than 1,000 dead sea otters were recovered, and another 350 oiled otters were rescued and taken to treatment centers for rehabilitation. Four critical factors were identified in the sea otter mortality during the spill in Alaska: (1) pulmonary emphysema, caused by the inhalation of toxic fumes, occurred primarily during the first 2 weeks of the spill; (2) low body temperature, or hypothermia, was a direct result of oil contamination of the fur, which decreased insulation; (3) low blood sugar, or hypoglycemia, was probably caused by poor gastrointestinal function because of ingestion of oil; and (4) lesions in other organs, including the liver, heart, spleen, kidney, and brain, were also probably caused by ingestion of oil and by stress. Oil spills can also affect sea otters, as well as other species, indirectly by reducing available food resources, either by killing prey organisms or making them unpalatable. Sea otter habitat can also be lost temporarily if kelp forest communities become contaminated (Pierson, 2000a).

In pinnipeds, oiling can also occur when the animals are out of the water. If oil is stranded on beaches, it will adhere to sand particles and will grind into the fur and skin of these animals as they travel over the fouled surfaces. Where young are concerned, actions by the parent to clean the pups may affect survival more than the fouling alone. Additionally, if very young animals become oiled, the mother may not recognize the scent of its young and abandon it, leaving it little to no chance of survival (Geraci and St. Aubin, 1990).

Some of the risks discussed above for pinnipeds also threaten cetaceans (whales and dolphins). Recent studies on the possible effects of oil on cetaceans have focused on the animals' ability to detect and avoid oil, behavioral effects, and physiological effects because of contact, inhalation, and ingestion of oil (Pierson, 2000b). Experiments have shown that dolphins can detect and will avoid a surface layer of oil. Baleen whales also appear to be capable of detecting oil. A field study (Pierson, 2000b) of the reactions of migrating gray whales to naturally occurring oil slicks from seeps in the Santa Barbara Channel recorded mainly subtle and short-term responses including changes in direction to avoid surface oil. During the oil spill in the Santa Barbara Channel (which began in January 1969), gray whales were beginning to arrive in the channel on their northward migration. By April, as much as 70,000 bbl of oil had been released, and as much as 800 mi^2 of water surface may have been contaminated, although the concentrations were highly variable and there were many areas of sheen and marine water where the animals could surface. Gray whales were observed moving northward through the area of the slick during this period. Although six dead gray whales were recovered from the area during the 2 months following the spill, no link was established between oil contamination and mortality, and no effects on the gray whale population or migration were observed (Pierson, 2000b).

Studies have shown that cetacean skin is nearly impenetrable to even the highly volatile constituents of oil. This indicates that contact with oil probably would be less harmful to cetaceans than previously believed. However, the toxic, volatile fractions in fresh crude oils could irritate and damage cetacean soft tissues, such as the mucous membranes of the eyes and airways. The effects could lead to death in extreme cases. A cetacean unable to leave the area during the first few hours after a spill, when vapor concentrations are still high, would inhale vapors and might be harmed. The extent of injury would depend on the health of the animal and its response to stress (Geraci and St. Aubin, 1990; Pierson, 2000a).

The preferred habitat of a species will influence the probability that it will encounter oil. The frequency of exposure is higher in species that frequent restricted areas such as bays and estuaries, where surface oil may be concentrated, and in developed areas, where spills may be more frequent. Examples are breeding and feeding humpback, gray, right, bowhead, and beluga whales; narwhals; bottlenose dolphins; harbor porpoises; and river dolphins. Cetaceans that range widely may contact some oil as they move quickly through a fouled area but are unlikely to be exposed for any extended period.

After a spill, oil is distributed primarily at the surface. Consequently, cetaceans that feed in these areas are more likely to contact oil than those that feed in the water column. These include skim-feeding right and bowhead whales and surface-lunging rorquals. Dolphins that habitually force schools of prey to the surface may also be at risk (Geraci and St. Aubin, 1990). Oil could also adhere to the fringed baleen plates that baleen whales use to filter their food, blocking the flow of water and interfering with feeding. A study of the fouling effects of oil on samples of the baleen plates from several species, including bowhead and gray whales, concluded that a spill of heavy oil or residual patches of weathered oil could foul the plates enough to interfere with feeding efficiency of surface skimming species for several days, and that such effects could be cumulative in heavily fouled areas like the center of a spill or in a contaminated bay (Pierson, 2000b). There was no evidence that the damage would be permanent.

Gray whales, which are mainly bottom feeders unlike most baleen whales, could ingest oil-contaminated bottom sediments. However, most of this risk would occur on the species' feeding grounds and is unlikely to be important because of the low probability of encountering areas of high contamination.

Effects of On-Water Mechanical Recovery

Operation of mechanical recovery equipment and vessels is not expected to result in increased risk since unoiled marine mammals would have no difficulty avoiding slow moving response vessels or towed boom. In addition, ACPs address ways to minimize impacts, and concentrations of marine mammals are avoided unless they are already at significant risk from the oil. Overall, mechanical recovery efforts will reduce the risk posed to marine mammals because oil is removed from the water.

Effects of On-Water Chemical Dispersion

Furred marine mammals rely on their dense fur layers for thermoregulation. A critical component of this fur layer is the animal's own oil which is excreted through the skin and worked into the fur to create a strong and virtually water-tight barrier between the outer fur layers and the inner thermoregulating layer. If these animals encounter dispersants, the dispersants will work into the fur of the animals and remove its natural oils. As was the case for floating oil, thermoregulation then becomes a serious issue.

Marine mammals may be affected by dispersants and dispersed oil in different ways. Baleen whales run the greatest risk of ingesting dispersants or dispersed oil. While there has been no experimentation on the effects of dispersed oils and dispersants on baleen plates, it is possible that either might reduce their overall efficiency, although the effect should be less than with untreated oil. Moderate toxic effects might be experienced, but it is unlikely that exposures would be high enough to exceed critical thresholds except possibly for very large spills (Dyrynda and Symberlist, 1998; Geraci and St. Aubin, 1990; Pierson, 2000a; USEPA, 2000).

The primary benefit for marine mammals of dispersing oil is that it lessens the risk of contact with floating or stranded oil in areas where they may feed or congregate, whether on land or in water. There is some concern about the potential for furred marine mammals contacting dispersed oil droplets if they were to dive through a plume of dispersed oil. However, the window of exposure for this would be of very limited duration, given rapid dilution within the water column. In comparison, floating oil may be present for weeks, stranded oil for years, and dispersed oil for hours, so the risk from the dispersed oil plume is very low, even if encountered by an animal not already exposed to floating oil.

Effects of On-Water In Situ *Burning*

Since an *in situ* burn would not be initiated with the presence of marine mammals within the burn perimeter, and mammals will avoid areas where burning is already in progress, the risk to marine mammals during *in situ* burning would be very limited. Burn residues, whether submerged or on the surface, might be ingested by feeding marine mammals, but given the small volume and the fact that as much residue as possible is recovered, this risk is very low. Based on the chemical and physical properties of the residue, burn residues should be less toxic to marine mammals than untreated oil. The other consideration for *in situ* burning is the smoke component of the burn. However, since the smoke from the burn will tend to rise into the atmosphere and occurs for only a limited time, it should not pose a risk to these animals. Because *in situ* burning is unlikely to remove more than a fraction of the floating oil, the overall risks are very similar to those for floating oil.

Thresholds and Recovery Patterns

The threshold of concern depends on the type of mammal under consideration. Whales and dolphins are at very low risk because they tend to avoid oil and are not sensitive to low levels of dermal contamination. Furred marine mammals are very sensitive to contact with even limited amounts of oil; their contact with even thin slicks (0.25 to 1 μm) could represent a risk. Shoreline oiling also poses a significant route of exposure; oiling of even a small portion of the body can have severe impacts.

Recovery times for marine mammal populations vary from several years to potentially ten or more, depending on the species. The concern is greatest with animals that mature slowly and have a low reproductive potential. Cetaceans in general mature slowly and only reproduce every few years. A primary example of such an animal would be the humpback whale, which reaches sexual maturity at 6 to 8 years of age. Females typically only bear a calf every 2 to 3 years. There are also certain pinnipeds, such as the California sea lion, that do not reach sexual maturity until 4 or 5 years of age and only bear a single pup each year.

4.3.2.2. Marine and Coastal Birds

Marine and coastal birds are highly susceptible to the acutely toxic effects of exposure to floating oil. Large losses of birds have been documented following oil spills worldwide (Burger, 1993; Day et al., 1995; Kajigaya and Oka, 1999; Oka et al., 1999). Following the *EXXON VALDEZ* oil spill, substantial numbers of dead oiled birds, particularly alcids (e.g., murres) and sea ducks, were recovered onshore (Maki, 1991; Piatt and Lensink, 1989; Piatt et al., 1990); and significant declines for some marine birds were documented in oiled versus unoiled areas within the first year after the spill (Day et al., 1995, 1997a, b; Irons et al., 2000; Klosiewski and Laing, 1994).

The two major pathways of oil exposure for birds are ingestion and oiling of the feathers (NRC, 1989). Birds may ingest oil directly from the water, through consumption of oiled prey, or from preening the feathers. Effects of oil ingestion may include Heinz-body hemolytic anemia; immunosuppression; pneumonia; intestinal irritation; kidney damage; altered blood chemistry; impaired osmoregulation; decreased growth; decreased production and viability of eggs; and abnormal conditions in the lungs, adrenals, liver, nasal salt gland, and fat and muscle tissues (Fry and Addiego, 1987; NRC, 1985; RPI International, 1988). All these complex biological reactions to oil ingestion result in three categories of toxic effects: (1) reduction in reproduction, (2) destruction of red blood cells and varying degrees of anemia, and (3) increased stress that leads to an increased susceptibility to disease. All these categories affect the health and survival of exposed birds. Certain marine-associated raptors are at risk of oil ingestion via oiled prey; bald eagles will scavenge oiled dead animals, and peregrine falcons will prey on oiled and debilitated birds (Bowman et al., 1995).

When birds become oiled by contact with floating slicks, their feathers lose their water-repellent characteristics, which may cause the birds to lose their buoyancy and/or become hypothermic because of the reduced insulation provided by their plumage (Fry and Lowenstine, 1985; Wiens, 1995). These losses may impair the ability of oiled birds to dive and fly, making feeding difficult, and increasing energetic demands on the stressed birds often leads to death (Wiens, 1995). Death by hypothermia, drowning, and starvation are all potential impacts of direct oiling (RPI International, 1988). Nesting birds may transfer oil from their feathers directly to their eggs during incubation, potentially affecting embryo development and reducing overall reproductive success (Wiens, 1995).

Behavior, ecology, and life history may affect the likelihood that birds will be exposed to oil, and to what extent the population will be affected by a spill. Birds that raft and feed on the water surface or feed by diving (e.g., pelicans, cormorants, terns, auks, penguins, seabirds, sea ducks, loons, diving ducks) may be at the greatest risk of exposure, because they spend all or most of their time on the water, or potentially passing through the oil-water interface (Hunt, 1987). Also, large aggregations of birds may feed in confined areas due to proximity to nesting habitats or a preferred food supply, therefore putting them at risk if those areas become oiled (Wiens, 1995). Some species, such as seabirds and loons, tend to be long lived and exhibit delayed maturation and/or breeding, low rates of reproduction, high chick mortality, and natural episodic reproductive failures (Wiens, 1995). These types of species may be at greater risk of population- or community-level impacts compared with other species, such as gulls and dabbling ducks, which are shorter lived with higher reproduction rates (RPI International, 1988).

In addition to acute impacts often experienced during direct contact with floating oil, marine and coastal birds may also exhibit sublethal and/or chronic (long-term) effects of exposure to oil stranded on the shoreline, or in sheltered habitats, via direct contact with oil residues and ingestion of oil during feeding.

Numerous studies were conducted regarding indirect, chronic, or delayed impacts on marine and coastal birds following the *EXXON VALDEZ* oil spill (summarized in Peterson, 2001). Black oystercatchers, harlequin ducks, and Barrow's goldeneyes, all of which feed on benthic invertebrates, were documented as having declined significantly in oiled areas and did not show signs of recovery for several years (Day et al., 1995, 1997a; Esler et al., 2000; Holland-Bartels et al., 1999; Irons et al., 2000; Klosiewski and Laing, 1994; Rosenberg, 1999; Rosenberg and Petrula, 1998). The sea ducks also showed evidence of an enzyme that is used for metabolizing petroleum hydrocarbons (Trust et al., 2000). Multiyear declines in several other marine and coastal species, including cormorants, black-legged kittiwake, murres, pigeon guillemot, mergansers, and loons, may be due to the indirect effects of oil exposure to important species of forage fish that may have declined following the spill, indicating that food chain impacts are also likely, even well after the initial floating oil slicks are no longer present (Day et al., 1995, 1997a; Irons et al., 2000; Klosiewski and Laing, 1994; Murphy et al., 1997). Also, some of the impacts associated with oil ingestion mentioned above, such as Heinz-body hemolytic anemia, may persist long after birds appear to have "recovered" from the initial exposure to oil (Fry and Addiego, 1987).

Birds that survive initial oil exposure or that avoid initial exposure, but continue to feed and/or nest in oiled areas, often experience reduced reproductive success. Following the *EXXON VALDEZ* oil spill, several studies documented that black oystercatchers that ate and fed their young oiled mussels, and/or nested on oiled shorelines, had lower numbers of breeding pairs, produced smaller and fewer eggs, and experienced decreased chick growth and higher chick mortality than oystercatchers that fed and nested in unoiled areas (Andres, 1996, 1997; Sharp et al., 1996). Harlequin ducks did not appear to breed successfully in oiled areas either, although this may be due more to human disturbance during cleanup than to physiological or habitat impacts

(Patten, 1993; Wiens, 1995). Brown pelicans that were oiled and rehabilitated following two Southern California Bight spills experienced lower survival than control pelicans and showed no signs of breeding, in contrast to actively breeding control pelicans (Anderson et al., 1996).

Eppley and Rubega (1990) reported "complete reproductive failure" in a population of South Polar skuas following the *BAHIA PARAISO* spill, and suggested that the exposure of nesting adults to oil resulted in changes in their parental behavior, including the neglect of chicks that were ultimately killed by neighboring adults. In another study, nest abandonment by oiled birds was documented for Cassin's auklets and wedge-tailed shearwaters, as well as delayed and lowered egg production, low hatching success, and complete reproductive failure in some cases (Fry, 1987).

Yet, despite all of the data supporting the premise that the *EXXON VALDEZ* oil spill caused acute and chronic impacts on birds, conflicting data exist, and several authors concluded that population- and community-level impacts were not apparent following the spill, that many populations affected early on appeared to have recovered within a relatively short period of time, and that impacts were inconsistent among species in the same guild (a group of species with similar feeding patterns) (Boersma et al., 1995; Day et al., 1995; Erikson, 1995; Piatt and Anderson, 1996; White et al., 1995; Wiens, 1995; Wiens et al., 1996). It is clearly documented, however, that marine and coastal birds are very susceptible to both acute and chronic exposures to oil, and the risk is greatest where large numbers of birds concentrate for breeding, migration, or overwintering.

Effects of On-Water Mechanical Recovery

Impacts on birds associated with the mechanical recovery of oil are most likely limited to disturbance of feeding, rafting, or breeding behaviors. Some species of birds are very sensitive to even minor human disturbances (e.g., bald eagles and harlequin ducks). If these sensitive species also have high nesting and/or feeding site fidelity because of limited nesting habitats or prey abundance, or if large aggregations of breeding birds occur in the spill area, impacts are possible from the operation of recovery equipment (Kuletz, 1993; Wiens, 1995). Mechanical recovery will not significantly reduce the potential impacts on birds because it has limited efficiency (10 to 15 percent removal of total oil volume; 75 to 90 percent recovery within the boom).

Effects of On-Water Chemical Dispersion

If used in pre-authorization agreement areas, dispersant application would reduce surface oil and reduce shoreline oiling, thereby reducing exposure. The guidance in ACPs for dispersant application during spills usually specifies that areas with large numbers of birds be avoided because of the concern that the dispersants could be toxic to birds, and to avoid possible noise impacts and to help minimize the possibility of bird strikes. It is possible for marine birds to be exposed to dispersed oil via direct spraying of the dispersant onto the birds during application to the oil slick, fouling of the feathers with dispersed oil droplets, and ingestion of dispersed oil.

Chemical dispersants may affect the water-repellency and insulating capacity of feathers, as well as the structural integrity of external membranes and surfaces; therefore, the direct spraying of rafting (large groups resting on the surface) birds should be avoided during application (NRC, 1989). Peakall et al. (1987) reviewed the available literature and found little difference between the toxicity of oil alone and the toxicity of dispersants or dispersed oil. Lambert et al. (1982) did not find significant differences in the metabolic rates of mallards that were exposed to dispersants versus control mallards (external dosing), although both oil and the oil-dispersant mixture did produce significant metabolic changes, with the mixture producing greater changes. Crude oil, dispersant alone, and oil-dispersant mixtures all reduced hatching success when mallard eggs were externally exposed to the different treatments (Albers, 1979; Albers and Gay, 1982). Weight gain in mallards and herring gulls exposed to crude oil and oil-dispersant mixtures through their diets or applied externally has also been studied, and no differences were found (Eastin and Rattner, 1982; Peakall et al., 1982). Butler et al. (1982) found that Leach's storm-petrels were more likely to abandon their nests, and their young were more likely to have lower survival and decreased weight gain, when adults were applied externally with high doses of a crude oil-dispersant mixture than when adults were exposed to external oiling alone. Decreases in hatchability between the two treatments (applied both internally and externally) were the same.

Another factor of concern regarding dispersants and seabirds is that the area of the slick on the water surface tends to increase temporarily following dispersant use prior to the slick's breaking up (Lichtenthaler and Daling, 1985). Therefore, rafting birds in the area may briefly be more at risk following dispersant application, although the amount of oil exposure per individual will be smaller (Peakall et al., 1987). Diving birds, such as pelicans, cormorants, terns, auks, penguins, seabirds, and sea ducks, may also be at an increased, but brief, exposure risk if they are feeding in the area while the oil is dispersing into the water column and is still present as large slicks on the surface that they may pass through (Peakall et al., 1987). There appears to be a negligible risk of birds becoming oiled by dispersed droplets under the water while diving because of the decrease in "stickiness" of the oil once it has been dispersed (Peakall et al., 1987).

Aside from the above-cited studies, there is little evidence of birds being more heavily affected by dispersants or oil-dispersant mixtures than by oil alone (Peakall et al., 1987); therefore, exposure to the floating oil on the surface seems to be of greater risk to birds than exposure to chemically dispersed oil. Dispersant use shortens the amount of time that floating oil is on the water surface and lessens the possibility that it will reach the shoreline, where severe impacts on birds that utilize shoreline habitats are likely to occur, and may continue to occur if shoreline oiling becomes a chronic source of exposure.

Effects of On-Water *In Situ* Burning

The main concerns associated with *in situ* burning of floating oil and birds are that species of concern will be consumed by flames or exposed to the smoke, and that birds will be exposed to toxic burn residues. Because the oil is contained within a boom prior to ignition, as long as birds are at a reasonably safe distance from oil, flames, and smoke, there is little concern that they would be directly affected by open-water *in situ* burning (Allen and Ferek, 1993). No studies have been done on bird exposure to smoke and fumes, so detailed information on possible impacts is not available. If smoke and fumes do reach birds on the shoreline or in the water, they may choose to leave the area; then it is possible that important breeding or feeding behaviors may be disrupted, resulting in indirect impacts. Since the burning would be a short-term activity, these impacts should be temporary.

Exposure to toxic residues on the water surface, especially the taffy-like floating residue that remains following the burn, may be a concern to birds as well (Allen and Ferek, 1993). *In situ* burning of contained oil is highly efficient and the percent removal of collected oil has been documented to range from 75 to 99 percent; therefore, only a relatively small amount of taffy-like floating residue will likely remain (Allen and Ferek, 1993; Campbell et al., 1994). These residues are typically collected and removed during manual cleanup following the burn (Allen and Ferek, 1993). Therefore, even if some risk would be associated with birds coming in contact with post-burn residues, the amount of oil residue that remains following the burn may be low enough to sufficiently decrease the likelihood of exposure. There does not appear to be any evidence that burn residues are more toxic to wildlife or aquatic resources than floating oil (Daykin et al., 1994). Yet because the total efficiency of *in situ* burning is limited to the amount of oil that can be contained in booms prior to ignition (~10 to 15 percent of total oil volume), many of the concerns associated with birds that contact floating oil would still be relevant.

Thresholds and Recovery Patterns

Information on thresholds of oiling that would cause impacts on birds is limited. Varoujean et al. (1983) considered a 0.1-g/m^2 (0.25-μm) oil slick to be too thin to cause acute mortality to birds resting on or swimming through it, while they considered a 1-g/m^2 (0.8-μm) slick to be 100 percent lethal. This is in contrast to other authors who did not consider slicks less than 1 μm to be harmful to seabirds (NRC, 1985; Peakall et al., 1985). Doses ranging from 20 to 70 ml of crude oil have been found to have metabolic effects on ducks, while doses of 200 to 500 ml have been observed to cause significant and lethal effects in ducks (French et al., 1996; Jenssen and Ekker, 1991).

Recovery time periods for birds following an oil spill undoubtedly vary because of oiling conditions, time of year, abundance of birds, and several other factors. In general, based on multiple surveys, most populations, including murres that suffered high initial casualties and marbled murrelets, were considered to be "recovered" between and 1.5 and 2.5 years following the *EXXON VALDEZ* oil spill (Boersma et al., 1995; Erikson, 1995; Kuletz, 1993; Wiens, 1995). Recovery times for other species, such as harlequin ducks, Barrow's goldeneyes, pigeon guillemots, cormorants, black-legged kittiwake, murres, mergansers, horned and red-necked grebe, mew gulls, and loons were much longer, and perhaps ranged from 3 to 9 years (Esler et al., 2000; Holland-Bartels et al., 1999; Irons et al., 2000; Klosiewski and Laing, 1994; Oakley and Kuletz, 1996; Rosenberg, 1999; Rosenberg and Petrula, 1998; Sharp et al., 1996; Trust et al., 2000). Pelicans that were oiled and rehabilitated did not appear to recover enough to regain normal breeding capacity even after 3 years (Anderson et al., 1996). Recovery time for some species following spills may be irrelevant, as significant impacts may not have occurred at the population level (Day et al., 1995; Wiens, 1995).

4.3.2.3. Plankton and Fish

The toxic effects of oil spills on plankton and fish result from acute exposures—during the time when surface oil is present and for short periods (days to weeks) afterwards. Once the source of hydrocarbons (from floating oil or oil on the shoreline) to the water column is gone, concentrations rapidly disperse to background levels, which usually are below thresholds of concern.

Water column organisms near the water surface and floating oil are most vulnerable to oil exposure, particularly those in the surface nephloid layer (the microlayer at the water surface). A number of planktonic organisms and early life stages of other organisms concentrate in the surface nephloid layer. In addition, organisms in shallow subtidal areas and the intertidal zone may be exposed to hydrocarbons dissolved or resuspended from stranded oil or oil contaminated sediments. As dilution in these areas is much slower than for deeper waters, concentrations remain higher for longer periods of time, exposing plankton, fish, and benthic organisms to potentially toxic levels.

Greater effects may occur if the spill occurs in or migrates to nearshore areas such as enclosed embayments, estuaries, or wetlands. In such confined or low-energy water bodies, the spilled oil is likely to be less dispersed and be more concentrated because of the decreased water depth. As discussed above, the 1996 *NORTH CAPE* oil spill resulted in high concentrations of the toxic components (PAHs) remaining for weeks after the spill, which caused a large impact to water column and benthic communities (technical report [French McCay et al., 2004]; French McCay, 2003).

There are three potential pathways of exposure for water column organisms to oil hydrocarbons: (1) dissolved hydrocarbons, (2) particulate oil (entrained oil droplets from either natural or chemical dispersion), and (3) via the food web. Of these, exposure to dissolved components is the most significant (French et al., 1996; French McCay, 2002), as dissolved hydrocarbons may be taken up directly through the surface (or skin), through the gills, and via the gut (by water intake). Fine particulate oil may be ingested by filter feeders, of which there are many examples among plankton (e.g., copepods, amphipods, ciliates) and fish (e.g., herrings). Contaminated organisms may, in turn, be ingested by larger plankton and fish, resulting in effects on these organisms. In addition, prey affected directly by a spill may become unavailable to the food web, affecting their predators (French and French, 1989; French et al., 1996; NRC, 1985, 2003).

The most toxic components of oil to water column and benthic organisms are lower molecular-weight compounds, which are both volatile and soluble in water, especially the aromatic compounds, the MAHs and the PAHs (Anderson et al., 1987; French et al., 1996; French McCay, 2002). Descriptions of typical MAHs and PAHs, their toxicity, and concentrations in the crude oils modeled as part of this study are in the Sections A-2.1, B-I.3, C-I.3, D-I.3, E-I.3, and F-I.3 of the technical report (French McCay et al., 2004). A brief summary of their fates and effects on plankton and fish is presented here.

It is important to note that the effects of MAHs and PAHs on plankton and fish are additive (DiToro et al., 2000; French et al., 1996; French McCay, 2002; Swartz et al., 1995). Because exposure to these compounds in water can occur for periods of a few days to weeks, the LC50 is the appropriate toxicity parameter for evaluation of effects. French McCay (2002) provides LC50s for the mixture of MAHs and PAHs originating from spilled oil.

The BTEX compounds (benzene, toluene, ethylbenzene, and xylene) of the MAHs are very soluble in water, so exposure concentrations in water can be high. However, BTEX are relatively low in toxicity (compared with other soluble compounds in oil) and evaporate quickly. Thus, the BTEX rapidly volatilize, reducing exposure concentrations and the time of exposure to toxic levels. For these reasons, the impact of BTEX after a spill is typically low and of very short duration (French McCay, 2002).

PAHs and many of the larger MAHs are less soluble than BTEX, but do dissolve in significant quantities into the water, thus becoming bioavailable. Because they are much more toxic than BTEX, PAHs and larger MAHs can have significant impacts on aquatic organisms (French McCay, 2002). In a typical crude or fuel oil spill (the only types considered suitable for dispersant use), the PAHs cause most of the toxicity to water column communities. The LC50 for a mixture of oil PAHs is about 50 parts per billion (ppb) for the average species. For sensitive species (2.5th percentile of a Gaussian-shaped distribution with the mean at 50 ppb), LC50 for total PAHs is about 5 ppb. For insensitive species (97.5th percentile), LC50 for total PAHs is about 400 ppb (French McCay, 2002).

Toxicity increases with duration of exposure; LC50 values decrease as exposure time increases (Anderson et al., 1987; French, 1991; French and French, 1989; French et al., 1996; French McCay, 2002; Kooijman, 1981; Mackay et al., 1992a, b, c; McAuliffe, 1987; McCarty et al., 1989, 1992; Sprague, 1969). This is due to the accumulation of toxicant over time up to a critical tissue concentration that causes significant effects or mortality. Since after an oil spill concentrations decrease rapidly on a scale of hours to days, duration of exposure needs to be considered in evaluating toxicity, particularly for the PAHs, which accumulate more slowly in tissues (French McCay, 2002).

The LC50s listed above are for long exposure durations of at least 4 days or a week. If exposure is shorter, as is typical in most oil spills, the LC50s are much higher and toxicity much lower, by an order of magnitude or more for a few hours of exposure (100 ppb for 6 hours of exposure to PAHs; see Part A, Table A.3-5 of the technical report [French McCay et al., 2004]). As an index of this effect of exposure duration, an exposure dose may be calculated by considering both concentration and exposure duration (i.e., ppb-hours). For PAHs from crude and fuel oils, the LC50s for sensitive, average, and insensitive species at 96 hours or more may be translated to equivalent exposure dose by multiplying by a factor of 100: 500 ppb-hours for sensitive species, 5,000 ppb-hours for average species, and 40,000 ppb-hours for insensitive species.

There is also a potential for naturally or chemically dispersed oil droplets (particulate oil) to adversely impact filter-feeding organisms in the water column, either by mechanical interference or via dissolution of hydrocarbons from ingested droplets (NRC, 1985). However, existing studies examining this potential have not documented adverse effects from (naturally or chemically) dispersed oil, and no quantitative data are available to estimate the magnitude of this impact. As the larger oil droplets would resurface rapidly, while the smaller droplets (less than 70 microns in diameter) would remain dispersed (Delvigne and Sweeney, 1988), the small particles are those of most concern for filter-feeders. Once weathered, the toxicity of the particulates related to the soluble compounds would be lower, and, if exposure is relatively short (hours to days) via external surfaces or the gut of the organisms such that higher molecular weight PAHs would not be assimilated into the organism’s tissues, the effects would be more mechanical than toxic.

Bioaccumulation of oil hydrocarbons is primarily via direct uptake from the water, either directly or through the gills. Hydrocarbons may also accumulate from contaminated food and particulate matter that have been ingested. Predators can consume hydrocarbons accumulated in tissues of organisms. However, plankton and fish have mechanisms to eliminate MAHs and PAHs from their bodies; therefore, these compounds do not biomagnify up the food web (Call et al., 1985; Giesy and Graney, 1989; Gobas, 1989; McCarty, 1986; McCarty and Mackay, 1993). The most important exposure route to and effects on water column communities are via direct exposure to dissolved, and possibly particulate, oil.

Effects of On-Water Mechanical Recovery

No additional adverse impacts on water column communities are expected to occur from mechanical recovery because most organisms can easily avoid the equipment and near surface plankton in the vicinity have already been affected by the oil. Water column impacts will be reduced by the additional amount of oil recovered.

Effects of On-Water Chemical Dispersion

In the open ocean or areas where there is sufficient tidal flow, dispersant application would treat surface oil and prevent shoreline oiling, thereby reducing exposure. The proposed regulations apply only to waters where pre-authorization agreement areas exist, which are generally demarcated as waters in the United States greater than 3 nm from shore[6]. Dispersant application is not likely in coastal waters given the extremely low application rates and rapid dilution; therefore, no impacts on coastal water column communities related to dispersant use are expected in those areas (see Appendix G). Coastal water column communities will most likely benefit from dispersant use in pre-authorization agreement areas, as the volume of oil that subsequently migrates to the nearshore areas will be reduced by the amount dispersed in marine waters.

In the offshore areas where dispersants are used, water column concentrations of dissolved hydrocarbons and particulate oil would increase. However, most of the soluble components will evaporate from surface-floating oil during the hours prior to the application of dispersant, and dissolution of these components from dispersed oil that has already weathered is likely to be very limited (French McCay and Payne, 2001).

Modern dispersants are much less toxic than the oils they disperse. Since the toxicities are additive and dispersed oil droplets are primarily oil, not dispersant, the increase in toxicity is negligible. This conclusion is supported by NRC (1989), which states, “Laboratory bioassays at measured concentrations show that the toxic effects per unit of dispersed oil are usually the same for chemically dispersed oil as those for physically dispersed oil” (p. 255). This issue was also examined by NRC (2005), which states that “there is no compelling evidence that the toxicity of chemically dispersed oil is enhanced over physically dispersed oil if comparisons are based on measured concentrations of petroleum hydrocarbons in the water column” (p. 229). The separate issue of dispersant toxicity alone has been well researched, and the results are presented in Appendix G.

Effects of On-Water In Situ *Burning*

Open-ocean *in situ* burning of spilled oil will create relatively small amounts of burn residue and leave a percentage of the oil spill unburned. Even if the residue were to sink, which can occur, only larger fish would be capable of ingesting the residue. The amount produced would be very small and the risk minimal. The potential impacts from any remaining unburned oil will be the same as discussed above, but will be reduced by the amount of oil that is burned.

Physical properties and fates of burn residues were discussed in Water Quality section (Section 4.3.1.1). Environment Canada coordinated a series of studies to determine whether *in situ* burning caused water column toxicity beyond that attributable to allowing the slick to remain on the surface of the water. Results from laboratory and field studies indicated that, although toxicity increased in water samples collected beneath oil burning on water, this increase was generally no greater than that caused by the presence of an unburned oil slick on water. Bioassays with water from laboratory- and field-generated burn residues of Alberta Sweet Mix Blend showed little or no acute toxicity to sand dollars (sperm cell fertilization, larvae, and cytogenetics), oyster larvae, and inland silversides (Daykin et al., 1994). Bioassays using burn residues from the Newfoundland *in situ* burn field study showed no acute aquatic toxicity to fish (rainbow trout and three-spine stickleback) and sea urchin fertilization (Blenkinsopp et al., 1997). Bioassays using laboratory-generated Bass Strait crude burn residue showed no acute toxicity to amphipods and very low sublethal toxicity (burying behavior) to marine snails (Gulec and Holdway, 1999). Chemical analyses performed along with the biological tests reflected low hydrocarbon levels in the water samples.

Thresholds and Recovery Patterns

Thresholds of concern to plankton and fish would be those concentrations causing acute toxic effects on the most sensitive species in the water column community. For crude and medium-to-heavy fuel oils (including No. 2 fuel), exposure to dissolved PAHs would cause the most effects. Based on the toxicity data, a reasonable threshold for effects on sensitive species would be 5 ppb for at least 4 days of exposure, or 100 ppb for short-term (6-hr) exposures. Expressed as an exposure dose, this threshold would be 500 ppb-hours (Part A, Section A.3.4 of the technical report [French McCay et al, 2004]; French McCay, 2002).

Thresholds of concern for particulate oil are not available. However, bioassays with filter-feeding organisms exposed to whole oil indicate that 1 mg/L (ppm) or higher is needed for an observable effect (NRC, 1985). Thus, 1 ppm is assumed as a threshold of concern.

As described for water quality, nearshore water contamination is expected during the time that the oil slicks remain on the surface of the water. It is expected that most slicks will dissipate within 10 days and that all oil sheen will be gone within 6 weeks. Concentration impacts on coastal marsh waters are expected to result in disturbances significant enough to degrade water column quality in localized areas of the contacted marsh for up to 10 years, depending on the degree of contamination (MMS, 1995). This could pose a localized risk to plankton and fish.

Affected water column communities will recover at time scales related to their life spans. Even in spills where water column impacts are large (e.g., *NORTH CAPE* oil spill as discussed in the technical report [French McCay et al., 2004] and French McCay, 2003), impacts would not normally be large enough to affect future reproduction and recruitment for the populations as a whole. The numbers of marine organisms affected would usually be relatively small portions of the total populations, and it is reasonable to assume that those populations would produce more than sufficient eggs to replace the population in the next generation. Thus, it is assumed that density-dependent compensation for lost reproduction would occur naturally. Given the evolutionary strategy of the fish and invertebrate species involved, this is considered a reasonable assumption, as was made by government trustees in developing the restoration plan for the *NORTH CAPE* spill (NOAA et al., 1999).

Impact would be limited to the normal life span of the affected (killed) individuals. For phytoplankton and zooplankton, the time scale would be days to months. For most small forage fish and invertebrates, the time scale for recovery would be about 1 year. For longer-lived fish and invertebrates, the recovery period would be on the order of about 5 years. Geographically restricted or rare species, if affected, might take longer to recover; however, the general trends among organism groups would still hold such that longer-lived species would take longer to recover. Many commercially valuable species are fished very efficiently once the individual matures and before age 5 or so, such that the population is highly skewed to smaller younger age classes. This artificially shortens the reproductive life span. All of these estimates of recovery time are based on the assumption that the impact to the water column is significant. If the impact were very small, the changes in the populations would not be measurable or significant within natural variability by location and over time.

4.3.2.4. Intertidal Habitats

The sensitivity of intertidal (coastal) habitats to spilled oil and the processes affecting oil fate and behavior on shorelines have been embodied in the Environmental Sensitivity Index (ESI) (Hayes et al., 1980). The ESI is a ranking scheme, on a scale of 1 (low) to 10 (high) that incorporates the relative exposure to wave and tidal energy, shoreline slope, substrate type, and biological productivity and sensitivity (Halls et al., 1997). The ESI has been the cornerstone of oil spill planning and response; therefore, it will be used as the basis for discussing the general impacts of oil on intertidal habitats. Shoreline habitats will be grouped into the following three categories: (1) exposed habitats, (2) sedimentary beaches, and (3) sheltered habitats. For all intertidal habitats, the primary pathway of exposure is the physical stranding and adherence of a floating oil slick on the intertidal zone. The stranded oil becomes a source of dissolved hydrocarbons that can contaminate nearshore water (see Section 4.3.1.l). Within a shoreline type, impacts are generally proportional to the amount of oil stranded. Impacts are also greater where the oil penetrates permeable substrates and persists in sheltered habitats.

Exposed shoreline habitats include exposed rocky shores, wave-cut platforms, erosional cliffs in clay, and exposed seawalls, and they are ranked as 1–2 on the ESI scale. In such exposed areas, oil is generally held offshore by wave reflection, and any oil that is deposited is rapidly removed by wave action.

Sedimentary beaches range in grain size from sand to gravel, and they are ranked 3 (for sand) to 6 (for gravel) on the ESI scale. The grain size controls several important factors controlling oil behavior on beaches, such as the degree of penetration into the sediments, the potential for burial by clean sediment, and the rate of natural sediment reworking. On sand beaches, oil penetration is limited to between 5 and 25 cm, and the risk of rapid burial increases with grain size. However, these beaches are the easiest to clean, and cleanup can be very effective. Sand beaches are important feeding habitats for shorebirds and nearshore fish, and declines in infauna (organisms that live in the sediments) can affect those species that prey on them.

Gravel beaches (ESI 6) vary widely in their grain size and degree of exposure to wave energy. Stranded oil will penetrate deeply into gravel beaches, up to 1 m, depending on the grain size and sorting (amount of finer-grained gravel and sand in between the larger gravel). The depth of routine sediment disturbance by waves will control the long-term persistence; in semisheltered locations such as Puget Sound and Prince William Sound, oil can persist for more than 10 years (Hayes and Michel, 1999). Buried oil in gravel beaches also weathers more slowly (Michel and Hayes, 1999), thus posing continued risks of uptake by intertidal organisms and continued exposure to animals that feed on them such as oystercatchers (Andres, 1997). Cleanup options are less effective than on sand beaches, and there can be significant additional impacts on intertidal communities resulting from cleanup efforts (Driskell et al., 1996).

Sheltered habitats include tidal flats (ESI 7), sheltered rocky shores (ESI 8), and wetlands (marshes and mangroves, ESI 10). Oil impacts on these habitats can be significant, especially when heavily oiled. This is because the natural removal rates are low, the sediments are generally fine-grained where oil degradation can be slow, and the intertidal communities are rich and highly sensitive to oil. With low natural removal rates, these shoreline types are often areas where there is significant pressure to actively remove the oil, which can be highly intrusive, and unless it is done with a great deal of care, often is not beneficial in terms of recovery.

Oil does not generally adhere to the water-saturated surface of tidal flats, but can still affect epifauna (organisms living on the surface) and infauna, thereby reducing food sources for birds and other predators (NOAA, 2000a). Sheltered muddy habitats are particularly sensitive because any stranded oil can persist and weather very slowly. Cleanup is very difficult, and there are few methods that will not result in significant damage (NOAA, 2000a).

Sheltered rocky shores often contain rich intertidal communities that provide vital ecosystem functions in the form of prey resources for many animals, as well as commercial and subsistence harvest, and aesthetic, cultural, and recreational opportunities. Natural removal rates can be very slow. Intertidal animals and plants are often killed or removed during cleanup, and the intertidal communities can go through cycles of succession before recovery is considered complete (Kimura and Steinbeck, 1999). Sell et al. (1995) analyzed twelve oil spills where sheltered to moderately exposed rocky shores were heavily oiled, finding that treated sites recovered more slowly (2–10 years) than those sites that were not treated (1–6 years). They also reported that lightly to moderately oiled sites recovered faster.

Marshes and mangroves are ranked as 10, highest on the ESI scale, because they have the potential for the greatest impacts from spilled oil, particularly when heavily oiled. Oil adheres readily to the vegetation, and it can penetrate the muddy sediments via root cavities and burrows (NOAA, 2000a). Oil spills are known to cause severe and long-term damage to mangrove and salt marsh ecosystems (e.g., Burns et al., 1993; Corredor et al., 1990; Duke et al., 1997; Mendelssohn et al., 1993). The vegetation and structure that salt marshes and mangroves provide may be affected, sediments may be contaminated, and ecosystem functions may be impaired with regard to utilization by organisms, including important fisheries species, processing of nutrients and chemicals, and stabilization of sediments. The rate of degradation of the oil in the sediments is influenced by the sediment type, oxygen content and bacterial component of the sediment; availability and level of nutrients in the sediments and at the oil/sediment interface; and the depth to which the oil has penetrated. Oil penetrated into marsh sediment can be highly persistent, up to 30 years at the *FLORIDA* spill site in Buzzards Bay, Massachusetts (Reddy et al., 2001). Oiling effects may be limited or negligible and be short term when the oil exposure is minimal, the vegetative structure is not affected (either by the oiling or various cleanup procedures), and residual oil levels are minimal or rapidly weathered.

Oil impacts on mangroves are a function of the oil type, spill volume, duration of re-oiling, extent of oil coverage on exposed roots, and degree of substrate oiling. Light refined products can be acutely toxic (Ballou and Lewis, 1989). Heavier types of oil can lead to eventual death by smothering. Oiling of mangroves following spills can lead to the death of those plants and ultimately unstable habitats and sediment erosion (Duke et al., 1997; Garrity et al., 1994). For example, during the Bahia Las Minas spill in Panama, about 82 km of shoreline were heavily oiled, including more than 1,000 ha of mangrove forests, intertidal reef flats, and subtidal flats. Large expanses of mangrove forest were inaccessible, and no oil removal was conducted. Approximately 69 ha of mangrove forest (dominated by red mangrove [*Rhizophora mangle*]) were killed and sublethal impacts affected approximately 308 ha (Duke et al., 1997).

Effects of On-Water Mechanical Recovery

No additional adverse impacts on shoreline habitats are expected to occur from mechanical recovery. Shoreline impacts will be reduced by the amount of oil recovered.

Effects of On-Water Chemical Dispersion

As stated previously, the proposed regulations apply only to waters where pre-authorization agreement areas exist, which are generally demarcated as waters in the United States greater than 3 nm from shore[7]. Dispersant application in areas greater than 3 nm from shore makes it unlikely that dispersants will be directly applied to oil stranded onshore. In the open ocean or areas where there is sufficient tidal flow, dispersant application would treat surface oil and prevent shoreline oiling, thereby reducing exposure. Intertidal habitats will be exposed to dispersed oil that is carried close to shore by currents after offshore application. In all cases, impacts on intertidal habitats will be significantly reduced compared with floating oil slicks. Three field studies were conducted in the 1980s to compare the impacts of controlled releases of oil and dispersed oil on intertidal and nearshore habitats: the Searsport, Maine study in a temperate setting (Gilfillan et al., 1983; 1985); the Tropical Oil Pollution Investigations in Coastal Systems (TROPICS) study of tropical ecosystems in Panama (Dodge et al., 1995; Getter and Ballou, 1985); and the Baffin Island Oil Study (BIOS) in the Canadian Arctic (Boehm et al., 1985).

In each of these studies, dispersed oil concentrations along the shoreline were much higher than what is likely to occur during actual spills. Impacts on shoreline habitats exposed to dispersed oil were much reduced, compared with the oil treatments. For example, at the TROPICS study, half of the mangrove trees at the oil-only site were dead by year 2. In contrast, there was no explicit mortality of trees at the chemically dispersed oil site over the entire 10 years of monitoring. At the Searsport, Maine, site, the oil-only site showed clear evidence of oil incorporation into sediments and impacts on benthic fauna, whereas there was no evidence of impacts on fauna at sites exposed to dispersed oil. In the Canadian Arctic at the BIOS sites, large amounts of untreated oil washed up on the beach and became a source of remobilized oil that persisted for at least 9 years, whereas dispersed oil caused a significant, but short-lived, increase in hydrocarbon compounds in the water column, a significant initial bioaccumulation of oil, and little sediment impact.

Because dispersants will not always be 100 percent effective, there will likely be some shoreline oiling, particularly for large spills and applications close to shore. If effective, however, impacts on shoreline habitats can be greatly reduced in terms of the extent of shoreline affected and oil loading.

Effects of On-Water In Situ *Burning*

Impacts on shoreline habitats from open-water *in situ* burning will result primarily from two types of exposure: (1) untreated oil that strands onshore, and (2) burn residues that are transported into the intertidal zone and strand onshore. Impacts from untreated oil will be the same as discussed above. The only difference will be a reduction in the amount of oil that might strand. Burn residues are semisolid and tar-like. Studies have predicted that about half of international crude oils would tend to produce a residue that would sink in seawater, but only after cooling (Buist and Trudel, 1995). Sinking residues would be less likely to strand than those that float. Response plans for *in situ* burning call for the collection of as much residue as possible.

Chemical analyses of burn residues show relative enrichment in metals and the higher molecular weight PAHs, which have high chronic toxicity but are thought to have low bioavailability in the residue matrix. Bioassays with water from laboratory- and field-generated burn residues have been conducted on a variety of organisms but not on intertidal species (see Section 4.3.2.3). In general, such residues show little or no toxicity; therefore, impacts on shoreline habitats from stranding of burn residues will be primarily a result of physical coating and smothering of intertidal organisms. The extent of impact is likely to be small because only a small amount of residue will form.

Thresholds and Recovery Patterns

Thresholds of concern for the amount of oil stranded onshore vary by habitat type and both ecological and recreational use. Even small amounts of oil on a high-use amenity beach during peak holiday periods will trigger the need for cleanup, whereas natural recovery will be considered on remote beaches during periods of low biological use. A suggested threshold of concern for all sedimentary beaches is an oil thickness of 0.1 mm. At this thickness, assuming that the oil penetrated or mixed to a depth of 10 cm, the sediment would contain 300 ppm oil, which would visibly stain sand, triggering the need for cleanup in most areas. This same threshold would apply to all rocky shores based on the potential impacts on intertidal communities (French et al., 1996).

On wetlands, there have been studies on the oil loading needed to kill the vegetation. For example, Alexander and Webb (1985) (Bowyer et al., 1994) reported that 0.35 gal/ft^2 had a detrimental effect on Texas salt marsh plants; Baker (1971) reported that 0.5 mm of fresh Kuwait crude spread over a salt marsh was not enough to kill most plant species and plants recovered the next growing season. However, even oil loading levels that do not kill plants would be of concern to animals that use these habitats. The CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) Type A model (French et al., 1996) assumes that a thickness of oil greater than 14 mm is lethal to wetland macrophytes. However, considering sublethal endpoints, a threshold of concern would be on the order of 0.1 mm.

Recovery time periods vary considerably from habitat to habitat, primarily in response to the ambient energy level provided by winds and waves. The higher the energy is, the more rapid the recovery is. Exposed rocky shorelines are expected to recover within 1 to 3 years, and often within a few months, regardless of response strategy (Sell et al., 1995). Sheltered rocky shores, on the other hand, may retain pockets of oil for longer periods, depending on the degree of exposure.

Sedimentary beaches will have variable recovery periods, with gravel beaches the longest under heavy oiling and semisheltered conditions (greater than 8 years, based on studies of the *EXXON VALDEZ* spill site [Michel and Hayes, 1999]). Sand beach recovery rates are variable, depending on conditions and initial disturbance. Keller and Jackson (1991) summarized recovery of sand beaches in Panama following oiling as being complete by 1 year, except for certain species. Bodin (1988) observed recovery within 5 years for three sand beaches in Brittany, France, over the years 1978 to 1984 after the *AMOCO CADIZ* oil spill. Baker et al. (1990) cite evidence from the Baltic Sea after a 1970 spill of medium and heavy fuel oil with mechanical cleanup. Recovery was estimated at 4 years. Judd et al. (1991) observed that Texas dune vegetation took 2 to 3 years to recover from removal experiments.

Documented recovery times for oiled marshes range from a few weeks to decades (summarized in Hoff, 1995). Longest recovery periods are for several well-studied marsh sites where recovery times ranged from 5 years to over 20 years, including two sites in Buzzards Bay, Massachusetts; the *MIGUASHA* spill in Quebec, Canada; the *METULA* spill in Chile; and the *AMOCO CADIZ* in France. These spills share the following characteristics: temperate to cold environments; sheltered location; heavy oiling; and spills of fuel oils (bunker C or No. 2 fuel). Recovery time periods for mangroves depend on the initial and residual oil loading as well damages resulting from cleanup efforts. Lightly oiled mangroves are likely to recover within 1 year, particularly if there is little or no substrate oiling. In contrast, recovery of heavily oiled mangroves will be delayed until the oil toxicity drops below threshold levels, the site is stabilized in terms of its structure (e.g., the dead trees are eroded or removed so they no longer move around the intertidal zone because of wave and tidal action and prevent recolonization by seedlings), and the hydrology is reestablished so that recruits survive and grow. At 5 to 6 years post-spill, vegetation gaps remained in sheltered locations at the Panama site (Duke et al., 1997). Once recovery begins, then the recovery curve is relatively predictable, depending on the age of the oiled forest (up to 25 to 50 years). Based on field dispersant trials, marshes and mangroves exposed to dispersed oil are expected to recover within 1 year.

4.3.2.5. Subtidal Habitats

The subtidal (benthic) habitat consists of the bottom substrate below the low tide level, as well as the species that live in, on, and near the substrate. This benthic community includes areas of hard substrate inhabited by dense growth of sessile algae, corals, and sponges (often referred to as live bottoms and reefs); sandy and muddy bottoms; low-relief live bottoms; subsurface canyons; and pinnacles. Organisms living in this area include corals, plants and seagrasses, benthic invertebrates (such as crabs, shrimp, snails, bivalve mollusks, and marine worms), and bottom-dwelling fish.

Subtidal benthic communities are rarely at risk from floating oil because, by definition, this environment is always below the surface. There are two rare exceptions to this: (1) extremely high energy environments caused by high sea state that could physically disperse the floating oil and force oil particles down to the benthos, and (2) extremely shallow subtidal environments (nonintertidal).

In extremely high-energy environments, wave action can force whole oil droplets down into the benthic habitat. In this case, the oil particles could adhere to bottom substrate, plants, and animals. This could result in both physical coating of plant leaf or animal gill surfaces, as occurred in the 1993 *BRAER* spill in the Shetland Islands, and toxic effects from exposure to the chemical constituents. However, a sea state of this magnitude would exclude the implementation of any of the three alternatives and, therefore, does not warrant further discussion here. This type of spill is rare, and only one of a handful where extreme weather, sea conditions, and a spill of an easily dispersible oil leads to direct impacts on the subtidal environment.

Water accommodated fraction (WAF) refers to that portion of a test oil that will enter the water and remain when the water and oil are mixed together gently. It represents, as closely as possible, the components that enter the water column under a floating oil slick. Its composition can vary considerably depending on how it is prepared, so results must be evaluated carefully. WAF toxicity testing on the early life stages of Pacific oysters has resulted in LC50 levels near 2 ppm (Clark et al., 2001) and studies with the eastern oyster embryonic/larval stages resulted in sublethal effects near 6 ppm in 24-hr exposures (Fucik, 1994). Studies on epifauna and infauna (e.g., polychaetes, bivalves and other mollusks, and decapod crustaceans) resulted in mortality at concentrations near 20 ppm (Knap et al., 1985). In the TROPICS study, Baca and Getter (1984) showed that turtle grass exposed to untreated Prudhoe Bay oil resulted in 96-hr LC50 levels of 4 ppm. Sustained hydrocarbon concentrations within the benthic habitat at levels cited in these experiments are unrealistic beneath an untreated oil slick, even at extremely shallow depths. Thus, the risk to fauna and flora of the subtidal benthic habitat is minimal.

Effects of On-Water Mechanical Recovery

Mechanical recovery is a risk to benthic environments when the water depth is shallow enough that recovery equipment might come in contact with subsurface life such as coral reefs, oyster beds, seagrass beds, and other benthic habitats. Vessels must also avoid anchoring in sensitive habitats. A well-planned mechanical recovery operation would identify and avoid shallow depths to ensure that equipment such as boats and skimmers would not come in contact with benthic habitats. However, when operations disturb the natural environment of the benthos, devastating results can occur. Areas that have experienced significant disturbance from mechanical recovery can take considerable time to recover (Cubit and Connor, 1993; NOAA, 2001a).

Effects of On-Water Chemical Dispersion

As stated previously, the proposed regulations apply only to waters where pre-authorization agreement areas exist, which are generally demarcated as waters in the United States greater than 3 nm from shore[8]. Dispersant application under these conditions limits the risk to the benthic environment.

A number of field studies have been conducted over the past two decades to study the fate and transport of chemically dispersed crude oil. McAuliffe et al. (1980; 1981) performed field trials in which they dispersed a Prudhoe Bay crude oil slick at sea. Within 30 minutes, 40 percent of the oil was dispersed in the top 2 m, and within an hour approximately 85 percent of the slick had dispersed into the top 7 m. Depending on the sea state, dispersed oil droplets are normally vertically distributed down to 10 m in the water column (NRC, 1989). From 1994 through 1996, three different projects were conducted that involved toxicity testing of water beneath untreated and dispersed oil slicks during field trials in the North Sea. In each of the studies, toxicity effects were negligible at depths greater than 1 m beneath the dispersed oil slick (Coelho and Aurand, 1996; Coelho et al., 1995; Wright et al., 1994). These studies clearly indicate that subtidal benthic habitats located below 10-m depth will not be affected from dispersant operations or resulting dispersed oil.

Three field studies were conducted in the 1980s and early 1990s that addressed the ecological effects of oil versus chemically dispersed oil in nearshore, shallow subtidal areas: the Searsport, Maine, study in a small bay (Gilfillan et al., 1983, 1985), the TROPICS study in a tropical embayment in Panama (Ballou et al., 1989; Dodge et al., 1995), and the BIOS in the Canadian Arctic (Sergy, 1985). In all three studies, chemically dispersed oil mixed into the water column and affected the benthos. It was concluded that, although the ecological effects from the dispersed oil were more severe initially, long-term recovery of the ecosystem was improved in the areas that were treated with dispersant.

Studies on corals have found that over the long term, corals such as *Diploria stringosa* appear relatively tolerant to brief exposures by chemically dispersed oil in the water column (Dodge et al., 1995; Knap et al., 1985). Laboratory studies on corals are backed by field studies such as the TROPICS study where chemically dispersed oil had relatively minor effects on corals and associated organisms (Ballou and Lewis, 1989). In corals, exposure to 20 ppm of chemically dispersed oil for 24 hours induced various behavioral reactions, including tentacle retraction, tissue contraction, and mesenterial filament extrusion. However, effects were typically sublethal, and recovery was evident within 4 days. These symptoms were not significant in long-term transplants (Knap et al., 1985). Dispersant use may be highly appropriate near submerged coral reefs (i.e., where water depth increases quickly and subsurface currents are likely to carry dispersed oil away from the reef). The National Oceanic and Atmospheric Administration (NOAA, 2001a) has modeled such situations for potential spills, focusing on when dispersants were considered as a response tool near a coral reef.

Experimentation and observation of dispersant applications have not shown specific toxic effects on marine plants and seagrasses. Chemically dispersed oils are less sticky than undispersed oil and tend not to adhere to marine plants (Lewis and Aurand, 1997). In the TROPICS study, Baca and Getter (1984) determined a 96-hr LC50 value for turtle grass exposed to chemically dispersed Prudhoe Bay oil of 202 ppm. These concentrations are much higher than those that would be expected in seagrass beds, unless dispersants were used directly over the bed in very shallow water, so direct toxicity is unlikely.

The primary concern for seagrass meadows is not necessarily the grass itself, but the fauna, since seagrass beds host numerous different species. Mortality of seagrass epifauna and infauna from dispersed oil was observed in the TROPICS study, but the recovery rate for the habitat was fairly rapid (i.e., within 1 year) (Ballou et al., 1989). Early life stages of epifauna and infauna are more vulnerable to dispersed oil than adults of the same species. Acute toxicity studies of polychaetes resulted in LC50s (24-hr exposures) of 220 ppm for oil-dispersant mixtures (NRC, 1989). Butler et al. (1982) found amphipod (*Gammarus oceanicus*) 36-hr LC50 levels to be between 10 to 100 ppm with supporting testing conducted by Gulec and Holdway (1997). These concentrations are much higher than those typically observed in a subtidal benthic habitat, so it is unlikely that these invertebrates would be affected by dispersed oil.

Laboratory toxicity tests utilizing dispersed Mayan crude oil on adult blue crabs resulted in LC50 values of 43 ppm in a static environment and greater than 150 ppm in a flow-through environment. Adult brown shrimp LC50s were 36 ppm in flow-through testing, and adult white shrimp LC50s were 44 ppm in flow-through testing (Norton et al., 1978; Ozelsel, 1983; Shuba and Heikamp, 1989; Wells et al., 1984; Wilson, 1977). CROSERF (Chemical Response to Oil Spills: Ecological Effects Forum) laboratory experiments utilizing spiked (declining concentration) exposures of larval and juvenile crustaceans to chemically dispersed oil resulted in similar LC50 values ranging from 1 to 60 ppm dispersed oil (Clark et al., 2001; Fuller and Bonner, 2001; Singer et al., 2001; Wetzel and Van Vleet, 2001). These results indicate that, in an extremely shallow benthic subtidal community, some juvenile crustacean mortality might occur from dispersed oil.

Mollusks have been found to survive in highly oiled sediments. Their resistance to the effects of hydrocarbons has been seen in both experimental studies as well as in actual spill site observations. Multiple studies have noted a lack of significant mortality associated with hydrocarbon concentrations in excess of 1,000 ppm (Anderson et al., 1987; Rosiejadi et al., 1978; Wells and Sprague, 1976). This resistance may be attributed to the fact that the very toxic components of oil rarely persist in highly oiled sediments in the field, and because of the highly variable feeding mechanisms found in mollusks, not all of which are conducive to uptake from the sediments. Even though adults tend to be resistant to relatively high concentrations, exposures in shallow areas have been high enough at some spills to result in mortality or narcosis to adults.

In benthic fish (much like pelagic fish), the early life stages are generally more sensitive. The later life stages of benthic fish are more resistant to the toxic effects of dispersed oil and dispersants (Shuba and Heikamp, 1989). The concern for benthic fish involves interaction with dispersed oil and oil-sediment particles that have mixed to the bottom of the water column. Benthic fish will experience the toxic effects longer than those in the water column if the sediments become contaminated. However, dispersed oil is less adhesive than untreated oil to sediment particles and is more likely to be carried away by currents than settle to the bottom and pose a serious risk (Boyd et al., 2001; Shuba and Heikamp, 1989). Additionally, biodegradation of chemically dispersed oil will reduce the risk presented to the benthic fish. The toxic concentrations cited in Section 4.3.2.3 for fish are much higher than those typically observed in a subtidal benthic habitat, so it is unlikely that adult or juvenile benthic fish would be affected by dispersed oil.

Effects of On-Water In Situ *Burning*

As stated in previous sections, most burns result in a taffy-like, buoyant layer of residue that can generally be recovered manually for disposal (Allen and Ferek, 1993). In some cases, residues may sink, which usually happens when the oil picks up sediments suspended in the water or when a highly efficient burn leaves only the heaviest part of the oil (ADEC, 1995). Residues that do sink are likely to settle to benthic environments and may interact with bottom-dwelling plants and animals (Shigenaka and Barnea, 1993). However, the amount of residue to be expected from an actual event is minimal, and would result in small patches of residue spread throughout the area of the burn. Several laboratory and field studies of burn residues on aquatic organisms have shown little or no acute toxicity to sand dollars, oysters, inland silversides, rainbow trout, three-spine sticklebacks, sea urchins, and amphipods (Blenkinsopp et al., 1997; Daykin et al., 1994; Gulec and Holdway, 1999), and very low sublethal toxicity to marine snails (Gulec and Holdway, 1999).

One exception to this was noted when *in situ* burning was utilized on the *HONAM JADE* spill that occurred off the coast of South Korea in 1993. Reportedly burn residues from heavy Arabian crude oil sank and adversely affected crabs being reared in nearby submerged pens. However, specific impacts were not identified in detail in any available publications. This burn was conducted on a spill that was nearly 3 km in diameter. Most *in situ* burns are conducted on spill sections of much smaller volume. Burn residue contamination is likely to be local in scale when it occurs (Shigenaka and Barnea, 1993).

Thresholds and Recovery Patterns

Thresholds for subtidal contamination vary significantly depending on the hydrocarbon compound under consideration. There are sediment quality guidelines, which were developed for the National Status and Trends Program, available for many of the PAHs of the most concern, as well as for total PAHs (NOAA, 2000b). These can be used as thresholds in areas with soft sediments. The effects range-low (ERL) value, which represents a conservative criterion based on its definition as a level where toxicity effects may begin to be observed, is approximately 4,000 ppb for total PAH. The effects range-median (ERM), which represents the 50th percentile, is approximately 45,000 ppb. The

PAHs of concern represent only a small fraction of crude oil, so these values must be multiplied at least tenfold to represent total petroleum hydrocarbons (TPHs). On this basis, TPH values would need to be in the range of 40 to 100 ppm to represent a concern. Thresholds for invertebrates and fish can be based on the information provided in Section 4.3.2.3, since the sensitivities are similar for benthic and water column species.

Recovery of contaminated sediments can be very slow, since the chemicals of concern (usually PAHs) may be bioavailable for years or decades. However, the results of a single, or even several, oil spills rarely leads to levels of concern because the limited amount of oil that reaches the bottom is not concentrated enough to exceed the thresholds. Spills in extreme weather conditions rarely will lead to localized areas of potentially significant contamination. Most concerns for benthic habitats involve areas of continuous hydrocarbon contamination from sources such as urban runoff or industrial pollution (such as polluted harbors), where long-term consequences have been observed. Once the source of the hydrocarbons is removed, sedimentary processes and biodegradation will gradually reduce the availability of the compounds. In complex subtidal communities, such as seagrass beds or coral reefs, recovery from single spill events is generally related to the growth rate and reproductive capacity of the key species and can take from 1 to several years.

4.3.2.6. Areas of Special Concern

Habitat areas of special concern are those areas of particular importance that may require additional protection from oil spills. These areas are defined on the basis of their ecological importance, sensitivity, exposure, and rarity of the habitat. These areas are usually protected by the federal government and may exist as marine protected areas or reserves (such as Marine Sanctuaries and Estuary Research Reserves), National Park units, National Wildlife Refuges, or National Forests.

Areas of special concern are identified in Section 3.X.2.6 for each of the six geographic regions. As stated previously, the proposed regulations apply only to waters where pre-authorization agreement areas exist, which are generally demarcated as waters in the United States greater than 3 nm from shore[9]. Only those areas that include intertidal or subtidal habitat are considered in this analysis. The risks to such areas have been described for the various resource or habitat types, but the potential levels of concern increase for areas with a high biological or socioeconomic value. These areas are most at risk from floating oil and benefit from any actions that reduce the potential for oiling. The levels of concern are highly site specific.

4.3.3. Consequences to Threatened, Endangered, or Candidate Species

Whenever an oil spill occurs, the risk to protected species is always a critical concern. If the spill occurs in an area where such species are present, the ACP always includes provision for special efforts to minimize the risk to such species. The threatened, endangered, or candidate species that are usually of concern during oil spills include a variety of bird species, all marine mammals, and sea turtles. Some species of fish, notably anadromous species such as salmon, may also be protected. Terrestrial species that are sometimes found near the coast may also be of concern, but are less likely to be affected than are marine or coastal species. The risks to birds, marine mammals, and sea turtles are greatest from floating oil and from oil that strands on the shoreline. Any response that reduces these conditions will benefit birds or marine mammals. Fish could be at risk from those sources, as well as from oil dispersed or dissolved in the water column. Whether fish would benefit from reduction in floating or stranded oil is more species dependent. The biological risks for three of these key groups, marine mammals, marine and coastal birds, and plankton and fish have been described in Sections 4.3.2.1, 4.3.2.2, and 4.3.2.3, respectively. The risks to sea turtles are presented below. Since protected species tend to be geographically restricted or very rare, it is difficult to assess the specific risk except on a site-by-site basis. If affected, populations of protected species ware more likely to be at risk than populations of more abundant, similar species because of their limited numbers and the potential effects on reproducing adults.

4.3.3.1. Sea Turtles

All sea turtle species and their life stages are vulnerable to the harmful effects of oil though direct contact or by fouling of their body, habitats, and food sources (MMS, 2001). Eggs, hatchlings, and small juveniles are particularly vulnerable to oil contact. Laboratory experiments show that crude oil has detrimental effects on sea turtle eggs, hatchlings, and juveniles. In general, sea turtle nests are located above the high tide level and usually are only susceptible to being coated with oil at very high tides. When nests do become oiled (by oil seeping down to the buried eggs) the unhatched sea turtle eggs are at increased risk. The number of unhatched eggs in a nest is much higher when fresh crude oil is on the surface of the sand during the last half or quarter of incubation. This effect is associated with crude oil aromatics entering the nest's atmosphere and results in a reduction of available oxygen during a critical developmental phase in which the embryo's oxygen consumption is reaching its peak. When oiled nests do produce viable young, the hatchling weight is generally lower and the animal size is smaller. This also applies when the eggs are exposed to a light dosage of oil mixed in the sand (Research Planning, Inc., 1991). Weathered oil, which is the most likely condition for oil that would contaminate nests, is less toxic to turtle eggs than fresh crude oil. When a new nesting season occurred after a year of weathering, there would be little residual risk (Research Planning, Inc., 1991).

Hatched turtle young that are exposed to oil respond by increasing their dive time and by diving deeper. With all sea turtles, regardless of age, oil exposure increases respiratory rate and decreases blood glucose level. Crude oil exposure causes reddening and sloughing off of the skin of juveniles, which can reduce the viability of the individual and increase the chance of infection (Research Planning, Inc., 1991). The oil also causes an immune system response, which is indicated by an increase in the white blood cells. The oil also interferes with the functioning of the salt gland, thereby upsetting the water balance and internal ion regulation (Research Planning, Inc., 1991). In the natural environment, disease and predators may kill already weakened animals exposed to oil, while in lab experiments test animals usually rehabilitate well from oil exposure (Research Planning, Inc., 1991). Tissues around the eyes and other mucous membranes would presumably be most sensitive to contact with hydrocarbons. A break in the skin barrier could act as a portal of entry for pathogenic organisms, leading to infection, neoplastic conditions, and debilitation. Experiments on the effects of hydrocarbons have shown that sea turtles are adversely affected by short exposure to weathered oil. Sea turtles accidentally exposed to oil or tar balls may suffer breathing disturbances, red blood cell disturbances, and digestive disorders or blockages. Although disturbances may be temporary, long-term effects remain unknown, and chronically ingested oil may accumulate in organs. Hatchling and small juvenile turtles are particularly vulnerable to contacting or ingesting oil because floating oil often concentrates in the debris mats where these young animals are sometimes found (MMS, 1996). Exposure to hydrocarbons may be fatal, particularly to juvenile and hatchling sea turtles (MMS, 2001).

Turtles feed on objects floating at the water surface. This makes them susceptible to floating or partially submerged tar balls. The oil that is ingested by the turtles does not pass rapidly through the digestive tract but is instead retained for several days. During this time toxic components of the oil can be passed on to other organs or tissues (MMS, 1996, 2001; Research Planning, Inc., 1991). Many detrital and filter feeders that turtles feed on concentrate pollutants. Some species of sea turtles eat pelagic jellyfish, which concentrate contaminants (because of their place in the food web). Because these turtles specialize in this one prey item, they could ingest high levels of chemicals (Research Planning, Inc., 1991).

Adult sea turtles do not appear to detect and avoid oil spills. Oil can adhere to the body surface of marine turtles. Oil has been observed to cling to the nares, eyes, and upper esophagus and even seal the mouth. Marine turtles may become entrapped by tar and oil slicks and rendered immobile (MMS, 1996, 2001). Turtles can potentially be exposed to the tar, which accumulates in the windrows of gulfweed (*Sargassum* sp.). When their flippers become coated with the tar, they may try to clean their flippers, thereby contaminating their mouths. The tar may then impede feeding, which could lead to starvation (Research Planning, Inc., 1991). Some captive turtles exposed to oil either reduced the amount of time spent at the surface, possibly avoiding the oil, or became agitated and had short submergence levels (MMS, 2001). Either behavior change could increase stress in the animals.

Effects of On-Water Mechanical Recovery

Mechanical recovery would benefit turtles by removing surface oil and minimizing shoreline impacts. The risks involved during mechanical recovery operations are virtually the same as those for floating oil. Encounters with boomed oil will result in oiling similar to encounters with an uncontained oil slick. Operation of mechanical recovery equipment and vessels is not expected to result in increased risk since sea turtles would have no difficulty avoiding slow-moving response vessels. In addition, ACPs address ways to minimize impacts, and responders are trained to watch for and avoid sea turtles.

Effects of On-Water Chemical Dispersion

In the open ocean or areas where there is sufficient tidal flow, dispersant application would treat surface oil and prevent shoreline oiling, thereby reducing exposure. Dispersants would be present at such low concentrations that they would not pose a risk, and even if sprayed, sea turtles would be at minimal risk, in contrast to many marine mammals or birds, because they do not rely on body oils and fur or plumage to create insulating layers or waterproofing (see Appendix G). Chemically dispersed oil would dilute rapidly enough to quickly reduce any risk to animals such as sea turtles. The shoreline risk from chemically dispersed oil, if it did contact a breeding beach, would be less than the risk from floating oil since dispersed oil is less likely to adhere to eggs or juveniles.

Effects of On-Water In Situ *Burning*

In situ burning of floating oil poses a minimal risk to sea turtles. Since an *in situ* burn would not be initiated with the presence of sea turtles within the burn perimeter, and they will avoid areas where burning is already in progress, the risk to sea turtles during *in situ* burning would be very limited. Residues from *in situ* burns might appear as food items to sea turtles that could be ingested and cause internal harm to these animals, but given the small volume, and the fact that as much residue as possible is recovered, this risk is very low. Based on the chemical and physical properties of the residue, burn residues should have a similar or perhaps reduced toxicity in comparison with naturally occurring tar balls, which turtles are known to ingest. The other consideration for *in situ* burning is the smoke component of the burn. Since the smoke from the burn tends to rise into the atmosphere and occurs for only a limited time, it should not pose a risk to these animals. Because *in situ* burning is unlikely to remove more than a fraction of the floating oil, the risks are very similar to those for floating oil, but somewhat reduced in proportion to the volume removed (Shigenaka and Barnea, 1993).

Thresholds and Recovery Patterns

Sea turtles are less sensitive to floating oil than are marine mammals with fur or birds, but contact with oil slicks can put them at risk to at least temporary physiological damage. On oiled shorelines, adults coming ashore to breed would probably only be affected by relatively thick oiling, but juveniles and eggs could be affected by even thin layers of stranded oil.

Recovery times for populations of sea turtles would be on the order of years (for the loss of juveniles or eggs on a nesting beach) to decades for the loss of an adult. In an extreme situation, the oiling of a primary breeding area for one of the more threatened species could be extremely severe unless the young could be rescued.

4.3.4. Consequences to Essential Fish Habitat

Essential Fish Habitat (EFH) is those waters and substrates necessary to federally managed fish for spawning, breeding, feeding, or growth to maturity (MSA, 16 U.S.C. 1802(10)). Because of the wide variation of habitat requirements for a multitude of species for each of their life-history stages, most estuarine and marine waters and substrates from the shoreline to the seaward limit of the U.S. Exclusive Economic Zone (EEZ) have been designated as EFH. In addition, numerous rivers and streams have been designated as EFH because of utilization by federally managed diadromous species.

Those waters specifically identified as EFH can be found on-line[10] for each of the six geographic regions. For the purposes of this document, the threat to EFH can be best characterized by the risk to either fish or the benthic habitat. The results of the modeling for plankton and fish and for subtidal habitats are applicable to EFH. There is often a direct relationship between the volume of oil spilled that is naturally dispersed into the water column and the potential for adverse effect on EFH. As the volume of dispersed oil increases, the potential risk of toxic hydrocarbon components being present in the water column also increases. Potential adverse effects increase as spill volume increase, with greatest concern for severe weather conditions and increased oil dispersion. In general, an EFH might be judged more susceptible to the toxic effects of oil and dispersants than areas that are not categorized as "essential habitat." ACPs review this issue when response options are evaluated, and such areas receive special consideration. Decisions concerning the best response strategy to protect such areas must be made on a case-by-case basis.

4.3.5. Consequences to the Socioeconomic Environment

This section addresses the potential effects an oil spill may have on the socioeconomic environment. Although oil spills have the capability of producing a variety of economic and social impacts, these effects are generally not significant when measured at the regional or national levels. Instead, impacts are typically felt in communities located near resources oiled by a spill. Significant impacts are generally limited to those economic sectors and populations of the community that depend on natural resources affected by the spill, including commercial and recreational fishing operations, recreation and tourism industries, and subsistence and cultural resource users.

4.3.5.1. Coastal Communities, Demography, and Employment

Oil spills can affect multiple aspects of a coastal community's economy, culture, and quality of life. The reliance of these communities on marine-related resources and industries (e.g., recreation and tourism, commercial fishing, maritime commerce) can lead to disruptions in employment, business revenue, import and export of materials, and other economic factors. A broad range of coastal communities exist, from the millions of people and diverse industries of the Galveston Bay region of Texas, to the isolated community of Cordova, Alaska, where the majority of the 2,500-person population is employed in fishing-related industries or tourism.

Coastal regions offer environmental amenities, recreational activities, and distinct job opportunities that many residents value highly. As a result, oil spills that negatively affect the environment will have corresponding adverse effects on members of coastal communities. For example, a spill that oils the shoreline, kills wildlife, and/or emits a petroleum odor can change the local resident's behavior and reduce their quality of life. Cleanup of the contaminated coastal area may require trucks, boats, and increased human presence, thus reducing the social welfare of the coastal community by disrupting the daily lives of its inhabitants (e.g., increased traffic, noise pollution, aesthetic disamenities). Even after cleanup is completed, a coastal area may be perceived as tainted; members of the coastal community may believe that the ecosystem is no longer pristine, diminishing the amenities provided by and value of the resource. This perception of taint can reduce the desirability of living in the region by decreasing demand for housing, reducing property values, and negatively affecting the property owners in the coastal community. The possible effects of an oil spill on a coastal community include, but are not limited to, the following:

- Risks to fisheries industries including fish and shellfish harvesting and processing
- Disruption of maritime commerce
- Decline in revenue for local businesses engaged in or supporting marine-based economic sectors
- Losses incurred by subsistence and artisinal fishermen (the latter being fishermen whose practice is rooted in cultural tradition and whose products may not enter formal markets)
- Risks to tribal, Native, and/or other ethnically defined communities
- Real and perceived risk to human health
- Reduction in quality of life of residents of and visitors to the spill area
- Financial obligations borne by local governments associated with spill response and cleanup activities

For the most part, the effects suffered by coastal communities as a result of an oil spill will persist only in the short to medium term. However, in the unlikely event that a spill forces the permanent closure of a fishery, for example, a spill may yield longer-term impacts. As such extreme events are rare, discussion of socioeconomic impacts in this section and the following sections focuses predominantly on short- to medium-term effects. The expected influence of various response options on socioeconomic factors within coastal communities is similar across other categories of potential impact (e.g., commercial fishing). Therefore, benefits and limitations of the various response options are discussed generically below, and only additional, category-specific information is included in subsequent sections, as needed.

Small to medium oil spills generally have minimal impacts on either demography or employment since the impacts of these events generally last only days or weeks. This is especially true in more populated areas where the employment base is likely to be diverse and less reliant on marine resources. Very large spills may have a temporary effect on both demography and employment, especially in remote or sparsely populated areas. For example, the workforce involved in the *EXXON VALDEZ* oil spill cleanup added a significant seasonal population to the local communities in Alaska for 3 years. Ultimately, however, even the effects of large spills on demography and employment are temporary and are expected to be local in nature.

Effects of On-Water Mechanical Recovery

Mechanical recovery is likely to mitigate the effects of spilled oil on coastal communities, demography, and employment and therefore is expected to provide socioeconomic benefits to coastal communities. Mechanical recovery of oil may reduce the amount of shoreline oiled or the area of surface water oiled, thus lessening the impacts on marine resource users (e.g., less surface water oiled may reduce the potential for fishery closures and eliminate the risk of job losses). In the case of major oil spill events, the recovery effort, in addition to the spill itself, may be large enough to significantly affect social and economic aspects of communities in the spill area. Cleanup of any beaches, piers, marinas, and other coastal resources will be noticeable to local residents and potentially disruptive to social and economic activities. Coastal communities also may serve as staging locations for offshore activities, with significant numbers of workers passing through. This effect can be both negative (in the form of disruption) and positive (in the form of enhanced revenue for local businesses). Large-scale oil spill cleanup operations can require a significant number of workers over an extended period of time. In some cases, response managers may hire local workers displaced by the spill, such as local commercial fishermen, to assist in the cleanup. Nonlocal workers and managers also require lodging and food, which can offset the losses hotels and restaurants, might otherwise suffer from a reduced number of tourists.

Effects of On-Water Chemical Dispersion

Dispersants are a countermeasure used to reduce the surface oil and its impact on the environment. The proposed regulations apply only to waters where pre-authorization agreement areas exist, which are generally demarcated as waters in the United States greater than 3 nm from shore[11]. Therefore, it is unlikely that dispersants will affect coastal areas directly (NOAA, 2002a). To the extent that coastal areas do experience effects of dispersants, they are likely to be positive in that dispersants reduce the quantity of surface oil from a spill, potentially reducing the quantity of oil that washes ashore or affects natural resources. This may subsequently reduce the negative perceptions residents and visitors may have regarding spill areas adjacent to coastal communities and may correspondingly reduce the risk to resource-dependent job markets.

Effects of On-Water In Situ *Burning*

NOAA (2002b) has stated that *in situ* burning can reduce sheen and surface oil quicker than mechanical recovery or natural processes. NOAA (2002c) has further stated that a properly planned *in situ* burn can mitigate the impact on coastal areas and recreational activities. If the burn occurs close to shore, the visible smoke plume can be an aesthetic and health concern, albeit a short-lived one. In addition, studies have concluded that *in situ* burning does not pose a significant threat to human health, especially at distances over 500 m, and so burns used to address offshore spills are not likely to affect the health of coastal communities directly (Fingas et al., 2001; Westphal et al., 1994). As such, the application of *in situ* burning would be expected to reduce the total socioeconomic impact of most spills on coastal communities, demography, and employment. However, although NOAA burning procedures require conditions that imply that any smoke will travel away from populated areas, the actual or potential presence of this smoke in or within view of a coastal community might affect recreation, tourism, and/or the overall quality of life of residents of that coastal community (NOAA, 2002d). Although most burn residue will be mechanically removed or will sink, the residue could potentially wash ashore, creating an environmental disamenity. Any expected negative impacts of *in situ* burning on demography and employment would be expected to be short-term and localized in nature, such as job disruptions in the tourism sector.

Thresholds and Recovery Patterns

There is no specific threshold or quantifiable relationship between the amount of oil spilled and the expected magnitude and duration of impact on a coastal community, its demographics, or its employment. Factors such as location of the spill, weather conditions at the time of the spill, season of the spill, and effectiveness of cleanup will all act to determine the scope and duration of the impact. It is expected, however, that such impacts will be linearly related to the proportion of physical resources at risk in a given spill area above generalized exposure thresholds (e.g., just visible sheen). That is, spills that result in greater oiling of shoreline or a larger area of surface water swept by oil will, on average, result in greater socioeconomic effects. Results based on specific monetary measures of damage, if they could be developed, would not be expected to differ significantly from the risk metrics presented in this analysis (Transportation Research Board, 2001).

Limiting the exposure of shorelines to spilled oil and minimizing the extent of surface water oiling will act to reduce the magnitude and duration of effects of spills on coastal communities. As such, response actions that minimize the physical impacts of spills will be expected to reduce the total expected socioeconomic impacts on affected coastal communities, demography, and employment.

4.3.5.2. Economic Status

The overall economic status of communities, industries, and individuals that rely on coastal resources for sustenance, revenue, and quality of life can be affected by an oil spill. As noted above, coastal communities can suffer directly and indirectly from an oil spill, as beach and fishery closures decrease revenue, eliminate jobs, and adversely affect subsistence users of the resources. More specifically, losses will be felt in commercial and recreational fisheries, both by the anglers themselves and by related industries as catch opportunities decrease or are eliminated entirely. Tourism and associated businesses will suffer economic setbacks as visits to affected coastal areas decline and purchases of area goods (e.g., fish in restaurants) decrease because of perception of resource taint, and environmental justice issues may arise as low-income or minority communities are disproportionately affected by the spill.

Coastal regions offer environmental amenities, recreational activities, and distinct job opportunities that many residents value highly. As discussed in the previous section, oil spills that negatively affect the environment will have a corresponding adverse effect on members of coastal communities. For example, a spill that oils the shoreline, kills wildlife, and/or emits a petroleum odor can change the behavior and reduce the quality of life of a community's residents. Cleanup of the contaminated coastal area may require trucks, boats, and increased human presence, thus reducing the social welfare of the coastal community by disrupting the daily lives of its inhabitants with increased traffic, noise pollution, and the aesthetics of natural resources. Even after cleanup is completed, a coastal area may be perceived as tainted; members of the coastal community and visitors to the region may believe that the ecosystem is no longer pristine, diminishing the amenities provided by and value of the resource. This perception of taint can reduce the desirability of living in the region, decrease demand for housing, reduce property values, and negatively affect the property owners in the coastal community.

As an integral part of coastal communities, commercial fishing and related industries like fish and shellfish processing rely on natural resources that are susceptible to injury from oil spills. Any major reduction in the volume of fish harvest because of an oil spill, such as oiled fish or fishery closures, can adversely affect onshore processing facilities and cause a corresponding reduction in employment and revenue. For example, after the *EXXON VALDEZ* spill, hundreds of fishermen were at least temporarily unable to harvest, and three local fish processing plants in Cordova, Alaska, were shut down for most of the season. Plant workforces were reduced from approximately 225 employees to less than 100, and some processors were forced to import fish to supplement their raw materials, thereby suffering lower profit margins (Piper, 1993).

An oil spill that initially decreases revenue for tourism, maritime commerce, and commercial fishing industries will have a subsequent detrimental effect on other sectors of the local economy. Industries within any geographic area are interdependent in the sense that they purchase output from various industries and sectors, while also supplying inputs to other businesses. Thus, the contribution of a particular industry or activity to the regional economy is greater than its individual output. A lobsterman may sell his catch to a local processor or distributor and at the same time locally purchase equipment and supplies (traps and bait). As a result, the effects of an oil spill on a lobster fishery may be significantly greater than just those borne by local lobstermen, potentially affecting regional revenues and employment across multiple industries.

Oil spills will generally not result in significant changes in economic status at either the regional or national levels. These effects, if significant, will be felt at the local level within populations and economic sectors that depend on the marine environment. In most cases, the effects of even large spills on the economic status of a community will be short term, on the order of weeks or months.

Effects of On-Water Mechanical Recovery

Mechanical recovery is likely to mitigate the effects of spilled oil on overall economic status in a manner that parallels the impact of this response action on coastal communities. First, mechanical recovery is expected to reduce the amount of resources oiled, causing a subsequent reduction in the adverse effects experienced by resource users. Second, in the case of major oil spill events, the recovery effort itself may be large enough to temporarily have a significant economic effect on the local community, perhaps increasing employment opportunities and income levels.

Effects of On-Water Chemical Dispersion

Chemical dispersion is likely to mitigate the effects of spilled oil the economic status of affected communities in a manner that parallels the impact of this response action on coastal communities. That is, to the extent that coastal areas experience effects of dispersants, they are likely to be positive in that dispersants reduce the quantity of surface oil from a spill, potentially reducing the quantity of oil that washes ashore or affects natural resources. This will allow for lessened impacts on the general economies of coastal communities and the specific industries related to marine resources (e.g., commercial fishing and recreation, and tourism).

Effects of On-Water In Situ *Burning*

In situ burn techniques are also likely to mitigate the effects of spilled oil on an affected community's economic status in a manner that parallels the impact of this response action on coastal communities. That is, to the extent that coastal areas experience effects of *in situ* burning, they are likely to be positive in that *in situ* burn application is expected to reduce the quantity of surface oil from a spill and to potentially reduce the quantity of oil that washes ashore or affects natural resources. This will allow for lessened impacts on communities and industries that rely on marine resources for success. Any expected negative impacts of *in situ* burning on a community are expected to be short term and localized in nature.

Thresholds and Recovery Patterns

There is no specific threshold or quantifiable relationship between the amount of oil spilled and the impact on a community's economic status (see discussion in Section 4.3.5.1). However, limiting the exposure of shorelines to spilled oil and minimizing the extent of surface water oiling will act to reduce the scope and duration of such impacts. As such, response actions that minimize the physical impacts of spills will be expected to reduce the total expected impact of an oil spill on a community's economic status. It is expected, however, that such impacts will, on average, be linearly related to both the area of surface water and the length of shoreline used for marine activities that are swept by oil. Results based on specific monetary measures of damage, if they could be developed, would not be expected to differ significantly from the risk metrics presented in this analysis (Transportation Research Board, 2001).

4.3.5.3. Vessel Transportation and Ports

An oil spill can disrupt maritime commerce if it results in the presence of significant quantities of oil in a shipping channel or at a port, or if it results in a moratorium on watercraft usage. Any interruption of marine commerce can affect a coastal community. For example, in 1990 the *SHINOUSSA* collided with two tank barges, releasing approximately 17,000 bbl of oil into Galveston Bay, Texas. The USCG Marine Safety Office (MSO) closed the Houston Ship Channel to all traffic, forcing boat traffic to use longer alternate routes or wait for passage for 3 days before limited use was permitted; the channel was not reopened for all traffic until 10 days later (NOAA-HMRAD, 1992). Similarly, barges incurred increased travel time and transportation costs—additional payroll costs, fuel expense, and port fees—when the *BAYWAY* released oil into the Arthur Kill, New Jersey, in 1990, forcing barges to travel around Staten Island, New York, to reach their desired ports (Meade and Unsworth, 1990). While these spills occurred in nearshore waters, the impact of closures because of the presence of oil from an offshore spill, while rare, could be similar.

The consequences of disruptions on maritime commerce are not limited to longer travel times and increased costs for the companies involved in this activity. Businesses depending on prompt delivery of inputs and raw materials for production will be negatively affected by delays. Further, firms that provide maritime services and/or supplies will suffer from any sort of stoppage. Intra- and international trade are important to local, state, and national economies. For example, Maryland exported $5 billion worth of goods to foreign markets in

2000, with more than half of this volume originating from the port of Baltimore (USDOC-ITA, 2001).

Effects of On-Water Mechanical Recovery

Mechanical recovery is likely to mitigate the effects of spilled oil on vessel transportation and ports by reducing the duration of any slowdown in operations, rerouting, or port closure. The ultimate cost of a spill to businesses that rely on marine transportation will rise with increased duration or geographic extent of closures. Thus, to the extent that mechanical recovery reduces the duration or extent of marine transportation impacts, it will help minimize the economic costs of oil spills.

Effects of On-Water Chemical Dispersion

As discussed above, dispersants are a countermeasure used to reduce surface oil. To the extent that dispersants can reduce the quantity of surface oil from a spill, their use would be expected to reduce the frequency, duration, and geographic scope of marine transportation impacts.

Effects of On-Water In Situ *Burning*

To the extent that *in situ* burning may reduce the extent and severity of surface water oiling, it would be expected to reduce the frequency, duration, and geographic scope of marine transportation impacts by reducing the geographic or temporal scope of shipping channel closures, and other marine transportation impacts.

Thresholds and Recovery Patterns

There is no specific threshold or quantifiable relationship between the amount of oil spilled and the impact on marine transportation. For example, a waterway might be closed following a spill event to allow for effective spill response, even in the absence of local surface oiling. Alternatively, a waterway might remain open despite the presence of an oil sheen if it is deemed that there is little risk associated with continuance of marine activities. It is expected, however, that such impacts will, on average, be linearly related to the area of surface water used for marine transportation that is swept by oil. Results based on specific monetary measures of damage, if they could be developed, would not be expected to differ significantly from the risk metrics presented in this analysis (Transportation Research Board, 2001).

Limiting the extent of surface oiling will act to reduce the scope and duration of any expected impacts on marine transportation. As such, response actions that minimize the physical impacts of spills will be expected to reduce the total expected impact of an oil spill on marine transportation. In any case, the duration of closures and other impacts on marine transportation are expected to be short lived.

4.3.5.4. Fisheries

Commercial Fisheries

Oil spills can have a wide range of impacts on commercial fishing operations that include, but are not necessarily limited to, the following:

- Closure of the fishery, or loss of access to the fishery because of port or transportation-corridor closures (such effects are generally temporary in nature)
- Perception of taint in fish from the spill area, which reduces the value of the product in the market
- Closure of the fishery to allow for recovery of affected stocks
- Reduced harvests due to reduced stocks
- Change in fishing practices leading to increased costs or diminished revenue, such as the need to access more distant fishing areas outside of the spill area

Marine fisheries are located in areas as diverse as the inlets of Prince William Sound and the waters off the Texas Gulf coast. The severity of oil spill effects on a region's commercial fisheries will be influenced by the location of the spill, target species, and type of equipment used in each fishery. In addition, location, spill size, oil type, and timing—especially weather conditions at the time of the spill—can alter the impacts of an oil spill on commercial fishing. For example, the time of year that an oil spill occurs plays a crucial role in determining whether a fishery will be affected for species that have distinct harvest seasons, and weather will determine if the oil remains on the surface or is dispersed into the water column.

Large oil spills can force a complete closure of a fishery because of increased morbidity/mortality in fish stocks, concern over possible adverse human health effects from consumption of contaminated fish, and/or the existence of an oily taste or odor in fish exposed to the oil (or the perception that fish from an area might have these characteristics). In all three cases, the fishery may remain closed not only until cleanup is completed, but until oil is eliminated from the system, stocks are recovered, or market confidence is returned. Regardless of the reason for the closure, inability to fish could lead to significant losses in revenue for the local commercial fishing industry.

Three examples of the impact of fishery closures include the *NORTH CAPE*, *GLACIER BAY*, and *AMOCO CADIZ* oil spills. The 1996 grounding of the *NORTH CAPE* off the coast of South Kingstown, Rhode Island, resulted in an oil spill of approximately 20,000 bbl that severely affected commercial lobster harvesting. As a result of the spill, coastal ponds and state and federal offshore water fisheries were temporarily closed for fish and shellfish. Although some of these fisheries reopened after only 3 weeks, the more heavily affected areas remained closed to lobstering for 5 months. The spill resulted in an estimated direct kill of over 9 million lobster and increased morbidity for other members of the population. The cost to restore the lobster fishery is estimated to be almost $10 million (NOAA et al., 1999). The 1987 *GLACIER BAY* oil spill released over 380,000 bbl of crude oil into Cook Inlet, Alaska, and resulted in the closure of the majority of the area's salmon fisheries. In addition, fish were contaminated by oiled gear during harvesting. As a result, drift gillnet fishermen and set net fisherman reported a total loss of $53.6 million (MMS, 1990). The 1978 *AMOCO CADIZ* oil spill discharged 1.6 million bbl of oil off the coast of Brittany, France. The spill had an enormous effect on benthic species, resulting in the loss of that year's oyster stocks, a delay in the preparation of oyster culture for next season and diminished oyster harvests for the next few years, resulting in a loss of over $22 million (NOAA, 1983).

Even if the oil spill does not affect a fishery directly (e.g., by killing fish), fishing may still be prohibited because of spill location, potential disruption of cleanup operations, or preservation of public perception regarding the health of the fishery. For example, the spill could occur in a location such that the boats are unable to reach the fishing grounds, or, if the oil spill occurs near a harbor or within traffic lanes, federal agencies may require docking of all boats to prevent disruption of cleanup operations.

In addition, fisheries may be closed to preserve the public's perception that fish sold on the market are of the highest quality and are not tainted by oil. For example, in 1989 the *EXXON VALDEZ* struck Bligh Reef, releasing 11 million gal of crude oil into Prince William Sound. Although some species of fish and shellfish, as well as some area stocks, were not directly in contact with the oil, concern that the fish would become tainted during extraction, transportation, or processing caused NOAA and the state of Alaska to close the herring, shrimp, crab, and salmon fisheries and hatcheries (Piper, 1993). The goal of the closures was to preserve the public's confidence in the safety of fish on the market. Fear of taint can lead to a reduction in the demand for fish, from both consumers and processors, causing economic losses to the commercial fishing industry. A study by Mendelssohn et al. (1993) found that Alaskan salmon and herring prices decreased below expected levels from 1989 to 1991 because of the *EXXON VALDEZ* spill. The study attributes this change in price to a decrease in demand because of consumer perception that the fishery had been tainted.

Oil spills can also force local fisherman to incur higher costs and/or diminished revenue. After a spill, fishermen may either travel farther than usual to reach an uncontaminated fishery, or they may be forced to use a lower quality fishery with lower catch rates, smaller fish, or species with lower market values. For example, the *GLACIER BAY* spill caused a closure of most of the salmon fisheries in Cook Inlet during the height of the salmon season. This forced many fishing vessels to travel longer distances to other fisheries, where, because of overcrowding of fishing vessels, catch sizes were reduced (Piper, 1993). The *GLACIER BAY* spill also resulted in another cost for the commercial fishing industry: the replacement of fishing gear ruined by the oil (MMS, 1990).

In some cases, even large oil spills can cause significant environmental damage with minimal impact on commercial fisheries. In 1988 the *NESTUCCA* was punctured by its tugboat, causing the release of 5,500 bbl of oil into Puget Sound. The spill resulted in the collection of over 10,300 oiled birds, with many more believed to have been oiled but not collected; however, commercial fishery losses were small, with only precautionary temporary closures of some crab and mollusk beds (NOAA-HMRAD, 1992).

Finally, in the event of a very large spill, there may be long-term damage to fish habitats and stocks. Long-term damage would imply that the effects on the commercial fishing industry mentioned above would extend farther into the future and force fishermen and the industries that support them to make permanent changes in their business strategies and employment choices.

Recreational Fisheries

While impacts on fisheries from oil spills generally center on the loss of commercial opportunities, recreational fisheries may suffer from similar impacts. Fishery closures, fish consumption advisories, moratoria on boating activities, and perception of taint can reduce recreational fishing activity levels and therefore the economic value of such activities to participants. In some coastal areas, recreational fishing is an important economic resource, and closures or the perception of a diminished resource can lead to significant local economic impacts, such as reduced tourism. Recreational fishing, however, is a seasonal activity; as such, the extent of an oil spill's impact on this activity will depend on the timing of the spill. For example, the *NORTH CAPE* oil spill occurred at the beginning of the winter cod season. Between January 1996 and June 1996, the spill caused a temporary moratorium on fishing, as well as perception of taint among anglers, resulting in a loss of over 3,300 party/charter angler trips for winter cod (NOAA et al., 1999). However, the *GLACIER BAY* oil spill in Cook Inlet, Alaska, a popular fishing destination, occurred at the early part of the season and had no adverse impact on recreational salmon and halibut fishing (MMS, 1990).

Although the relative size of the recreational fishing industry may be smaller than commercial fishing operations in an oil spill location, the impact of various response actions on recreational fisheries, as well as the impact thresholds and recovery patterns following a spill, parallel those described for commercial fisheries. Therefore, the discussions in the Commercial Fishing Section on the effects of mechanical recovery, chemical dispersion, and *in situ* burning, as well as information on thresholds and recovery, apply to recreational fishing as well.

Effects of On-Water Mechanical Recovery

No adverse impacts on commercial and recreational fisheries are expected to occur from mechanical recovery. Rather, mechanical recovery is expected to reduce the amount of oil in the environment, thereby reducing exposure of biota to oil and/or impacts on transportation routes and reducing adverse effects on fisheries and associated industries.

Effects of On-Water Chemical Dispersion

Chemical dispersion is a countermeasure used to reduce the impact of oil on surface and near-surface organisms. This remedial measure has the potential to reduce the levels of oil in the water as well as the area affected, leading to a corresponding reduction in the risk of adverse socioeconomic effects on fisheries and related industries. Dispersants reduce both sheen and oil in the upper 2 m of the water column more quickly than mechanical recovery or natural processes, and thus would be expected to allow for the rapid removal of oil and a faster resumption of offshore commercial fishing activities.

Current restrictions make it unlikely for dispersants to be applied near any coastal fisheries or shallow water or intertidal harvested mollusk and shellfish beds, eliminating any direct effect of dispersant use on nearshore commercial and recreational fisheries. Offshore fisheries could be at risk from application of dispersants, but field trials of dispersants have demonstrated that after application, dispersed oil is rarely detectable more than a few meters, usually less than 5 or 10, below the surface (NRC, 1989).

Effects of On-Water *In Situ* Burning

In situ burning will act to reduce the sheen and surface oil more quickly than mechanical recovery or natural removal, allowing for a more rapid resumption of commercial and recreational fishing and a reduction in the risk of adverse socioeconomic effects to fisheries and related industries. Although *in situ* burning can have some ecological impacts such as a "small adverse effect" on the upper reaches of the water column, including fish eggs or larvae, and possibly on benthic resources because of sinking residue, these effects are expected to be very localized in nature, less severe than exposure to the oil itself, and insignificant in terms of adverse impacts on the fishing industry (NOAA, 2002b, c).

Thresholds and Recovery Patterns

There is no specific threshold or quantifiable relationship between the amount of oil spilled and the impact on commercial and recreational fisheries in the spill area. For example, a fishery might be closed for an extended period of time following a spill event to protect the integrity of the products from the spill area in the market. Similarly, a fishing fleet may be unable to access a fishery, given the need to close to allow for effective spill response, even in the absence of local surface oiling. The severity and duration of damage to a fishery resulting from an oil spill will be influenced both by the amount of oil spilled and the retention time of the oil in that particular environment, among other factors. Estimating the impact of an oil spill on a fishery requires consideration of factors such as spill location, weather conditions at the time of the spill, oil type, seasonality of the spill, cleanup effectiveness, and fishery characteristics. Absent spill specific information, it is expected that such impacts will, on average, be linearly related to the area of surface water swept by oil that supports commercial and recreational fisheries. Results based on specific monetary measures of damage to specific fisheries, if they could be developed, would not be expected to differ significantly from the risk metrics presented in this analysis (Transportation Research Board, 2001). Irrespective of the conditions that occur at a particular spill site, any mechanism for reducing the quantity of oil spilled and the amount of time that the oil remains in contact with the environment will mitigate the impact on commercial and recreational fisheries.

4.3.5.5. Subsistence

When an oil spill damages natural resources, it is likely to harm local subsistence users as well as commercial fishermen. In some coastal areas, portions of the population rely on regional fisheries and marine species for subsistence or as part of an artisanal economic system—a system in which resources are harvested, sold, and consumed within the local community. Individuals in areas such as Prince William Sound, Alaska, rely on their own harvests from the ocean for a significant portion of their diets. These individuals may experience the effects of a spill more directly than the general population, which relies on a more widespread and commercially available selection of foods.

Subsistence use of natural resources has value beyond that of a food source. Many communities associate their subsistence use with their ethnic and cultural identities, subscribing to a unique lifestyle built around environmental awareness and interaction with the same natural resources that are susceptible to injury from oil spills. Damage to these resources not only disrupts a major source of food for these communities, but it also can cause a loss of cultural identity. As a result, cash payments or replacement food supplies cannot compensate fully for losses caused by an oil spill, as subsistence use incorporates aspects of history, culture, social identity and family, and food supply.

Species collected and consumed in subsistence communities include finfish, bivalves, crustaceans, octopus, squid, seals, walruses, whales, waterfowl, seaweed, and algae. The state of Alaska has a large population of Native people who rely on marine mammals, birds, fish, and shellfish for subsistence (Field et al., 1999). Harvesting marine fish, invertebrates, and algae is also very important in the Native Hawaiian culture. Little research has been done on oil contamination of subsistence species other than fish and invertebrates; therefore, these groups will be the primary focus of this review.

In general, finfish seldom become tainted because they are able to avoid oiled areas and can rapidly metabolize oil (Law and Hellou, 1999; Law et al., 1997; Moller et al., 1989), while shellfish are more likely to become contaminated because of their lack of mobility and feeding strategies. The level and persistence of contamination in shellfish depends on the behavior of the oil, shoreline types, and cleanup techniques used. Typically, wind and currents transport floating oil on the water surface to the shoreline where it strands. Stranded oil can directly coat intertidal habitats, organisms, and fishing and cultivation equipment. If large volumes of oil penetrate permeable substrates, such as sand beaches, gravel beaches, and rocky rubble shores, there can be episodic releases of relatively fresh oil. If these areas are also sheltered from direct wave energy, the potential for long-term persistence of oil is greatly increased. Natural removal processes usually include physical breakup and dispersal of persistent oil residues over a period of months to years, during which time it remains available to intertidal and shallow subtidal beds of mussels, oysters, and clams (Hayes and Michel, 1999; Shigenaka and Barnea, 1997; Shigenaka and Henry, 1995). The longest fishery closure periods have been for bivalves in areas where sediments remained heavily contaminated for long periods of time (up to 19 months) following spills (Fall and Field, 1996).

Tissue samples collected from harbor seals and sea lions following the *EXXON VALDEZ* oil spill showed very low accumulations of PAHs in blubber even for highly exposed animals. These results indicate that marine mammals are able to metabolize oil and prevent accumulation even in blubber (Field et al., 1999).

Regardless of the actual degree of taint or contamination of subsistence resources, confidence in the safety of harvesting species that typically make up the majority of the diets of Native Alaskans was severely affected following the *EXXON VALDEZ* oil spill (Field et al., 1999). Despite multiple reports based on extensive monitoring of subsistence seafood stating that finfish from all areas were safe to consume, but that intertidal shellfish from specific contaminated areas should not be consumed, post-spill harvests of marine species declined dramatically in Native villages (Fall, 1999; Fall and Field, 1996). After the first post-spill year, the amount of resources harvested gradually increased but after 5 years still averaged less than the amount harvested prior to the spill (Fall, 1999). In addition to fears about consuming contaminated food items, Native villagers were very concerned about the future of the resource populations, considering the large number of dead and dying birds, marine mammals, and invertebrates they witnessed on their beaches, and they chose to harvest less or not harvest certain species at all (Fall, 1999).

Even assuming high consumption rates, the possibility of a subsistence seafood consumer being exposed to hydrocarbon levels high enough to cause an acutely toxic effect is unlikely. No adverse effects were observed in rats exposed to doses of 150 mg/kg/d of benzo[a]pyrene (BaP) for 1 to 4 days (Danz et al., 1991; Nousianen et al., 1984). The highest concentrations of PAHs reported for mussels collected from contaminated areas following the *EXXON VALDEZ* spill were 45.2 mg/kg (dry weight) in one study, and approximately 25 mg/kg (wet weight) in another (Bence and Burns, 1995; Short and Harris, 1996). A concentration of 34 mg/kg (wet weight) for PAHs was reported for a finfish collected following the *NOWRUZ* spill in the Gulf of Arabia (Fayad et al., 1996). Reported values for most finfish and shellfish samples collected from spills are much lower than these, and even these levels would appear to pose little acute toxicity risk to the general population. Certain population groups, such as pregnant women and children, may experience adverse effects at lower exposure levels than the general population, as was the case in studies on reproduction in mice exposed to high levels of BaP (Legraverend et al., 1984; Mackenzie and Angevine, 1981).

Effects of On-Water Mechanical Recovery

Open-ocean mechanical recovery will reduce the amount of oil that reaches important nearshore harvest areas, which would benefit subsistence resources. However, mechanical recovery operations, especially along the shoreline and in traditional harvest areas, may influence harvesting patterns. Following the *EXXON VALDEZ* oil spill, Native communities were severely disrupted by the intrusiveness of the massive cleanup effort (Peacock and Field, 1999). Almost all villagers abandoned their normal ways of life to assist in oil recovery, to monitor the oil path while fisheries were closed, and to rescue and to collect dead and dying wildlife (Peacock and Field, 1999). Intracommunity relationships were stressed, as Native Alaskans, particularly those who owned boats, were offered monetary compensation to assist in the cleanup effort, resulting in debates within the communities about the morality of aiding the polluter (Russell et al., 1996).

Effects of On-Water Chemical Dispersion

Dispersants are not likely to be directly applied to floating oil in nearshore areas where many subsistence harvest activities occur. Intertidal habitats could be exposed to dispersed oil that is carried close to shore by currents after offshore application. Yet, overall impacts on intertidal habitats and to seals and sea lions when they are hauled out on the shoreline will be reduced compared with floating oil slicks.

In the water column, chemical dispersion will increase the risk of oil exposure and potentially taint organisms in the upper layers of the water column compared with floating oil (NRC, 1989). Following the *BRAER* oil spill of 84,700 tonnes of light crude oil, hurricane-force winds caused the oil to naturally disperse into the water column, resulting in contaminated bottom sediments and tainted benthic organisms, including haddock, dab, lobsters, and scallops (Topping et al., 1997). The wild fishery was closed for 2 months, while the lobster fishery was closed for over 6 years (Kingston, 1999). Even in the absence of an actual health threat or closure, subsistence users can lose confidence in the safety of seafood. Hearing that the oil is being dispersed into the water column may increase their fear that seafood may not be safe to eat.

Chemical dispersion can increase the risk of tainting filter-feeding bivalves because they can readily uptake dispersed oil. Ackman et al. (1991) found that scallops experimentally exposed to chemically dispersed oil in the water column had hydrocarbon levels several orders of magnitude higher than scallops exposed to crude oil alone. Sensory panelists were able to recognize taint in scallops that had been exposed to dispersed oil more easily than taint in scallops that were exposed to oil alone.

Effects of On-Water In Situ *Burning*

Impacts on subsistence resources from open-ocean *in situ* burning could result from exposure to the untreated oil and semisolid, tar-like burn residues that float, strand onshore, or sink in harvest areas. Studies have shown that about half of internationally transported crude oils tested tend to sink in seawater after burning (Buist and Trudel, 1995). Impacts from untreated oil will be similar to those discussed above for oil, except that the reduction in the amount of stranded oil will result in lower numbers of potentially contaminated resources and fewer impacts on the subsistence community. Impacts on nearshore habitats and species from the sinking of burn residues will primarily be a result of physical coating of both animals and traps used to collect them. The extent of impact on subsistence users is likely to be small because only a small amount of residue will form.

It is unlikely that water column organisms will be affected at the burn site because toxic volatile and soluble fractions of oil are typically consumed in the fire (Campbell et al., 1994). Burning will actually reduce the risk of dissolution of these more bioavailable compounds. Overall, *in situ* burning should reduce the risk of impacts on subsistence resources and their users.

Thresholds and Recovery Patterns

Recovery time—return to background PAH levels or the absence of taint—for subsistence resources varies greatly by species, duration of exposure, degree of contamination, metabolic capability, and other factors. Case studies from several spills show that wild finfish are rarely tainted; the duration of taint from the *BRAER* spill, during which a large amount of a light crude oil was naturally dispersed under storm conditions, was less than 1 month (Whittle et al., 1997). The duration of taint for lobsters following the *NORTH CAPE* spill, during which a No. 2 fuel oil was naturally dispersed during storm conditions, was between 2.5 and 5 months (Mauseth et al., 1997). Bivalves, particularly filter feeders, are likely to show elevated levels of PAHs shortly after exposure, although elimination rates can be rapid (less than 1 month) (Meador et al., 1995). Heavily oiled sediments can be a source of chronic exposure, such as at the *SEA EMPRESS* spill where intertidal mussels remained contaminated in one heavily oiled bay for 19 months after the spill (Law et al., 1997).

4.3.5.6. Archaeological/Historic Resources

Potential damage to cultural resources both on the shoreline and under the water, including archaeological and historical sites, needs to be addressed following an oil spill, as do the risks associated with various cleanup options (Bittner, 1996). Floating oil on the water surface is not typically considered to be a threat to cultural resources, as long as the oil stays offshore and does not adhere to intertidal or shoreline areas (Mobley et al., 1990). Shoreline resources are at much greater risk than underwater resources, since oil rarely contaminates sediments enough to affect such areas, and subtidal cleanup is very rarely an issue. Resources in very shallow water could be affected by shoreline cleanup and nearshore operation of equipment.

In Alaska, the types of cultural resources potentially present in the intertidal zone include stone and wooden remains, petroglyphs, shipwrecks, piers and pilings, bone, shell, metal, textiles, leather, midden deposits, and other items and features that were historically associated with domestic and commercial facilities, villages, and cultural practices (Mobley et al., 1990). In Hawaii, cultural resources located along the shoreline include subsurface deposits, stone and food remains, broken tools, charcoal and pollen (used for dating), and remnants of trails and agricultural fields (Cordy, 2001). These resources are historically associated with permanent and temporary habitations, burials, and religious structures, and they may be present in a variety of habitats, including low and high dunes, sandy flats, beaches, floodplains, and along rocky and clay shorelines (Cordy, 2001). In Puerto Rico, sites such as Spanish colonial forts, bridgeheads, walls, and remnants are present in nearshore areas; artifacts such as shells and pottery pieces are present in sand dunes (McKinley and Pantel, 1995).

Potential impacts on cultural resources during an oil spill include direct contact with oil, which may physically or chemically alter the artifact or feature (Mobley et al., 1990). One problem associated with the physical coating of artifacts by oil is that the oil may render them temporarily unidentifiable by archaeologists, although, in most cases, oil is quickly removed by wave action (Mobley et al., 1990). Results from several studies (Bittner, 1996; Dekin, 1993; Reger et al., 1992; Wooley and Haggarty, 1995) indicated that direct oiling caused negligible impacts on cultural resources following the *EXXON VALDEZ* oil spill. Also, for those artifacts that were oiled, it was possible to clean them with detergents and degreasers, which will not damage the artifacts if applied properly (Mobley et al., 1990). Yet, historical structures along the shoreline were re-oiled daily in San Juan, Puerto Rico, following the 1994 *MORRIS J. BERMAN* spill of No. 6 fuel oil. Little is known about the chemical effects of oiling, although there is some concern about foreign hydrocarbons affecting the possibility of using radiocarbon dating techniques on artifacts following spills (Mifflin & Associates, 1991; Mobley et al., 1990). Yet, Reger et al. (1992) found that radiocarbon dating was still accurate at sites contaminated with oil during the *EXXON VALDEZ* spill.

Cultural resources can also be affected by the disturbance or destruction of resources during shoreline cleanup, with indirect effects resulting from the presence of cleanup crews in the area. Some cleanup techniques are more likely to cause damage to cultural resources than others (Mobley et al., 1990). For spills that affect cultural resources, cleanup guidelines often require that an archaeologist be present during cleanup at the site to assure that the cultural resources are not damaged during cleanup activities, as well as to assure that artifacts are not removed by workers. Manual removal of oil and oily debris by hand, rake, shovel, or sorbent use may cause disturbance to the sediments and the artifacts associated with them. Other indirect impacts on cultural resources may include the creation of debris or the movement of sediments or artifacts that may compromise the integrity of the site or later be misinterpreted by archaeologists as historical features. Mechanical removal of oil and oiled sediments, as well as washing, flooding, and vacuuming, involves using heavy equipment that may damage artifacts. High-pressure washing, burning of oiled surfaces, using abrasives, and altering or removing any sediment have the potential for negative impacts on cultural resources (McKinley and Pantel, 1995; Mobley et al., 1990).

Therefore, open-water response options, such as mechanical recovery, chemical dispersion, and *in situ* burning, may help reduce the amount of oil that strands on the shoreline, which will also reduce the amount of shoreline clean up and disturbance of sensitive cultural resources.

Effect of Mechanical Recovery

No additional adverse impacts on cultural resources are expected to occur from mechanical recovery. Impacts on shoreline resources will be reduced by the amount of oil recovered.

Effects of On-Water Chemical Dispersion

The only documented chemical dispersion in association with cultural resources along shoreline habitats was during an experimental treatment of *EXXON VALDEZ* oiled shorelines in 1989 (Mobley et al., 1990). In this case, a dispersant was applied directly to oiled substrates potentially containing archaeological and/or historical sites. No adverse impacts on cultural resources were recorded following the treatment.

Because the proposed regulations apply only to waters where pre-authorization agreement areas exist, which are generally demarcated as waters in the United States greater than 3 nm from shore[12], and dilution is so rapid, impacts on cultural resources related to the chemical properties of dispersants are very unlikely. Impacts on the shoreline and intertidal resources, including cultural sites, will most likely be reduced when dispersants are used, compared with floating oil slicks. There are limited data that identify long-term or chronic degradation to cultural resources due to chemical dispersion.

Effects of On-Water In Situ *Burning*

Impacts on shoreline cultural resources from open-ocean *in situ* burning may include the stranding of untreated oil and burn residues onshore. Burn residues are semisolid and tar-like, and would most likely cause less harm to artifacts with which they came in contact than would untreated oil because less residue is likely to adhere to the artifacts. *In situ* burning may also reduce the amount of untreated oil that comes ashore. The only documented negative effect of *in situ* burning on cultural resources is the direct burning of artifacts in the intertidal zone, such as wooden shipwrecks (Mobley et al., 1990). Open-ocean *in situ* burning would be far enough offshore not to affect intertidal areas directly. The small amount of residue from *in situ* burning of oil on water would pose a minimal risk to subtidal archaeological sites if the residues sink.

Thresholds and Recovery Patterns

Two issues will trigger thresholds of concern for cultural resources: (1) the amount of oil that may damage an artifact, and (2) the amount of oil that would require shoreline cleanup and place the artifact at risk of damage during cleanup activities. There is no information from which to estimate the amount of oil that might damage specific types of artifacts. For cleanup-related impacts, the threshold would be the same as discussed for shoreline habitats. Recovery usually occurs at the completion of the cleanup activity; otherwise, the artifact may be permanently damaged.

4.3.5.7. Recreation and Tourism

Recreation and tourism in coastal areas can consist of visiting developed and undeveloped landscapes and doing on-water activities, such as swimming and boating. Expenditures for recreation and tourism can be a significant component of the local economy. For example, in 1998, beach recreation in the state of California generated $14 billion in direct revenue and $73 billion through indirect and induced benefits (Kingston, 1999). Major recreational and tourist resources include coastal beaches, barrier islands, estuarine bays, sounds, river deltas, and tidal marshes. These resources can be publicly owned (national seashores, parks, beaches, wildlife areas, or preservations) or privately owned (resorts, marinas, or amusement parks).

Oil spills that occur near coastal areas can have a significant impact on recreation and tourism. The extent of the impacts depends on the following:

- The season in which the oil spill occurs
- Whether the oil comes ashore
- Whether a perception of contamination exists
- Whether there is a closure of a recreational beach, fishing waters, and/or boating areas
- The time period needed for natural resources to recover (e.g., whales may not return to popular whale-watching areas for an extended period of time)

One key determinant of an oil spill's impacts on recreation and tourism is the season in which the spill occurs. Oil spills that occur immediately prior to or during peak seasons will have a more significant impact on local economies than oil spills occurring during off-peak months. For example, approximately 60,000 tonnes of oil washed ashore from the *AMOCO CADIZ* oil spill on March 16, 1978. As a result, 245,000 fewer people visited Brittany, France, a popular tourist destination during July and August, in that year (NOAA, 1983). In contrast, impacts of the 1996 *NORTH CAP*E oil spill occurred from January to April, when recreational beach usage in southern Rhode Island is minimal (NOAA et al., 1999). Other regions of the United States do not have such a significant divide between peak and off-peak tourism and recreation seasons; Padre Island National Seashore in Texas receives a significant number of visitors year-round (NPS, 2001a).

Although offshore oil spills have little direct impact on recreation and tourism (since oil never reaches the shoreline), nearshore oil spills can result in coastal oiling and have a significant effect on local economies and social welfare. While the presence of oil offshore could affect offshore recreational activities such as deep sea diving and fishing, recreationalists will generally have substitute locations for such activities, and the number of individuals involved is small compared with onshore and nearshore activities. The most detrimental impact is usually a beach closure, reducing the number of visitors and harming the local economy. When the *AMERICAN TRADER* ruptured, spilling almost 9,500 bbl of oil into the Pacific Ocean in 1990, 14 mi of beaches, including Huntington Beach, California, were closed for 23 days (NOAA and Oregon State University, 1992). The lost recreation days were valued at $13.2 million (State of California, 2001), with regional economic effects likely far greater (e.g., lost revenues to local businesses).

Even in the absence of an oiled shoreline, offshore oil spills can adversely affect recreation and tourism in coastal areas because of a perception of taint or a shutdown by a regulatory agency. A decrease in beach visits might occur because of the presence of a petroleum odor or news coverage of the oil spill incident. In all cases, visitors may change their behavior, such as canceling a trip to the coastal region or choosing to recreate at a different beach or parkland. Substitution of a less desirable recreational location, as well as loss in revenue from the local coastal community, would cause a reduction in social welfare (changes in producer and consumer economic surpluses or the benefits derived by consumers and producers from the exchange of goods and services).

Effects of On-Water Mechanical Recovery

Regulatory agencies can enact beach closures and recreational fishing moratoriums, or restrict watercraft usage in anticipation of the use of mechanical recovery equipment. No additional adverse impacts on recreation and tourism are expected to occur from mechanical recovery. Rather, mechanical recovery is expected to reduce the amount of oil in the ecosystem, thereby decreasing the amount of oil washing up on shore and minimizing impacts on recreation and tourism (less oil may decrease the length of any beach and/or fishery closures).

Effects of On-Water Chemical Dispersion

Chemical dispersion is a countermeasure used to reduce surface oil and its impact on the environment. The proposed regulations apply only to waters where pre-authorization agreement areas exist, which are generally demarcated as waters in the United States greater than 3 nm from shore[13]. Therefore, it is unlikely that dispersants will affect any coastal areas, thus eliminating any direct adverse effect on nearshore recreational areas. In addition, as dispersants reduce the quantity of surface oil from a spill, less oil is likely to wash ashore and affect beach usage or recreational fishing and boating. Finally, a rapid reduction in surface oil will minimize any moratoriums on recreational watercraft usage.

Effects of On-Water In Situ Burning

NOAA (2002a) believes that *in situ* burning reduces sheen and surface oil quicker than mechanical recovery or natural processes, thereby decreasing the risk of beach closure and allowing for a more rapid resumption of recreational and tourism activities. NOAA (2002b) further states that a properly planned *in situ* burning can mitigate the impact on coastal areas and associated recreation. However, *in situ* burning will also produce large quantities of highly visible black smoke that is potentially harmful to humans (see Section 4.3.5.10 and NOAA, 2002c for more details). Although NOAA burning procedures require that the smoke travel away from populated areas, the actual or potential presence of this smoke in a recreational area could result in a reduction in beach usage (NOAA, 2002d). Finally, although most burn residue will be mechanically removed or will sink, the residue could potentially wash ashore and disturb the aesthetics of natural resources, thus leading to a reduction in recreation and tourism.

Thresholds and Recovery Patterns

There is no specific threshold or quantifiable relationship between the amount of oil spilled and the impact on recreation and tourism in the spill area. For example, a recreational beach may be closed for an extended period of time following a spill event to allow for cleanup activities. Estimating the impact of an oil spill on recreation and tourism requires considering factors such as location of the spill, weather conditions at the time of the spill, oil type, seasonality of the spill, effectiveness of cleanup, and specific recreational activities that occur in the spill area. Absent spill-specific information, it is expected that such impacts will, on average, be linearly related to the area of surface water swept by oil and shoreline oiled that supports recreational activities. Results based on specific monetary measures of damage to specific areas, if they could be developed, would not be expected to differ significantly from the risk metrics presented in this analysis (Transportation Research Board, 2001). Irrespective of the conditions that occur at a particular spill site, any mechanism for reducing the quantity of oil spilled and the amount of time that the oil remains in contact with the environment will mitigate the impact on recreation and tourism.

4.3.5.8. Environmental Justice

When an oil spill affects a low-income, indigenous, or minority community using marine resources for subsistence, concerns about environmental justice are raised. Executive Order 12898 (p. 1) states that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations," and identifies subsistence users of fish and wildlife as communities of concern. In addition to subsistence groups, many ethnic minority communities, such as the Vietnamese-American population of fishermen along the Texas Gulf coast, are centered on coastal industries. Regardless of the type of interaction between the community and the injured resources, disproportionate effects on any such population merit special attention. This general concern regarding environmental justice is further reinforced by research indicating that damage to natural resources has a greater psychological effect on Native groups and their community structure than on Anglo or white populations (Palinkas et al., 1992).

Along many shorelines, environmental justice is related to the potential for disproportionate impacts of an oil spill on low-income groups. While coastal property may be expensive, its price is not necessarily a reflection of the resident population's income or of those that rely on coastal resources. Counties along the Eastern Shore of Virginia include many low-income communities. In 1999, the median household income for Virginia was $46,677, but for Accomack and Northampton Counties on the Eastern Shore, these figures were much lower, at $30,250 and $28,276, respectively (U.S. Census Bureau, 2000a). In the state of New Jersey, it is estimated that 8.5 percent of people live below the poverty line, but in Atlantic City 23.6 percent live below the poverty line, more than double the county average (Atlantic County, 10.5 percent), and almost three times the state average. In Penns Grove and Salem City, both coastal towns, the figure is above 20 percent. Further, more than 25 percent of Wildwood City's population lives below the poverty line versus 8.6 percent for Cape May County as a whole (U.S. Census Bureau, 2000a, b).

Effects of On-Water Mechanical Recovery

Mechanical recovery is likely to mitigate the effects of spilled oil on environmental justice in a manner that parallels the impact of mechanical recovery on income and employment in coastal communities. That is, mechanical recovery of oil following a spill would be expected to affect environmental justice in ways similar to those that this recovery technology has on general levels of employment and income in coastal communities, as discussed in detail in the preceding sections. Mechanical recovery of oil may reduce the amount of shoreline oiled or the area of surface water oiled, thus lessening the impacts on marine resource users. As mentioned above, in the case of major oil spill events, the recovery effort itself may be large enough to have a significant economic effect on the local community, perhaps increasing employment opportunities and income levels, with potential benefits to low-income communities. If there is a rise in demand for food and lodging services from cleanup efforts, low-income and minority groups may find new job opportunities or higher wages for jobs where labor is in short supply.

Effects of On-Water Chemical Dispersion

Chemical dispersion is a countermeasure used to reduce the surface oil and its impact on the environment. To the extent that coastal areas do experience effects of dispersants used in pre-authorization agreement areas, these effects are likely to be positive in that dispersants reduce the quantity of surface oil from a spill and potentially reduce the quantity of oil that washes ashore or affects natural resources, thereby reducing the potential for adverse social and economic effects on low-income and minority groups.

Effects of On-Water *In Situ* Burning

In situ burning can reduce sheen and surface oil quicker than mechanical recovery or natural processes and mitigate the impact on coastal areas by reducing the amount or extent of resources oiled, thereby reducing the adverse effects on low-income and minority groups. The visible smoke plume, if the burn occurs close to shore, can be an aesthetic and health concern, albeit a short-lived one.

Thresholds and Recovery Patterns

There is no specific threshold or quantifiable relationship between the amount of oil spilled and the impact on environmental justice. There is good reason to believe, however, that monetary damages are linearly related to the portion of physical resources at risk; thus, results based on monetary measures of damage would not be expected to differ significantly from the resource risk-based measures presented in this analysis (Transportation Research Board, 2001). Further, factors such as location of the spill, weather conditions at the time of the spill, season of the spill, and effectiveness of cleanup will determine the severity of the impact, thus influencing the resources at risk as well as the recovery time period. In addition, the unpredictability of oil spill damage increases the importance of methodologies that mitigate the impact of the oil spill, such as dispersants and *in situ* burning, and can reduce the recovery time for coastal communities, thus minimizing impacts on low-income and minority groups.

4.3.5.9. Public Safety and Worker Health

Offshore oil spills do not generally represent a risk to public safety since the event occurs at a distance from potential population concentrations. Oil stranded on the shoreline can represent a risk of air pollution or present a physical hazard to the public if the public comes in contact with the oil, but these concerns are generally minimal. Restricting access easily controls these risks. Any response option that reduces shoreline oiling will reduce these concerns.

Worker health and safety is always a concern but is less so with proper training. First responders who arrive on-scene before volatile compounds have evaporated could suffer from exposure to hydrocarbon fumes. Similarly, the presence of oil on equipment and vessels can increase the risk of injury. Application of dispersants can expose workers to low levels of dispersants if improperly applied. Proper planning and the use of protective equipment can be minimized by all these concerns.

In the event of an offshore oil spill, individuals living in coastal communities are unlikely to experience any of the acute health effects associated with exposure to oil. However, spills in Alaska, Wales, and Scotland measured significant elevations in mental health symptoms in local populations that included anxiety, depression, and post-traumatic stress disorder. Researchers associate these symptoms with both the oil spill itself and indirect effects such as the stress of potential loss of jobs or subsistence resources (Palinkas et al., 1993). For example, oil spilled offshore can contaminate fish, shellfish, marine mammals, birds, and other sources of food. Concerns regarding such contamination were so significant following the *EXXON VALDEZ* spill that representatives of state and federal agencies, Native Alaskan organizations, and Exxon formed a task force that analyzed tissue samples from affected species for oil-related contaminants. Only a few samples collected from the most heavily oiled locations exhibited elevated levels of contaminants, and public health warnings consisted of advising people against consuming anything that smelled of oil. Similar measures were taken following the *NEW CARISSA* spill off the coast of Oregon in 1999. While an oil spill may contaminate fish, shellfish, and other marine and coastal species, local, state, and federal health officials generally identify and publicize associated risks to reduce the likelihood of consumption and corresponding harm to human health.

4.4. ANALYTICAL APPROACH USED TO EVALUATE THE IMPACTS OF RESPONSE OPERATIONS

4.4.1. Analytical Methodology

The impacts of oil spills are difficult to predict and are highly site and event specific. Understanding the potential impacts of the alternatives within this context is even more difficult. There is a large body of knowledge about the effects of oil spills that can be used to understand the broad implications of spills in general, but the analysis of the alternatives is easier to understand if there are specific, quantitative estimates of how the various alternatives could benefit the environment by changing oil spill response options, as well as what any associated risks might be. The best approach to obtaining such estimates is through simulation modeling of potential oil spill events. Since there are broad regional differences in the current response capabilities and environmental concerns, the USCG has chosen to address impacts for each of the six geographic regions presented in Chapter 3. Oil spills vary dramatically in size, which is a major factor in determining risk, so the model examines the probable effects of a small (200-bbl), medium (2,500-bbl), and large (40,000-bbl) oil spill, as defined in Section 4.1. Using the modeling results to confirm (or modify) the expectations from the scientific literature review allows for a more rigorous analysis of the risks and benefits of the alternatives.

The analysis of the alternatives presented in this PEIS is based on combining four elements. First, the generic information presented in Section 4.3 is used to establish broad expectations for the effects of oil spills in general; these expectations establish a range of probable impacts for oil spills in the various geographic regions. Second, a model was selected that can be run in a probabilistic mode to examine average and extreme events, thus allowing for the analysis of oil spill fates, as well as biological exposure and effects; five representative locations of the six geographic regions around the United States were selected as sites of a detailed modeling using the oil spill model (Section 4.4.2). Third, the results of the modeling effort were evaluated using a relative risk approach (Section 4.4.3). Finally, all this information was integrated to evaluate the expected regional impacts, which were used to develop a national perspective on the risks and benefits of the various alternatives (Sections 4.5 through 4.10).

4.4.2. Modeling of Oil Spill Impacts for Five Representative Locations

4.4.2.1. General Modeling Rationale

A comprehensive understanding of the structure (species composition and relative abundance) and function (energy flow and nutrient cycling) of aquatic ecosystems is necessary to understand the potential effects of environmental fluctuations and stressors such as oil spills. The structure, function, and dynamics of aquatic ecosystems can only be understood by considering biological processes at the level of individual populations acting in concert with processes over the domain of the entire community (Mann, 1988). Local processes at the species level permanently change macroscopic properties of the system, which then impose new constraints on the species themselves (Mann, 1988). Thus, a holistic approach is necessary for the derivation of ecological patterns at the ecosystem level (Gaedke, 1995).

However, the complexity of aquatic ecosystems does not allow the consideration of ecosystem dynamics in its entirety, forcing one to abstract from the particular situation under study. Therefore, ecosystem dynamics should be studied from as many angles as possible. This task is facilitated by the use of conceptual and mathematical models. Models, as simplified descriptions of the real world, portray distinct features of the natural systems they are designed to aid the study of. Hence, mathematical models are essential in promoting an increased understanding of the dynamics of aquatic ecosystems. Models are designed to either reproduce observed biological, physical, and chemical patterns, or to predict the effects of natural or anthropogenic environmental fluctuations on the temporal and spatial dynamics of the structure and function of the ecosystems they describe (Mantilla, 1999).

Dynamic simulation models allow the unique possibility of studying the dynamic nature and spatio-temporal organization of aquatic ecosystems. In addition, they represent a coherent way to investigate direct and indirect cause-effect relationships of a large number of dynamic interacting processes (Gaedke, 1995).

4.4.2.2. *Oil Spill Modeling Rationale*

The fate and impacts of oil spills will vary based on environmental conditions at the time of the spill and the biological and socioeconomic resources exposed to the oil. The available data from real spill case studies are not sufficient to indicate potential impacts on all resources in every combination of conditions that might occur. However, the information learned from past spills, as well as from laboratory and tank studies, has been analyzed and synthesized into oil fates and effects models, which represent an understanding of the processes and potential for impacts. Modeling provides quantitative estimates of the potential pathways and fates of the oil, and thus estimates of exposure to the water surface, shorelines and other habitats, water column, and sediments. These estimates may be used to evaluate potential impacts on wildlife, aquatic organisms, shorelines, habitats, and socioeconomic uses of those resources. The alternative to modeling would be to make general statements about impacts, which would make the distinction between dispersant use versus no-dispersant use scenarios, for example, imprecise and based on subjective judgments using incomplete information. The modeling results provide quantitative best-estimate results that can be compared in an objective manner.

The oil spill modeling was performed using the SIMAP model developed by Applied Science Associates (ASA). SIMAP contains both physical fates and biological effects models. In a recent review of oil spill models (NRC, 2003), SIMAP was found to be the most comprehensive model available based on the fates processes simulated, the inclusion of a biological exposure and effects model, and the ability to run the model in stochastic (probabilistic) mode (necessary for ecological risk assessments). SIMAP has been validated for more than twenty case histories, including the *EXXON VALDEZ* and other large spills (technical report [French McCay et al, 2004]; French and Rines, 1997; French McCay, 2003, 2004). SIMAP also makes use of a recently published oil toxicity algorithm that addresses the different toxicities of the various hydrocarbons in oil and their additive toxic effects (French McCay, 2002).

SIMAP was developed from the oil fates and biological effects submodels in the Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDAM/CME, Version 2.4, April 1996), which ASA developed for the U.S. Department of the Interior for use in NRDA regulations[14]. While the NRDAM/CME is focused on NRDAs for specific hindcasts, SIMAP is designed to evaluate fates and effects of both real and hypothetical spills, including running in stochastic mode to evaluate a probability distribution of results, rather than just a single result for a specific hindcast.

The oil fates model in SIMAP uses wind data, current data, and transport and weathering algorithms to calculate mass balance of oil components in various environmental compartments (water surface, shoreline, water column, atmosphere, sediments, etc.), oil pathway over time (trajectory), surface oil distribution, and concentrations of the oil components in water and sediments. Hourly wind speed and direction data over a long historical period were obtained from nearby meteorological stations for each representative location. Tidal and other currents were modeled based on known water heights using a hydrodynamic model based on physical laws, which conserves mass and momentum. Geographical data (habitat mapping and shoreline location) were obtained from existing Geographical Information System (GIS) databases based on ESIs. Water depth was available from NOAA's National Ocean Service (NOS) soundings databases. SIMAP was used to evaluate exposure of aquatic habitats and organisms to whole oil and the potentially toxic components.

SIMAP was run in stochastic mode to determine the probabilities and degrees of exposure, assuming each of the response options being considered. In stochastic mode, a large number of simulations (i.e., 100) were run for each of the selected sites, oil release and oil response scenarios, varying the spill date and time, and thus the environmental conditions, for each run. The output of the stochastic model includes time histories of a large number of spill trajectories. These distributions are used to estimate the percentage of runs (weather conditions) where water surface, water column, and shoreline areas would be affected by a release from the given site; to determine the highest exposure in time for each possible environmental condition (each run); and to identify the distribution of degrees of exposure for all runs. The mean and standard deviation of degree of exposure for the 100 runs provided the estimates used in the risk assessment.

There is essentially an infinite number of possible spill sites and scenarios that could be modeled, as well as a wide range of biological and socioeconomic resources that could be impacted. The objective of the modeling was not to statistically describe the universe of possible results for all possible permutations of model inputs and assumptions, as for example in a Monte Carlo design. Rather, the purpose of the modeling was to examine a manageable but sufficient set of representative spill volumes, locations and scenarios to provide quantitative estimates of impacts that could be compared among the alternatives and inform the analysis of risks.

The ultimate risk analysis is expressed in relative terms, in recognition that the entire universe of impact results has not been quantified. Because oil spill impacts vary most by the weather and current transport conditions after the spill—such that examining single arbitrarily chosen or historical scenarios would be biased and not representative—the randomization in the stochastic modeling is to vary the spill date, and so the specific weather (wind speed and direction sequence and temperature) and current patterns. Thus, the variability addressed is that related to weather and currents, but not to other uncertainties in the inputs such as the location of the spill, rate of release, and dispersion coefficients.

SIMAP provided estimates of hydrocarbon mass lost to the atmosphere by volatilization. These data were input to an air dispersion model, which is part of the chemical fate and transport model CHEMMAP (Chemical Spill Model Application Package[15]). The air dispersion model simulated the wind transport, turbulent dispersion, and degradation rate of hydrocarbons evaporated from the spill, with an output of concentration in the lower atmosphere over time. The air emissions from *in situ* burning were evaluated with an empirical burning model developed by Fingas et al. (2001) that predicts air concentrations as a function of distance from the fire. The predicted air concentrations were compared with air quality criteria as part of the analysis.

Oil Fates Model

The oil fates model estimates the distribution of oil (as mass and concentrations) on the water surface, on shorelines, in the water column, and in sediments. The model is three-dimensional, using a latitude-longitude grid for environmental and geographical data. Algorithms based on state-of-the-art published research include spreading, evaporation, transport, dispersion, emulsification, entrainment, dissolution, volatilization, partitioning, sedimentation, and degradation. Oil mass is tracked separately for lower molecular weight aromatics (MAHs and PAHs) that are soluble and cause toxicity (in reality and in the model), other volatiles, and non-volatiles. The lower molecular weight aromatics dissolve from floating oil and oil droplets, and are adsorbed to particulate materials in the water column and sediments according to standard equilibrium partitioning theory (French et al., 1996, 1999; French McCay, 2004). The algorithms and assumptions of the oil fates model are described in French et al. (1999) and French McCay (2004), and summarized in Part A of the technical report (French McCay et al., 2004).

All but a very few oils are lighter than water at the time they are spilled. If released under water, oil droplets are formed, which surface rapidly because of the buoyancy of the oil relative to water. Wind and currents transport the surface oil until it strands on shorelines. Oil may be entrained (mixed) into the water by high winds. Entrained droplets may adsorb to suspended sediments and settle to the bottom because of the higher density of the combined material, which occurs most commonly in shallow waters with high wave activity. In addition to these processes, the model simulates dissolution of the toxic aromatic components from the entrained droplets and the fate (and effects) of these aromatics in the water column and sediments.

The SIMAP oil fates model quantifies the following outputs, in space and over time, for each individual model run:

- Spatial distribution of oil mass and volume on water surface over time
- Oil mass, volume, and thickness on shorelines over time

- Subsurface oil droplet concentration, as total hydrocarbons, in three dimensions over time
- Dissolved aromatic concentration in three dimensions over time
- Total hydrocarbons and aromatics in sediments over time

Biological Effects Model

The algorithms and assumptions of the biological effects model are described in detail in Part A, Section A.2 of the technical report (French McCay et al., 2004) and are summarized in this section. The biological effects model estimates the area, volume, or portion of a population affected by surface oil, concentrations of oil components in the water, or sediment contamination. The model calculates the extent and duration of exposure based on the outputs of the oil fates model. A rectangular grid of habitats represents the area potentially affected by the spill, with each grid cell coded according to its habitat type. Habitats considered include various offshore, nearshore, reef, wetland, and shoreline environments that have unique assemblages of species. A contiguous grouping of habitat grid cells with the same habitat code represents an ecosystem in the biological effects model. Fish, invertebrates, birds, mammals, and production rates of organisms lower in the food chain are assumed constant and evenly distributed across an ecosystem within the time period of the simulation. Fish, birds, and mammals are assumed to move at random within each ecosystem. Planktonic stages (eggs and larvae in the water column) move with the currents.

In the biological effects model, surface slicks affect wildlife such as birds, mammals, and reptiles. A portion of wildlife in the area affected by a slick over a threshold thickness—area swept—is assumed to die based on probability of encounter with the slick and mortality once oiled. Area swept is calculated for the habitats occupied by the behavior group. Species are assigned to behavior groups to evaluate their loss. The threshold is 10 micron (~10 g/m^2) thick oil, based on data and calculations in French et al. (1996). Estimates for the mortality probabilities are derived from information on behavior and field observations of mortality under similar circumstances (French et al., 1996). Wildlife mortality is directly proportional to area swept, probability of mortality for the behavior group, and species abundance per unit area. Percent mortality for a population of interest is calculated as the area swept times probability of oiling, divided by the area occupied by the population.

Fish and their eggs and larvae are affected by dissolved aromatic concentration (in the water or sediment). Because exposures in the water column are short (hours to days), mortality is calculated using laboratory acute toxicity test data (LC50) corrected for temperature and time of exposure, and assuming a log-normal relationship between percent mortality and dissolved concentration—the relationship of percent mortality to log(concentration) is the bell-shaped Gaussian distribution. LC50s for the mixture of the most toxic components of oil, dissolved MAHs and PAHs, are used to define the center of that log-normal function. The effects of the MAHs and PAHs are additive, and LC50s for the oil mixture are estimated using an additive (toxic unit) formula. LC50s for the most sensitive species tested are used in this study to provide a conservative analysis (French McCay, 2002).

For plankton, fish, and invertebrates, movements of biota, either active or by current transport, are accounted for in determining time and concentration of exposure. Tracers representing schools or groups of animals move or remain stationary with respect to currents in the model according to the behavior of the animal type, and concentration and duration of exposure are recorded. Exposures are integrated over space and time by habitat type to calculate a total percentage killed.

Behavior groups are used to represent species or stages within species. The following behavior groups cover the possible movement patterns (or lack thereof) for aquatic organisms (plankton, fish, and invertebrates):

- Planktonic (move with currents)
- Demersal and stationary (within 1 m of the ocean bottom exposed to water near the ocean bottom)
- Benthic (in the sediments and stationary)
- Demersal fish and invertebrates (on the ocean bottom exposed to water near the ocean bottom and moving slowly)
- Small pelagic fish and invertebrates (moving randomly and slowly throughout the water column)
- Large pelagic fish and invertebrates (moving randomly and rapidly throughout the water column)

The biological effects model tracks organisms in six habitat types, which are assumed indistinguishable to organisms occupying the same given habitat type. These six habitat categories account for the fact that fish and other aquatic biota tend to prefer one or more of these types: offshore (marine) open water, estuarine open water, marine wetland and seagrass, estuarine wetland and seagrass, marine reef, and estuarine reef.

Mortality is calculated as percent loss in specified areas, which is translated into the equivalent area of 100 percent loss. That area is divided by the total area of habitat available in the region of interest to estimate a percentage of a population affected.

The biological effects model has been validated using simulations of about thirty spill events where data are available for comparison (French and Rines, 1997; French McCay, 2003, 2004). In most cases, only the wildlife impacts could be verified because of limitations of the available observational data (French and Rines, 1997). However, in *NORTH CAPE* spill simulations, both wildlife and water column impacts on lobsters could be verified (technical report [French McCay et al., 2004]; French McCay, 2003).

Modeled Scenarios

There are many possible spill scenarios that could be modeled, as well as an essentially infinite number of potential spill sites. However, the modeling was performed for a finite number of scenarios that is sufficient to provide understanding of the expected effects resulting from spills under the various response options. A stochastic (probabilistic) approach was used to allow the range and frequency of possible environmental conditions to be examined for each possible spill site, spill volume, and response option. Long-term (decade or more) wind and current records were sampled at random. Model runs were performed for each spill date-time selected, which provides a statistical description of the environmental fate and effects that would result if a spill occurred. The alternative of examining selected individual model runs would not be representative of all possible events and would provide biased results. Moreover, it is impossible to determine *a priori* (before running many model runs) what particular environmental scenarios would be representative or worst case. In addition, what is representative or worst case varies by the resource examined.

Stochastic modeling was performed in five modeling locations of the United States that are all high-risk areas and are broadly representative of the six geographic regions in this PEIS. The following five modeling locations were chosen to represent the major environmental and ecological regions in U.S. waters:

- Offshore of Delaware Bay representing the Atlantic region
- Offshore of Galveston Bay representing the Gulf of Mexico region
- Offshore of San Francisco Bay representing the Pacific region
- Prince William Sound representing the Alaska region
- The Florida Straits representing the subtropical and tropical Caribbean and Oceania regions[16]

In evaluating potential impacts of spills in the six geographic regions considered in this PEIS, inferences were drawn from the modeling results from all regions. For example, for the five modeling locations, the amount of water surface oiling and the water volume contaminated is similar for a given spill volume and the same environmental conditions. Thus, the results of a specific spill site can be extrapolated to other locations.

With respect to the biological effects, the major habitats are unique to each of these five modeling locations. For example, south Florida contains mangrove forests, tropical seagrass beds, and coral reefs typical of the Caribbean and Oceania regions. The Atlantic coast contains salt marshes dominated by *Spartina* spp. and eelgrass beds, while the Pacific coast contains kelp beds and wetlands dominated by species other than *Spartina*. Alaskan waters, while also unique, have ecological similarities to the areas off Maine and Washington-Oregon. The fish and invertebrates of these habitats also vary by these broad regions. In addition, the temperature and weather regimes that are input into the model will cover the characteristic ranges of each modeling location.

While these five modeling locations are broadly representative of major ecological systems, no one site can provide specific information for an entire geographic region. The purpose of the modeling effort is to examine generalities about the spills, based on the stochastic treatment, which can then be applied more broadly. For example, if modeling results for the Florida Straits indicate that water concentrations of concern for corals are never exceeded more than 1 mi away from the spill site, regardless of environmental conditions, then it is reasonable to assume that in any similar geographic region there may be a similar limited risk to corals. On the other hand, if the model results indicate that surface oil could significantly contaminate shorelines at significant distances, then a similar threat may exist in other areas of near equal distance from shore. These considerations were made on a resource-by-resource basis, as discussed in Sections 4.5 through 4.9 and Parts B through F of the technical report (French McCay et al., 2004).

Oil fates and biological effects modeling were used to provide data to be used in the evaluation of potential impacts of alternative response scenarios in this PEIS. In addition, air dispersion modeling was performed to evaluate potential impacts of spills and response actions on air quality. The objectives were to provide an assessment of the potential pathways and fate of the oil, thus estimating exposure to the water surface, shoreline and other habitats, water column, and sediments. These were used to evaluate potential impacts on wildlife, aquatic organisms, and habitats on a region-by-region basis.

The spill site was assumed to be 7.5 statute mi from shore, which is the midpoint of the nearshore area as defined in 33 CFR 155.1020 (approximately 3 to 12 nm offshore). The nearshore area is the worst case location for currently pre-authorized dispersant use, as dispersants cannot be used closer than approximately 3 nm from shore[17], and dilution would be less than the dilution that would occur in waters further than 12 nm from shore. Results from the midpoint of the nearshore area may be used to infer potential impacts in the entire area, and the water column impacts will be worse than those that would occur if the spill were further offshore than 12 nm.

Two spill volumes were assumed, for medium (2,500-bbl) and large (40,000-bbl) spills. USCG regulations (33 CFR 155.1020) define various spill sizes, and these volumes were developed from those definitions, as discussed in Section 4.1. The regulations define the WCD as the loss of all cargo from a tank vessel; however, the use of this volume would overwhelm any of the available response options and prevent any discrimination between the alternatives. On that basis, the "large" volume was selected to be the loss of cargo from two storage tanks, which is approximately 40,000 bbl. The MMPD is defined as 2,500 bbl, so this volume was used to represent a "medium" spill.

The oil types modeled were South Louisiana crude oil for the Atlantic, Gulf of Mexico, and Florida modeling locations and Alaskan North Slope crude oil for the Pacific and Prince William Sound modeling locations. These oils were chosen to be representative of shipping in each geographic region, and to be consistent from region to region to allow comparisons.

Three response scenarios were modeled for each of the two spill volumes and for each of the five modeling locations:

- Mechanical removal at present levels of capability, or with some of that removal accomplished by *in situ* burning
- Same mechanical removal response as above, or with some of that removal accomplished by *in situ* burning, plus dispersant application at 45 percent efficiency (based on minimum dispersant effectiveness criteria established in the National Oil and Hazardous Substances Pollution Contingency Plan [NCP, 40 CFR part 300]
- Same mechanical removal response as above, or with some of that removal accomplished by *in situ* burning, plus dispersant application at 80 percent efficiency (based on theoretically successful dispersant operation)

The modeled response scenarios apply to one or more of the alternatives being considered in the PEIS, depending on the combination of response capabilities required. For example, for Alternative 1 in the Atlantic, Caribbean, Pacific, and Oceania regions, only mechanical recovery or *in situ* burning would be used because appropriate response times cannot currently be met for chemical dispersion. Thus, the first of the three modeled response scenarios applies to Alternative 1 in these four geographic regions. For Alternative 1 in the Gulf of Mexico and Alaska regions, where dispersant capability currently exists, the modeled response scenarios involving dispersants also apply. For Alternative 3, where dispersant capability would be required, the modeled response scenarios involving dispersants would apply. The applications of the modeled scenarios to the alternatives are described in Sections 4.5 to 4.9.

The specific details of the response scenarios modeled were developed by the USCG based on existing and proposed planning factors, as described in Appendix D. Mechanical removal (skimming) occurs in all water locations where surface oil is present and from hour 12 until hour 96 during daylight only. The light period is assumed 6 A.M.–6 P.M., a 12-hr day. Hourly mechanical recovery rate is 50 percent of the total oil available on the water at the beginning of that hour divided by 48 (the total number of cleanup hours in the 4-d response). The total amount of oil removed is calculated as the summation of the individual hourly rates of removal.. Thus, the total amount removed equals 0.50 (50 percent) divided by 48 hours, which equals 0.0104167, multiplied by the amount of oil floating that hour, summed over 12–96 hours after the spill (during daylight only).

Percent mortality for a population of interest is calculated as the area swept times probability of oiling, divided by the area occupied by the population.

Dispersant application also occurs only in the light period (6 A.M.–6 P.M.) and within location-specific pre-authorized agreement areas. For all locations, dispersants may be applied in waters greater than 10 m deep that are 3 or more nm from shore. No dispersant is assumed applied within Galveston Bay, San Francisco Bay (inside the Golden Gate), Delaware Bay, or within coastal inlets and estuaries near the modeled spill sites.

Because it is proposed to allow *in situ* burning to offset the existing mechanical removal requirements by 25 percent, *in situ* burning is assumed to remove 25 percent of the available oil each hour while the amount removed using mechanical recovery is reduced by 25 percent. Thus, *in situ* burning replaces 25 percent of the mechanical removal when it applies, and both response options remove oil from the water surface with equal effectiveness. The amount burned is 25 percent of the model estimate of the amount cleaned up in a given scenario. It is assumed that burning occurs at a location 3 or more nm from shore, and that the burn volume is available in that area. Thus, for those runs where greater than 75 percent of the cleanup would occur closer to shore (in the absence of burning), the burned volume would be overestimated and provide a conservative (high) estimate of impact on air quality. The water surface, shoreline, and water column impacts are assumed the same, whether the oil is mechanically removed or burned. Burn residues are assumed to remain floating in the model and to behave as other floating oil.

Based on existing or proposed planning factors (Appendix D), dispersants are applied in three tiers involving several aircraft sorties (flights without reloading). For all tiers, application will be assumed to be made using one or more C-130 aircraft. According to the *Response Plan Equipment Caps Review* (USCG, 1999) the C-130 is capable of delivering 5,495 gal of dispersant per sortie. In the Gulf of Mexico region, Tier 1 would require delivery of 8,250 gal of dispersant in two sorties over the course of 5 hours starting at hour 7 or at the first hour of daylight. The first sortie is 5,495 gal, followed by a second sortie beginning 5 hours later of 2,756 gal. Outside the Gulf of Mexico region, Tier 1 would require delivery of 4,125 gal in one sortie at hour 7 or at the first hour of daylight. Tiers 2 and 3 each require delivery of 23,375 gal of dispersant in four sorties of 5,495 gal each and one sortie of 1,395 gal. Sorties occur at tier start time plus 1, 3, 5, 7, and 9 hours. When sorties from two tiers overlap because of darkness, both sorties were assumed to occur simultaneously.

Dispersant is assumed applied at efficiencies of 45 percent or 80 percent, referring to the percentage of oil treated by dispersant that is dispersed into the water column. Thus, the model runs examined the worst case for oil contamination into the water. If dispersant efficiency is in practice lower than the assumed efficiency that was modeled, as might occur in limited daylight and very cold conditions, less oil would be dispersed into the water column per volume of dispersant applied. In the reduced efficiency case, the expected impacts would be between the results for the 45 percent dispersant scenario and the mechanical-only scenario.

Unburned Oil

The atmospheric concentrations of volatilized hydrocarbons released by unburned oil as it weathers were modeled using the atmospheric dispersion model in CHEMMAP (described in Part A, Section A.5 of the technical report [French McCay et al., 2004]), since SIMAP only tracks hydrocarbons in water, in sediments, and on shorelines. The estimated concentrations at the water surface were then compared with air quality standards to evaluate the potential for human health effects and wildlife impacts.

For unburned oil, MAHs, PAHs, and other volatile hydrocarbons will be volatilized over the first few hours to days after the spill. The amount of volatilized mass entering the atmosphere of each chemical (or chemical class) of concern was estimated from the oil spill modeling with SIMAP. SIMAP also provides the time frame over which the emissions occur. SIMAP runs with light winds that were used to estimate how long volatilization occurs under a worst case situation for atmospheric exposure. The duration was the time for 95 percent of the volatiles to enter the atmosphere.

The mass in the atmosphere was then tracked with CHEMMAP using an approach analogous to the in-water transport model for oil. In the model, the chemical is transported by the wind. Degradation is included for volatilized hydrocarbons at an empirical rate estimated for in air. The atmospheric dispersion model in CHEMMAP provided estimates of hydrocarbon concentrations in the air layer within 2 m of the water and land surface (or, within the approximate height of a person who might be exposed).

Atmospheric dispersion was modeled for the major volatile compounds released from unburned oil that would be of concern to human health based on the available thresholds that are presumably protective of wildlife as well. The total mass and composition of volatilized hydrocarbons released to the atmosphere was estimated from the oil evaporation and volatilization totals estimated by SIMAP over the time of the majority of the release. For alternatives involving *in situ* burning, assumed to burn 25 percent of the mechanically removed oil, the volatile content of that oil was assumed to be burned and did not enter the atmosphere.

Burned Oil Emissions

The atmospheric concentrations of compounds and particulates released by *in situ* burning were estimated using the models developed by Fingas et al. (2001). Atmospheric emission concentrations depend on both the distance from and the area of the fire. Fingas et al. (2001) generated such predictions and equations for more than 150 individual compounds.

For each model scenario—no dispersant, dispersants at 45 percent efficiency, and dispersants at 80 percent efficiency—for a given spill volume and location, the distance where concentrations would fall below a threshold of concern was estimated for each constituent in the *in situ* burn emissions. The thresholds of concern were the minimum concentration for which there is a human health criterion in U.S. regulations and guidance (described in Section 4.3.1.2).

4.4.3. Evaluation of Relative Risk

Given the inherent uncertainty associated with oil spills, it is very difficult to assess and compare the relative potential impacts and benefits of the alternatives presented in this PEIS. There are two areas of concern. The first is the absolute potential impact, and the second is the relative risks and benefits of using various response options. In addition, the anticipated impacts need to be placed in an ecological or socioeconomic context so that their significance can be estimated. The approaches used to interpret the modeling results to address these goals are described below.

The discussion of the affected environment (Chapter 3) identified twenty-four resource categories. These same categories are used for the evaluation of potential impacts, but not all could be quantified using the modeling results. The objective of the analysis is to compare the overall impacts and benefits of each alternative (regionally and nationally) for each of these resources. To make these comparisons, it is important to establish a frame of reference that provides some standard basis. The analysis used a risk matrix approach to define levels of concern (as an indicator of significance) for the ecological effects (Section 4.4.3.1) and an incremental change analysis for socioeconomic effects (Section 4.4.3.2).

4.4.3.1. Ecological Risk Analysis

Risk matrices have a long history as a way to evaluate the interrelationship of scaled variables. Paul (1998) discusses their use as a basic decision tool for risk analysis. They have been used to support risk decisions in a wide range of areas, including such diverse subjects as business planning, engineering decisions, sales and promotion strategies, foreign policy, and military strategies to name only a few. Norton (1991) was an early proponent of the use of a risk matrix using spatial scale, temporal scale, and reversibility to address relative ecological risk. In a review of analytical approaches available for ecological risk assessment, Norton (1996) reviewed the risk square approach for both economic and ecological risk evaluation. He concluded that it could be a valuable tool for both. According to Harwell et al. (1994), this approach is consistent with the goals and objectives of the USEPA's Ecology and Welfare Subcommittee of the USEPA Relative Risk Reduction Project. They found that the "ecological risk square can be useful for analyzing decisions that have long-term, difficult to reverse, and spatially pervasive impacts" (Harwell et al., 1994, p. 2-23). Foran and Ferenc (1999) reviewed available ranking methods that involve the use of matrices comparing stressors and endpoints and found them to be a useful analytical tool. The National Academy of Sciences (NRC, 1992) used a risk square as a "project assessment matrix" to interrelate human and ecological value scales as a way to plan and to analyze potential restoration projects for aquatic ecosystems; the goal was to find projects that met both ecological and sociological value scales. Belluck et al (1993) reviewed the utility of generic risk assessments for ecological planning decisions and concluded that a descriptive evaluation, supported by qualitative data, provided an appropriate level of detail.

The matrix developed for this analysis allows the evaluation of two parameters, the extent of exposure versus the length of recovery time for the resource. This follows the approach described by Norton (1991) and Harwell et al. (1994). The proportion of the resource (spatial scale) and time of recovery (temporal scale) provide sufficient resolution to effectively rate ecological effects. These parameters describe the level of effect for each possible interaction between a risk factor (such as dispersed oil) and a resource under evaluation. The entire set of risk scores for each option can then be evaluated and compared. For the purpose of this analysis, the estimates of ecological risk are based on the series of oil spill scenarios described in Section 4.4.2. These scenarios were designed to be representative of conditions where spills are likely to occur 3 or more nm from shore; they include estimates of effects for the various response options. The numerical results from SIMAP or CHEMMAP and the risk scores relate to those particular scenarios and must be interpreted with care. Patterns across regions or within scenarios, however, do offer insight into the absolute effects and the relative risks and benefits of the alternatives.

The simplest risk matrix is a two-by-two square (Figure 4.4-1). For example, consider a matrix in which the x-axis rates “recovery” and ranges from “reversible” to “irreversible,” and the y-axis evaluates “magnitude” and ranges from “severe” to “trivial.” In its simplest (two-by-two) form, the risk matrix is divided into four cells. Each cell is assigned an alphanumeric value to represent relative effect. Thus, “1A” represents an irreversible and severe effect, whereas “2B” represents a reversible and trivial effect (Figure 4.4-1). Obviously, a two-by-two matrix does not allow much in the way of resolution and is ineffective in rating effects. On the other hand, in large matrices, the scaling becomes challenging, and the resulting ranks are difficult to interpret.

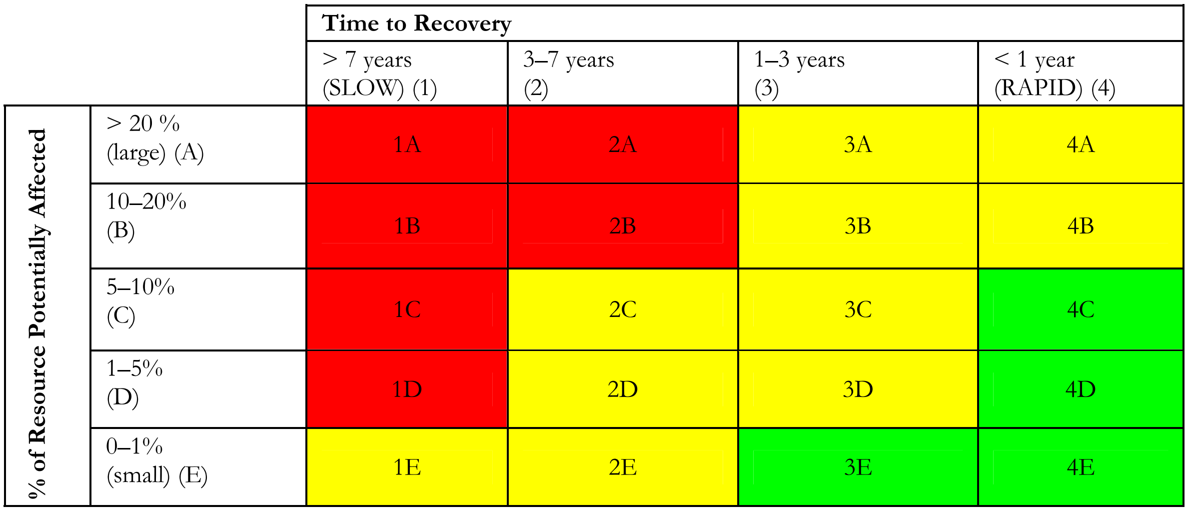
Figure 4.4-1
Basic Ecological Risk Matrix

	RECOVERY	
MAGNITUDE	1. Irreversible	2. Reversible
A. Severe	1A	2A
B. Trivial	1B	2B

The use of this approach in the context of oil spill response planning is described in Aurand et al. (2001) and Kraly et al. (2001). The process has been used by the USCG and various state and federal agencies for risk evaluations in San Francisco Bay, Galveston Bay, Santa Barbara Channel area of California, middle Chesapeake Bay, and Upper Florida Keys. Normally, four or five risk categories on each axis are expected to allow a reasonable degree of resolution (Aurand et al., 2001; Kraly et al, 2001). Once the detailed matrix has been completed, it is generally useful to establish simplified categories for comparison purposes, based on summary levels of risk (or significance).

Figure 4.4-2 provides the risk matrix used in this PEIS. It is based on an evaluation of two factors—the proportion of the resource affected by the action and the time for the resource to recover—for each ecological resource included in this analysis. The proportion of the resource is obtained directly from the SIMAP results, while recovery time is based on the information gained from past research and actual spills (see Section 4.3). The scaling is based on establishing intervals that allow for discrimination of the significance of potential levels of concern, as well as differences between response options.

Figure 4.4-2
Risk Matrix and Definition of Levels of Concern



		Time to Recovery			
		> 7 years (SLOW) (1)	3–7 years (2)	1–3 years (3)	< 1 year (RAPID) (4)
% of Resource Potentially Affected	> 20 % (large) (A)	1A	2A	3A	4A
	10–20% (B)	1B	2B	3B	4B
	5–10% (C)	1C	2C	3C	4C
	1–5% (D)	1D	2D	3D	4D
	0–1% (small) (E)	1E	2E	3E	4E

Source: Adapted from Part A of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern; yellow, a medium level of concern; and green, a low level of concern.

For this risk matrix, the summary scale was established by expanding from the maximum level of concern (1A) and the minimum level of concern (4E) to establish high and low levels of potential risk. A medium level of concern was assumed for intermediate squares. The high level area was determined based on a consensus that any effect that took more than 7 years to recover potentially affecting more than 1 percent of the resource or any effect affecting 10 percent of the resource for more than 3 years was a high concern. Conversely, any effect that affected 10 percent or less of the resource and recovered in 1 year or affected 1 percent or less of the resource and recovered in 1 to 3 years was considered a low risk. The levels of concern are based on the consensus of the project senior professional staff using their experience at actual oils spills, damages assessment studies, and local ecological risk assessments for the Coast Guard. Developing a scale to differentiate high, moderate, and low environmental impacts is a requirement of both ecological risk assessment and NEPA analysis. This pattern is consistent with those accepted by the participants in the oil spill ecological risk assessments done in the risk assessments mentioned earlier. Frequently, these rankings are based on analysts' subjective judgments, which are difficult to evaluate. By using this system, the basis for the assignment is specific, and the additional information provided by the actual numerical risk scores allows a more detailed evaluation, if the reader feels that is appropriate. The alphanumeric ranking is also presented for clarity.

All risk ranking systems, or scales for the determination of significance, are arbitrary to some degree. Harwell et al. (1994, p. 2-11) defines ecological significance as "(1) whether a change that is detected or projected in the ecological system or its individual components of concern is a change of importance to the structure, function, or health of the system and whether the change exceeds a variance estimate (i.e., the context of natural variability) and (2) whether such a change in the ecological system is of sufficient type, intensity, extent, or duration to be important to society." The use of the risk matrix allows for the direct comparison of effects to diverse resources, and the summary scores are used to scale the significance of the potential effects, which can be interpreted against the above definition.

As a simplified example of this approach, assume that a hypothetical oil spill could affect only two resources, seabirds congregating on the sea surface or a coral reef, and that there were only two response options, mechanical recovery and chemical dispersion. Further, assume that mechanical recovery is effective in removing 25 percent of the surface oil before the slick reaches the area where the seabirds are congregated, but that the remaining oil is still sufficient to coat a large number of birds with oil and most subsequently die. Based on biological data, the loss to the population represented about 50 percent of the regional population, and this particular species is long lived and has a relatively low rate of reproduction, so recovery will take 7 to 10 years. There is little to no oil found in the water column, so there is minimal risk to coral from exposure to hydrocarbons. In the other option, assume that chemical dispersion is highly effective, removing enough of the surface oil so that the slick largely dissipates before reaching the seabirds and many fewer die. Recovery is still slow based on their life history. There is also an elevated exposure to dispersed oil in the water over the coral reefs. Concentrations of hydrocarbons down to 10 m deep exceed levels that are reported to kill coral larvae (but only based on continuous exposures for 96 hours in the laboratory); however, those concentrations are only present for 3 hours. All coral reefs are at depths below the 10-m level and are not exposed to high levels of hydrocarbons. Since adult coral polyps are less sensitive to oil than coral larvae, there is little risk to the reef itself.

Table 4.4-1 shows a comparison of the two alternatives (mechanical recovery and dispersants) relative to their levels of concern for the two resource groups for this hypothetical example. Mechanical recovery leads to a high potential level of concern to birds, based on the removal of a large portion of a population that is slow to recover. It does not, however, pose more than a low level of concern for the coral reef, since the small amount of dissolution and dispersion that occurs as a result of natural processes does not threaten either the reef itself or larvae in the water column. When dispersants are used, the seabirds are exposed to much less floating oil and many fewer die. The number now lost from the population is similar to natural mortality in many years, and the population can be expected to recover in 3 to 7 years. The coral reef area is exposed to enough oil that there is a risk to larval organisms in the water column, but the area affected, relative to the area where coral larvae occur, is not large. The adult corals are not affected. Dilution rapidly reduces the risk. Based on the potential loss of some larvae, the level of risk increases slightly but remains an overall low level of concern due to the rapid recovery rate of the larvae. Therefore, in this example, chemical dispersion reduced the potential level of concern for seabirds from high to medium, while the risk to coral reefs remain unchanged as low.

Table 4.4-1
A Hypothetical Example of the Use of Relative Risk Scores to Compare Response Options

	Resource at Risk	
Response Option	**Seabirds**	**Coral Reef**

Mechanical Recovery	1B	4E
Chemical Dispersion	2D	4D

The evaluation required for the analysis of alternatives is much more complicated than the example; however, the principle is the same. For each scenario the appropriate thresholds described in Section 4.4.2 and Part A of the technical report (French McCay et al., 2004) are used to estimate the potential effect to the resource group under consideration. The anticipated effect is then compared with the total resource present in the appropriate biogeographical provinces, as delineated by French et al. (1996) and presented in Part A, Table A.4-2 of the technical report (French McCay et al., 2004). Basic biological and life history data for representative species or habitats, as well as spill studies, were used to estimate recovery time (see Section 4.4). Using these data, a risk score is developed for each option for each ecological resource, and the effectiveness of alternatives can thus be compared.

4.4.3.2. Socioeconomic Risk Analysis

The modeling of social and economic effects of enhanced spill response is framed in terms of the degree of risk posed to economic and social factors. For example, the modeling considers the length of beach oiled as a result of a modeled spill above an assumed threshold of concern to indicate the risk of effect of that spill on recreational activities. By comparing the degree of risk posed with economic and social factors under various spill response scenarios, the modeling generates estimates of the degree of risk reduction achieved. This analysis of the modeling does not attempt to express damages in absolute, monetary terms.

The steps followed in modeling the economic and social effects of enhanced spill response include describing the economic resources at risk in each modeled location, determining the best physical metrics to act as an indicator of economic damages (e.g., shoreline length oiled, surface water area oiled), establishing oil coverage thresholds above which the effects on the chosen physical resources are likely to be significant, modeling the extent and magnitude of oil coverage for a range of hypothetical spills, establishing the absolute risk of effects under each scenario, and determining the relative risk of economic and social effects under each of the enhanced cleanup scenarios versus the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit).

In some cases the degree of expected risk to economic and social factors can be modeled directly. For example, it is possible to model the risk of effects to recreational activities by considering the expected extent of oiling of sandy beaches under a variety of scenarios. Oil spills may also impose impacts on coastal communities and populations that cannot be modeled directly. For example, an oil spill that initially decreases revenue for tourism may have subsequent detrimental effects on other sectors of the local economy. Similarly, a spill may result in a change in equity. That is, low-income communities may rely more heavily on coastal resources than other subsections of the coastal populations and therefore may face more severe consequences from contamination of those resources. There are limitations inherent in any attempt to model the effects felt by coastal communities as a result of oil spills. This analysis of the modeling applies an approach to oil spill consequence assessments, specifically the risk of socioeconomic effects, which are based on an approach developed by an expert committee established by the Transportation Research Board of the National Academy of Sciences to evaluate the environmental performance of double-hull tanker design alternatives (Transportation Research Board, 2001). This approach was developed explicitly to compare the expected performance of alternative tanker designs in avoiding the environmental and socioeconomic effects of oil spills, and thus can be applied to assess the relative risk of socioeconomic effects given alternative response measures.

4.4.4. Modeling and Risk Analysis Results

Detailed results for each of the five modeled geographic locations are presented in the technical report (French McCay et al., 2004). The risk matrices list the resources of concern that are analyzed. Some categories are combined where there was no difference in risk, such as coastal and marine water quality, so they may not match exactly the categories presented in Chapter 3. Some categories, such as public safety, could not be evaluated using the model since they are not directly related to the model outputs. The data in the technical report (French McCay et al., 2004) are used throughout the alternatives discussions in Sections 4.5 through 4.9 to evaluate the potential levels of concern.

4.5. ENVIRONMENTAL CONSEQUENCES: ALTERNATIVE 1—NO ACTION, WHEREBY NO CHANGE IN RESPONSE PLAN REGULATIONS WOULD BE IMPLEMENTED

4.5.1. Introduction

This section addresses the potential beneficial and adverse environmental impacts associated with Alternative 1—No Action for the resources described in Chapter 3. Under Alternative 1, the USCG would not implement any changes to existing oil spill response regulations; therefore, the availability of all response options would remain unchanged. Responders would continue to rely primarily on mechanical recovery equipment to remove as much oil as possible from the water surface. Oil that is not removed by this method would be removed through natural recovery or shoreline cleanup methods. Chemical dispersion and *in situ* burning would continue to be used infrequently in areas with pre-authorization agreements.

Under this alternative it is assumed that mechanical recovery and *in situ* burn capabilities are currently available in all six regions described in this PEIS. Although dispersant pre-authorization agreement areas exist in all six regions (Figure 2.2-1), appropriate response times cannot currently be met for chemical dispersion in the Atlantic, Caribbean, Pacific, and Oceania regions. However, in the Gulf of Mexico and Alaska regions, dispersant capabilities are available and their use for response operations is feasible (USCG, 1999); thus, chemical dispersion will only be discussed for these two regions. Table 4.5-1 shows the options available under Alternative 1—No Action for each of the six regions in this PEIS.

Table 4.5-1
Response Options for Each Region under Alternative 1

Region	Mechanical Recovery	Chemical Dispersion	*In Situ* Burning
Atlantic	Yes	No	Yes
Caribbean	Yes	No	Yes
Gulf of Mexico	Yes	Yes	Yes
Pacific	Yes	No	Yes
Alaska	Yes	Yes	Yes
Oceania	Yes	No	Yes

Source: Adapted from USCG, 2008.

As explained in the description of the analytical approach in Section 4.4, the modeling and risk assessment performed to determine the effects of Alternative 1 are based on the assumption that a spill has occurred (no beneficial impacts are expected from an oil spill). (To interpret the risk scores listed in the tables in Sections 4.5 and 4.7, Figure 4.4-2 is reproduced on the inside back cover for quick reference.) Potential effects on all resources within each region are based on the analysis of three representative spill sizes—small (200 bbl), medium (2,500 bbl), and large (40,000 bbl). Effects for the small spill are extrapolated from the modeling results for the medium and large spills. The determination of potential effects from oil spills under Alternative 1 was based on the use of a concentration threshold for adverse effects; the selected values were 10 g/m^2 for oiled shoreline and 0.01 g/m^2 for oiled surface water (technical report [French McCay et al., 2004]).

Under Alternative 1, it is assumed that current response options for each region are available and utilized in response operations (for detailed results of the modeling and risk assessment, see the technical report [French McCay et al., 2004]).

It is important to note that, in terms of the potential environmental consequences, the results of mechanical recovery and mechanical recovery combined with *in situ* burning are very similar, with air quality being the only resource showing a quantifiable difference between the two response options. This is because the physical limitations for skimming and collecting the oil floating on the water are essentially the same for the two response options. As discussed in Section 4.2.1.3, oil removed by *in situ* burning is equivalent to mechanical recovery, so shoreline, water surface, and water column effects remain unchanged. There are much greater differences when chemical dispersion is available (see Section 4.7).

4.5.2. Consequences in the Atlantic Region

For the purpose of this PEIS, the Atlantic region will specifically cover the waters extending from the Gulf of Maine to the Florida Straits (Figure 3.1-1). The location selected for modeling and risk assessment purposes was a site offshore Delaware Bay because it is in a high-traffic area at greater risk for oil spills. Modeling results from this location were evaluated relative to the geographic area in Section B.1.2 of the technical report (French McCay et al., 2004), herein referred to as the Mid-Atlantic Shelf. The Mid-Atlantic Shelf encompasses three biogeographical provinces: New York-New Jersey Shelf, Delaware Bay, and Delmarva Shelf. In general, the Mid-Atlantic Shelf is representative of offshore sites throughout the region and provides a basis for the modeling of potential environmental effects. The results of the modeling—used to evaluate spills of concern in this risk analysis (i.e., 3 or more statute mi offshore[18])—are presented in detail in Part B of the technical report (French McCay et al., 2004) and summarized in this section.

Table 4.5-2 presents the risk ranking for the modeling of Alternative 1 in the Atlantic region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) for three spill sizes (small, 200 bbl; medium, 2,500 bbl; and large, 40,000 bbl). The risk scores presented in the table are based on the modeling results for an average spill and on regional considerations; however, in any specific oil spill situation local concerns could be higher (see the risk matrix pullout at the end of the document for definitions of the levels of concern). Table 4.5-3 summarizes the significance of the potential beneficial and adverse environmental impacts associated with Alternative 1 in the Atlantic region, based on the extrapolation of the modeling results for an average spill to the region in general.

Although dispersant pre-authorization agreement areas exist in the Atlantic region (Figure 2.2-1), under the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) of Alternative 1 appropriate response times cannot currently be met for chemical dispersion; thus, chemical dispersion is not considered in the analysis of the Atlantic region. Further, the modeling shows that *in situ* burning would not significantly change the level of effects identified from those obtained when using mechanical-only recovery.

For spills analyzed in this document (i.e., those that occur 3 or more statute mi offshore) using mechanical-only recovery, there are likely to be minor or insignificant regional adverse impacts on all resources for a small spill, based on the speed with which such a spill would weather and dissipate and the small area that could be affected, except for marine and coastal birds, which could be moderate. For a medium spill, adverse impacts are minor or insignificant for all resources except for marine and coastal birds, which could be moderate. For a large spill, there is the potential for moderate adverse impacts on marine and coastal birds, intertidal habitats, and areas of special concern.

Table 4.5-2
Risk Ranking[*] of Offshore Oil Spills[†] under Alternative 1 Using the Basic Response Scenario[‡] in the Atlantic Region

	Resources of Concern												
	Physical Environment			Biological Environment								Socioeconomic Environment	
Spill Size	Coastal Water Quality	Marine Water Quality	Air Quality	Marine Mammals[§]	Marine and Coastal Birds[§]	Plankton and Fish[§]	Intertidal Habitats	Subtidal Habitats	Sea Turtles[§]	Areas of Special Concern	Essential Fish Habitat	Subsistence[‖]	Archaeological/Historic Resources[‖]
Small (200 bbl)	4E	4E	4E	3E	3D	4E	4E	4E	3E	4E	4E	4E	4E
Medium (2,500 bbl)	4E	4E	4E	3E	3D	4E	3E	4E	3E	3E	4E	4E	4E
Large (40,000 bbl)	4D	4E	4E	3E	3B	4E	2D	4E	3E	2D	4E	4E	4E

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] This risk ranking is a summary of risk scores for the resources considered in this PEIS. The risk scoring process is explained in Section 4.4.3.

[†] Average spills.

[‡] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[§] Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles. If such species are affected by an actual spill, the level of concern would be high.

[‖] Subsistence and archaeological/historic resources are the only socioeconomic resources that could be ranked using the risk matrix.

Table 4.5-3
Summary of Potential Adverse Regional Impacts of Offshore Oil Spills* under Alternative 1 Using the Basic Response Scenario† in the Atlantic Region

	Resources of Concern																			
	Physical Environment			Biological Environment								Socioeconomic Environment								
Spill Size	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals‡**	**Marine and Coastal Birds‡**	**Plankton and Fish‡**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles‡**	**Areas of Special Concern**	**Essential Fish Habitat**	**Coastal Communities, Demography, and Employment**	**Economic Status**	**Vessel Transportation and Ports**	**Fisheries**	**Subsistence**	**Archaeological/Historic Resources**	**Recreation and Tourism**	**Environmental Justice**	**Public Safety and Worker Health**
Small (200 bbl)	Ins	Ins	Ins	Min	Mod	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
Medium (2,500 bbl)	Ins	Ins	Ins	Min	Mod	Ins	Min	Ins	Min	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
Large (40,000 bbl)	Min	Ins	Ins	Min	Mod	Ins	Mod	Ins	Min	Mod	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins

Note: Based on Table 4.5-2. Sig, significant; Mod, moderate; Min, minor; and Ins, insignificant.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles.

4.5.2.1. Consequences to the Physical Environment

Water Quality

Potential adverse consequences of oil spills to water quality are related to hydrocarbon contamination, as other constituents in oils are at concentrations that would not exceed thresholds of concern. The hydrocarbons that could affect water quality are the soluble aromatics, MAHs (monoaromatic hydrocarbons) and PAHs (polynuclear aromatic hydrocarbons) (Section 4.3.1.1). Thus, evaluation of potential adverse effects is based on the degree of potential contamination by these compounds. No beneficial effects on water quality would be expected to result from an oil spill.

For oil spills in marine waters, adverse effects on water quality are generally low, whether mechanical-only recovery or mechanical recovery plus *in situ* burning is employed. This is because of the tendency for most chemical compounds of concern to evaporate, rather than dissolve, and because of the rapid dilution of any chemical compounds that might enter the water column. During periods of extreme turbulence, oil generally mixes into the water column where aromatics may dissolve rapidly, but resurfacing and dilution of oil droplets result in only localized contamination at levels of concern unless the dilution volume is restricted. Overall, based on the modeling and risk assessment results, it is concluded that—using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit)—adverse water-quality effects under Alternative 1 would be low in marine waters, even in the event of a large spill in the Atlantic region. However, if the spill moved into shallow and confined coastal waters, adverse effects could be locally important for medium and large spills under conditions where oil is mixed into water by strong turbulence or in areas where oil collects for a few weeks to months after a spill.

The variable used to determine potential water-quality effects is "volume of water contaminated" by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer, which is less than all established water-quality criteria and thresholds of concern for effects on aquatic biota (Sections 4.3.1.1 and 4.3.2.1). The affected water volume increases with spill volume and varies with the level of physical dispersion during the time of the spill. Natural dispersion increases with stronger winds and currents, lessening the volume of water that is contaminated above the threshold of concern if in unconfined waters. Since the volume of water contaminated increases exponentially as a function of spill size, the estimated volume of water contaminated for a small spill was extrapolated from the mean medium- and large-spill model results. The estimates of the volume of water contaminated—and its variability—are generally applicable to spills of the same size throughout the Atlantic region because the mixing of oil into water and process of dilution are similar in all areas.

Coastal

Delaware Bay is used as a representative of coastal water for analyzing the Mid-Atlantic Shelf, as well as the Atlantic region. Delaware Bay is approximately 2,669 km^2 in area and about 10 m deep on average, with a total volume of approximately 26,690 million m^3. The estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of Delaware Bay to determine the potential consequences of small, medium, and large spills (Table 4.5-4). This approach yields a very conservative estimate, in that it assumes all of the contamination would occur in coastal water.

Table 4.5-4
Risk Ranking of Offshore Oil Spills[*] to Coastal Water Quality Using the Basic Response Scenario[†] in the Mid-Atlantic Shelf[‡]

Spill Size	Volume of Water Contaminated (million m^3)	Area Contaminated (estimated %)	Risk Score[§]
Small (200 bbl)	$< 42 \times 10^{-6}$	8×10^{-8}	4E
Medium (2,500 bbl)	130	0.5	4E
Large (40,000 bbl)	698	2.6	4D

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Because of natural dilution, evaporation, and biological processes, contamination levels would decrease rapidly even in the case of a large spill, and recovery time would be on the order of days to weeks (NRC, 1985, 2005). Oil may be incorporated into shallow water or intertidal sediments where, through leaching, it could become a continuing source of contamination over time. However, this would generally only lead to noticeable water-quality degradation in the locality where the oil collects. This is unlikely to occur with a spill that originates offshore. Because mechanical removal would begin within the required response time under Tier I standards (beginning about 12 hours after the spill), much of the soluble components of concern to water quality would have evaporated or dissolved. Thus, mechanical recovery and *in situ* burning would have an insignificant influence on the volume of water adversely affected, and the risk score results would apply whether either response is implemented.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal water quality in the Atlantic region under Alternative 1 are expected to be insignificant for small and medium spills, and minor for large spills.

Marine

In marine waters, which are 3 or more statute mi offshore, mechanical recovery and *in situ* burning currently may be used for spill response in the Atlantic region; although dispersant pre-authorization agreement areas exist in the Atlantic region (Figure 2.2-1), chemical dispersion is not used because appropriate response times cannot currently be met. As was done for coastal waters, the estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of the reference area, the Mid-Atlantic Shelf.

The Mid-Atlantic Shelf was selected for the modeling as representative of the marine waters in the Atlantic region. The total surface area of the Mid-Atlantic Shelf is approximately 68,541 km^2, so the area of interest is much vaster for marine waters than for coastal waters. Water-quality effects were calculated using a spill site in relatively shallow water—18 m deep. which is much shallower than most of the Atlantic region's marine waters. The results for the selected modeling location (Table 4.5-5) represent conservative estimates of adverse water-quality effects using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit).

Table 4.5-5
Risk Ranking of Offshore Oil Spills* to Marine Water Quality Using the Basic Response Scenario† in the Mid-Atlantic Shelf‡

Spill Size	Area Contaminated (estimated %)	Risk Score§
Small (200 bbl)	2×10^{-9}	4E
Medium (2,500 bbl)	0.01	4E
Large (40,000 bbl)	0.6	4E

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Natural dispersion of the oil would be very rapid after a spill, and recovery time would be on the order of hours to days. Leaching from oil contamination reaching the sediments would not have a significant effect on marine water quality because of the large dilution volume and natural dispersing forces in marine waters. The results would apply whether a mechanical response is implemented. Since *in situ* burning would replace some of the mechanical response, and both methods remove oil that would otherwise result in water contamination, the potential water-quality effects would not change significantly if *in situ* burning were used. For a spill in water deeper than the 18 m evaluated here, the potential adverse effects would be even smaller.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine water quality in the Atlantic region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Air Quality

Concentrations of hydrocarbons of concern in the air resulting from oil spills and response operations were compared with air quality standards to evaluate the potential for adverse effects (Section 4.3.1.2). The effects of an oil spill on air quality may involve all volatile components of the oil. In addition, if *in situ* burning was used, particulates and other contaminants emitted from burns could become an air quality concern. However, adverse air quality effects from oil spills are normally very localized and short lived for small, medium, and large oil spills. The addition of *in situ* burning does not significantly increase any potential adverse effects: the volume of oil that could be burned is not large, and the temporary smoke plume would be localized and rapidly diluted.

The modeling shows that results do not vary by spill location, or size in the Atlantic region. Two possible sources of contamination to the atmosphere were evaluated for their potential effects on air quality: volatilization of hydrocarbons from unburned oil and emissions produced by *in situ* burning. Concentrations in the lowest 2 m of the atmosphere were compared with the U.S. Environmental Protection Agency's National Ambient Air Quality Standards (USEPA's NAAQS) and other thresholds of concern (as discussed in Section 4.3.1.2).

The modeling results show that the potential adverse effects on air quality are low for all spill sizes involving mechanical-only recovery; hence, the risk scores are virtually identical for small, medium, and large spills. Volatilized hydrocarbons would not exceed air quality standards for human health at more than 1 km from the spill site. Evaporation off the water surface and volatilization from the water column create a plume of volatile hydrocarbon gases that disperses quickly after a spill, such that the concentrations in the atmosphere at the water surface would not exceed human health thresholds of concern at any location. The recovery time for the atmosphere would be on the order of days. Thus, a low level of concern is expected for small, medium, and large spills involving mechanical-only recovery.

Mechanical recovery plus *in situ* burning would increase atmospheric pollutants by the amount emitted via burning. For small spills, it would be very unlikely that *in situ* burning would be used, as the oil would disperse too rapidly for it to be feasible (Table 4.5-6). The maximum area potentially exceeding the NAAQS or thresholds of concern is 1.6 km^2 for a medium spill and 15.8 km^2 for a large spill (Table 4.5-6). If humans or sensitive resources (i.e., wildlife) are within these areas, they could be affected by poor air quality for a short time, on the order of hours. Since *in situ* burning can only be used offshore in marine waters, a region of interest equivalent to the Mid-Atlantic Shelf (68,541 km^2) would have less than 1 percent of its area adversely affected, and the atmosphere would recover in a matter of hours. Thus, low levels of concern are expected from small, medium, and large oil spills involving *in situ* burning (Table 4.5-6).

Table 4.5-6
Risk Ranking of Offshore Oil Spills* to Air Quality under *In Situ* Burning in the Mid-Atlantic Shelf†

Spill Size	Area Exceeding Threshold (km^2)	Area Contaminated (estimated %)	Risk Score‡
Small (200 bbl)	1.6	0.002	4E
Medium (2,500 bbl)	1.6	0.002	4E
Large (40,000 bbl)	15.8	0.023	4E

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

‡ The risk scoring process is explained in Section 4.4.3.

Based on the modeling results (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on air quality in the Atlantic region under Alternative 1 are expected to be insignificant for small, medium, and large spill sizes, with or without *in situ* burning.

4.5.2.2. Consequences to the Biological Environment

Marine Mammals

The species of cetaceans inhabiting the Atlantic region (Section 3.2.2.1, Table F.2-1) have concentrations that vary depending on location and seasonal migrations. The only pinniped of concern in the Atlantic region is the harbor seal (*Phoca vitulina*), which is found along shorelines, near river mouths, and even inland along the north Atlantic coast. Harbor seals are generally found from Maine to New Jersey; their presence south of Maine is seasonal. They gather in small groups when they haul out but are usually solitary when in the water. The Florida manatee (*Trichechus manatus latirostris*), which is a sirenian, inhabits the southern coastal waters of the Atlantic. It has extreme sensitivity to cold temperatures, so the base population remains along the Florida coast year round. However, manatees have been spotted as far north as the Chesapeake Bay during the warm months of the year. There are no fur-bearing marine mammals of concern inhabiting this region (Section 3.2.2.1).

Marine mammals such as whales, dolphins, seals, and manatees are vulnerable to spilled oil since they spend considerable time at the water's surface, which enhances possible contact with oil. The majority of these species remain offshore, and populations vary according to season and migration directions. Cetaceans appear able to detect and are likely to avoid floating oil or oil being recovered by mechanical means (Geraci, 1990). Studies have shown that cetacean skin is nearly impenetrable to even the highly volatile constituents of oil, indicating that contact with oil probably would be less harmful to cetaceans than often believed. However, the toxic, volatile fractions in fresh crude oils could irritate and damage cetacean soft tissues, such as the mucous membranes of the eyes and airways.

Marine mammals that are more commonly found in the nearshore regions and intertidal habitats, such as harbor seals, are of greater concern. Harbor seals' use of restricted haulout areas and instinctual behavior to return to the same breeding area every year may increase the likelihood of physical contact with oil in the event of a nearby spill. Potential concerns include toxicity from ingestion of oil during grooming and adverse effects on juveniles through contact with contaminated teats when nursing. Overall, the potential adverse effects depend on the spill size, and the number and species of marine mammals present.

Based on the surface area in the Mid-Atlantic Shelf, the area equivalent to 100 percent mortality for cetaceans and for pinnipeds and sirenians is less than 0.01 percent of the available habitat, and the risk from floating oil is low. Pinnipeds could also come into contact with oil on the shoreline. Estimated average shoreline length oiled is 11.6 km for a medium spill and 29.2 km for a large spill. The likelihood that these lengths would actually involve a pinniped haulout area is low. Based on the scattered presence and migratory nature of these mammals in the Atlantic region, the potential level of concern was determined to be low for small, medium, and large oil spills. The results of the modeling for marine mammals for the Mid-Atlantic Shelf are presented in Table 4.5-7.

Based on the modeling for the Mid-Atlantic Shelf, the likelihood of adversely affecting large numbers of marine mammals is low unless the spill occurs in the immediate vicinity of a pinniped haulout area. Since the difference in shoreline oiling between the medium and large spills is small, and such locations are rare along most of the Atlantic coast, it is unlikely that more than 1 percent of any regional population of concern would be adversely affected. The addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the severity of potential adverse effects nor increase risk to marine mammals. If mortality did occur, however, the population would probably require 1 to 3 years to recover.

Table 4.5-7
Risk Ranking of Offshore Oil Spills* to Marine Mammals Using the Basic Response Scenario† in the Mid-Atlantic Shelf‡

Spill Size	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	0–1	3E
Medium (2,500 bbl)	0–1	3E
Large (40,000 bbl)	0–1	3E

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine mammals in the Atlantic region under Alternative 1 are expected to be minor for small, medium, and large spills.

Marine and Coastal Birds

Potential adverse effects on marine and coastal birds are usually of highest concern during an oil spill because birds are highly susceptible to the acutely toxic effects from exposure to oil. There are many areas in the Atlantic region where high concentrations of birds may be found along the shore, in nearshore and estuarine habitats, or in offshore marine-water habitats (Section 3.2.2.2). Adverse effects on birds in this region would result mostly from shoreline oiling in sensitive staging and nesting habitats for shorebirds, wading and marsh birds, and waterfowl. Surface water oiling may also adversely affect feeding, rafting, and diving birds and waterfowl (Section 3.2.2.2). Gulls, terns, raptors, and seabirds also occur in the region and use shoreline, offshore, and wetland habitats (see Section 4.3.2.2 for information on the main issues of concern for birds exposed to an oil spill).

The Mid-Atlantic Shelf was selected for the modeling as representative of the coastal habitats and wildlife in the Atlantic region (Table 4.5-8). Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the potential adverse effects on birds. Potential levels of concern for birds in the Mid-Atlantic Shelf are medium for all spill sizes, as discussed below. However, for a small spill very little oil is likely to strand onshore in staging and nesting habitats, and oil loading would be light in most cases. The potential for adverse effects increases for large spills, with greatest concern for conditions where sand beaches, wetlands, and tidal flats become heavily oiled.

Table 4.5-8
Risk Ranking of Offshore Oil Spills* to Marine and Coastal Birds Using the Basic Response† Scenario in the Mid-Atlantic Shelf‡

Spill Size	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	1–5	3D
Medium (2,500 bbl)	1–5	3D
Large (40,000 bbl)	10–20	3B

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Three Western Hemisphere Shorebird Reserve Network (WHSRN) sites (a hemispheric site, an international site, and a regional site), three Ramsar sites (wetlands of international importance), and six National Wildlife Refuge sites occur in the Mid-Atlantic Shelf. The presence of these sites indicates that large numbers of shorebirds (WHSRN sites) and wetland birds (Ramsar site) concentrate in the area during migration and/or nesting and wintering. From 0.95 to over 1.3 million birds have been observed at the Delaware Bay WHSRN site, which is the second largest stopover location in the Western Hemisphere during spring migration. The Delaware Bay site hosts 80 percent of the hemisphere's red knots (*Calidris canutus*) and ruddy turnstones (*Arenaria interpres*), 80 percent of Atlantic flyway snow geese (*Chen caerulescens),* and 30 percent of the hemisphere's sanderlings (*Calidris alba*) (USFWS, 2004; Wetlands International, 2004; WHSRN, 2003). Thus, the risk score was determined based on the possibility that a large number of staging birds may be concentrated in a relatively small area that is heavily oiled during a medium or large spill (Table 4.5-8). It is important to recognize that adverse effects on birds may be more or less severe depending on the time of year and locations of their habitats, as well as the extent of shoreline and surface water oiling. For instance, an oil spill occurring during peak spring migration for shorebirds at the Delaware Bay WHSRN site would result in more extreme adverse effects on regional shorebird populations than a spill occurring at a different time of year.

Adverse effects on birds in the Mid-Atlantic Shelf for a small spill were determined by extrapolating from the results obtained for a medium spill and the expectation that recovery from light oiling is usually rapid for all habitat types. The volume of oil released in the small spill was approximately an order of magnitude less than in the medium spill; but the potential adverse effects on the bird population could be similar and pose a medium risk. The modeling of effects on birds for medium and large spills under mechanical-only recovery resulted in estimates of 1 to 5 percent and 10 to 20 percent, respectively, of the regional bird population being potentially adversely affected because important wetland nesting areas and shorebird staging areas (medium spill), and key sand beach habitats used by staging shorebirds and wetland nesting areas (large spill) were oiled. The risk scores in Table 4.5-8 reflect the predicted recovery rates of 1 to 3 years for most bird species, as was the case following the *EXXON VALDEZ* oil spill (Section 4.3.2.2). Although areas other than the Mid-Atlantic Shelf in the Atlantic region were not modeled, the results are consistent with those for all other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on bird populations will fall within a similar range throughout the Atlantic region. The addition of *in situ* burning does not change the significance of these adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine and coastal birds in the Atlantic region under Alternative 1 are expected to be moderate for small, medium, and large spills.

Plankton and Fish

Plankton and fish, a diverse group of species, are important to the marine food web, ecosystem function, and fisheries. Adverse effects on these groups are of high concern. As described in Section 4.3.2.3, plankton and fish are adversely affected either directly or via the food web by the toxic effects of oil components that enter the water column—the soluble compounds (MAHs and PAHs) and microscopic oil droplets mixed by waves into the water (French McCay, 2002; NRC, 1985). The most important pathway of exposure is direct uptake of dissolved oil components, originating directly from surface oil or dissolving from the microscopic oil droplets in the water. Overall, as spill size increases, so do adverse effects. However, there is great variability related to the environmental conditions after a spill; plankton and fish suffer much more adverse effects in storm conditions where high waves mix unweathered oil into the water, which happened during the *NORTH CAPE* oil spill (French McCay, 2003), than in calm weather. In addition, many species utilize shallow waters and even the intertidal zone, where they are more likely to be exposed to oil and dissolved components when oil comes ashore. Species and life stages vary considerably in sensitivity to toxic components, with species from relatively unpolluted and environmentally stable locations being more sensitive than those from polluted and environmentally variable areas.

In marine and open coastal environments, small, medium, and large oil spills do not cause large or long-term toxic effects to plankton and fish in the water column. The toxic effects of oil spills result from acute exposure during the time when surface oil is present and for short periods (days to weeks) afterwards. Once the source of hydrocarbons (from floating oil or the shoreline) to the water column is gone, concentrations rapidly disperse to background levels. However, there may be longer-term effects if the spill migrates to nearshore shallow areas such as enclosed embayments, estuaries, or wetlands where dilution and flushing are slow. Many fish and other organisms spawn and develop through larval and juvenile stages in these shallow areas. Juvenile fish are more abundant in salt marshes and seagrass beds than in other shallow subtidal and intertidal areas, so these areas are of most concern (see discussion of potential effects on these habitats below). Under Alternative 1 in most cases, chemical dispersion could not be used within 3 nm of shore[19], but the dispersed oil plume could be transported by currents into this area. The percentage of plankton and fish adversely affected by oil spills was estimated using the modeling results (technical report [French McCay et al., 2004]) of water volumes exposed to toxic oil components. Percent loss multiplied by volume exposed was integrated over time and space to calculate an equivalent volume of 100 percent loss. These volumes were translated to equivalent areas by multiplying them by water depth at the spill site, allowing comparison with other resources, such as birds and shorelines, which are distributed on a per-area basis. The use of area is appropriate because plankton and fish abundance is much more uniformly distributed when expressed on a per-area basis than on a per-volume basis since the ecosystem is driven by sunlight and plant photosynthesis at the water surface (French et al., 1996; Odum, 1971). As indicated by the similar results for the four modeled spill sites in 10 to 30 m of water—offshore Delaware Bay, offshore Galveston Bay, the Florida Straits, and offshore San Francisco (Parts B, C, D, and E, respectively, of the technical report [French McCay et al., 2004])—the equivalent areas of adverse effect on plankton and fish (both average and variable) are applicable to spills of the same size in any location of similar water depth in any region considered in this PEIS. The modeled spill site was 18 m deep water: adverse effects would be less for deeper waters because of greater vertical dilution of both oil components and organisms, and proportionately greater in shallower waters because of the restricted dilution potential.

The model-estimated areas are those where there is a potential to affect the most sensitive species, which are two standard deviations more sensitive than the average of all species tested (2.5th percentile in rank order of sensitivity). For species of average sensitivity (50th percentile), the areas adversely affected would be much less. Thus, the model-estimated areas should not be interpreted as experiencing 100 percent mortality of all plankton and fish; they are conservative estimates used for comparative purposes among response scenarios.

The Mid-Atlantic Shelf was selected for the modeling as representative of the Atlantic region (Table 4.5-9). The adverse effects were estimated as a percentage of the total area of concern (68,541 km^2). Based on the evaluation of the volume where water quality would be affected for a small spill (Table 4.5-5), the volume of adverse effects on plankton and fish would be low for a small spill using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) (Table 4.5-9).

Table 4.5-9
Risk Ranking of Offshore Oil Spills[*] to Plankton and Fish Using the Basic Response Scenario[†] in the Mid-Atlantic Shelf[‡]

Spill Size	Equivalent Area Affected (km^2)	Area Affected (estimated %)	Risk Score[§]
Small (200 bbl)	< 1	3×10^{-11}	4E
Medium (2,500 bbl)	4	0.005	4E
Large (40,000 bbl)	53	0.08	4E

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Since the adverse effects are in a small percentage of the area of concern and less than the range of natural variability, the recovery time would be less than 1 year. Overall, based on the modeling, adverse effects on plankton and fish in the Atlantic region under Alternative 1 would be localized to the immediate area around the spill site and similar in all marine-water areas of the region. For large spills that might move rapidly into shallow coastal areas due to winds and currents, the concentrations of toxic components might be high enough to cause some level of concern for water column communities, especially early life history stages of fish and invertebrates using intertidal and shallow subtidal habitats.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on plankton and fish in the Atlantic region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Intertidal Habitats

Intertidal habitats are always of high concern during oil spills, particularly when sensitive habitats such as marshes and tidal flats are oiled because recovery can take many years. There are few effective cleanup methods for these sensitive habitats; thus, natural recovery is often the primary response. For a discussion of the relative ranking of the sensitivity of intertidal habitats to spilled oil and the processes affecting oil fate and behavior on shorelines, see the explanation of the Environmental Sensitivity Index (ESI) in Section 4.3.2.4. The Atlantic region contains extensive, productive estuaries (Section 3.2.2.4) and numerous tidal inlets and bays through which oil could affect sheltered wetlands and tidal flats. Sheltered habitats are of special concern because oil is likely to persist for longer periods and have chronic effects on fish and birds that rely on these habitats. Wetland loss and degradation rates in the Atlantic region are high (Section 3.2.2.4), and adverse effects from oil spills can be very important. In addition, sand beaches along the extensive coastal barrier islands in this region are important habitats for migratory and nesting shorebirds, increasing the environmental consequences of stranded oil. There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on intertidal habitats in that larger spills tend to have higher oil loading on the shoreline and affect larger areas.

Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed and, thus, does not reduce potential adverse effects. Adverse effects on intertidal habitats in the Atlantic region are low for a small spill in that very little oil is likely to strand onshore, and oil loading would be light in most cases. However, the potential for adverse effects increases with spill volume, with the greatest concern for conditions where marshes and tidal flats become heavily oiled. The risk scores in Table 4.5-10 are based on estimated effects on the intertidal habitats of Delaware Bay because even large spills usually will not affect large shoreline areas. For example, the maximum percentage of shoreline oiled under the large spill scenarios was only 0.02 percent of the shoreline area in the entire Mid-Atlantic Shelf.

Table 4.5-10
Risk Ranking of Offshore Oil Spills* to Intertidal Habitats
Using the Basic Response Scenario† in the Mid-Atlantic Shelf‡

Spill Size	Habitats Affected (estimated %)	Risk Score§
Small (200 bbl)	0–1	🟩 4E
Medium (2,500 bbl)	0–1	🟩 3E
Large (40,000 bbl)	1–5	🟨 2D

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Adverse effects on intertidal habitats for a small spill were determined to be low by extrapolating from the results of a medium spill and expecting recovery from light oiling to usually be rapid for all habitat types. For a medium spill under mechanical-only recovery, the modeling resulted in an estimated 11.6 km of oiled shoreline, which is a small percentage of the total shoreline in the entire Mid-Atlantic Shelf. However, moderate amounts of oil on wetlands could cause long-term adverse effects. For a large spill, the modeling resulted in an estimated 29.2 km of oiled shoreline. This oiled area represents less than 1 percent of the entire shoreline area in the region but includes 3.5 percent of outer sand beach habitats and heavy oiling of sensitive wetlands that have recovery rates up to 3 to 7 years (Section 4.3.2.4). Although areas other than Delaware Bay in the Atlantic region were not modeled, the results are consistent with those for all other regions analyzed in this PEIS, and it is expected that the severity of adverse effects on intertidal habitats will fall within a similar range throughout the Atlantic region. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on intertidal habitats in the Atlantic region under Alternative 1 are expected to be insignificant for small spills, minor for medium spills, and moderate for large spills.

Subtidal Habitats

The subtidal (benthic) habitat consists of the bottom substrate below the low tide level, as well as the species that live in, on, and near the substrate. This benthic community includes areas of live, sandy, muddy, and low-relief bottoms; subsurface canyons; and pinnacles. Organisms living in this area—demersal species—include corals, plants and seagrasses, benthic invertebrates (such as crabs, shrimp, snails, bivalve mollusks, and marine worms), and bottom-dwelling fish. Because subtidal benthic communities do not include the intertidal zone, they are at little risk from floating oil because, by definition, this environment is always below the surface. The greatest risk of exposure comes from sinking oil, as well as *in situ* burn residue, or dispersed oil or the sorption of naturally dispersed or mechanically mixed oil that has become suspended on sediments and is deposited onto the ocean floor. However, significant natural dispersion of oil and sediment into the water column only occurs during large storms or for nearshore oil spills. Oil particles could adhere to bottom substrate, plants, or animals, which could result in both physical coating of organisms, as occurred in the 1993 *BRAER* spill in the Shetland Islands, and toxic effects from exposure to the chemical constituents (Section 4.3.2.5). Such adverse effects are not normally observed.

The risk to fauna and flora of the subtidal benthic habitat is minimal, based on the diluting effect of the overlying water (Section 2.2.2)—the deeper the water, the lower the risk. Chemical compounds of concern tend to evaporate, rather than dissolve, and the rapid dilution of any chemical entering the water column decreases the toxicity of any oil residue potentially reaching the bottom substrate.

Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects. It might slightly increase the risk of remaining oil residues sinking to the bottom. Residual oil from *in situ* burning that reaches the bottom is expected to have little or no adverse effects on subtidal habitats since the majority of its toxic components would have either evaporated or been destroyed during burning and the volume of residue produced is so small (Section 4.3.2.5). Under the modeled conditions, the quantity of *in situ* burn residue produced would not result in a level of concern that exceeds low.

Based on the data for a medium spill, sediment contamination never exceeded thresholds of concern and the median area equivalent to 100 percent mortality for sensitive demersal species exposed to oil in the water column was less than 0.001 percent of the reference area. For a large spill sediment values did exceed the threshold of concern in a small area, but it was less than 0.001 percent of the reference area. Water column exposure also increased slightly, but still affected less than 0.02 percent of the reference area. Based on the total subtidal area present in the Mid-Atlantic Shelf the risk from water column exposure or sediment contamination is low (Table 4.5-11).

Table 4.5-11
Risk Ranking of Offshore Oil Spills* to Subtidal Habitats Using the Basic Response Scenario† in the Mid-Atlantic Shelf‡

Spill Size	Habitats Affected (estimated %)	Risk Score§
Small (200 bbl)	0–1	4E
Medium (2,500 bbl)	0–1	4E
Large (40,000 bbl)	0–1	4E

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subtidal habitats in the Atlantic region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Areas of Special Concern

The potential effects on areas of special concern, such as National Marine Sanctuaries and National Wildlife Refuges, are important during an oil spill since these areas are under increased scrutiny and protection. Whereas most coastal and nearshore areas have a wide range of habitats or are very similar to other areas throughout the Atlantic region, areas of special concern are set aside for their uniqueness (Appendix F, Tables D.F-3 through D.F-5 and Figures F.2-1 through F.2-4). The potential risks and adverse effects associated with shoreline areas of special concern are identical to those discussed for intertidal habitats. The risks to subtidal areas, such as those included in National Marine Sanctuaries, are identical to those discussed above for subtidal habitats. For this analysis, the risks to areas of special concern are assumed to be the same as those for either intertidal or subtidal habitats (Sections 4.5.2.2), whichever are greater. Since the risk to intertidal habitats is greater, those risk scores were used. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on data presented for a medium spill, the estimated average extent of shoreline oiling is 11.6 km; this figure increases to 29.2 km for a large spill. The potential risk of surface oil reaching a shoreline associated with an area of special concern is low in the Mid-Atlantic Shelf because of the number and scattered locations of these areas. The potential adverse effects on areas of special concern are normally low (Table 4.5-12). However, potential concerns associated with a large spill increase to medium levels because of the increased shoreline contamination.

Table 4.5-12
Risk Ranking of Offshore Oil Spills[*] to Areas of Special Concern Using the Basic Response[†] Scenario in the Mid-Atlantic Shelf[‡]

Spill Size	Areas Affected (estimated %)	Risk Score[§]
Small (200 bbl)	0–1	4E
Medium (2,500 bbl)	0–1	3E
Large (40,000 bbl)	1–5	2D

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Since areas of special concern are scattered along the Atlantic coast, it is unlikely that shoreline associated with areas of special concern would be disproportionately affected by an average spill. If an area of special concern was highly adversely affected, it is anticipated that the recovery time for the affected area would be the same as for other intertidal habitats. These areas are most at risk from floating oil and benefit from any actions that reduce potential oiling.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on areas of special concern in the Atlantic region under Alternative 1 are expected to be insignificant for small spills, minor for medium spills, and moderate for large spills, based on the risk to intertidal habitats.

4.5.2.3. Consequences to Threatened, Endangered, or Candidate Species

The Atlantic region has a variety of threatened, endangered, or candidate species (Section 3.2.3). The overall regional risk that a threatened, endangered, or candidate species would be adversely affected or even present in the area of a spill is low; however, killing a single individual of such a species can be considered a severe adverse effect. Potential adverse effects on marine mammals, marine and coastal birds, or fish that are threatened, endangered, or candidate species are identical to those discussed in Section 4.5.2.2 for these groups. Potential adverse effects on the six threatened or endangered species of sea turtles were discussed in detail in Section 4.3.3.1 and are similar to those described in Section 4.5.2.2 (Marine Mammals) for pinnipeds. Sea turtles are a particular concern if the spill occurs in the vicinity of a nesting beach. Overall, the highest risk scores were calculated for coastal and marine birds with other types of protected species at lower risk. Regardless of the species, the majority of threatened, endangered, or candidate species in the Atlantic region mature slowly and do not reach sexual maturity for several years; therefore, any adverse effects on the reproduction or survival of these species should be considered high.

Adverse effects on threatened, endangered, or candidate species in the Atlantic region for any spill size are difficult to predict. Depending on the location and season, the number and type of species present will vary. Based on the overall size of the Atlantic region and the low populations of threatened, endangered, or candidate species inhabiting this region, the likelihood of adversely affecting an individual of concern would be low unless the spill affects important shoreline or critical marine habitats. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on threatened, endangered, and candidate species in the Atlantic region under Alternative 1 are expected to be moderate for small, medium, and large spills, based on the risk to marine and coastal birds.

4.5.2.4. Consequences to Essential Fish Habitat

Virtually all waters along the Atlantic coast and out to the limits of the U.S. Exclusive Economic Zone (EEZ) are considered Essential Fish Habitat (EFH). Areas such as bays, river mouths, and harbors are designated EFH for at least one life stage of at least one species and are protected by legislation (Section 3.2.4). The primary issue with respect to EFH is either (1) exposure of sensitive resources in the water column to hydrocarbon concentrations of concern, or (2) the contamination of bottom sediments, both of which could lead to either acute or chronic exposures.

Adverse effects would include either the death of individual organisms, the possibility of sublethal effects affecting long-term population viability, or degradation of habitat that reduces its availability to managed species. For this analysis, the risks to EFH are assumed to be the same as those for plankton and fish or for subtidal habitats (Section 4.5.2.2), whichever are greater. The results for plankton and fish and for subtidal habitats indicate only low effects and form the basis for the EFH risk score. Under Alternative 1, the addition of *in situ* burning does not remove enough oil to reduce potential adverse effects. The data presented in Section 4.5.2.2 indicate that the volume of water or area of sediment contaminated above thresholds of concern never approaches 1 percent of the reference area, so the risk is very low.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on EFH in the Atlantic region under Alternative 1 are expected to be insignificant for small, medium, and large spills, based on the risk to plankton and fish and to subtidal habitats.

4.5.2.5. Consequences to the Socioeconomic Environment

As discussed in Section 4.3.5, oil spills can produce a variety of adverse social and economic effects. These adverse effects are generally not significant when measured at the regional level, but instead are typically felt in communities located near resources oiled by the spill. Specifically, high adverse effects are generally limited to those industries and populations that are affected by the spill. Some of the most visible and high effects are likely to include effects on water- and shore-based recreation, commercial and recreational fisheries, and tourism. In addition, large-scale spills hold the potential to adversely affect the well-being of the residents and economies of coastal communities. Individuals who rely on coastal resources for employment and income are at risk of experiencing disproportionately adverse effects from oil spills.

This modeling considers the risk of adverse socioeconomic effects posed by oil spills, which can include, but are not limited to, reduced recreational activity because of beach closures, limited accessibility, or perceived taint; closure of commercial fishing grounds or hatcheries, or reduced commercial harvests; and altered marine transportation patterns. In addition to these and other direct adverse effects, oil spills can have secondary adverse effects on social and economic welfare along the coast. For example, an oil spill may cause changes in employment and firm revenues of resource-based businesses. While these effects are not quantified in this modeling, the following discussion provides absolute and relative measures of the overall risk of adverse social and economic effects of small, medium, and large oil spills using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) in the Atlantic region. (Although dispersant pre-authorization agreement areas exist in the Atlantic region [Figure 2.2-1], appropriate response times cannot currently be met for chemical dispersion.)

This modeling evaluates the effects of oil spills based on the risk of adverse effects on various factors of the socioeconomic environment rather than changes in monetary benefits. The methodology assumes that the risk posed by oil spills to the socioeconomic environment is directly related to the extent to which coastal resources (e.g., sandy recreational beach, marine waters used for commercial fishing) are oiled above selected thresholds of concern. That is, the proportion of total shoreline or surface water oiled above selected thresholds in the modeled spill area is used to represent the risk of socioeconomic effects (see Section 4.4.3.2 for details on the method used).

Comparing the absolute risk of adverse socioeconomic effects (e.g., meters of sandy shoreline oiled above a recreational threshold of concern) across hypothetical spill scenarios, including variations in spill response scenarios, allows for an understanding of the relative risk of adverse socioeconomic effects across these scenarios. In this section, only basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) results are examined. Determining relative risk also allows for extrapolation of site-specific results to the entire region. For example, some of the risk estimates presented below are based on modeled spills affecting the Mid-Atlantic Shelf. While any given spill may exhibit distinctly different patterns of socioeconomic effect, the relative risk measures reported for the Mid-Atlantic Shelf modeling scenario are expected to be broadly applicable to a range of spill locations along the Atlantic coast. In addition, the conclusions reached for the Mid-Atlantic Shelf modeled area are supported by results for other modeled areas.

Extrapolating results from modeled spills in specific areas to other coastal sites is more valid for measures of relative risk of losses than absolute measures of monetary losses. For example, if additional oil spill response in the waters off the New Jersey coast causes a 30 percent reduction in shoreline resources oiled (and, therefore, recreational beach use affected), that 30 percent could be applied to any site along the Atlantic coast. If losses to New Jersey beaches were evaluated in terms of dollars, however, seasonal and visitation differences between New Jersey and other states such as Maine would prevent accurate application of those monetary losses. For this reason, there is precedent in applying relative risk in evaluating potential changes to response regulations; for example, environmental performance of double-hull tanker design alternatives was evaluated based on risk of environmental and socioeconomic effects of oil spills (Transportation Research Board, 2001).

This methodology was used to evaluate socioeconomic risks and differs from that used to address the risks posed to other ecological resources. The rationale behind this deviation is based on the fact that this methodology is judged to most accurately reflect the threat to these resources while facilitating comparisons across specific modeled areas and generalizations to broader contexts (see Section 4.4). In addition, the socioeconomic risk metric closely parallels the measure of proportion of resource affected that was quantified in the preceding sections for ecological resources. The risk matrix used for ecological resources defines risk based on the percentage of the resource potentially affected in combination with the time to recovery (Figure 4.4-2). While the percentage of the resource affected is relevant to the modeling of socioeconomic effects, the time to recovery is difficult to define in a socioeconomic context. The time necessary for socioeconomic recovery is subject to factors outside the influence of oil spill cleanup operations, such as national economic trends, recreational preferences, consumption patterns, and public perceptions. Changes in these factors, which are independent of the oil spill, could affect the time to recovery; thus, assigning "time to recovery" would be arbitrary.

There is no existing standard for "significance" related to the socioeconomic effect of oil spills (e.g., how much shoreline or surface water must be oiled to be considered a "high," "medium," or "low" effect). The significance of the effect will depend on a number of factors, including the scope of the analysis (i.e., national, regional, local), opportunities for resource substitution (e.g., an unoiled beach or fishing ground nearby, alternative ports of call), and the duration of the spill event. Generally, a spill event would be of low concern if it is not of long enough duration to affect the financial viability of local businesses, and the affected communities are able to find substitutes to replace the oiled resources.

For this PEIS, (1) the greatest effect modeled at the regional level was less than approximately 10 percent of available shoreline or surface water resources (indicating the likely presence of substitute resources), and (2) resource use following these modeled spills (e.g., vessel transportation and fishing) would be expected to resume as soon as oil recovery efforts were completed. As a result, the modeled effects under all modeled scenarios would likely be low at the regional level. As noted in the text, any adverse effects that occur would be expected to be localized in nature.

Table 4.5-13 highlights the effects of small, medium, and large oil spills on the Atlantic region's socioeconomic resources by presenting estimates of resources oiled as a result of the average modeled spill in absolute terms (length of shoreline oiled or area of surface water oiled above the threshold of concern) and as a percentage of the total resource base in the modeled area (Mid-Atlantic Shelf). For oiled shoreline, the threshold of concern is 10 g/m^2 and for oiled surface water it is 0.01 g/m^2 (technical report [French McCay et al., 2004]). This resource area is based on an estimate of the extent to which the coastal community in the Mid-Atlantic Shelf potentially relies on each resource in this specific modeled area.

For this modeling, the socioeconomic environment is divided into components representative of the major parameters of coastal life potentially affected by an oil spill. Absolute and relative risk are discussed for coastal communities, demography, and employment; general economic status of a coastal community; vessel transportation and ports; commercial and recreational fisheries; archaeological and historic resources; recreation and tourism; environmental justice; and public safety and worker health.

Coastal Communities, Demography, and Employment

Coastal communities benefit from and rely on the marine environment to provide residents with sustenance, livelihoods, leisure opportunities, and shipping avenues. Individuals who live and work in close proximity to the coast derive both social and economic rewards from the natural beauty, recreational opportunities, quality of life, economic resources, and cultural attributes associated with these coastal locations. These rewards are derived from assets such as National Parks, public beaches, fishing opportunities, and commercial and tourism-related industries.

Table 4.5-13

Risk Ranking of Offshore Oil Spills[*] to Coastal Communities as a Result of Shoreline and Surface Water Oiled Using the Basic Response Scenario[†] in the Mid-Atlantic Shelf[‡]

	Shoreline Length		**Surface Water Area**	
Spill Size	**m Oiled Above Threshold[§]**	**Estimated % Oiled[‖]**	**m^2 Oiled Above Threshold[§]**	**Estimated % Oiled[‖]**
Small (200 bbl) [#]	N/A	N/A	N/A	N/A
Medium (2,500 bbl)	7,122	1.2	810×10^6	0.55
Large (40,000 bbl)	17,458	2.9	$1{,}155 \times 10^6$	0.79

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

[§] Thresholds above which some economic or social risk is expected were determined, and the length of shoreline oiled and the area of surface water oiled above this threshold for the average modeled spill are reported. The threshold of concern because of oiled shoreline and surface water is 10 g/m^2 and 0.01 g/m^2 of oil, respectively (technical report [French McCay et al., 2004]).

[‖] Percentages reflect the proportion of the total modeled area above the threshold of concern.

[#] A 200-bbl spill is assumed to have negligible effect.

Thus, oil spills can affect any number of a coastal community's assets, leading to adverse effects on the economic benefits of community activities. For example, as the number of visitors to local parks and beaches decreases, so too will the demand for hotel rooms, restaurant meals, and other revenue-generating activities. Individuals working in these affected communities and providing services to recreationists and tourists will suffer from the corresponding drop in demand for their services. Demand will decrease in proportion to the local resources contaminated or affected by the spill. In addition, by contaminating key waters, an oil spill can affect commercial and/or recreational fishing. These effects will be felt throughout the local community by those businesses directly and indirectly connected to the fishing industry (e.g., fish processing). Moreover, fishing enthusiasts will see the social welfare benefit of coastal living or visits diminish. Given their reliance on marine resources, coastal communities are likely to be more vulnerable to the adverse effects of a spill than communities with a more diverse economic base.

As a result of oiling, beaches in the immediate vicinity of a spill may be closed to visitors, and fishing may not be permitted in waters exposed to oil, causing losses in revenue to both the tourism and commercial and recreational fishery sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill, causing short-term decreases in recreation and tourism; commercial and recreational fishing; and the employment opportunities, income, and associated businesses these industries support. In addition, an oil spill may temporarily reduce the appeal of coastal living in a given area.

For a small spill along the Atlantic coast, there is no risk of high adverse effects on coastal communities. In many cases, a spill of this size is expected to pose no risk to shoreline or surface water resources because the spilled oil will never reach the threshold of concern (Table 4.5-13).

The risk of adverse effects on coastal communities for a medium spill is likely to be greater than for a small spill. Using mechanical-only recovery, a medium spill in the Mid-Atlantic Shelf will have a spill area[20] above the corresponding threshold of concern that will adversely affect approximately 7,122 m of shoreline and sweep approximately 810 million m^2 of marine waters used for recreation and by the commercial fishing industry, respectively (Table 4.5-13). A large spill would sweep 17,458 m of sandy shoreline and 1,155 million m^2 of marine waters (Table 4.5-13). A spill of this size would affect the pleasure that coastal residents and visitors derive from coastal activities and the economic contribution that recreational resources make to local income and employment. However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources at all or at levels above the selected threshold. For medium and large spills along the Mid-Atlantic Shelf shoreline, such conditions prevail 30 and 21 percent of the time, respectively, based on the modeled spills when the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) is used in the cleanup. For these spill events, no adverse effects on the shoreline are expected.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal communities, demography, and employment in the Atlantic region under Alternative 1 are expected to be insignificant for small, medium, and large spills. The adverse impacts of a large spill would be similar to those for a medium spill and would generally be limited to the spill area—the adverse impacts would not be felt at the regional economic level. However, a large spill could result in significant local adverse impacts, even though regionally less than 1 percent of critical surface water and 3 percent of critical shoreline would be affected. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 17,458 m of sandy shoreline and 1,155 m^2 of surface water above recognized thresholds [Table 4.5-13]); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Economic Status

The overall economic status of communities, industries, and individuals that rely on coastal resources for sustenance, revenue, and quality of life can be affected by an oil spill. As noted above, coastal communities can suffer direct and indirect adverse economic effects from an oil spill, as beach and fishery closures decrease revenue and eliminate jobs. More specifically, losses will be felt in commercial and recreational fisheries, by both the anglers themselves and by related industries as catch opportunities decrease or are eliminated entirely. Tourism and associated businesses will suffer economic setbacks as visits to affected coastal areas decline and purchase of area goods and services decrease because of perceived resource taint. Similarly, environmental justice issues may arise as low-income or minority communities are disproportionately affected by the spill (discussed below in more detail).

A small spill that is 3 or more statute mi offshore would have essentially no adverse effects on either the local or regional economies (Table 4.5-13). There is little to no risk that economically important resources would be oiled, and it is unlikely that any fisheries or recreational areas would be affected.

A medium spill, with mechanical recovery and *in situ* burn operations, could be expected to have short-term adverse economic effects as a result of oiling recreational beaches, closing fisheries and recreational areas, and degrading the appeal of coastal locations. A large spill's adverse economic effects could be high for the local economy, even with mechanical recovery and *in situ* burning, based on the anticipated level of shoreline oiling and the possibility that closure of commercial and recreational fishing grounds will occur. Compared with a medium spill, the amount of sandy shoreline oiled above the expected threshold is more than double under the large spill and the surface water area oiled is over 40 percent greater for a large spill (Table 4.5-13). As noted above, while 30 percent of all modeled medium spills resulted in no adverse effects on the shoreline, only 21 percent of modeled large spills generated no adverse effects. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could heighten adverse socioeconomic effects.

Based on the modeling results (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on economic status in the Atlantic region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 17,458 m of sandy shoreline and 1,155 m^2 of surface water above recognized thresholds [Table 4.5-13]); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Vessel Transportation and Ports

Oil spills occurring 3 or more statute mi offshore are not likely to cause great adverse effects on vessel transportation and ports; any adverse effects would likely be of short duration. However, an oil spill can disrupt marine commerce if it occurs in and around a shipping channel or port and results in limits on watercraft movement as a means of facilitating spill response. Any interruption in the standard use of vessels or increase in travel times over water can result in hardship for coastal communities as fewer goods are exchanged, transportation costs rise, and the revenue streaming through the local economy falls. These adverse effects might be felt at a number of levels. For example, vessel operators may incur additional costs associated with delays and longer shipping distances; businesses that depend on timely receipt of feedstock or other goods may experience adverse effects such as production slowdowns; and individuals who work in adversely affected sectors may be displaced. To the extent that businesses in other locations depend on the affected industries, a longer-term disruption of vessel transportation could yield adverse effects beyond the immediate spill area. However, given substitute suppliers and shipping modes and the expected short-term nature of any disruption in vessel traffic, such adverse effects are not likely to be large.

Vessel transportation is extremely important to many industries along the Atlantic coast. For example, in the Mid-Atlantic states (Pennsylvania, New Jersey, Delaware, Maryland, and Virginia), a spill that interferes with traffic in and out of the Chesapeake Bay would have serious implications for the city of Baltimore. In total, Maryland exported $5 billion worth of goods to foreign markets in 2000, with more than half of this volume originating from the port of Baltimore (USDOC-ITA, 2001). Similarly, a spill outside of New York Harbor might slow or even halt traffic in and out of the area. The 8-day shut down of the port of New York in the wake of September 11, 2001, resulted in losses of $58 billion in economic activity, averaging $7.25 billion in economic activity per day (CBSNews.com, 2002). While these data provide a sense of the importance of marine transportation in some areas, it is important to note that oil spills would not generally be expected to result in closures of this duration or geographic scope. To the extent that mechanical recovery and *in situ* burning reduce the surface area of slicks above a threshold of concern, some combination of spill response options will reduce the risk of adverse effects on vessel transportation and ports.

For a small spill, no large adverse effects on vessel transportation or ports are expected (Table 4.5-13), but there is some risk of adverse effects from a medium spill. Therefore, the nature of the risk to vessel transportation and ports will be a function of the location, area, and pattern of surface water oiling: for a medium spill, only a fraction of surface water area is affected, equal to less than 1 percent of total surface water area in the Mid-Atlantic Shelf (810 million m^2) (Table 4.5-13). A large spill will oil 1,155 million m^2 of surface water area (Table 4.5-13), increasing the degree of adverse effects by 40 percent from a medium spill. However, a spill occurring under specific location, weather, and tidal conditions could adversely affect vessel transportation and ports and the industries and communities that depend on this traffic. Any adverse effects on vessel transportation and ports would likely be short lived—that is, even if shipping waters or ports are exposed to oil and are therefore closed, as soon as recovery efforts remove surface oil, these facilities would be expected to be reopened.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on vessel transportation and ports in the Atlantic region under Alternative 1 are expected to be insignificant for small, medium, and large spills. The fraction of the total area affected by these various spills clearly indicates that the adverse impact of most oil spills will be localized; a regional or even statewide adverse impact is unlikely to result from spills in this size range.

Fisheries

Commercial Fisheries

Commercial fisheries are vulnerable to oil spills because of both closures and perceived taint. A moratorium on fishing operations in the wake of an oil spill can lead to significant revenue losses for the commercial fishing industry, as well as related industries, including those that supply equipment to and purchase products from commercial fleets. For example, the Atlantic region's commercial fisheries generated over $1.1 billion in 2001, or 38 percent of the nation's total catch, with state catches ranging in size from $280 million in Massachusetts to $44,000 in Pennsylvania (NMFS, 2004a). In addition, oil spills can lead to a decreased demand for fish from affected waters because of actual or perceived taint and can instigate alterations to fishing practices in a manner that increases operating costs and/or decreases revenues. Large spills can potentially injure fish nursery grounds and impose other risks that could reduce fish harvests longer term.

By contaminating key waters, an oil spill may disrupt employment in commercial fisheries and related sectors of the economy. The *NORTH CAPE* oil spill had a severe effect on the harvest of lobster and shellfish off the coast of southern Rhode Island. With oil covering a large portion of Block Island Sound, a 250-mi^2 area was closed to fishing (NOAA et al., 1999). More than 9 million lobsters were killed in this area (NOAA et al., 1999), forcing lobstermen to seek alternative fishing grounds. However, while the local adverse effects of a spill on commercial fisheries might be high, such effects should be placed in the context of the state or regional economies. For example, the economy of the state of Rhode Island was $32.5 billion in 1999, of which only 0.3 percent was generated by commercial fishing activity (Bureau of Economic Analysis, 1999; NOAA, 2000c).

For a small spill in the Atlantic region, the risk to commercial fisheries is negligible using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) (Table 4.5-13). For a medium spill, the risk of adverse effects on commercial fisheries is likely to be greater than for a small spill, but the effects remain localized. A medium spill along the Atlantic coast will sweep approximately 810 million m^2 of marine waters used by the commercial fishing industry above the corresponding threshold of concern (Table 4.5-13). A risk of economic loss to commercial fisheries will occur when waters exceed relevant management and/or risk-based thresholds. For example, fishing may not be permitted in waters swept by oil above the modeled threshold of concern, resulting in reductions in commercial fish landings for a period of time following a spill. The resulting adverse effects would be expected to reverberate through communities in the area of the spill, causing decreases in employment, income, and the viability of businesses associated with the commercial fishing industry. To the extent that substitute fishing grounds are available, spill effects on the commercial fishing economy may be less severe.

These risks to commercial fisheries increase with a large spill, as the size of the area oiled increases. A large spill presents risk to approximately 1,155 m^2 of marine waters potentially important to commercial fisheries above the corresponding threshold of concern (Table 5.4-13). A spill of this size may cause significant decreases in local commercial fishing activities and revenues. These declines may spill over to create additional adverse impacts on businesses associated with the commercial fishing sector. To the extent that commercial fishing operations can, for a time, move to substitute fishing grounds, the potentially severe adverse effects of even a large spill may be avoided.

Recreational Fisheries

Similar to commercial fishing operations, recreational fisheries are at risk of closure or loss in value as a result of oil spills. These adverse effects will not generally be at the regional or national level but could be high at the local level. For this modeling, the risks posed to recreational fishing activities are modeled in the same manner as risks to commercial fishing activities, in square meters of surface water oiled above the corresponding threshold of concern. The effects of an oil spill on recreational fishery-related activities will be felt more heavily by various populations, including recreational anglers and firms that supply goods and services to recreational anglers. For example, recreational anglers fish for pleasure or sport, as opposed to monetary gain. In the wake of an oil spill, such anglers may choose to fish at a substitute location, may experience a reduced quality of experience, or may choose to forgo fishing entirely. The losses suffered will be related to these missed opportunities. In addition, while closing waters to recreational fishing will decrease the social welfare of recreationists, it would also be expected to affect the demand for boat rentals and other services consumed by fishing enthusiasts.

For a small spill, adverse effects on recreational fishing resources in the Atlantic region would likely be negligible (Table 4.5-13). Medium and large spills may cause decreases in local recreational fishing activities and in the revenues generated from these activities.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on fisheries (commercial and recreational) in the Atlantic region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 17,458 m of sandy shoreline and 1,155 m^2 of surface water above recognized thresholds [Table 4.5-13]); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Subsistence

Potential adverse effects on marine species are a concern during spills where traditional use of subsistence resources occurs. Information on subsistence use of fish and shellfish in the Atlantic region is limited. While some residents may supplement their diets with these resources, subsistence is not known to be a prominent activity in this region (Section 3.2.5.5), as compared to the Alaska region, where Native communities may suffer substantial economic and cultural losses due to contamination of subsistence seafood during an oil spill. Tissue tainting would be the primary concern for these subsistence resources.

The Mid-Atlantic Shelf was selected for the modeling as representative of the coastal habitats, fish, and wildlife in the Atlantic region. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the severity of potential adverse effects nor increase risk to subsistence resources. Potential adverse effects on subsistence resources in the Atlantic region are low for small, medium, or large spills (Table 4.5-14).

Table 4.5-14
Risk Ranking of Offshore Oil Spills* to Subsistence
Using the Basic Response Scenario† in the Mid-Atlantic Shelf‡

Spill Size	Resources Affected (estimated %)	Risk Score§
Small (200 bbl)	0–1	4E
Medium (2,500 bbl)	0–1	4E
Large (40,000 bbl)	0–1	4E

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Effects on subsistence resources for a small spill were determined to be low by extrapolating from the results for a medium spill. For a medium spill, the modeling results showed water column exposure to dissolved aromatics to be at low concentrations (1–100 ppb) and to only occur directly outside and inside the entrance to Delaware Bay. Tainting of fish and invertebrates becomes a concern when water concentrations exceed approximately 100 ppb (Section 4.3.5.6). Sediment exposure was estimated to be negligible.

For a large spill, the modeling results showed water column exposure at low concentrations (10–100 ppb) in a more widespread area, from inside Delaware Bay to approximately 116 km offshore, and from Maryland to southern New Jersey. Sediment exposure was estimated to be negligible. The risk scores in Table 4.5-14 reflect the predicted recovery rates for subsistence resources of less than 1 year for all spill sizes (Section 4.3.5.6). Although areas other than the Mid-Atlantic Shelf in the Atlantic region were not modeled, the results are consistent with those for all other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on subsistence resources will fall within a similar range throughout the Atlantic region. While adverse effects on subsistence resources are not likely to be high on a regional level, they may be high on a local level.

Based on the modeling results (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subsistence resources in the Atlantic region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Archaeological/Historic Resources

Under Alternative 1 using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), adverse effects on archaeological resources in the Atlantic region would likely be negligible, regardless of spill size, because most archaeological resources in the

Atlantic region are buried under offshore sediments and are not at risk of becoming oiled (Section 3.2.5.6).

Similar to archaeological resources, adverse effects on historic resources are expected to be low, regardless of spill volume or response option. Most historic sites in the Atlantic region are either located on land and protected from oiling by bulwarks or other barriers, or are submerged shipwrecks that are typically not well preserved due to strong currents and wave action in the region (Section 3.2.5.6). Results from several studies indicated that direct oiling caused negligible effects on cultural resources following the *EXXON VALDEZ* oil spill (Bittner, 1996; Dekin, 1993; Reger et al., 1992; Wooley and Haggarty, 1995). Mechanical-only recovery or mechanical recovery plus *in situ* burning may help reduce the amount of oil that strands on the shoreline, which will also reduce the amount of shoreline cleanup and potential disturbance to sensitive historic structures.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on archaeological and historic resources in the Atlantic region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Recreation and Tourism

Oil spills can adversely affect a coastal community's recreation and tourism assets. For example, stretching from Maryland into Virginia, the Assateague Island National Seashore received approximately 1.9 million visitors in fiscal year 2001 (NPS, 2002). Recreational activities at the seashore include hiking, biking, bird watching, fishing and hunting, kayaking, and swimming. Both residents of and visitors to such areas appreciate the recreational opportunities offered to them by the coast. A large spill occurring in the Atlantic region could contaminate up to 17,458 m of sandy shoreline (Table 4.5-13), or if it directly hits the Assateague Island National Seashore, 30 percent of the seashore's shoreline would be contaminated above corresponding thresholds of concern. A spill of this size would be expected to result in broader effects on tourism, such as deterring visitors from the spill area. A similar scenario could be outlined for the parks, seashores, beaches, and recreational fishing areas that line the Atlantic coast.

An oil spill would be expected to affect recreationists' overall social welfare; in addition, the social and economic implications of a spill would reach beyond direct effects on visitors and into the community. For example, visitors may be less likely to visit and spend money in an area perceived as affected by a spill, potentially leading to loss of business revenue and jobs (see Coastal Communities, Demography, and Employment above for more details).

For a small spill in the Atlantic region, the risk to recreation and tourism is negligible using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) (Table 4.5-13). For a medium spill, the risk of adverse effects on recreation and tourism is likely to be greater than for a small spill. A medium spill near the Atlantic coast will adversely affect approximately 7,122 meters (m) of the total recreational shoreline above the corresponding threshold of concern (Table 4.5-13). For a large spill, although the nature of the risk remains the same as for a medium spill, the risk to recreation and tourism along the Atlantic coast increases to nearly 17,458 m of the total recreational shoreline (Table 4.5-13).

Under these conditions for medium and large spills, beaches in the spill area may be closed to visitors, and fishing and boating may not be permitted in waters exposed to oil, causing losses in revenue to the recreation and tourism sectors of the coastal economy. These effects would be expected to reverberate through the spill area's communities, causing decreases in tourism and recreation, and the revenue and employment associated with them. However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources at all or at levels above the selected threshold (i.e., no effects are expected). Such conditions prevail in 30 percent of medium modeled spills and in 21 percent of large modeled spills along the Atlantic coast when using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit).

Based on the modeling results (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on recreation and tourism in the Atlantic region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 17,458 m of sandy shoreline and 1,155 m^2 of surface water above recognized thresholds [Table 4.5-13]); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Environmental Justice

As mentioned above, low-income, indigenous, and minority populations in some coastal areas may rely on regional fisheries and other marine resources in the context of participating in commercial fishery or other marine resource-based employment. These groups may experience the effects of a spill more severely than the general population, which relies on a more diverse economic base for its livelihood and on the availability of a widespread, commercially available selection of foods. Additionally, employment in marine resource-related industries might have value beyond the importance this resource holds as an employment opportunity.

Poverty in these populations is the best indicator of potential environmental justice issues. This modeling assumes that low-income groups would disproportionately suffer adverse socioeconomic effects from an oil spill. Considering the demographic variety of the counties that line the Atlantic coast, analyzing the Mid-Atlantic Shelf with respect to environmental justice serves as a good proxy for the potential of oil spills at various locations along the Atlantic coast to disproportionately affect disadvantaged populations.

While coastal property may be expensive, its price is not necessarily a reflection of the resident population's income or of those that rely on coastal resources. Counties along the Eastern Shore of Virginia include many low-income communities. In 1999, the median household income for Virginia was $46,677, but for Accomack and Northampton Counties on the Eastern Shore, these figures were much lower, at $30,250 and $28,276, respectively (U.S. Census Bureau, 2000a). In the state of New Jersey, it is estimated that 8.5 percent of people live below the poverty line, but in Atlantic City 23.6 percent live below the poverty line, more than double the county average (Atlantic County, 10.5 percent), and almost three times the state average. In Penns Grove and Salem City, both coastal towns, the figure is above 20 percent. Further, more than 25 percent of Wildwood City's population lives below the poverty line versus 8.6 percent for Cape May County as a whole (U.S. Census Bureau, 2000a, b).

The income disparity among individuals living along and/or near to the coast implies that low-income groups may face a disproportionate burden following an oil spill. In Wilmington, Delaware, the mean hourly wage is $18.10, yet the mean wage for lodging managers is $13.82; for food preparers and servers, $7.57; and for amusement/recreation attendants, $8.09. In terms of mean annual earnings for this area, lodging managers make 75 percent; food preparers and servers, 50 percent; and amusement/recreation attendants, 42 percent (OES Program, 2001). Individuals that work in these jobs may not live on the coast, but the security of their employment depends on the coast's attracting visitors. To the extent that an oil spill deters visits and reduces demand for hotel and restaurant services, the economic status of low-income groups may be affected.

A small spill that is 3 or more statute mi offshore would have essentially no effects on either the local or regional economies (Table 4.5-13). There is little to no risk of shoreline oiling, and it is unlikely that any fishing waters would be affected. A medium spill would be expected to have short-term adverse effects by affecting economic stability. For a large spill, the adverse effects would be high for the local economy based on the anticipated level of shoreline oiling and on the likelihood that closures will occur for various commercial and recreational fisheries. Specifically, the amount of sandy shoreline that becomes oiled from a large spill is more than double that for a medium spill (Table 4.5-13) and the surface water area oiled is over 40 percent greater for a large spill (Table 4.5-13). While the physical effects would be relatively short lived, the public reaction to perceived resource taint could cause adverse effects to be higher.

As a result of oiling, beaches in the immediate vicinity of a spill may be closed to visitors, and fishing may not be permitted in waters exposed to oil, causing losses in revenue to both the tourism and commercial and recreational fishery sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill and disproportionately affect low-income and minority populations, causing decreases in employment opportunities. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on environmental justice in the Atlantic region under

Alternative 1 are expected to be insignificant for small, medium, and large spill sizes. On average, only a small percentage of the total available resources in the modeled area is affected from even the largest modeled spills (affecting up to 17,458 m of sandy shoreline and 1,155 m^2 of surface water above recognized thresholds [Table 4.5-13]); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Public Safety and Worker Health

Potential adverse effects on public safety are defined as the risk to the public from direct exposure to oil or response activities as a result of the spill. There are many areas in the Atlantic region with high population concentrations along the coast. However, it is unlikely that there would be adverse effects on public safety from oil spills that occur 3 or more statute mi offshore for any of the spill sizes considered, regardless of the response options used. The USCG has protocols to keep the public from risk during shoreline response operations, as well as on-water protocols to prevent the public from entering the response area.

Potential adverse effects on worker health are related to direct exposure to oil during response operations. In addition, operating oil spill response equipment can be dangerous, which is well recognized and is the basis for the worker certification and training requirements that are now in place. There is also a health risk from inhalation of hydrocarbon fumes for first responders, which is recognized in current safety protocols. The risk is greater as the spill size and the corresponding intensity and duration of operations increase, but is minimized if safety standards are followed.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on public health and worker safety in the Atlantic region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

4.5.3. Consequences in the Caribbean Region

For the purpose of this PEIS, the Caribbean region consists of the tropical waters of the Caribbean Sea and Atlantic Ocean and is enclosed to the south by Venezuela, Colombia, and Panama; to the west by Belize, Honduras, Nicaragua, and Costa Rica; and to the north, it wraps toward the southeast with the Greater and Lesser Antilles Islands, beginning with Cuba and ending with Trinidad and Tobago. The tropical waters of the southwestern Atlantic Ocean are off the north shores of Puerto Rico and the U.S. Virgin Islands (the U.S.-affiliated islands discussed in this section), and the tropical waters of the Caribbean Sea are off their south and west shores (Figure 3.1-1). There was no location in this region for modeling and risk assessment purposes. However, due to readily available modeling data, the Florida Straits, which is actually in the Atlantic region, was selected for modeling because it contains very similar habitats (mangroves, seagrass beds, coral reefs) and amenity resources as the Caribbean region. The Florida Straits results were used to evaluate effects in the Caribbean region. Modeling results from this location were evaluated relative to the geographic area in Section D.1.2 of the technical report (French McCay et al., 2004), herein referred to as the Florida Straits. The Florida Straits encompasses two biogeographical provinces: Florida Straits and Florida Bay. The results of the modeling—used to evaluate spills of concern in this risk analysis (i.e., 3 or more statute mi offshore)—are presented in Part D of the technical report (French McCay et al., 2004) and summarized in this section.

Table 4.5-15 presents the risk ranking for the modeling of Alternative 1 in the Caribbean region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) for three spill sizes (small, 200 bbl; medium, 2,500 bbl; and large, 40,000 bbl). The risk scores presented in the table are based on the modeling results for an average spill and on regional considerations; however, in any specific oil spill situation local concerns could be higher. Table 4.5-16 summarizes the significance of the potential beneficial and adverse environmental impacts associated with Alternative 1 in the Caribbean region, based on the extrapolation of the modeling results for the average spill to the region in general.

Although dispersant pre-authorization agreement areas exist in the Caribbean region (Figure 2.2-1), under the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) of Alternative 1, appropriate response times cannot currently be met for chemical dispersion; thus, chemical dispersion is not considered in the analysis of the Caribbean region. Further, the modeling shows that *in situ* burning would not significantly change the level of effects identified from those obtained when using mechanical-only recovery.

For spills analyzed in this document (i.e., those that occur 3 or more statute mi offshore) using mechanical-only recovery, there are likely to be minor or insignificant regional adverse impacts on all resources for a small spill, except for marine and coastal birds and intertidal habitats, which experience moderate impacts, based on the speed with which such a spill would weather and dissipate and the small area that could be affected.

Table 4.5-15
Risk Ranking* of Offshore Oil Spills† under Alternative 1 Using the Basic Response Scenario‡ in the Caribbean Region

	Resources of Concern												
	Physical Environment			**Biological Environment**								**Socioeconomic Environment**	
Spill Size	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals§**	**Marine and Coastal Birds§**	**Plankton and Fish§**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles§**	**Areas of Special Concern**	**Essential Fish Habitat**	**Subsistence‖**	**Archaeological/Historic Resources‖**
Small (200 bbl)	4E	4E	4E	3E	3D	4E	1E	4E	3E	1E	4E	4E	4E
Medium (2,500 bbl)	4D	4E	4E	3E	3B	4D	1D	3D	3E	1D	3D	4E	4E
Large (40,000 bbl)	4C	4E	4E	3D	3A	4D	1C	3C	3D	1C	3C	4E	4E

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern; yellow, a medium level of concern; and green, a low level of concern.

* This risk ranking is a summary of risk scores for the resources considered in this PEIS. The risk scoring process is explained in Section 4.4.3.

† Average spills.

‡ Current levels of mechanical recovery and *in situ* burning when circumstances permit.

§ Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles. If such species are affected by an actual spill, the level of concern would be high.

‖ Subsistence and archaeological/historic resources are the only socioeconomic resources that could be ranked using the risk matrix.

Table 4.5-16
Summary of Potential Adverse Regional Impacts of Offshore Oil Spills* under Alternative 1 Using the Basic Response Scenario† in the Caribbean Region

	Resources of Concern																			
	Physical Environment			Biological Environment								Socioeconomic Environment								
Spill Size	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals‡**	**Marine and Coastal Birds‡**	**Plankton and Fish‡**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles‡**	**Areas of Special Concern**	**Essential Fish Habitat**	**Coastal Communities, Demography, and Employment**	**Economic Status**	**Vessel Transportation and Ports**	**Fisheries**	**Subsistence**	**Archaeological/Historic Resources**	**Recreation and Tourism**	**Environmental Justice**	**Public Safety and Worker Health**
Small (200 bbl)	Ins	Ins	Ins	Min	Mod	Ins	Mod	Ins	Min	Mod	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
Medium (2,500 bbl)	Min	Ins	Ins	Min	Mod	Min	Sig	Mod	Min	Sig	Mod	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
Large (40,000 bbl)	Min	Ins	Ins	Mod	Mod	Min	Sig	Mod	Mod	Sig	Mod	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Mod	Ins

Note: Based on Table 4.5-15. Sig, significant; Mod, moderate; Min, minor; and Ins, insignificant.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles.

For a medium spill, adverse impacts are minor or insignificant for all resources except for marine and coastal birds, subtidal habitats, and Essential Fish Habitat, which could be moderate, and intertidal habitats and areas of special concern, which could be significant. Sea turtles are also at risk, and concern is particularly high for mangrove forests. For a large spill, there is the potential for moderate adverse impacts on marine mammals, coastal and marine birds, subtidal habitat, Essential Fish Habitat, and environmental justice and significant adverse impacts on intertidal habitats and areas of special concern. Such a spill could also cause significant, but localized, adverse, short-term socioeconomic impacts. For extreme events under the large spill scenario, water quality could also be a short-term concern if the spill moved rapidly into shallow water. All adverse impacts occur despite the treatment or recovery of some of the oil, but are reduced by these actions when they are effective.

4.5.3.1. Consequences to the Physical Environment

Water Quality

Potential adverse consequences of oil spills to water quality are related to hydrocarbon contamination, as other constituents in oils are at concentrations that would not exceed thresholds of concern. The hydrocarbons that could affect water quality are the soluble aromatics, MAHs (monoaromatic hydrocarbons) and PAHs (polynuclear aromatic hydrocarbons) (Section 4.3.1.1). Thus, evaluation of potential adverse effects is based on the degree of potential contamination by these compounds. No beneficial effects on water quality would be expected to result from an oil spill.

For oil spills in marine waters, adverse effects on water quality are generally low, whether a mechanical-only recovery or mechanical recovery plus *in situ* burning is employed. This is because of the tendency for most chemical compounds of concern to evaporate, rather than dissolve, and the rapid dilution of any chemical compounds that might enter the water column. During periods of extreme turbulence, oil generally mixes into the water column where aromatics may dissolve rapidly, but resurfacing and dilution of oil droplets result in only localized contamination at levels of concern unless the dilution volume is restricted. Overall, based on the modeling and risk assessment results, it is concluded that—using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit)—adverse water-quality effects under Alternative 1 would be low in marine waters, even in the event of a large spill in the Caribbean region. However, if the spill moved into shallow and confined coastal waters, adverse effects could be locally important for medium and large spills under conditions where oil is mixed into water by strong turbulence or in areas where oil collects for a few weeks to months after a spill.

The variable used to determine potential water-quality effects is "volume of water contaminated" by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer, which is less than all established water-quality criteria and thresholds of concern for effects on aquatic biota (Sections 4.3.1.1 and 5.3.2.1). The affected water volume increases with spill volume and varies with the level of physical dispersion during the time of the spill. Natural dispersion increases with stronger winds and currents, lessening the volume of water that is contaminated above the threshold of concern if in unconfined waters. Since the volume of water contaminated increases exponentially as a function of spill size, the estimated volume of water contaminated for a small spill was extrapolated from the mean medium- and large-spill model results. The estimates of the volume of water contaminated—and its variability—are generally applicable to spills of the same size throughout the Caribbean region because the mixing of oil into water and process of dilution are similar in all areas.

Coastal

Florida Bay is used as a representative of coastal water for analyzing the Florida Straits, as well the Caribbean region. Florida Bay is approximately 16,288 km^2 in area and about 2 m deep on average, with a total volume of approximately 32,576 million m^3. The estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of Florida Bay to determine the potential effects of small, medium, and large spills (Table 4.5-17). This approach yields a very conservative estimate, in that it assumes all of the contamination would occur in coastal water.

Table 4.5-17
Risk Ranking of Offshore Oil Spills[*] to Coastal Water Quality Using the Basic Response Scenario[†] in the Florida Straits[‡]

Spill Size	Volume of Water Contaminated (million m^3)	Area Contaminated (estimated %)	Risk Score[§]
Small (200 bbl)	$< 40 \times 10^{-6}$	8×10^{-7}	4E
Medium (2,500 bbl)	83	1.7	4D
Large (40,000 bbl)	326	6.8	4C

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Because of natural dilution, evaporation, and biological processes, contamination levels would decrease rapidly even in the case of a large spill, and recovery time would be on the order of days to weeks. Oil may be incorporated into shallow water or intertidal sediments where, through leaching, it could become a continuing source of contamination over time. However, this would generally only lead to noticeable water-quality degradation in the locality where the oil collects. This is unlikely to occur with a spill that originates offshore. Because mechanical removal would begin within the required response time under Tier I standards (beginning about 12 hours after the spill), much of the soluble components of concern to water quality would have evaporated or dissolved. Thus, mechanical recovery and *in situ* burning would have an insignificant influence on the volume of water adversely affected, and the risk score results would apply whether either response is implemented.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal water quality in the Caribbean region under Alternative 1 are expected to be insignificant for small spills, and minor for medium and large spills.

Marine

In marine waters, which are 3 or more statute mi offshore, mechanical response and *in situ* burning currently may be used for spill response in the Caribbean region; although dispersant pre-authorization agreement areas exist in the Caribbean region (Figure 2.2-1), chemical dispersion is not used because appropriate response times cannot currently be met. As was done for coastal waters, the estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of the reference area, the Florida Straits.

The Florida Straits was selected for the modeling as representative of the marine waters around the islands in the Caribbean region. The total surface area of the Florida Straits is approximately 42,689 km^2, so the area of interest is much vaster for marine waters than for coastal waters. Water-quality effects were calculated using a spill site in relatively shallow water—20 m deep, which is much shallower than most of the Caribbean region's marine waters. The results for the selected modeling location (Table 4.5-18) represent conservative estimates of adverse water-quality effects using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit).

Table 4.5-18
Risk Ranking of Offshore Oil Spills[*] to Marine Water Quality Using the Basic Response Scenario[†] in the Florida Straits[‡]

Spill Size	Area Contaminated (estimated %)	Risk Score[§]
Small (200 bbl)	5×10^{-9}	4E
Medium (2,500 bbl)	0.1	4E
Large (40,000 bbl)	0.4	4E

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Natural dispersion of the oil would be very rapid after a spill, and recovery time would be on the order of hours to days. Leaching from oil contamination reaching the sediments would not have a large effect on marine water quality because of the large dilution volume and natural dispersing forces in marine waters. The results would apply whether a mechanical response is implemented. Since *in situ* burning would replace some of the mechanical response, and both methods remove oil that would otherwise result in water contamination, the potential water-quality effects would not change significantly if *in situ* burning were used. For a spill in water deeper than the 20 m evaluated here, the potential adverse effects would be even smaller.

Based on the modeling results (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine water quality in the Caribbean region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Air Quality

Concentrations of hydrocarbons of concern in the air resulting from oil spills and response operations were compared with air quality standards to evaluate the potential for adverse effects (Section 4.3.1.2). The effects of an oil spill on air quality may involve all volatile components of the oil. In addition, if *in situ* burning was used, particulates and other contaminants emitted from burns could become an air quality concern. However, adverse air quality effects from oil spills are normally very localized and short lived for small, medium, and large oil spills. The addition of *in situ* burning does not significantly increase any potential adverse effects: the volume of oil that could be burned is not large, and the temporary smoke plume would be localized and rapidly diluted.

The modeling shows that results do not vary by spill location or size in the Caribbean region. Two possible sources of contamination to the atmosphere were evaluated for their potential effects on air quality: volatilization of hydrocarbons from unburned oil and emissions produced by *in situ* burning. Concentrations in the lowest 2 m of the atmosphere were compared with the U.S. Environmental Protection Agency's National Ambient Air Quality Standards (USEPA's NAAQS) and other thresholds of concern (as discussed in Section 4.3.1.2).

The results of the modeling show that the potential adverse effects on air quality are low for all spill sizes involving mechanical-only recovery; hence, the risk scores are virtually identical for small, medium, and large spills. Volatilized hydrocarbons would not exceed air quality standards for human health at more than 1 km from the spill site. Evaporation off the water surface and volatilization from the water column create a plume of volatile hydrocarbon gases that disperses quickly after a spill, such that the concentrations in the atmosphere at the water surface would not exceed human health thresholds of concern at any location. The recovery time for the atmosphere would be on the order of days. Thus, a low level of concern is expected for small, medium, and large spills involving mechanical-only recovery.

Mechanical recovery plus *in situ* burning would increase atmospheric pollutants by the amount emitted via burning. For small spills, it would be very unlikely that *in situ* burning would be used, as the oil would disperse too rapidly for it to be feasible (Table 4.5-19). The maximum area potentially exceeding the NAAQS or thresholds of concern is 1.6 km^2 for a medium spill and 12.7 km^2 for a large spill. If humans or sensitive resources (i.e., wildlife) are within these areas, they could be affected by poor air quality for a short time, on the order of hours. Since *in situ* burning can only be used offshore in marine waters, and considering a region of interest equivalent to the Florida Straits (42,689 km^2), the area of adverse effects would be less than 1 percent, and the atmosphere would recover in a matter of hours. Thus, low levels of concern are expected from small, medium, and large oil spills involving *in situ* burning (4.5-19).

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on air quality in the Caribbean region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without *in situ* burning.

Table 4.5-19
Risk Ranking of Offshore Oil Spills* to Air Quality under *In Situ* Burning in the Florida Straits †

Spill Size	Area Exceeding Threshold (km²)	Area Contaminated (estimated %)	Risk Score‡
Small (200 bbl)	1.6	0.004	4E
Medium (2,500 bbl)	1.6	0.004	4E
Large (40,000 bbl)	12.7	0.18	4E

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

‡ The risk scoring process is explained in Section 4.4.3.

4.5.3.2. *Consequences to the Biological Environment*

Marine Mammals

The cetacean and sirenian species inhabiting the Caribbean region (Section 3.3.2.1, Table F.3-1) exist in concentrations that vary depending on seasonal migrations. Cetaceans are found throughout the region and spend their entire lives at sea. The Caribbean monk seal (*Monachus tropicalis)*, which is thought to be extinct, is the only native pinniped known to have inhabited this region. In Puerto Rico, there have been rare sightings and reports of hooded seal (*Cystophora cristata*) strandings; however, these occurrences are scattered and rare, and have been attributed to lost seals following cold-water currents. There are no indigenous fur-bearing marine mammals of concern inhabiting this region (Section 3.3.2.1).

Marine mammals such as whales, dolphins, and manatees are vulnerable to spilled oil since they spend considerable time at the water's surface, which enhances possible contact with oil. The majority of these species remain offshore, and populations vary according to season and migration directions. Cetaceans appear able to detect and are likely to avoid floating oil or oil being recovered by mechanical means (Geraci, 1990). Studies have shown that cetacean skin is nearly impenetrable to even the highly volatile constituents of oil, indicating that contact with oil probably would be less harmful to cetaceans than often believed. However, the toxic, volatile fractions in fresh crude oils could irritate and damage cetacean soft tissues, such as the mucous membranes of the eyes and airways.

Marine mammals that are more commonly found in the nearshore regions and intertidal habitats, such as manatees, are of increased concern. Potential concerns include toxicity from ingestion of oil during grooming and adverse effect on juveniles through contact with contaminated teats when nursing. Overall, the potential adverse effects depend on the spill size, and the number and species of marine mammals present.

Based on the surface area in the Florida Straits, the equivalent area for 100 percent mortality for cetaceans and for pinnipeds and sirenians is 0.002 percent (or less) of the available habitat for a medium spill. For a large spill the equivalent area at risk does increase, but remains low—0.003 percent for cetaceans and 0.03 percent for pinnipeds and sirenians). There are no known breeding or haulout areas associated with pinnipeds for this region; therefore, shoreline oiling will have no adverse impacts on most marine mammals, but there is a low risk for terrestrial species using the shoreline and for nearshore species (in this region, manatees). Based on the scattered presence of these species, the potential adverse impacts were determined to be low for small and medium oil spills, but may potentially increase to medium levels for large oil spills based on the risk to terrestrial or nearshore species. The modeling results for marine mammals in the Florida Straits are presented in Table 4.5-20.

Table 4.5-20
Risk Ranking of Offshore Oil Spills* to Marine Mammals Using the Basic Response Scenario† in the Florida Straits‡

Spill Size	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	0–1	3E
Medium (2,500 bbl)	0–1	3E
Large (40,000 bbl)	1–5	3D

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Based on the modeling for the Florida Straits, the likelihood of adversely affecting large numbers of marine mammals is low. On-water adverse effects are negligible but there is a low risk to species on or near the shoreline. The addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the severity of potential adverse effects nor increase risk to marine mammals. If mortality did occur however, the population would probably require 1 to 3 years to recover.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine mammals in the Caribbean region under Alternative 1 are expected to be minor for small and medium spills, and moderate for large spills.

Marine and Coastal Birds

Potential adverse effects on marine and coastal birds are usually of highest concern during an oil spill because birds are highly susceptible to the acutely toxic effects from exposure to oil. There are many areas in the Caribbean region where high concentrations of birds may be found along the shore, in nearshore and estuarine habitats, or in offshore marine-water habitats (Section 3.3.2.2). Adverse effects on birds in this region would result mostly from oiling of mangroves, salt marshes, beaches, shallow grass beds, tidal flats, and small keys and islands that serve as nesting and foraging habitats for wading birds, diving birds, raptors, gulls, terns, and shorebirds. Surface water oiling may also adversely affect feeding, rafting, and diving birds and wintering waterfowl (Section 3.3.2.2; see Section 4.3.2.2 for information on the main issues of concern for birds exposed to an oil spill).

The Florida Straits was selected for the modeling as representative of the coastal habitats and wildlife in the Caribbean region (Table 4.5-21). Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the potential adverse effects on birds. Potential levels of concern for birds in the Caribbean region are medium for all spills, as discussed below. However, for a small spill very little oil is likely to strand onshore in nesting and foraging habitats, and potential exposure to floating oil is only likely to occur in a small area. The potential for adverse effects increases for medium and large spills, with greatest concern for conditions where mangroves and sand beaches become heavily oiled and where potential exposure to floating oil occurs in a large area.

Table 4.5-21
Risk Ranking of Offshore Oil Spills* to Marine and Coastal Birds Using the Basic Response Scenario† in the Florida Straits ‡

Spill Size	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	1–5	3D
Medium (2,500 bbl)	10–20	3B
Large (40,000 bbl)	> 20	3A

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Two National Parks, one Ramsar site (wetlands of international importance), and two National Wildlife Refuges occur in the Florida Straits and Florida Bay area. The presence of these sites indicates that large numbers of wetland birds (Ramsar site) concentrate in the area during migration and/or nesting and wintering. The majority of small keys and mangrove islands in the area provide important nesting, roosting, and foraging habitats for over 250 avian species. Abundant diving birds utilize marine water habitats in this area, and high mortality rates are typical for these species during a spill. In the Caribbean region, the risks to intertidal nesting, roosting, and foraging habitats are greater than in many other regions because a significant amount of shoreline habitats on an island or group of small islands can be affected by a spill. There may not be alternative sites for use until the habitat recovers, which would lead to a higher degree of adverse effects. Thus, the risk score was determined based on the possibility that a large number of birds in sensitive life stages may be concentrated in a relatively small area that is heavily oiled, possibly having limited opportunities for relocation to similar nearby habitats. It is important to recognize that adverse effects on birds may be more or less severe depending on the time of year and locations of their habitats, as well as the extent of shoreline and surface water oiling.

Adverse effects on birds for a small spill were determined by extrapolating from the results obtained for a medium spill. The volume of oil released in the small spill was approximately an order of magnitude less than in the medium spill; therefore, the adverse effects on the bird population were estimated to be proportionally less but still medium because of the recovery time. The modeling of effects on birds for a medium spill under mechanical-only recovery resulted in estimates of 10 to 20 percent of the regional bird population being potentially adversely affected because 95 percent of the oiled shoreline was mangroves, which are used for nesting, roosting, and feeding and often have a long recovery periods, and the total mean surface water area oiled above a 10-micron threshold was 92 km^2. For a large spill, the modeling resulted in estimates of over 20 percent of the local area bird population being potentially adversely affected because 95 percent of the oiled shoreline was mangroves, and the area of wetlands oiled was over three times as large as for the medium spill. The total mean surface water area oiled above the threshold was 1,100 km^2. The adverse effects on mangrove habitats would be considered regionally important, particularly considering the small size and extent of intertidal habitats in the Caribbean region. The risk scores in Table 4.5-21 reflect the predicted recovery rates for birds of 1 to 3 years for most species, as was the case following the *EXXON VALDEZ* oil spill (Section 4.3.2.2). Although no specific area in the Caribbean region was modeled, the results are consistent with those for all other regions modeled in this PEIS; therefore, it is expected that the severity of adverse effects on bird populations will fall within a similar range throughout the Caribbean region. The addition of *in situ* burning does not change the significance of these adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine and coastal birds in the Caribbean region under Alternative 1 are expected to be moderate for small, medium, and large spills.

Plankton and Fish

Plankton and fish, a diverse group of species, are important to the marine food web, ecosystem function, and fisheries. Adverse effects on these groups are of great concern. As described in Section 4.3.2.3, plankton and fish are adversely affected either directly or via the food web by the toxic effects of oil components that enter the water column—the soluble compounds (MAHs and PAHs) and microscopic oil droplets mixed by waves into the water (French McCay, 2002; NRC, 1985). The most important pathway of exposure is direct uptake of dissolved oil components, originating directly from surface oil or dissolving from the microscopic oil droplets in the water. Overall, as spill size increases, so do adverse effects. However, there is great variability related to the environmental conditions after a spill; plankton and fish suffer much more adverse effects in storm conditions where high waves mix unweathered oil into the water, which happened during the *NORTH CAPE* oil spill (French McCay, 2003), than in calm weather. In addition, many species utilize shallow waters and even the intertidal zone, where they are more likely to be exposed to oil and dissolved completely when oil comes ashore. Species and life stages vary considerably in sensitivity to toxic components, with species from relatively unpolluted and environmentally stable locations being more sensitive than those from polluted and environmentally variable areas.

In marine and open coastal environments, small, medium, and large oil spills do not cause large or long-term toxic effects to plankton and fish in the water column. The toxic effects of oil spills result from acute exposure during the time when surface oil is present and for short periods (days to weeks) afterwards. Once the source of hydrocarbons (from floating oil or the shoreline) to the water column is gone, concentrations rapidly disperse to background levels. However, there may be longer-term effects if the spill migrates to nearshore shallow areas such as enclosed embayments, estuaries, or wetlands where dilution and flushing are slow. Many fish and other organisms spawn and develop through larval and juvenile stages in these shallow areas. Juvenile fish are more abundant in salt marshes and seagrass beds than in other shallow subtidal and intertidal areas, so these areas are of most concern (see discussion of potential effects on these habitats below). Under Alternative 1 in most cases, chemical dispersion could not be used within 3 nm of shore[21], but the dispersed oil plume could be transported by currents into this area.

The percentage of plankton and fish adversely affected by oil spills was estimated using the modeling results (technical report [French McCay et al., 2004]) of water volumes exposed to toxic oil components. Percent loss multiplied by volume exposed was integrated over time and space to calculate an equivalent volume of 100 percent loss. These volumes were translated to equivalent areas by multiplying by water depth at the spill site, allowing comparison with other resources, such as birds and shorelines, which are distributed on a per-area basis. The use of area is appropriate because plankton and fish abundance is much more uniformly distributed when expressed on a per-area basis than on a per-volume basis since the ecosystem is driven by sunlight and plant photosynthesis at the water surface (French et al., 1996; Odum, 1971). As indicated by the similar results for the four modeled spill sites in 10 to 30 m of water—offshore Delaware Bay, offshore Galveston Bay, the Florida Straits, and offshore San Francisco (Parts B, C, D, and E, respectively, of the technical report [French McCay et al., 2004])—the equivalent areas of adverse effect on plankton and fish (both average and variable) are applicable to spills of the same size in any location of similar water depth in any region considered in this PEIS. The modeled spill site was 20 m deep water: adverse effects would be less for deeper waters because of greater vertical dilution of both oil components and organisms, and proportionately greater in shallower waters because of the restricted dilution potential.

The model-estimated areas are those where there is a potential to affect the most sensitive species, which are two standard deviations more sensitive than the average of all species tested (2.5th percentile in rank order of sensitivity). For species of average sensitivity (50th percentile), the areas adversely affected would be much smaller. Thus, the model-estimated areas should not be interpreted as experiencing 100 percent mortality of all plankton and fish; they are conservative estimates used for comparative purposes among response scenarios.

The Florida Straits, was selected for the modeling as representative of the Caribbean region, because the geography (characterized by islands), bottom topography (steeply sloping away from shore), environmental regime (warm, trade winds, occasional severe storms) and ecosystems (subtropical-tropical, areas of coral reefs, seagrasses, etc.) are similar in the two regions. The adverse effects were estimated as a percentage of the total area of concern (42,689 km^2). Based on the evaluation of the volume where water quality would be affected for a small spill (Table 4.5-18), the volume of adverse effects on plankton and fish would be low for a small spill using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) (Table 4.5-22).

Since the adverse effects are in a small percentage of the area of concern and less than the range of natural variability, the recovery time would be less than 1 year. Overall, based on the modeling, adverse effects on plankton and fish in the Caribbean region under Alternative 1 would be localized to the immediate area around the spill site and similar in all marine-water areas of the region. For large spills that might move rapidly into shallow coastal areas due to winds and currents, the concentrations of toxic components might be high enough to cause some level of concern for water column communities, especially early life history stages of fish and invertebrates using intertidal and shallow subtidal habitats.

Table 4.5-22
Risk Ranking of Offshore Oil Spills[*] to Plankton and Fish Using the Basic Response Scenario[†] in the Florida Straits[‡]

Spill Size	Equivalent Area Affected (km^2)	Area Affected (estimated %)	Risk Score[§]
Small (200 bbl)	0.082	5×10^{-11}	4E
Medium (2,500 bbl)	32	0.07	4D
Large (40,000 bbl)	72	0.02	4D

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Based on the discussion in Part D of the technical report (French McCay et al., 2004), if the adversely affected area is marine-water habitat or for water column organisms with broad distribution over all subtidal habitats, a risk score of 4E applies. A risk score of 3C applies to coral reefs, 4E applies to seagrass, and 3D applies to hard-bottom habitat organisms. Given that many species and life stages of plankton and fish on and over coral reefs are more broadly distributed rather than restricted to the coral reefs (for example, they inhabit hard-bottom habitats as well), and that these organisms reproduce on time scales less than 1 year, the overall risk score of 4D is assigned for plankton and fish for the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit).

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on plankton and fish in the Caribbean region under Alternative 1 are expected to be insignificant for small spills, and minor for medium and large spills.

Intertidal Habitats

Intertidal habitats in the Caribbean region are of particular concern during oil spills. Because of their relatively small extent, they have a high degree of historical loss and degradation, and ecological importance. Sand beaches that are sea turtle nesting habitat are of high concern: adults concentrate in offshore areas prior to nesting; the nests are at risk of direct oiling; and the hatchlings are at risk of oiling as they escape to sea. Mangroves are very important habitats in this region, providing shoreline protection and key nursery value for fish and shellfish (Section 3.3.2.4). The Caribbean region has extensive areas of these sensitive habitats, so reducing the adverse effects of oil spills to mangroves is of high priority because of their very long recovery rates, which can be more than 20 years. There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on intertidal habitats in that larger spills tend to have higher oil loading on the shoreline and affect larger areas. For a discussion of the relative ranking of the sensitivity of intertidal habitats to spilled oil and the processes affecting oil fate and behavior on shorelines, see the explanation of the Environmental Sensitivity Index (ESI) in Section 4.3.2.4.

In the Caribbean region, the risks to intertidal habitats are greater than in many other regions because a significant amount of shoreline habitat on an island or group of small islands can be affected by a spill. Thus, there may not be alternative sites for use until the habitat recovers, which would lead to a higher degree of adverse effects.

Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed and, thus, does not reduce potential adverse effects. Adverse effects on intertidal habitats in the Caribbean region are medium for a small spill, in that very little oil is likely to strand onshore, and oil loading would be light in most cases. However, the potential for adverse effects increases with spill volume, with the greatest concern for conditions where mangroves and sand beaches become heavily oiled. The risk scores in Table 4.5-23 are based on estimated effects on the intertidal habitats of the Florida Straits.

Table 4.5-23
Risk Ranking of Offshore Oil Spills* to Intertidal Habitats Using the Basic Response Scenario† in the Florida Straits‡

Spill Size	Habitats Affected (estimated %)	Risk Score§
Small (200 bbl)	0–1	1E
Medium (2,500 bbl)	1–5	1D
Large (40,000 bbl)	5–10	1C

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern, and yellow, a medium level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Adverse effects on intertidal habitats from a small spill were determined to be medium by extrapolating from the results of a medium spill and expecting oiled mangroves to have a long recovery rate. For a medium spill under mechanical-only recovery, the modeling resulted in nearly 10 km of oiled shoreline. Although this represents less than 1 percent of the total shoreline in the Florida Straits, most of the oiled shoreline would consist of mangroves. The risk score represents the higher percentage of mangroves adversely affected under the highest shoreline effect conditions, which would be more representative of oiling effects on small islands or groups of islands. For a large spill, the modeling resulted in an estimated 27.1 km of oiled shoreline. This oiled area also represents less than 1 percent of the total shoreline in the modeled area, but again mangroves would account for 95 percent of the oiled shoreline, making the effects regionally important given the small size and extent of intertidal habitats in the Caribbean region. Although areas other than the Florida Straits in the Caribbean region were not modeled, the results are consistent with those for all other regions modeled in this PEIS; therefore, it is expected that the severity of adverse effects on intertidal habitats will fall within a similar range throughout the Caribbean region. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on intertidal habitats in the Caribbean region under Alternative 1 are expected to be moderate for small spills, and significant for medium and large spills.

Subtidal Habitats

The subtidal (benthic) habitat consists of the bottom substrate below the low tide level, as well as the species that live in, on, and near the substrate. This benthic community includes areas of live, sandy, muddy, and low-relief bottoms; subsurface canyons; and pinnacles. Organisms living in this area—demersal species—include corals, plants and seagrasses, benthic invertebrates (such as crabs, shrimp, snails, bivalve mollusks, and marine worms), and bottom-dwelling fish. Because subtidal benthic communities do not include the intertidal zone, they are at little risk from floating oil because, by definition, this environment is always below the surface. The greatest risk of exposure comes from sinking oil, as well as *in situ* burn residue, or dispersed oil or the sorption of naturally dispersed or mechanically mixed oil that has become suspended on sediments and is deposited onto the ocean floor. However, significant natural dispersion of oil and sediment into the water column only occurs during large storms or for nearshore oil spills. Oil particles could adhere to bottom substrate, plants, or animals, which could result in both physical coating of organisms, as occurred in the 1993 *BRAER* spill in the Shetland Islands, and toxic effects from exposure to the chemical constituents (Section 4.3.2.5). Such adverse effects are not normally observed.

The risk to fauna and flora of the subtidal benthic habitat is minimal, based on the diluting effect of the overlying water (Section 2.2.2)—the deeper the water, the lower the risk. Chemical compounds of concern tend to evaporate, rather than dissolve, and the rapid dilution of any chemical entering the water column decreases the toxicity of any oil residue potentially reaching the bottom substrate.

Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects. It might slightly increase the risk of remaining oil residues sinking to the bottom. Residual oil from *in situ* burning that reaches the bottom is expected to have little or no adverse effects on subtidal habitats since the majority of its toxic components would have either evaporated or been destroyed during burning and the volume of residue produced is so small (Section 4.3.2.5). Under the modeled conditions, the quantity of *in situ* burn residue produced would not result in a level of concern that exceeds low.

For a medium spill the sediment threshold concentration for dissolved aromatic hydrocarbons was never exceeded, and the threshold concentration for total hydrocarbons was exceeded only in a very small area (less than 0.001 percent of the reference area). However there are three special subtidal habitats in this region of particular value—seagrass beds, coral reefs, and hard-bottom habitat. Of these three habitats, the modeling results indicated that coral reefs were at the most risk from exposure to hydrocarbons in the water column, with 4.6 percent of the total reef area exceeding threshold concentrations for at least a limited period. Recovery should occur in 1 to 3 years, perhaps less, from these short-term exposures. For a large spill the sediment exposures remained low, but the area of coral reefs at risk increased to 5.0 percent of the total reference area. The recovery pattern would be similar, in that exposure is still brief. The results for the selected modeling location (Table 4.5-24) represent estimates of adverse impacts on subtidal habitats using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit).

Table 4.5-24
Risk Ranking of Offshore Oil Spills[*] to Subtidal Habitats Using the Basic Response Scenario[†] in the Florida Straits[‡]

Spill Size	Habitats Affected (estimated %)	Risk Score[§]
Small (200 bbl)	0–1	4E
Medium (2,500 bbl)	1–5	3D
Large (40,000 bbl)	5–10	3C

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subtidal habitats in the Caribbean region under Alternative 1 are expected to be insignificant for small spills, and moderate for medium and large spills.

Areas of Special Concern

The potential effects on areas of special concern, such as National Marine Sanctuaries and National Wildlife Refuges, are important during an oil spill since these areas are under increased scrutiny and protection. Whereas most coastal and nearshore areas have a wide range of habitats or are very similar to other areas throughout the Caribbean region, areas of special concern are set aside for their uniqueness (Appendix F, Tables F.3-3 through F.3-5 and Figures F.3-1 through F.3-6). The potential risks and adverse effects associated with shoreline areas of special concern are identical to those discussed for intertidal habitats. The risks to subtidal resources, such as coral reefs in National Parks, are identical to those discussed for subtidal habitats. For this analysis, the risks to areas of special concern are assumed to be the same as those for either intertidal or subtidal habitats (Sections 4.5.3.2), whichever are greater. Since the risk to intertidal habitats is greater, those risk scores were used. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on data presented for a medium spill, the estimated average extent of shoreline oiling is 10 km; this figure increases to 27 km for a large spill. The potential risk of surface oil reaching a shoreline associated with an area of special concern is low in this region because of the number and scattered locations of these areas. The potential adverse effects on areas of special concern with small spills are medium (Table 4.5-25). However, potential concerns associated with a medium or large spill increase to high levels because of the increased shoreline contamination.

Table 4.5-25
Risk Ranking of Offshore Oil Spills[*] to Areas of Special Concern Using the Basic Response[†] Scenario in the Florida Straits[‡]

Spill Size	Areas Affected (%)	Risk Score[§]
Small (200 bbl)	0–1	1E
Medium (2,500 bbl)	1–5	1D
Large (40,000 bbl)	5–10	1C

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern, and yellow, a medium level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Based on the modeling for the Florida Straits, the likelihood of affecting an area of special concern within the localized area of a spill is minimal, unless the spill occurs directly adjacent to such an area. Since areas of special concern are scattered throughout the Caribbean region, they are unlikely to be disproportionately affected by the average spill. If an area of special concern was highly adversely affected, it is anticipated that the recovery time for the affected area would be the same as for other intertidal habitats. These areas are most at risk from floating oil and benefit from any actions that reduce potential oiling.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on areas of special concern in the Caribbean region under Alternative 1 are expected to be moderate for small spill sizes, and significant for medium and large spill sizes, based on the risk to intertidal habitats.

4.5.3.3. *Consequences to Threatened, Endangered, or Candidate Species*

The Caribbean region has a variety of threatened, endangered, or candidate species (Section 3.3.3). In this region, the overall risk that a threatened, endangered, or candidate species would be adversely affected or even present in the area of a spill is low; however, killing a single individual of such a species can be considered a severe adverse consequence. Potential adverse effects on marine mammals, marine and coastal birds, or fish that are threatened, endangered, or candidate species are identical to those discussed in Section 4.5.2.2 for these groups. Potential adverse effects on the four threatened or endangered species of sea turtles were discussed in detail in Section 4.3.3.1. Sea turtles are a particular concern if the spill occurs in the vicinity of a nesting beach. Overall, the highest risk scores were calculated for coastal and marine birds with other species at lower risk. Regardless of the species, the majority of threatened, endangered, or candidate species in the Caribbean region mature slowly and do not reach sexual maturity for several years; therefore, any adverse effects on the reproduction or survival of these species or result in death should be considered high.

Adverse effects on threatened, endangered, or candidate species in the Caribbean region for any spill size are difficult to predict. Depending on the location and season, the number and type of species present will vary. Based on the overall size of the Caribbean region and the low populations of threatened, endangered, or candidate species inhabiting this region, the likelihood of adversely affecting an individual of concern would be low unless the spill affects important shoreline or critical marine habitats. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse consequences.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on threatened, endangered, and candidate species in the Caribbean region under Alternative 1 are expected to be moderate for small, medium, and large spills, based on the risk to marine and coastal birds.

4.5.3.4. Consequences to Essential Fish Habitat

Virtually all waters in the Caribbean region out to the limits of the U.S. Exclusive Economic Zone (EEZ) are considered Essential Fish Habitat (EFH). Areas such as bays, river mouths, and harbors are designated EFH for at least one life stage of at least one species and are protected by legislation (Section 3.3.4). The primary issue with respect to EFH is either (1) exposure of sensitive resources in the water column to hydrocarbon concentrations of concern, or (2) the contamination of bottom sediments, both of which could lead to either acute or chronic exposures.

Adverse consequences would include either the death of individual organisms, the possibility of sublethal effects affecting long-term population viability, or degradation of habitat that reduces its availability to managed species. For this analysis, the risks to EFH are assumed to be the same as those for plankton and fish or for subtidal habitats (Section 4.5.3.2), whichever are greater. Since the risk to subtidal habitats is greater, those risk scores were used.

Under Alternative 1, the addition of *in situ* burning does not remove enough oil to reduce potential adverse consequences. The data presented in Section 4.5.3.2 indicate low risk from sediment and water column contamination overall, but subtidal habitats of high value—seagrass beds, coral reefs, and hard-bottom habitat—are more at risk. The risk scores for EFH are based on the estimated risk to coral reef habitat.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on EFH in the Caribbean region under Alternative 1 are expected to be insignificant for small spills, and moderate for medium and large spills, based on the risk to subtidal habitats.

4.5.3.5. Consequences to the Socioeconomic Environment

As discussed in Section 4.3.5, oil spills can produce a variety of adverse social and economic effects. Some of the most visible and important effects are likely to include effects on water- and shore-based recreation, commercial fisheries, and tourism. In addition, large spills have the potential to adversely affect the well-being of the residents and economies of coastal communities, in particular low-income and minority populations to a greater extent than the general population. Individuals who rely on coastal resources for employment and income are at risk of experiencing disproportionately adverse effects from oil spills.

This modeling considers the risk of adverse socioeconomic effects posed by oil spills, which can include, but are not limited to, reduced recreational activity because of beach closures, limited accessibility, or perceived taint; closure of commercial fishing grounds or hatcheries, or reduced commercial harvests; and altered marine transportation patterns. In addition to these and other direct adverse effects, oil spills can have secondary adverse effects on social and economic welfare along the coast. For example, an oil spill may cause changes in employment and firm revenues of resource-based businesses. While these effects are not quantified in this modeling, the following discussion provides absolute and relative measures of the overall risk of adverse social and economic effects of small, medium, and large oil spills using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) in the Caribbean region. (Although dispersant pre-authorization agreement areas exist in the Caribbean region [Figure 2.2-1], appropriate response times cannot currently be met for chemical dispersion.) The methodology is described in more detail in the Atlantic region (Section 4.5.2.5).

There is no existing standard for "significance" related to the socioeconomic effect of oil spills (e.g., how much shoreline or surface water must be oiled to be considered a "high," "medium," or "low" effect). The significance of the effect will depend on a number of factors, including the scope of the analysis (i.e., national, regional, local), opportunities for resource substitution (e.g., an unoiled beach or fishing ground nearby, alternative ports of call), and the duration of the spill event. Generally, a spill event would be of little concern if it did not last long enough to affect the financial viability of local businesses, and the affected communities are able to find substitutes to replace the oiled resources.

For this PEIS, (1) the greatest effect modeled at the regional level was less than approximately 10 percent of available shoreline or surface water resources (indicating the likely presence of substitute resources), and (2) resource use following these modeled spills (e.g., vessel transportation and fishing) would be expected to resume as soon as oil recovery efforts were completed. As a result, the modeled effects under all modeled scenarios would likely be low at the regional level. As noted in the text, any adverse effects that occur would be expected to be localized in nature.

This modeling assumes that the risk posed by oil spills to the socioeconomic environment is directly related to the extent to which resources are affected above selected thresholds of concern—for the Caribbean region, the square meters of marine water oiled above the threshold of concern. Comparing the absolute risk of adverse socioeconomic effects (e.g., meters of sandy shoreline oiled above a recreational threshold of concern) across spill scenarios, including variations in spill response scenarios, allows for an understanding of the relative risk of adverse socioeconomic effects across these scenarios. In this section, only basic the response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) results are examined. Determining relative risk also allows for extrapolation of site-specific results to the entire region. For example, the risk estimates presented below are based on modeled spills affecting the Florida Straits as an appropriate surrogate for the Caribbean region in this modeling. While any given spill may exhibit distinctly different patterns of socioeconomic effect, the relative risk measures are expected to be broadly applicable to a range of spill locations, especially in island regions, as long as spills occur in areas where mechanical recovery and/or *in situ* burning are feasible. In addition, the conclusions reached for the Florida Straits are supported by results for other modeled areas—the relative degree of risk reduction achieved under various removal assumptions across spill size is similar in magnitude.

Table 4.5-26 highlights the effects of small, medium, and large oil spills on the Caribbean region's socioeconomic resources by presenting estimates of resources oiled as a result of the average modeled spill in absolute terms (area of surface water oiled above the threshold of concern) and as a percentage of the total resource base in the modeled area. The threshold of concern because of surface water oiled is 0.01 g/m² (technical report [French McCay et al., 2004]). This resource area is based on an estimate of the extent to which the coastal community in the modeled area potentially relies on each resource. For the Caribbean region, length of shoreline oiled above the threshold of concern is not considered relevant. A single metric was selected for this region because (1) the shoreline oiling results from the Florida Keys area were highly sensitive in the modeled spill location; (2) the ability to identify shoreline with characteristics amiable to use (i.e., sandy shore) was limited; and (3) area of surface water oiled above the threshold of concern was expected to provide a more accurate measure of expected risk, given the region's geographic characteristics.

Table 4.5-26
Risk Ranking of Offshore Oil Spills* to Coastal Communities as a Result of Surface Water Oiled Using the Basic Response Scenario† in the Florida Straits‡

Spill Size	Surface Water Area	
	m² Oiled Above Threshold§	Estimated % Oiled‖
Small (200 bbl)§	N/A	N/A
Medium (2,500 bbl)	312 × 10⁶	3.2
Large (40,000 bbl)	659 × 10⁶	6.8

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

§ Thresholds above which some economic or social risk is expected were determined, and the area of surface water oiled above this threshold for the average modeled spill is reported. The threshold of concern because of oiled surface water is 0.01 g/m² of oil (technical report [French McCay et al., 2004]).

‖ Percentages reflect the proportion of the total modeled area above the threshold of concern.

§ A 200-bbl spill is assumed to have negligible effect.

For this modeling, the socioeconomic environment is divided into components representative of the major parameters of coastal life potentially affected by an oil spill. Absolute and relative risk are discussed for coastal communities, demography, and employment; general economic status of a coastal community; vessel transportation and ports; commercial and recreational fisheries; archaeological and historic resources; recreation and tourism; environmental justice; and public safety and worker health.

Coastal Communities, Demography, and Employment

Coastal communities benefit from and rely on the marine environment to provide residents with sustenance, livelihoods, leisure opportunities, and shipping avenues. Individuals who live and work in close proximity to the coast derive both social and economic rewards from the natural beauty, recreational opportunities, quality of life, economic resources, and cultural attributes associated with these coastal locations. These rewards are derived from assets such as National Parks, public beaches, fishing opportunities, and commercial and tourism-related industries.

Thus, oil spills can affect any number of a coastal community's assets, leading to adverse effects on the economic benefits of community activities. These effects, in turn, can impose changes on that community's demographic and employment patterns. In addition to direct employment and other adverse economic effects on marine resource-based economic sectors associated with oil spills, oil spills can have secondary adverse effects on coastal communities. For example, because the Caribbean region relies on tourism for employment and earnings, plus the importance of maritime activities to various Caribbean coastal communities, coastal communities in this region are at risk of experiencing adverse effects from oil spills that affect tourism. Further, the importance of water transportation in delivering goods to the region's islands implies a heightened risk of adverse effects from an oil spill. Given their reliance on marine resources, coastal communities on Caribbean islands are likely to be more vulnerable to the adverse effects of a spill than communities located on the mainland, which have a more diverse economic base.

The *VISTA BELLA* spill affected beaches on Puerto Rico and St. John at the height of tourist season. A 1-km stretch of the Playa Larga, Puerto Rico, was reported to have 100 percent oil coverage. In addition to the economic effects of recreational beach oiling in the wake of this spill, the tourism industry suffered from the surface water oiling that affected recreation in the reefs surrounding the islands. Individuals employed in the tourism industry were likely to have suffered as well (NOAA-HMRAD, 1992). To the extent that mechanical recovery and *in situ* burning reduce the surface area of slicks above a threshold of concern, some combination of spill response options will reduce the risk of adverse effects on coastal communities.

For a small spill in the Caribbean region, there is little risk of large adverse effects on coastal communities. Because of the small surface water area exposed to oil, marine-based economic factors such as local commercial fisheries may experience little or no adverse effects. In many cases, a spill of this size is expected to pose no risk to surface water resources because the spilled oil will never reach the threshold of concern (Table 4.5-26).

The risk of adverse effects on coastal communities for a medium spill is likely to be greater than for a small spill. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill will sweep approximately 312 million m^2 of marine waters in the spill area[22] above the corresponding threshold of concern (Table 4.5-26). The economic and social losses will occur in recreational areas and commercial fishing grounds that exceed the threshold of concern. For example, beaches in the Caribbean region may be closed to visitors and fishing may not be permitted in waters exposed to oil, causing losses in revenue to the tourism and commercial fishery sectors of the coastal economy. The resulting adverse effects would be expected to reverberate through communities in the area of the spill, causing short-term decreases in employment, income, the viability of associated businesses, and the appeal of coastal living.

For a large spill, there is a substantial risk of adverse effects on coastal communities. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a large spill will sweep approximately 659 million m^2 of marine waters (Table 4.5-26) potentially important to recreational and commercial fishery activities in the spill area. A spill of this size would affect the pleasure that coastal residents and visitors derive from coastal activities and the economic contribution that recreational and commercial fishing resources make to local income and employment. The scope of potential losses to commercial fishing, recreation, and tourism is described in more detail in subsequent sections. Further, the contamination of the shoreline may adversely affect the quality of coastal living.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal communities, demography, and employment in the Caribbean region under Alternative 1 are expected to be insignificant for small, medium, and large spills. The adverse impacts of a large spill would be similar to those of a medium spill and would generally be limited to the spill area—the adverse impacts would not be felt at the regional economic level. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 659 million m^2 of surface water above recognized thresholds [Table 4.5-26]); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Economic Status

The overall economic status of communities, industries, and individuals that rely on coastal resources for sustenance, revenue, and quality of life can be affected by an oil spill. As noted above, coastal communities can suffer direct and indirect adverse economic effects from an oil spill, as beach and fishery closures decrease revenue and eliminate jobs. More specifically, losses will be felt in commercial and recreational fisheries, by both the anglers themselves and by related industries as catch opportunities decrease or are eliminated entirely. Tourism and associated businesses will suffer economic setbacks as visits to affected coastal areas decline and purchase of area goods and services decrease because of perceived resource taint. Similarly, environmental justice issues may arise as low-income or minority communities are disproportionately affected by the spill (discussed below in more detail).

A small spill 3 or more statute mi offshore would have essentially no adverse effect on either the local or regional economies (Table 4.5-26). There is little to no risk of oiling of economically important resources, and it is unlikely that any commercial fisheries or recreational areas would be affected.

A medium spill, with mechanical recovery and *in situ* burn operations, could be expected to have short-term adverse economic effects as a result of oiling recreational resources, limited closing of fisheries and recreational areas, and needing to supplement the normal response operation employment base. These adverse effects would probably be very short lived—cleanup operations would not require a long period of time and would be local in nature. A large spill's adverse economic effects could be high for the local economy, even with mechanical recovery and *in situ* burning, based on the anticipated level of marine-water oiling and the possibility that closure of commercial and recreational fishing grounds will occur. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause adverse socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on economic status in the Caribbean region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 659 million m^2 of surface water above recognized thresholds [Table 4.5-26]); any adverse impacts are expected to be localized (and could be substantial)—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Vessel Transportation and Ports

Oil spills occurring 3 or more statute mi offshore are not likely to cause large adverse effects on vessel transportation and ports; any adverse effects would likely be of short duration. However, an oil spill can disrupt marine commerce if it occurs in and around a shipping channel or port and results in limits on watercraft movement as a means of facilitating spill response. Any interruption in the standard use of vessels or increase in travel times over water can result in hardship for coastal communities as fewer goods are exchanged, transportation costs rise, and the revenue streaming through the local economy falls.

This issue is particularly relevant to the islands of the Caribbean region. St. Thomas is home to the Virgin Islands Port Authority's Edward Wilmoth Blyden IV Marine Facility, which provides important transportation services between the British and U.S. Virgin Islands (USDOI-OIA, 1999). Further, ports on each island provide berths for cruise ships, bringing tourists and revenue to the islands. Disruption of transportation and cruises is as detrimental as disruption of the movement of cargo ships, which is also critical to island imports and exports. For example, molasses, a key ingredient in rum, must be imported to support rum production, a key island export. On St. Croix, a $9 million molasses tanker pier was built to facilitate the import of this good for rum production, a major source of revenue for the Virgin Islands (USDOI-OIA, 1999). Substantial funds have been invested in ports like Crown Bay, where a 274 m cargo bulkhead and a number of storage facilities have been built. Vessel transportation is of paramount importance to the Caribbean region's trade and tourism industries. To the extent that mechanical recovery and *in situ* burning reduce the surface area of slicks above a threshold of concern, some combination of spill response options will reduce the risk of adverse effects on vessel transportation and ports, and the corresponding trade of essential goods.

While these adverse effects would affect the ease with which vessels access ports, they will also affect the economic sectors that depend on the efficient movement of goods to and from ports. Although the possibility exists that the affected area's trade partners will be affected by interruptions in vessel transportation in the spill area, the availability of substitute means of transportation and sources of goods and products indicates that any closures would be unlikely to generate high adverse effects outside of the spill area.

For a small spill, no great adverse effects on vessel transportation or ports are expected (Table 4.5-26), but there is some risk of adverse effects for medium and large spills. Therefore, the nature of the risk to vessel transportation will be a function of the location, area, and pattern of surface water oiling, as well as the extent of oiling in port areas. A medium or large spill in the Caribbean region, however, would not generally be expected to result in large adverse effects on vessel transportation and ports since any effects would likely be short lived—that is, even if shipping waters or ports are exposed to oil and are therefore closed, as soon as recovery efforts remove surface oil, these facilities would be expected to be reopened.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on vessel transportation and ports in the Caribbean region under Alternative 1 are expected to be insignificant for small, medium, and large spils. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 659 million m^2 of surface water above recognized thresholds [Table 4.5-26]); any adverse impacts are expected to be localized (and could be substantial)—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Fisheries

Commercial Fisheries

Commercial fisheries are vulnerable to oil spills because of both closures and perceived taint. A moratorium on fishing operations in the wake of an oil spill can lead to significant revenue losses for the commercial fishing industry, as well as related industries, including those that supply equipment to and purchase products from commercial fleets. In addition, oil spills can lead to a decreased demand for fish from affected waters because of actual or perceived taint and can instigate alterations to fishing practices in a manner that increases operating costs and/or decreases revenues. Large spills can potentially injure fish nursery grounds and impose other risks that could reduce fish harvests longer term.

In the Caribbean region, commercial fishing is an important economic activity, generating over $5 million per year (NMFS, 2004b). To the extent that mechanical and *in situ* burning reduce the surface area of slicks above a threshold of concern, some combination of response options will reduce the risk of adverse effects on regionally important fisheries.

For a small spill in the Caribbean region, the risk to commercial fisheries is negligible using the basic response scenario (current levels of mechanical recovery and *in situ* burning as circumstances permit) (Table 4.5-26). For a medium spill, the risk of adverse effects on commercial fisheries is likely to be much greater than for a small spill. A medium spill in the Caribbean region will sweep approximately 312 million m^2 of marine waters used by the commercial fishing industry above the corresponding threshold of concern (Table 4.5-26). A risk of economic loss to commercial fisheries will occur when waters exceed relevant management and/or risk-based thresholds. For example, fishing may not be permitted in waters swept by oil above the modeled threshold of concern, resulting in reductions in commercial fish landings for a period of time following a spill. The resulting adverse effects would be expected to reverberate through communities in the area of the spill, causing decreases in employment, income, and the viability of businesses associated with the commercial fishing industry. To the extent that substitute fishing grounds are available, spill effects on the commercial fishing economy may be less severe.

For a large spill, there is a substantial risk to commercial fisheries. This risk to commercial fisheries increases with a large spill, as the size of the area oiled increases. A large spill presents risk to approximately 659 million m^2 of the marine waters potentially important to commercial fisheries above the corresponding threshold of concern (Table 4.5-26). A spill of this size may cause significant decreases in local commercial fishing activities and revenues, and may negatively affect the revenues of associated businesses. To the extent that commercial fishing operations can, for a time, move to substitute fishing grounds, the potentially severe effects of even a large spill may be avoided.

Recreational Fisheries

Similar to commercial fishing operations, recreational fisheries are at risk of closure or loss in value as a result of oil spills. These adverse effects will not generally be at the regional or national levels but could be high at the local level. For this modeling, the risks posed to recreational fishing activities are modeled in the same manner as risks to commercial fishing activities, in square meters of surface water oiled above the corresponding threshold of concern. The effects of an oil spill on recreational fishery-related activities will be felt more heavily by various populations, including recreational anglers and firms that supply goods and services to recreational anglers. For example, recreational anglers fish for pleasure or sport, as opposed to monetary gain. In the wake of an oil spill, such anglers may choose to fish at a substitute location, may experience a reduced quality of experience, or may choose to forgo fishing entirely. The losses suffered will be related to these missed opportunities. In addition, while closing waters to recreational fishing will decrease the social welfare of recreationists, it would also be expected to affect the demand for boat rentals and other services consumed by fishing enthusiasts.

Recreational fishing is a popular activity in the Caribbean region. Although the total recreational catch is not available, it is known that in 2001 recreational fishermen caught 2.1 million fish off the coast of Puerto Rico (NMFS, 2001).

For a small spill, adverse effects on recreational resources in the Caribbean region would likely be negligible (Table 4.5-26), regardless of the response option used. The risk of adverse effects on recreational fishing activities for a medium spill is likely to be much greater than for a small spill. A medium spill will sweep approximately 312 million m^2 of marine waters used by the recreational fishermen above the corresponding threshold of concern. For a large spill, there is substantial risk of adverse effects on recreational fishing, approximately 659 million m^2 of the marine waters potentially important to recreational fishing in the spill area. A spill of this size may harm businesses associated with recreational fishing.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on fisheries (commercial and recreational) in the Caribbean region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 659 million m^2 of surface water above recognized thresholds [Table 4.5-26]); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Subsistence

Potential adverse effects on marine species are a concern during spills where traditional use of subsistence resources occurs. Information on subsistence use of fish and invertebrates in the Caribbean region is limited (Section 3.3.5.5). Recreational fishing for and consumption of spiny lobster and reef fish are popular activities in this area. Tissue tainting would be the primary concern for these subsistence resources.

The Florida Straits was selected for the modeling as representative of the coastal habitats, fish, and wildlife in the Caribbean region. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the severity of potential adverse effects nor increase risk to subsistence resources. Potential adverse effects on subsistence resources in the Caribbean region are low for small, medium, or large spills (Table 4.5-27).

Effects on subsistence resources for a small spill were determined to be low by extrapolating from the results for a medium spill. For a medium spill, the modeling results showed water column exposure to dissolved aromatics to be at low concentrations (1–100 ppb) occurring mostly around the lower Florida Keys, with some small areas of higher concentrations (100–10,000 ppb). Tainting of fish and invertebrates becomes a concern when water concentrations exceed approximately 100 ppb (Section 4.3.5.6). Sediment exposure is expected to be negligible. Less than 1 percent of shoreline was oiled, including subsistence resources associated with shoreline and intertidal habitats.

Table 4.5-27
Risk Ranking of Offshore Oil Spills[*] to Subsistence
Using the Basic Response Scenario[†] in the Florida Straits[‡]

Spill Size	Resources Affected (estimated %)	Risk Score[§]
Small (200 bbl)	0–1	4E
Medium (2,500 bbl)	0–1	4E
Large (40,000 bbl)	0–1	4E

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

For a large spill, the modeling results showed water column exposure at low concentrations (1–100 ppb) occurring mostly around the lower Florida Keys, with some small areas of higher concentrations (100–10,000 ppb), especially near Marquesas Key. Sediment exposure is expected to be negligible. The modeling estimated that less than 1 percent of shoreline and intertidal resources were exposed to oil. The risk scores in Table 4.5-27 reflect the predicted recovery rates for subsistence resources of less than 1 year for all spill sizes (Section 4.3.5.6). Although areas other than the Florida Straits for the Caribbean region were not modeled, the results are consistent with those for all other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on subsistence resources will fall within a similar range throughout the Caribbean region. While adverse effects on subsistence resources are not likely to be high on a regional level, they may be high on a local level.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subsistence resources in the Caribbean region under Alternative 1 are expected to be insignificant for small, medium, and large spill sizes.

Archaeological and Historic Resources

Under Alternative 1 using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), adverse effects on archaeological resources in the Caribbean region are expected to below. Most archaeological artifacts and some shipwrecks are buried under sediment and coral formation and, therefore, would not become oiled (Section 3.3.5.6).

Similar to archaeological resources, adverse effects on historic resources are expected to be low, regardless of spill volume or response option. Historic sites in the Caribbean region, such as forts and walls, are located on land and protected from oiling by barriers and proximity to shore; submerged shipwrecks in nearshore waters are not likely to become oiled. Results from several studies indicated that direct oiling caused negligible effects on cultural resources following the *EXXON VALDEZ* oil spill (Bittner, 1996; Dekin, 1993; Reger et al., 1992; Wooley and Haggarty, 1995). Mechanical-only recovery or mechanical recovery plus *in situ* burning may help reduce the amount of oil that strands on the shoreline, which will also reduce the amount of shoreline cleanup and potential disturbance to sensitive historic structures.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on archaeological and historic resources in the Caribbean region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Recreation and Tourism

The tropical islands of the Caribbean region provide visitors and residents with the opportunity to enjoy a number of outdoor recreational activities and scenic vistas. For example, the beaches of this region are popular, as are all manner of water sports. In 1997, 2.1 million people visited the U.S. Virgin Islands, with 1,619,000 visitors arriving on cruise ships (USDOI-OIA, 1999). According to the U.S. Department of the Interior, tourist revenues in the Caribbean were $500 million in 1998 (USDOI-USVI, 1998). Further, National Parks and National Marine Sanctuaries are key attractions in these islands, and associated water recreation and wildlife viewing are also important (USVIDT, 2002).

As an example of these resources being at risk in the event of an oil spill, the *VISTA BELLA* spill affected beaches on Puerto Rico and St. John at the height of tourist season despite the fact that the spill occurred 321.8 km from the beaches of Puerto Rico. A 1-km stretch of the Playa Larga, Puerto Rico, was reported to have 100 percent oil coverage, while 14.82 km of beach on St. John was estimated to have been oiled to the extent that clean up was required. Shoreline cleanup in Puerto Rico was significant on beaches popular with tourists visiting the island (NOAA-HMRAD, 1992).

An oil spill such as the *VISTA BELLA* would be expected to affect recreationists' overall social welfare; in addition, the social and economic implications of a spill would reach beyond direct effects on visitors and into the community. For example, visitors may be less likely to visit and spend money in an area perceived as affected by a spill, potentially leading to loss of business revenue and jobs (see Coastal Communities, Demography, and Employment above for more details).

For a small spill in the Caribbean region, the risk of adverse effects on recreation and tourism is negligible using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) (Table 4.5-26). Because of the small surface water area exposed to oil as a result of a small spill, water-based attractions, such as beach visitation, may experience few or no adverse effects.

For a medium spill, the risk of adverse effects on recreation and tourism is likely to be greater than for a small spill. A medium spill will adversely affect approximately 312 million m^2 of recreational waters in the spill area above the corresponding threshold of concern (Table 4.5-26). Under these conditions in the Caribbean region, beaches in the spill area may be closed to visitors, and fishing and boating may not be permitted in waters exposed to oil, causing losses in revenue to the recreation and tourism sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill, causing decreases in employment, income, and the viability of businesses associated with recreation and tourism.

For a large spill, there is a substantial risk of adverse effects on recreation and tourism. A large spill will adversely affect approximately 659 million m^2 of recreational waters in the spill area (Table 4.5-26). A spill of this size may cause significant decreases in tourism, recreation, associated business activities and revenues, and the quality of coastal living.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on recreation and tourism in the Caribbean region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 659 million m^2 of surface water above recognized thresholds [Table 4.5-26]); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Environmental Justice

As mentioned above, low-income, indigenous, and minority populations in some coastal areas may rely on regional fisheries and other marine resources in the context of participating in commercial fishery or other marine resource-based employment. These groups may experience the effects of a spill more severely than the general population, which relies on a more diverse economic base for its livelihood and on the availability of a widespread, commercially available selection of foods. Additionally, employment in marine resource-related industries might have value beyond the importance this resource holds as an employment opportunity.

Given that an estimated 30 percent of the Caribbean region's population lives below the poverty line (USDOI-OIA, 1999), it is expected that several disadvantaged populations, including low-income groups, would disproportionately suffer from the adverse effects of an oil spill in this region, which could affect low-income, indigenous, and minority populations' access to important sources of food and key resources that support their livelihoods.

For a small spill in the Caribbean region, the risk of significant changes in any group's economic status is negligible, regardless of the response options employed. A small spill 3 or more statute mi offshore would have essentially no effects on either the local or regional economies (Table 4.5-26). Because of the small surface water area exposed to oil as a result of a small spill, marine-based economic factors such as local commercial fisheries may experience little or no adverse effects.

For a medium spill, the risk of changes in the economic status of any disadvantaged population is likely to be greater than for a small spill. A medium spill would be expected to sweep approximately 312 million m^2 of marine waters in the spill area. The risk of economic and social losses will occur in fishing waters that exceed thresholds of concern. For example, the recreational facilities along a Caribbean island's coast may be closed to visitors, and fishing may not be permitted in waters exposed to oil, causing losses in revenue to both the tourism and commercial fishery sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill and disproportionately affect the low-income communities, causing decreases in employment opportunities and limited or no access to certain fishing areas.

For a large spill, there is a substantial risk of adverse effects on disadvantaged populations that depend on coastal and marine resources. A large spill would be expected to present risk to approximately 659 million m^2 of marine waters in the spill area. A spill of this size may cause significant decreases in water-based business activities.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on environmental justice in the Caribbean region under Alternative 1 are expected to be insignificant for small and medium spills, but could be moderate for large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 659 million m^2 of surface water above recognized thresholds [Table 4.5-26]); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Public Safety and Worker Health

Potential adverse effects on public safety are defined as the risk to the public from direct exposure to oil or response activities as a result of the spill. There are many areas in the Caribbean region with high population concentrations along the coast. However, adverse effects on public safety are unlikely from oil spills that occur 3 or more statute mi offshore for any of the spill sizes considered, regardless of the response options—mechanical recovery and/or *in situ* burning—used. The USCG has protocols to keep the public from risk during shoreline response operations, as well as on-water protocols to prevent the public from entering the response area.

Potential adverse effects on worker health are related to direct exposure to oil during response operations. In addition, operating oil spill response equipment can be dangerous, which is well recognized and is the basis for the worker certification and training requirements that are now in place. There is also a health risk from inhalation of hydrocarbon fumes for first responders, which is recognized in current safety protocols. The risk is greater as the spill size and the corresponding intensity and duration of operations increase, but is minimized if safety standards are followed.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on public health and worker safety in the Caribbean region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

4.5.4. Consequences in the Gulf of Mexico Region

For the purpose of this PEIS, the Gulf of Mexico region will specifically cover the waters that lie south and west of the continental United States; east and north of Mexico, and northwest of Cuba (Figure 3.1-1). The location selected for modeling and risk assessment purposes was a site offshore of the entrance to Galveston Bay, TX, because it is in a high-traffic area at greater risk for oil spills. Modeling results from this location were evaluated relative to the geographic area in Section C.1.2 of the technical report (French McCay et al., 2004), herein referred to as the North Texas Shelf. The North Texas Shelf encompasses Galveston Bay and the Texas portion of the Louisiana-North Texas Shelf. In general, the site is representative of offshore sites throughout the region and provides a basis for the modeling of potential environmental effects. The results of the modeling—used to evaluate spills of concern in this risk analysis (i.e., 3 or more statute mi offshore)—are presented in Part C of the technical report (French McCay et al., 2004) and summarized in this section.

Table 4.5-28 presents the risk ranking for the modeling of Alternative 1 in the Gulf of Mexico region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with or without the addition of chemical dispersion at 45 and 80 percent recovery efficiency[23] for three spill sizes (small, 200 bbl; medium, 2,500 bbl; and large, 40,000 bbl). The risk scores presented in the table are based on the modeling results for an average spill and on regional considerations; however, in any specific oil spill situation local concerns could be higher. Table 4.5-29 summarizes the significance of the potential beneficial and adverse environmental impacts associated with Alternative 1 in the Gulf of Mexico region, based on the extrapolation of the modeling results for the average spill to the region in general.

Under Alternative 1, dispersant capability is available and its use is feasible in the Gulf of Mexico region (Figure 2.2-1), so chemical dispersion is considered at two levels of efficiency: 45 percent and 80 percent. For spills analyzed in this document (i.e., those that occur 3 or more statute mi offshore), there are likely to be minor or insignificant regional adverse impacts on all resources for a small spill, based on the speed with which such a spill would weather and dissipate and the small area that could be affected, regardless of response option used, except for marine and coastal birds, which could be moderate. For a medium spill, adverse impacts are minor or insignificant for all resources except for marine and coastal birds, which could be moderate regardless of the response option used. Coastal marshes are of particular concern. In addition, adverse impacts could be moderate for intertidal habitat, sea turtles and areas of special concern with on-water mechanical recovery only, but are reduced to minor with chemical dispersion.

Table 4.5-28
Risk Ranking[*] of Offshore Oil Spills[†] under Alternative 1 Using the Basic Response Scenario[‡] with the Addition of Chemical Dispersion in the Gulf of Mexico Region

		Resources of Concern														
		Physical Environment			**Biological Environment**								**Socioeconomic Environment**			
Spill Size	**Response Option (% dispersant efficiency)**	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals[§]**	**Marine and Coastal Birds[§]**	**Plankton and Fish[§]**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles[§]**	**Areas of Special Concern**	**Essential Fish Habitat**	**Subsistence[‖]**	**Archaeological/Historic Resources[‖]**	**Shoreline Oiling Index[#]**	**Surface water Oiling Index[#]**
Small (200 bbl)	Basic	4E	4E	4E	3E	3D	4E	4E	4E	3E	4E	4E	4E	4E	N/A[**]	N/A[**]
	Chemical Dispersion (45)	4E	4E	4E	3E	3D	4E	4E	4E	3E	4E	4E	4E	4E	N/A[**]	N/A[**]
	Chemical Dispersion (80)	4E	4E	4E	3E	3D	4E	4E	4E	3E	4E	4E	4E	4E	N/A[**]	N/A[**]
Medium (2,500 bbl)	Basic	4D	4E	4E	3E	3C	4E	3D	4E	3D	3D	4E	4E	4E	1.00	1.00
	Chemical Dispersion (45)	4D	4E	4E	3E	3D	4E	3E	4E	3E	3E	4E	4E	4E	0.44	0.36
	Chemical Dispersion (80)	4D	4E	4E	3E	3D	4E	3E	4E	3E	3E	4E	4E	4E	0.35	0.25
Large (40,000 bbl)	Basic	4B	4E	4E	3E	3A	4E	2D	4E	3C	2D	4E	4E	4E	1.00	1.00
	Chemical Dispersion (45)	4B	4E	4E	3E	3A	4E	2D	4E	3C	2D	4E	4E	4E	0.89	0.90
	Chemical Dispersion (80)	4A	4E	4E	3E	3A	4E	2D	4E	3C	2D	4E	4D	4E	0.81	0.80

Source: Adapted from Part C of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] This risk ranking is a summary of risk scores for the resources considered in this PEIS. The risk scoring process is explained in Section 4.4.3.

[†] Average spills.

[‡] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[§] Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles. If such species are affected by an actual spill, the level of concern would be high.

[‖] Subsistence and archaeological/historic resources are the only socioeconomic resources that could be ranked using the risk matrix.

[#] The Socioeconomic Index is calculated using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with value equal to 1.0. Risk factors reflect the ratio of the percentage of the model area or volume oiled using the basic response scenario to the percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected with response limited to the basic response scenario.

[**] Index cannot be calculated for small spills since they were not modeled.

Table 4.5-29

Summary of Potential Adverse Regional Impacts of Offshore Oil Spills[*] under Alternative 1 Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (45 or 80% Efficiency) in the Gulf of Mexico Region

		Resources of Concern																			
		Physical Environment			Biological Environment								Socioeconomic Environment								
Spill Size	**Response Option (% dispersant efficiency)**	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals[‡]**	**Marine and Coastal Birds[‡]**	**Plankton and Fish[‡]**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles[‡]**	**Areas of Special Concern**	**Essential Fish Habitat**	**Coastal Communities, Demography, and Employment**	**Economic Status**	**Vessel Transportation and Ports**	**Fisheries**	**Subsistence**	**Archeological/Historic Resources**	**Recreation and Tourism**	**Environmental Justice**	**Public Safety and Worker Health**
Small (200 bbl)	Basic	Ins	Ins	Ins	Min	Mod	Ins	Ins	Ins	Min	Ins	Ins	Min	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins
	Chemical Dispersion (45 or 80)	Ins	Ins	Ins	Min	Mod	Ins	Ins	Ins	Min	Ins	Ins	Min	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins
Medium (2,500 bbl)	Basic	Min	Ins	Ins	Min	Mod	Ins	Mod	Ins	Mod	Mod	Ins	Min	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins
	Chemical Dispersion (45 or 80)	Min	Ins	Ins	Min	Mod	Ins	Min	Ins	Min	Min	Ins	Min	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins
Large (40,000 bbl)	Basic	Mod	Ins	Ins	Min	Mod	Ins	Mod	Ins	Mod	Mod	Ins	Min	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins
	Chemical Dispersion (45 or 80)	Mod	Ins	Ins	Min	Mod	Ins	Mod	Ins	Mod	Mod	Ins	Min	Min	Ins	Ins	Min[§]	Ins	Ins	Ins	Ins

Note: Based on Table 4.5-28. Sig, significant; Mod, moderate; Min, minor; and Ins, insignificant.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles.

[§] Since there are different levels of concern at 45 and 80 percent dispersant efficiency, the highest level of concern is shown in this table.

For a large spill, there is the potential for moderate adverse impacts on coastal water quality, marine and coastal birds, intertidal habitats, sea turtles, and areas of special concern. Chemical dispersion does not change these general results. Such a spill could also cause significant, but localized, short-term socioeconomic adverse impacts. These adverse impacts occur despite the treatment or recovery of some of the oil, but are reduced by these actions when they are effective. The availability of a dispersant capability under this alternative particularly helps mitigate potential adverse effects on marine and coastal birds, and coastal habitat and shoreline, especially for medium spills, without significantly increasing the risk to water column or subtidal resources. Chemical dispersion is less effective for large spills. Further, the modeling shows that *in situ* burning would not significantly change the level of concern identified from those obtained when using mechanical-only recovery.

4.5.4.1. Consequences to the Physical Environment

Water Quality

Potential adverse consequences of oil spills to water quality are related to hydrocarbon contamination, as other constituents in oils are at concentrations that would not exceed thresholds of concern. The hydrocarbons that could affect water quality are the soluble aromatics, MAHs (monoaromatic hydrocarbons) and PAHs (polynuclear aromatic hydrocarbons) (Section 4.3.1.1). Thus, evaluation of potential adverse effects is based on the degree of potential contamination by these compounds. No beneficial effects on water quality would be expected to result from an oil spill.

For oil spills in marine waters, adverse effects on water quality are low, regardless of the response option used (current levels of mechanical recovery with or without *in situ* burning and chemical dispersion). This is because of the tendency for most chemical compounds of concern to evaporate, rather than dissolve, and the rapid dilution of any chemical compounds that might enter the water column, even after periods of extreme turbulence that induce relatively high dissolution rates. Dispersants would be applied to surface oil after much of the evaporation of the toxic components occurs because of logistics (i.e., greater than 12 hours after the spill), such that the resulting increase of concentrations of toxic components in the water column would be relatively small.

Overall, based on the modeling and risk assessment results, it is concluded that—using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion—adverse water-quality effects under Alternative 1 would be low in marine waters, even in the event of a large spill in the Gulf of Mexico region. If an offshore spill moved into shallow and confined coastal waters, adverse effects could be locally important for medium and large spills under conditions where oil is mixed into water by strong turbulence. Chemical dispersion would not be used in shallow and confined coastal waters (less than 3 nm[24] from shore) under Alternative 3, so it could only contribute to adverse water-quality effects in those areas if the dispersed oil plume drifted into coastal waters with only minimal, or no, dilution.

The variable used to determine potential water-quality effects is "volume of water contaminated" by more than 1 ppb of dissolved aromatic concentration for

1 hour or longer, which is less than all established water-quality criteria and thresholds of concern for effects on aquatic biota (Sections 4.3.1.1 and 4.3.2.1). The affected water volume increases with spill volume and the level of physical or chemical dispersion during the time of the spill. Natural dispersion increases with stronger winds and currents, lessening the volume of water that is contaminated above the threshold of concern if in unconfined waters. Since the volume of water contaminated increases exponentially as a function of spill size, the estimated volume of water contaminated for a small spill was extrapolated from the mean medium- and large-spill model results. The estimates of the volume of contaminated water—and its variability—are generally applicable to spills of the same size throughout the Gulf of Mexico region because the mixing of oil into water and process of dilution are similar in all areas.

Coastal

In estuaries and coastal waters within 3 statute mi of shore, mechanical-only recovery would be used under Alternative 1. Thus, the model results for the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are used to assess coastal water-quality effects. If dispersants were applied offshore, the dispersed oil plume could move into these nearshore areas. Since chemical dispersion would not be used in these areas, the level and duration of exposure would be negligible because of dilution.

Galveston Bay is used as a representative of coastal water for modeling the North Texas Shelf, as well as the Gulf of Mexico region. Galveston Bay is approximately 1,786 km^2 in area and about 2 m deep on average, with a total volume of approximately 3,572 million m^3. The estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of Galveston Bay to determine the potential effects of small, medium, and large spills (Table 4.5-30). This approach was used both with and without dispersant use, and yields very conservative estimates, in that it assumes all of the water column contamination would occur in coastal water. Since dispersants would not be employed in such areas, this would imply that the dispersed oil plume would move directly into coastal waters without any dilution, which will not occur.

Table 4.5-30
Risk Ranking of Offshore Oil Spills[*] to Coastal Water Quality Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion in the North Texas Shelf[‡]

Spill Size	Response Option (% dispersant efficiency)	Volume of Water Contaminated (million m³)	Area Contaminated (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	$< 40 \times 10^{-6}$	8×10^{-8}	4E
	Chemical Dispersion (45 or 80)	$< 40 \times 10^{-6}$	8×10^{-8}	4E
Medium (2,500 bbl)	Basic	71	2.0	4D
	Chemical Dispersion (45)	163	4.6	4D
	Chemical Dispersion (80)	166	4.6	4D
Large (40,000 bbl)	Basic	373	10.4	4B
	Chemical Dispersion (45)	642	18.0	4B
	Chemical Dispersion (80)	719	20.1	4A

Source: Adapted from Part C of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the North Texas Shelf (as discussed in the text) as representative of the Gulf of Mexico region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Because of natural dilution, evaporation, and biological processes, contamination levels would decrease rapidly even in the case of a large spill, and recovery time would be on the order of days to weeks. Oil may be incorporated into shallow water or intertidal sediments where, through leaching, it could become a continuing source of contamination over time. However, this would generally only lead to noticeable water-quality degradation in the locality where the oil collects. This is unlikely to occur with a spill that originates offshore. Because mechanical removal would begin within the required response time under Tier I standards (beginning about 12 hours after the spill), much of the soluble components of concern to water quality would have evaporated or dissolved. Thus, mechanical recovery and *in situ* burning would have an insignificant influence on the volume of water adversely affected, and the risk score results would apply whether either response is implemented.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal water quality in the Gulf of Mexico region under Alternative 1 are expected to be insignificant, minor, and moderate for small, medium, and large spills, respectively, with or without dispersant use.

Marine

In marine waters, which are 3 or more statute mi offshore, mechanical recovery, *in situ* burning, and chemical dispersion currently may be used for spill response in the Gulf of Mexico region. As was done for coastal waters, the estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of the reference area, the North Texas Shelf.

The North Texas Shelf was selected for the modeling as representative of the marine waters in the Gulf of Mexico region. The total surface area of the North Texas Shelf is approximately 39,602 km^2, so the area of interest is much vaster for marine waters than for coastal waters. Water-quality effects were calculated using a spill site in relatively shallow water—10 m deep, which is much shallower than most of the Gulf of Mexico region's marine waters. The results for the selected modeling location (Table 4.5-31) represent conservative estimates of adverse water-quality effects using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit).

Table 4.5-31
Risk Ranking of Offshore Oil Spills[*] to Marine Water Quality Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion in the North Texas Shelf[‡]

Spill Size	Response Option (% dispersant efficiency)	Area Contaminated (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	5×10^{-9}	4E
	Chemical Dispersion (45 or 80)	5×10^{-9}	4E
Medium (2,500 bbl)	Basic	0.2	4E
	Chemical Dispersion (45)	0.4	4E
	Chemical Dispersion (80)	0.4	4E
Large (40,000 bbl)	Basic	0.9	4E
	Chemical Dispersion (45)	1.6	4E
	Chemical Dispersion (80)	1.8	4E

Source: Adapted from Part C of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the North Texas Shelf (as discussed in the text) as representative of the Gulf of Mexico region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Natural dispersion of the oil would be very rapid after a spill, and recovery time would be on the order of hours to days. Leaching from oil contamination reaching the sediments would not have a high effect on marine water quality because of the large dilution volume and natural dispersing forces in marine waters. The results would apply whether a mechanical response is implemented. Since *in situ* burning would replace some of the mechanical response, and both methods remove oil that would otherwise result in water contamination, the potential water-quality effects would not change significantly if *in situ* burning were used. For a spill in water deeper than the 10 m evaluated here, the potential adverse effects would be even smaller.

With the addition of chemical dispersion, the results in Table 4.5-31 are nearly identical (with some uncertainty reflected in the variability of the results) at both 45 and 80 percent efficiency because the amount of dispersants at 45 percent efficiency is sufficient to treat all dispersible surface oil. For a small spill, the volume of water contaminated with the addition of chemical dispersion would be the same as for the basic response scenario because, due to logistics, dispersants could only be applied after a small spill has mostly dispersed naturally. Chemical dispersion for medium or large spills increases the volume of water contaminated, but would not change the risk score. *In situ* burning (in combination with mechanical recovery and chemical dispersion) would not significantly change the volume contaminated or the consequence on water quality since it would substitute for some of the mechanical response.

Because of natural dilution, evaporation, and biological processes, contamination levels would decrease rapidly even after a large spill, with or without dispersant use, and recovery time would be on the order of days to weeks. The estimates of the volume of water contaminated—and its variability—are generally applicable to spills of the same size throughout the Gulf of Mexico region because natural and chemical dispersion of oil into the water column and dilution processes are similar in all areas.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine water quality in the Gulf of Mexico region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Air Quality

Concentrations of hydrocarbons of concern in the air resulting from oil spills and response operations were compared with air quality standards to evaluate the potential for adverse effects (Section 4.3.1.2). The effects of an oil spill on air quality may involve all volatile components of the oil. In addition, if *in situ* burning was used, particulates and other contaminants emitted from burns could become an air quality concern. However, adverse air quality effects from oil spills are normally very localized and short lived for small, medium, and large oil spills. The addition of *in situ* burning does not significantly increase any potential adverse effects: the volume of oil that could be burned is not large, and the temporary smoke plume would be localized and rapidly diluted. Chemical dispersion reduces the volatilization of unburned oil to the atmosphere to only a slight extent, so that effects are essentially identical with or without dispersant use.

The modeling shows that results do not vary by spill location, or size in the Gulf of Mexico region. Two possible sources of contamination to the atmosphere were evaluated for their potential effects on air quality: volatilization of hydrocarbons from unburned oil and emissions produced by *in situ* burning. Concentrations in the lowest 2 m of the atmosphere were compared with the U.S. Environmental Protection Agency's National Ambient Air Quality Standards (USEPA's NAAQS) and other thresholds of concern (as discussed in Section 4.3.1.2).

The results of the modeling show that the potential adverse effects on air quality are low for all spill sizes involving mechanical-only recovery and chemical dispersion; hence, the risk scores are virtually identical for small, medium, and large spills. Volatilized hydrocarbons would not exceed air quality standards for human health at more than 1 km from the spill site. Evaporation off the water surface and volatilization from the water column create a plume of volatile hydrocarbon gases that disperses quickly after a spill, such that the concentrations in the atmosphere at the water surface would not exceed human health thresholds of concern at any location. The recovery time for the atmosphere would be on the order of days. Thus, a low level of concern is expected for small, medium, and large spills involving mechanical-only recovery and chemical dispersion (Table 4.5-32).

Mechanical recovery plus *in situ* burning, with or without chemical dispersion, would increase atmospheric pollutants by the amount emitted via *in situ* burning. For small spills, it would be very unlikely that *in situ* burning would be used, as the oil would disperse too rapidly for it to be feasible (Table 4.5-32). The maximum area potentially exceeding the NAAQS or thresholds of concern is 1.6 km^2 for a medium spill and 9.5 km^2 for a large spill (Table 4.5-32). If humans or sensitive resources (i.e., wildlife) are within these areas, they could be affected by poor air quality for a short time, on the order of hours. Since *in situ* burning can only be used offshore in marine waters, a region of interest equivalent to the North Texas Shelf (39,602 km^2) would have less than 1 percent of its area adversely affected, and the atmosphere would recover in a matter of hours. The addition of chemical dispersion does not change the results in Table 4.5-32.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on air quality in the Gulf of Mexico region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without *in situ* burning.

Table 4.5-32
Risk Ranking of Offshore Oil Spills* to Air Quality under *In Situ* Burning in the North Texas Shelf†

Spill Size	Area Exceeding Threshold (km²)	Area Contaminated (estimated %)	Risk Score‡
Small (200 bbl)	1.6	0.004	4E
Medium (2,500 bbl)	1.6	0.004	4E
Large (40,000 bbl)	9.5	0.02	4E

Source: Adapted from Part C of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Calculations are based on the appropriate portions of the North Texas Shelf (as discussed in the text) as representative of the Gulf of Mexico region for modeling.

‡ The risk scoring process is explained in Section 4.4.3.

4.5.4.2. Consequences to the Biological Environment

Marine Mammals

The cetaceans, pinnipeds, and sirenians in the Gulf of Mexico region (section 3.4.2.1, Table F.4-1) spend their entire lives at sea, and their concentrations vary depending on location and seasonal migrations. The Florida manatee (*Trichechus manatus latirostris*) is fairly common along the Florida west coast and sporadic elsewhere. There are no fur-bearing marine mammals of concern that inhabit this region (Section 3.4.2.1).

Marine mammals such as whales, dolphins, and manatees are vulnerable to spilled oil since they spend considerable time at the water's surface, which enhances possible contact with oil. The majority of these species remains offshore, and populations vary according to season and migration directions. Cetaceans appear able to detect and are likely to avoid floating oil or oil being recovered by mechanical means (Geraci, 1990). Studies have shown that cetacean skin is nearly impenetrable to even the highly volatile constituents of oil, indicating that contact with oil probably would be less harmful to cetaceans than often believed. However, the toxic, volatile fractions in fresh crude oils could irritate and damage cetacean soft tissues, such as the mucous membranes of the eyes and airways.

Marine mammals that are more commonly found in the nearshore regions and intertidal habitats, such as manatees, are of greater concern. Manatees tend to inhabit intertidal areas such as bays, rivers, harbors, and estuaries and are very rarely spotted in deep marine waters. They usually remain in deep channels, feeding for extended periods of time. The likelihood of manatees coming into direct contact with oil from a spill occurring 3 or more statute mi offshore is low. Overall, the potential adverse effects depend on the spill size, and the number and species of marine mammals present.

Based on the surface area in the North Texas Shelf, the equivalent area for 100 percent mortality for cetaceans, pinnipeds, and sirenians is 0.002 percent (or less) of the available habitat for a medium spill without chemical dispersion. For a large spill without chemical dispersion the equivalent area at risk increases, but remains low (0.002 percent for cetaceans and 0.02 percent for pinnipeds and sirenians). There are no known breeding or haulout areas associated with pinnipeds for this region; therefore, shoreline oiling will have no adverse impacts on most marine mammals, but there is a low risk for terrestrial species using the shoreline and for nearshore species (in this region, manatees). Based on the scattered presence of these species, the potential adverse impacts were determined to be low for all spill sizes without chemical dispersion. If mortality did occur, however, the population would probably require 1 to 3 years to recover. The results of the modeling for marine mammals using the basic response scenario in the North Texas Shelf are presented in Table 4.5-33.

Table 4.5-33
Risk Ranking of Offshore Oil Spills* to Marine Mammals Using the Basic Response Scenario† with the Addition of Chemical Dispersion in the North Texas Shelf‡

Spill Size	Response Option (% dispersant efficiency)	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E
Medium (2,500 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E
Large (40,000 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E

Source: Adapted from Part C of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the North Texas Shelf (as discussed in the text) as representative of the Gulf of Mexico region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

For any spill size, the addition of chemical dispersion is not expected to change the adverse effects on marine mammals. There would be a reduction in the amount of oil that strands onshore (Section 4.3.2.4), and the equivalent area of 100 percent mortality for the groups of concern would also be reduced, but the risk is already very low, so the scores do not change. The addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the severity of potential adverse consequences nor increase risk to marine mammals. Adverse effects on marine mammals for a small spill were determined by extrapolating from the results of a medium spill.

Although areas other than the North Texas Shelf in the Gulf of Mexico region were not modeled, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on marine mammals will fall within a similar range throughout the Gulf of Mexico region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine mammals in the Gulf of Mexico region under Alternative 1 are expected to be minor for small, medium, and large spills, with or without dispersant use.

Marine and Coastal Birds

Potential adverse effects on marine and coastal birds are usually of highest concern during an oil spill because birds are highly susceptible to the acutely toxic effects of exposure to oil. There are many areas in the Gulf of Mexico region where high concentrations of birds may be found in a variety of habitats. Adverse effects on birds in this region would result mostly from shoreline oiling of sand beaches and mudflats that are staging habitats for migratory shorebirds; oiling of wetlands that are used by wading and marsh birds, waterfowl, diving birds, and raptors for nesting, roosting, and wintering; and surface water oiling in marine-water habitats that are used by diving birds and seabirds (Section 3.4.2.2) (see section 4.3.2.2 for information on the main issues of concern for birds exposed to an oil spill).

The North Texas Shelf was selected for the modeling as representative of the intertidal habitats and wildlife in the Gulf of Mexico region (Table 4.5-34). Under Alternative 1, the addition *in situ* burning does not change the amount of oil removed, so it does not reduce the potential adverse effects on birds. Potential levels of concern for birds in the North Texas Shelf are medium for all spill sizes, as discussed below. However, for a small spill very little oil is likely to strand onshore, and oil loading would be light in most cases. The potential for adverse effects increases for medium and large spills; most concerning are conditions where wetlands and sand beaches that are used by nesting birds become heavily oiled.

Two international Western Hemispheric Shorebird Reserve Network (WHSRN) sites and four National Wildlife Refuges occur in the North Texas Shelf. The presence of these sites indicates that large numbers of shorebirds (WHSRN sites) concentrate in the area during migration and/or nesting and wintering. Approximately 300,000 shorebirds, including wintering piping plover (*Charadrius melodus*) (designated as a threatened species), use Galveston Bay beaches and flats as staging areas during the fall, winter, and spring. Wetlands, estuaries, and nearshore waters serve as habitats for large numbers of diving birds, raptors, nesting wading birds, and wintering waterfowl. Thus, the risk rankings were determined based on the possibility that a large number of birds may be concentrated on heavily utilized beaches or in wetlands that are significantly oiled. Also, high mortality rates are typical for diving birds and waterfowl that are exposed to oil on the water's surface. It is important to recognize that adverse effects on birds may be more or less severe depending on the time of year and locations of their habitats, as well as the extent of shoreline and surface water oiling. For instance, an oil spill occurring during peak staging and wintering in

Galveston Bay would result in more extreme adverse effects on regional bird populations than a spill occurring at a different time of year.

Table 4.5-34
Risk Ranking of Offshore Oil Spills* to Marine and Coastal Birds Using the Basic Response Scenario† with the Addition of Chemical Dispersion in the North Texas Shelf‡

Spill Size	Response Option (% dispersant efficiency)	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	1–5	3D
	Chemical Dispersion (45 or 80)	1–5	3D
Medium (2,500 bbl)	Basic	5–10	3C
	Chemical Dispersion (45)	1–5	3D
	Chemical Dispersion (80)	1–5	3D
Large (40,000 bbl)	Basic	> 20	3A
	Chemical Dispersion (45 or 80)	> 20	3A

Source: Adapted from Part C of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the North Texas Shelf (as discussed in the text) as representative of the Gulf of Mexico region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Under the basic response scenario, adverse effects on birds in the North Texas Shelf for a small spill were determined by extrapolating from the results obtained for a medium spill and the expectation that recovery from light oiling is usually rapid for all habitat types. The volume of oil released in the small spill was approximately an order of magnitude less than in the medium spill; therefore, the adverse effects on bird populations were estimated to be proportionally less. For a small spill, oiling is expected to be light, affecting only outer sand beaches. The modeling of effects on birds for a medium spill under mechanical-only recovery resulted in estimates of 5 to 10 percent of the regional bird population being adversely affected because outer sand beaches that are used as staging habitats by large numbers of shorebirds were oiled. For a large spill under mechanical-only recovery, the modeling resulted in estimates of over 20 percent of the local area bird population being adversely affected. Nearly 10 percent of outer sand beach habitat in the North Texas Shelf was oiled, and 9.4 km of interior marsh habitats that have long recovery periods were also oiled. Shorebirds, wading birds, and waterfowl heavily use the shoreline areas oiled in this scenario. The risk scores in Table 4.5-34 reflect the predicted recovery rates of 1 to 3 years for most bird species, as was the case following the *EXXON VALDEZ* oil spill (Section 4.3.2.2).

With the addition of chemical dispersion for a medium spill, 45 and 80 percent efficiency reduced the length of oiled shoreline by 50 and 65 percent, respectively, and adverse effects on important bird habitats were also reduced. The risk scores were the same, regardless of dispersant efficiency (Table 4.5-34). For a large spill, 45 and 80 percent efficiency only reduced shoreline oiling by 11 and 21 percent, respectively, so the decrease in the amount of shoreline oiling in sensitive bird habitats with chemical dispersion was not enough to change the risk score, regardless of dispersant efficiency (Table 4.5-34). Although areas other than the North Texas Shelf in the Gulf of Mexico region were not modeled, the results are consistent with those for all other regions modeled in this PEIS; therefore, it is expected that the severity of effects on bird populations will fall within a similar range throughout the Gulf of Mexico region. On an overall regional level, adverse effects from medium spills to birds are reduced when chemical dispersion is modeled. For large spills, adverse effects on marine and coastal birds are not consistently reduced when chemical dispersion is used in the Gulf of Mexico modeling scenario, but are in most other regions. The addition of *in situ* burning does not change the significance of these adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine and coastal birds in the Gulf of Mexico region under Alternative 1 are expected to be moderate for small, medium, and large spills, with or without dispersant use.

Plankton and Fish

Plankton and fish, a diverse group of species, are important to the marine food web, ecosystem function, and fisheries. Adverse effects on these groups are of high concern, particularly when chemical dispersion is considered as a potential response option. As described in Section 4.3.2.3 and 4.5.2.2, plankton and fish are adversely affected either directly or via the food web by the toxic effects of oil components that enter the water column—the soluble compounds (MAHs and PAHs) and microscopic oil droplets mixed by waves into the water (French McCay, 2002; NRC, 1985). The most important pathway of exposure is direct uptake of dissolved oil components, originating directly from surface oil or dissolving from the microscopic oil droplets in the water. Overall, as spill size increases, so do adverse effects. However, there is great variability related to the environmental conditions after a spill; plankton and fish suffer much more adverse effects in storm conditions where high waves mix unweathered oil into the water, which happened during the *NORTH CAPE* oil spill (French McCay, 2003), than in calm weather. In addition, many species utilize shallow waters and even the intertidal zone, where they are more likely to be exposed to oil and dissolved components when oil comes ashore. Species and life stages vary considerably in sensitivity to toxic components, with species from relatively unpolluted and environmentally stable locations being more sensitive than those from polluted and environmentally variable areas.

In marine and open coastal environments, small, medium, and large oil spills do not cause large or long-term toxic effects to plankton and fish in the water column. The toxic effects of oil spills result from acute exposure during the time when surface oil is present and for short periods (days to weeks) afterwards. Once the source of hydrocarbons (from floating oil or the shoreline) to the water column is gone, concentrations rapidly disperse to background levels.

There may be longer-term effects if an offshore spill occurs in or migrates to nearshore shallow areas such as enclosed embayments, estuaries, or wetlands where dilution and flushing are slow. Many fish and other organisms spawn and develop through larval and juvenile stages in these shallow areas. Juvenile fish are more abundant in salt marshes and seagrass beds than in other shallow subtidal and intertidal areas, so these areas are of most concern (see discussion of potential effects on these habitats below). Under Alternative 1 in most cases, chemical dispersion could not be used within 3 nm of shore[25], but the dispersed oil plume could be transported by currents into this area.

The percentage of plankton and fish adversely affected by oil spills was estimated using the modeling results (technical report [French McCay et al., 2004]) of water volumes exposed to toxic oil components. Percent loss multiplied by volume exposed was integrated over time and space to calculate an equivalent volume of 100 percent loss. These volumes were translated to equivalent areas by multiplying by water depth at the spill site, allowing comparison with other resources, such as birds and shorelines, which are distributed on a per-area basis. The use of area is appropriate because plankton and fish abundance is much more uniformly distributed when expressed on a per-area basis than on a per-volume basis since the ecosystem is driven by sunlight and plant photosynthesis at the water surface (French et al., 1996; Odum, 1971). As indicated by the similar results for the four modeled spill sites in 10 to 30 m of water—offshore Delaware Bay, offshore Galveston Bay, the Florida Straits, and offshore San Francisco (Parts B, C, D, and E, respectively, of the technical report [French McCay et al., 2004])—the equivalent areas of adverse effect on plankton and fish (both average and variable) are applicable to spills of the same size in any location of similar water depth in any region considered in this PEIS. The modeled spill site was 10 m deep water: adverse effects would be smaller for deeper waters because of greater vertical dilution of both oil components and organisms, and proportionately greater in shallower waters because of the restricted dilution potential.

The model-estimated areas are those where there is a potential to affect the most sensitive species, which are two standard deviations more sensitive than the average of all species tested (2.5th percentile in rank order of sensitivity). For species of average sensitivity (50th percentile), the areas adversely affected would be much less. Thus, the model-estimated areas should not be interpreted as experiencing 100 percent mortality of all plankton and fish; they are conservative estimates used for comparative purposes among response scenarios.

The North Texas Shelf was selected for the modeling as representative of the Gulf of Mexico region (Table 4.5-35). The adverse effects were estimated as a percentage of the total area of concern (39,602 km^2).

Table 4.5-35
Risk Ranking of Offshore Oil Spills[*] to Plankton and Fish Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion in the North Texas Shelf[‡]

Spill Size	Response Option (% dispersant efficiency	Equivalent Area Affected (km^2)	Area Affected (estimated %)	Risk Score[§]
	)			
Small (200 bbl)	Basic	< 0.082	3×10^{-11}	4E
	Chemical Dispersion (45 or 80)	<0.082	1×10^{-10}	4E
Medium (2,500 bbl)	Basic	0	0	4E
	Chemical Dispersion (45)	15	0.039	4E
	Chemical Dispersion (80)	16	0.041	4E
Large (40,000 bbl)	Basic	96	0.2	4E
	Chemical Dispersion (45)	200	0.51	4E
	Chemical Dispersion (80)	230	0.58	4E

Source: Adapted from Part C of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the North Texas Shelf (as discussed in the text) as representative of the Gulf of Mexico region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

With the addition of chemical dispersion, the results for 80 percent efficiency were only slightly higher than those for 45 percent efficiency because more than sufficient dispersant would be available under both conditions to disperse available surface oil for spills up to 40,000 bbl (with some variability, as reflected in the results in Table 4.5-35). For a small spill, based on the evaluation of the volume where water quality would be affected for a small spill (Tables 4.5-30), the volume of adverse effects on plankton and fish would be low for all response options under Alternative 1.

Since the adverse effects are in a small percentage of the area of concern and less than the range of natural variability, the recovery time would be less than 1 year. Overall, based on the modeling results, adverse effects on plankton and fish in the Gulf of Mexico region under Alternative 1—using mechanical recovery, *in situ* burning, and chemical dispersion—would be localized to the immediate area around the spill site and similar in all marine water areas of the region. For large spills that might move rapidly into shallow coastal areas during rare storm events, the concentrations of toxic components might be high enough to cause some concern for water column communities, especially early life history stages for fish and invertebrates using intertidal and shallow subtidal areas. For large spills in the relatively shallow area within 12 statute mi of the coast, the adverse effects due to winds and currents without chemical dispersion would be greater than those for the average spill event where chemical dispersion is used.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on plankton and fish in the Gulf of Mexico region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Intertidal Habitats

Intertidal habitats are always of great concern during oil spills, particularly when sensitive habitats such as salt marshes are oiled because recovery can take many years. The sand beaches fronting the coastal barrier islands throughout the Gulf of Mexico region support high concentrations of overwintering birds, making these intertidal habitats highly susceptible to major adverse effects from oil spills. The wetlands along the many estuaries and bays support large populations of wildlife and provide nursery habitats for many commercially important fish and shellfish (Section 3.4.4). Oil spills in these extensive and shallow wetland areas would be very difficult to contain and clean up. Thus, oil often is left to degrade naturally, and the ecological functions of the wetlands can be affected throughout the recovery period. The Gulf of Mexico region has extensive areas of these sensitive habitats, and many areas are regionally important for different wildlife species. For a discussion of the relative ranking of the sensitivity of intertidal habitats to spilled oil and the processes affecting oil fate and behavior on shorelines, see the explanation of the Environmental Sensitivity Index (ESI) in Section 4.3.2.4. There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on intertidal habitats in that larger spills tend to have higher oil loading on the shoreline and affect larger areas.

Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed and, thus, does not reduce potential adverse effects. Adverse effects on intertidal habitats in the Gulf of Mexico region are low for a small spill in that very little oil is likely to strand onshore, only outer beaches are likely to be oiled, and oil loading would be light in most cases. However, the potential for adverse effects increases with spill volume, with the greatest concern for conditions where salt marshes and sand beaches become heavily oiled. The North Texas Shelf was selected for the modeling as representative of the intertidal habitats in the Gulf of Mexico region (Table 4.5-36).

Table 4.5-36
Risk Ranking of Offshore Oil Spills* to Intertidal Habitats Using the Basic Response Scenario† with the Addition of Chemical Dispersion in the North Texas Shelf‡

Spill Size	Response Option (% dispersant efficiency)	Habitats Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	1–5 [1–5]	3D
	Chemical Dispersion (45 or 80)	0–1	3E
Large (40,000 bbl)	Basic	1–5 [5–10]	2D
	Chemical Dispersion (45 or 80)	1–5 [1–5]	2D

Source: Adapted from Part C of the technical report (French McCay et al., 2004).

Note: Values in brackets represent the percentage of outer sand beach habitat affected. Yellow represents a medium level of concern, and green, a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the North Texas Shelf (as discussed in the text) as representative of the Gulf of Mexico region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Adverse effects on intertidal habitats for a small spill were determined to be small by extrapolating from the results of a medium spill and expecting recovery from mostly light oiling of outer sand beaches within 1 year. For a medium spill under mechanical-only recovery, the modeling resulted in 16 km of oiled shoreline, which is a small percentage of the total shoreline in the entire North Texas Shelf. However, most of this oiled shoreline consisted of outer sand beaches, representing 1 to 5 percent of this habitat in the North Texas Shelf. The risk scores in Table 4.5-36 reflect the predicted recovery rate for oiled sand beaches being 1 to 3 years. For a large spill under mechanical-only recovery, the modeling resulted in an estimated 56.4 km of oiled shoreline. This value is still less than 1 percent of the entire shoreline area but nearly 10 percent of the outer sand beach habitat in the North Texas Shelf. An estimated 9.4 km of interior marsh habitat were also affected. Oiled marshes are expected to take 3 to 7 years to recover.

With the addition of chemical dispersion for a medium spill, 45 and 80 percent efficiency reduced the length of oiled shoreline by 50 and 65 percent, respectively, and the amount of oil that stranded in wetlands was very low (0.3 km). The risk scores were the same, regardless of dispersant efficiency (Table 4.5-36). For a large spill, 45 and 80 percent efficiency reduced shoreline oiling by 11 and 21 percent, respectively, so the decrease in the amount of shoreline oiling in sensitive bird habitats with chemical dispersion was not enough to change the risk score, regardless of dispersant efficiency (Table 4.5-36). However, chemical dispersion did significantly increase the number of times no oil came ashore at all, which is a significant benefit. For large spills, chemical dispersion does not change the significance of adverse effects on intertidal habitats based on the median event.

Although areas other than the North Texas Shelf in the Gulf of Mexico region were not modeled, the results are consistent with those for all other regions modeled in this PEIS; therefore, it is expected that the severity of adverse effects on intertidal habitats will fall within a similar range throughout the Gulf of Mexico region. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on intertidal habitats in the Gulf of Mexico region under Alternative 1 are expected to be insignificant and moderate for small and large spill sizes, respectively, with or without dispersant use. For medium spill sizes, adverse impacts are expected to be moderate but are reduced to minor levels of concern when chemical dispersion is used.

Subtidal Habitats

The subtidal (benthic) habitat consists of the bottom substrate below the low tide level, as well as the species that live in, on, and near the substrate. This benthic community includes areas of live, sandy, muddy, and low-relief bottoms; subsurface canyons; and pinnacles. The East and West Flower Garden Banks, located off the Louisiana-Texas coast, are particularly valuable coral habitats. Organisms living in this area—demersal species—include corals, plants and seagrasses, benthic invertebrates (such as crabs, shrimp, snails, bivalve mollusks, and marine worms), and bottom-dwelling fish. Because subtidal benthic communities do not include the intertidal zone, they are at little risk from floating oil because, by definition, this environment is always below the surface. The greatest risk of exposure comes from sinking oil, as well as *in situ* burn residue, dispersed oil, or the sorption of naturally dispersed or mechanically mixed oil that has become suspended on sediments and is deposited onto the ocean floor. However, significant natural dispersion of oil and sediment into the water column only occurs during large storms or for nearshore oil spills. Oil particles could adhere to bottom substrate, plants, or animals, which could result in both physical coating of organisms, as occurred in the 1993 *BRAER* spill in the Shetland Islands, and toxic effects from exposure to the chemical constituents (Section 4.3.2.5). Such adverse effects are not normally observed.

The risk to fauna and flora of the subtidal benthic habitat is minimal, based on the diluting effect of the overlying water (Section 2.2.2)—the deeper the water, the lower the risk. Chemical compounds of concern tend to evaporate, rather than dissolve, and the rapid dilution of any chemical entering the water column decreases the toxicity of any oil residue potentially reaching the bottom substrate.

Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects. It may slightly increase the risk of remaining oil residues sinking to the bottom. Residual oil from *in situ* burning that reaches the bottom is expected to have few or no adverse effects on subtidal habitats since the majority of its toxic components would have either evaporated or been destroyed during burning and the volume of residue produced is so small (Section 4.3.2.5). Under the modeled conditions, the quantity of *in situ* burn residue produced would not result in a level of concern that exceeds low.

For a medium spill without chemical dispersion the sediment threshold concentrations for dissolved aromatic and for total hydrocarbons were never exceeded. For a large spill the sediment threshold for total hydrocarbon exposure was exceeded, but only in an area of less than 0.0002 percent of the total reference area and less than 0.005 percent of Galveston Bay. Benthic habitat was also assumed to be at risk if there threshold of concern for dissolved aromatic hydrocarbons affected stationary demersal species (those living at the sediment-water interface). With mechanical-only recovery less than 0.001 percent of the North Texas Shelf was affected by water column concentrations above the threshold for the medium spill. For a large spill, the percentage increased to 0.087 percent. The results for the selected modeling location (Table 4.5-37) represent estimates of adverse impacts on subtidal habitats using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion.

Table 4.5-37
Risk Ranking of Offshore Oil Spills[*] to Subtidal Habitats Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion in the North Texas Shelf[‡]

Spill Size	Response Option (% dispersant efficiency)	Habitats Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Large (40,000 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E

Source: Adapted from Part C of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the North Texas Shelf (as discussed in the text) as representative of the Gulf of Mexico region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

With the addition of chemical dispersion at 45 and 80 percent efficiency for medium spills (Table 4.5-37), the modeling results show essentially no change in sediment contamination. With the addition of chemical dispersion at 45 and 80 percent efficiency for a large spill, sediment exposure increases to 0.002 and 0.004 percent of the total reference area, respectively, which are still low risks. The area of exposure of stationary demersal species to dissolved aromatic hydrocarbon concentrations above the threshold increased to 0.022 and 0.023 percent of the total reference area for a medium spill and to 0.17 and 0.19 percent for a large spill at 45 and 80 percent efficiency, respectively. Overall the potential increase in adverse effects associated with the addition of chemical dispersion to subtidal habitat is small because the affected area is small relative to the North Texas Shelf reference area.

Although areas other than the North Texas Shelf in the Gulf of Mexico region were not modeled, the results are consistent with those for many other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on subtidal habitats will fall within a similar range throughout the Gulf of Mexico region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subtidal habitats in the Gulf of Mexico region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Areas of Special Concern

The potential adverse effects on areas of special concern, such as National Marine Sanctuaries, National Parks, National Wildlife Refuges, and National Estuarine Research Reserves, are important during an oil spill since these areas are under increased scrutiny and protection. Whereas most coastal and nearshore areas have a wide range of habitats or are very similar to other areas throughout the Gulf of Mexico, areas of special concern are set aside for their uniqueness (Appendix F, Tables F.4-3 through F.4-5 and Figures F.4-1 through F.4-3). The potential risks and adverse effects associated with shoreline areas of special concern are identical to those discussed above for intertidal habitats. The risks to subtidal resources, such as those included in National Marine Sanctuaries, are identical to those discussed above for subtidal habitats. For this analysis, the risks to areas of special concern are assumed to be the same as those for either intertidal or subtidal habitats (Sections 4.5.4.2), whichever are greater. Since the risk to intertidal habitats is greater, those risk scores were used. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on data presented for a medium spill using mechanical-only recovery, the estimated average extent of shoreline oiling is 16 km; this figure increases to 56 km for a large spill. The potential risk of surface oil reaching a shoreline associated with an area of special concern is low in the North Texas Shelf because of the number and scattered locations of these areas. The potential adverse effects of small spills to areas of special concern are low. The level of concern increases to moderate for medium and large spills based on the extent of the shoreline oiling

(Table 4.5-38). Potential concerns associated with a large spill are moderate if the spill occurs in close proximity to an area of special concern.

With the addition of chemical dispersion at 45 and 80 percent efficiency for a medium spill (Table 4.5-38), the average amount of shoreline oiling decreases by an estimated 61 percent, and for a large spill, by over 70 percent. For a medium spill, chemical dispersion will also increase the number of times no oil reaches shore, an important benefit that did not occur for large spills.

Table 4.5-38
Risk Ranking of Offshore Oil Spills* to Areas of Special Concern Using the Basic Response Scenario†
with the Addition of Chemical Dispersion in the North Texas Shelf‡

Spill Size	Response Option (% dispersant efficiency)	Areas Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	1–5	3D
	Chemical Dispersion (45 or 80)	0–1	3E
Large (40,000 bbl)	Basic	1–5	2D
	Chemical Dispersion (45 or 80)	1–5	2D

Source: Adapted from Part C of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the North Texas Shelf (as discussed in the text) as representative of the Gulf of Mexico region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Based on the modeling for the North Texas Shelf, the likelihood of adversely affecting an area of special concern in the localized region of a spill is minimal, unless the spill occurs directly adjacent to such an area. Since these areas are few and scattered throughout the Gulf of Mexico region, they are unlikely to be disproportionately affected by the average spill. If an area of special concern was highly adversely affected, it is anticipated that the recovery time for the affected area would be the same as for other intertidal habitats. These areas are most at risk from floating oil and, therefore, benefit from any action that reduces potential shoreline oiling.

Although areas other than the North Texas Shelf in the Gulf of Mexico region were not modeled, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on areas of special concern will fall within a similar range throughout the Gulf of Mexico region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on areas of special concern in the Gulf of Mexico region under Alternative 1 are expected to be insignificant and moderate for small and large spills, respectively, with or without dispersant use, based on the risk to intertidal habitats. For medium spills, adverse impacts are expected to be moderate but are reduced to minor levels of concern when chemical dispersion is used.

4.5.4.3. Consequences to Threatened, Endangered, or Candidate Species

The Gulf of Mexico region has a variety of threatened, endangered, or candidate species (Section 3.4.4). The overall regional risk that a threatened, endangered, or candidate species would be adversely affected or even present in the area of a spill is low; however, killing a single individual of such a species can be considered a severe effect. Potential adverse effects on marine mammals, marine and coastal birds, or fish that are threatened, endangered, or candidate species are identical to those discussed in Section 4.5.4.2 for these groups. Potential adverse effects on the four threatened or endangered species of sea turtles were discussed in Section 4.3.3.1 and are similar to those described in Section 4.5.4.2 (Marine Mammals) for pinnipeds. Sea turtles are a particular concern if the spill occurs in the vicinity of a nesting beach. Overall, risk scores were highest for marine and coastal birds. While the risks to these groups have been described, the level of concern for threatened, endangered, or candidate species tends to be higher. Therefore, any adverse effects on breeding or that result in death should be considered high.

Adverse effects on threatened, endangered, or candidate species in the Gulf of Mexico region for any spill size are difficult to predict. Depending on the location and season, the number and type of species present will vary. Based on the overall size of the Gulf of Mexico region and the sporadic distribution of threatened, endangered, or candidate species inhabiting the region, the likelihood of adversely affecting an individual of concern would be low unless the spill affects important shoreline or critical marine habitats. However, if a threatened, endangered, or candidate species were present in the spill area, the resulting adverse effect would be high. The severity of the effect varies depending on the sensitivity of the individuals present. The addition of chemical dispersion at 45 or 80 percent efficiency will decrease the average amount of surface oiling and shoreline oiling, which would benefit the species in these areas, such as sea turtles or coastal birds. No additional risk from chemical dispersion is expected for fish. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on threatened, endangered, and candidate species in the Gulf of Mexico region under Alternative 1 are expected to be moderate for small, medium, and large spills, with or without dispersant use, based on the risk to marine and coastal birds.

4.5.4.4. *Consequences to Essential Fish Habitat*

Virtually all waters in the Gulf of Mexico region out to the limits of the U.S. Exclusive Economic Zone (EEZ) are considered Essential Fish Habitat (EFH). Areas such as bays, river mouths, and harbors are designated EFH for at least one life stage of at least one species and are protected by legislation (Section 3.4.4). The primary issue with respect to EFH is either (1) exposure of sensitive resources in the water column to hydrocarbon concentrations of concern, or (2) the contamination of bottom sediments, both of which could lead to either acute or chronic exposures.

Adverse effects would include either the death of individual organisms, the possibility of sublethal effects affecting long-term population viability, or degradation of habitat that reduces its availability to managed species. For this analysis, the risks to EFH are assumed to be the same as those for plankton and fish or for subtidal habitats (Section 4.5.4.2), whichever are greater. The results for plankton and fish and for subtidal habitats indicate only low effects and form the basis for the EFH risk score. Under Alternative 1, the addition of *in situ* burning does not remove enough oil to reduce potential adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on EFH in the Gulf of Mexico region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without dispersant use, based on the risk to plankton and fish and to subtidal habitats.

4.5.4.5. *Consequences to the Socioeconomic Environment*

As discussed in Section 4.3.5, oil spills can produce a variety of adverse social and economic effects. These adverse effects are generally not large when measured at the regional level, but instead are typically felt in communities located near resources oiled by the spill. Specifically, high adverse effects are generally limited to those industries and populations that are affected by the spill. Some of the most visible and high effects are likely to include effects on water- and shore-based recreation, commercial fisheries, and the overall well-being of the residents of coastal communities in the Gulf of Mexico region. In addition, oil spills have the potential to adversely affect low-income and minority populations living along the coast to a greater extent than the general population.

This modeling considers the risk of adverse socioeconomic effects posed by oil spills, which can include, but are not limited to, reduced recreational activity because of beach closures, limited accessibility, or perceived taint; closure of commercial fishing grounds or hatcheries, or reduced commercial harvests; and altered transportation patterns. In addition to these and other direct adverse effects, oil spills may generate other direct, as well as secondary, effects on social and economic welfare along the coast. For example, an oil spill may cause changes in the employment and revenues of resource-based businesses. While these effects are not quantified in this modeling, the following discussion provides absolute and relative measures of the overall risk of adverse social and economic effects of small, medium, and large oil spills using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), with or without chemical dispersion, in the Gulf of

Mexico region. The methodology is described in more detail in the Atlantic region (Section 4.5.2.5).

The resources most likely to be affected by any oil spill are important to the Gulf coast economy. For example, Galveston Island boasts 32 mi of sandy beachfront (GIC&VB, 2002). This island generated a large portion of the almost $480 million in tourism revenues for Galveston County in 2000 (Texas Tourism, 2002). Furthermore, Texas has been ranked as one of the top three producers of shrimp nationally since 1950. In 2000, approximately 73.8 million pounds of shrimp were landed in Texas for a total value of $210 million (Maril, 2002). Both the natural resources and the revenues generated by these resources are susceptible to the adverse effects of an oil spill.

There is no existing standard for "significance" related to the socioeconomic effect of oil spills (e.g., how much shoreline or surface water must be oiled to be considered a "high," "medium," or "low" effect). The significance of the effect will depend on a number of factors, including the scope of the analysis (i.e., national, regional, local), opportunities for resource substitution (e.g., an unoiled beach or fishing ground nearby, alternative ports of call), and the duration of the spill event. Generally, a spill event would be of low concern if it is not of long enough duration to affect the financial viability of local businesses, and the affected communities are able to find substitutes to replace the oiled resources.

For this PEIS, (1) the greatest effect modeled at the regional level was less than approximately 10 percent of available shoreline or surface water resources (indicating the likely presence of substitute resources), and (2) resource use following these modeled spills (e.g., vessel transportation and fishing) would be expected to resume as soon as oil recovery efforts were completed. As a result, the modeled effects under all modeled scenarios would likely be low at the regional level. As noted in the text, any adverse effects that occur would be expected to be localized in nature.

The risk factor reflects the ratio of the percentage of the shoreline or surface water oiled using the basic response scenario to the percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected given response options limited to mechanical recovery and *in situ* burning.

This modeling assumes that the risk posed by oil spills to the socioeconomic environment is directly related to the extent to which resources (meters of recreational beach and square meters of marine waters) are oiled above thresholds of concern for the Gulf of Mexico region. By comparing the absolute and relative degree of risk to the socioeconomic environment under various spill sizes, this modeling considers the degree of risk reduction achieved under a given spill response option (see Section 4.4.3.2 for details on the method used). The risk estimates presented (Table 4.5-39) are based on modeled spills affecting the North Texas Shelf. While any given spill may exhibit distinctly different patterns of socioeconomic effect, these results are expected to be broadly applicable to a range of spill locations along the entire Gulf coast, as long as spills occur in areas where mechanical recovery, *in situ* burning, and/or chemical dispersion are feasible. In addition, the conclusions reached for the North Texas Shelf are supported by results for other modeled areas—the relative degree of risk reduction achieved under various removal assumptions across spill size is similar in magnitude.

Table 4.5-39 highlights the effects of small, medium, and large spills on the Gulf of Mexico region's socioeconomic resources by presenting estimates of resources oiled as a result of the average modeled spill in absolute terms (area of shoreline and surface water oiled above the threshold of concern) and as a percentage of the total resource base in the modeled spill area (North Texas Shelf). The threshold of concern due to oiled surface water is 0.01 g/m^2 (technical report [French McCay et al., 2004]). The resource area is based on the estimated extent to which the coastal community in the modeled area potentially relies on each resource. Table 4.5-39 presents the shoreline and surface water oiled under the basic scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), with or without chemical dispersion. Table 4.5-39 illustrates that an 80 percent effective dispersant results in less oiled shoreline than a 45 percent effective dispersant, for similar spill sizes, and that the spatial extent of oiling is also less under the scenario with the most efficient dispersant (i.e., 80 percent).

For this modeling, the socioeconomic environment is divided into components representative of the major parameters of coastal life potentially affected by an oil spill. Absolute and relative risk are discussed for:

- coastal communities, demography, and employment;
- general economic status of a coastal community;
- vessel transportation and ports;
- commercial and recreational fisheries;
- archaeological and historic resources;
- recreation and tourism;
- environmental justice;
- and public safety and worker health.

Coastal Communities, Demography, and Employment

Coastal communities benefit from and rely on the marine environment to provide residents with sustenance, livelihoods, leisure opportunities, and shipping avenues. Individuals who live and work in close proximity to the coast derive both social and economic rewards from the natural beauty, recreational opportunities, quality of life, and cultural attributes associated with these coastal locations. These rewards are derived from assets such as National Parks, public beaches, fishing opportunities, and commercial and tourism-related industries. Thus, oil spills can affect multiple aspects of a coastal community's assets, leading to adverse effects on the economic benefits of community activities.

These effects, in turn, can impose changes on an affected community's demographics and employment patterns.

Table 4.5-39

Risk Ranking of Offshore Oil Spills[*] to Coastal Communities as a Result of Shoreline and Surface Water Oiled Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion in the North Texas Shelf[‡]

		Shoreline Length			Surface Water Area		
Spill Size	**Response Option (% dispersant efficiency)**	**m Oiled Above Threshold[§]**	**Estimated % Oiled[‖]**	**Risk Factor[#]**	**m^2 Oiled Above Threshold[§]**	**Estimated % Oiled[‖]**	**Risk Factor[#]**
Small (200 bbl)[**]	Basic	N/A	N/A	N/A	N/A	N/A	N/A
	Chemical Dispersion (45 or 80)	N/A	N/A	N/A	N/A	N/A	N/A
Medium (2,500 bbl)	Basic	9,386	3.4	1.0	338×10^6	0.85	1.0
	Chemical Dispersion (45)	4,109	1.5	0.44	121×10^6	0.31	0.36
	Chemical Dispersion (80)	3,315	1.2	0.35	86×10^6	0.21	0.25
Large (40,000 bbl)	Basic	28,531	10.4	1.0	789×10^6	2.0	1.0
	Chemical Dispersion (45)	25,468	9.3	0.89	706×10^6	1.8	0.90
	Chemical Dispersion (80)	23,049	8.4	0.81	652×10^6	1.6	0.80

Source: Adapted from Part C of the technical report (French McCay et al., 2004).

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the North Texas Shelf (as discussed in the text) as representative of the Gulf of Mexico region for modeling.

[§] Thresholds above which some economic or social risk is expected were determined, and the length of shoreline oiled and the area of surface water oiled above this threshold for the average modeled spill are reported. The threshold of concern because of oiled shoreline and surface water is 10 g/m^2 and 0.01 g/m^2 of oil, respectively (technical report [French McCay et al., 2004]).

[‖] Percentages reflect the proportion of the total modeled area above the threshold of concern.

[#] A risk factor reflects the ratio of the percentage of the model area or volume oiled using the basic response scenario to the model area or percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected with response limited to the basic response scenario.

[**] A 200-bbl spill is assumed to have negligible effect.

In addition to the direct employment and other adverse effects associated with oil spills on marine resource-based economic sectors, spills may generate secondary adverse effects on coastal communities. For example, in Texas it has been estimated that $1 of revenue from the shrimping industry translates into $3 in the local economy (Texas Shrimpers, 2002). Canneries, distribution facilities, transportation companies, restaurants, and grocery stores are essential to the industry's supply chain and as an outlet for its catch. Thus, oil spills can affect commercial fishing operations, as well as upstream suppliers and downstream purchasers. The adverse effects of an oil spill on commercial fishing and its dependent industries may affect coastal residents through decreased income and employment opportunities. Because of its large population and the importance of many maritime activities to various coastal communities, the entire Gulf coast is at risk of experiencing adverse social and economic effects from an oil spill.

A number of spills have affected the entire Gulf coast in the past. The 1979 *BURMAH AGATE* spill in Galveston Bay, for example, led to the accumulation of tarballs on the shores of Padre Island, a popular vacation spot for beach goers (NOAA-HMRAD, 1992). In addition to closing the Houston Shipping Channel, the Apex Barge-Greek Tank Vessel *SHINOUSSA* collision resulted in the closure of shellfish, shrimp, and finfish fisheries throughout Galveston Bay. Although the ban on finfishing lasted only a few days, the shellfish and shrimp fisheries were closed for a longer time (NOAA-HMRAD, 1992).

To the extent that mechanical recovery, *in situ* burning, and chemical dispersion can reduce shoreline oiling and the geographic scope of surface water oiling, some combination of spill response options can be expected to reduce the risk to coastal communities in the Gulf of Mexico region.

For a small spill in the Gulf of Mexico region, the risk of large adverse effects on coastal communities is negligible (Table 4.5-39). In many cases, a spill of this size is expected to pose no risk to shoreline resources because the spilled oil will never reach the shoreline above a threshold of concern. In addition, because of the small surface water area exposed to oil as a result of a small spill, marine-based economic factors such as local commercial fisheries may experience little or no effect (Table 4.5-39).

The risk to coastal communities for a medium spill is likely to be greater than for a small spill. However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources at all or at levels above the selected threshold. For a medium spill along the North Texas Shelf, such conditions prevail in only 1 percent of modeled spills when mechanical recovery and *in situ* burning are modeled in the cleanup process. With dispersant application, the model indicates that fewer medium spills will reach shore. At 45 and 80 percent efficiency, dispersants reduce the number of medium spills reaching shore by 18 and 27 percent, respectively. For these spill events, no adverse effects are expected on the shoreline.

Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill near the North Texas Shelf will have a spill area[26] above the corresponding thresholds of concern that will adversely affect approximately 9,386 m of recreational shoreline and sweep approximately 338 million m^2 of marine waters (Table 4.5-39). The risk of social and economic losses will occur in areas of both sandy shoreline and fishery waters that exceed the risk-based thresholds. For example, beaches along the entire Gulf coast may be closed to visitors, and fishing may not be permitted in waters exposed to oil, causing losses in revenue to both the tourism and commercial fishery sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill by affecting employment opportunities, earnings, and the value of coastal living.

The risk to coastal communities from a medium spill can be further mitigated with chemical dispersion. With the addition of chemical dispersion, a medium spill in the North Texas Shelf will adversely affect approximately 3,315 to 4,109 m of recreational shoreline and sweep approximately 86 million to 121 million m^2 of marine waters in the spill area used for recreation and by the commercial fishing industry, respectively, above the corresponding thresholds of concern (Table 4.5-39). At 45 and 80 percent efficiency, the risk to resources essential to tourism, recreation, and commercial fisheries is dramatically reduced, falling 56 and 64 percent, respectively, from those resources at risk when mechanical recovery and *in situ* burning are modeled. In the Gulf of Mexico region, these estimates of expected risk reduction for medium oil spills are assumed to be valid as proxy indicators of the overall expected risk reduction for the well-being of coastal communities' residents.

For a large spill using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit), there is a substantial risk of adverse effects on coastal communities because, based on the modeling results, the likelihood of a spill reaching the shoreline is very high. The addition of chemical dispersion at 45 and 80 percent efficiency results does not reduce the risk because there is only a minor reduction (1 percent) in the number of spills that reach shore above a threshold of concern.

Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a large spill will sweep approximately 28,531 m of sandy shoreline and approximately 789 million m^2 of marine waters (Table 4.5-39). A spill of this size may disrupt tourism, recreation, and commercial fishing, affecting the revenues, employment, and income directly and indirectly associated with these industries. Further, an oil spill may temporarily reduce the quality of coastal living in a given area.

The risk to coastal communities of a large spill can be mitigated with the addition of chemical dispersion. With the addition of chemical dispersion, a large spill in the North Texas Shelf will adversely affect approximately 23,049 to 25,468 m of recreational shoreline and sweep approximately 652 million to 706 million m^2 of marine waters in the spill area used for recreation and by the commercial fishing industry, respectively, above the corresponding thresholds of concern (Table 4.5-39). The risk to resources essential to tourism, recreation, and commercial fisheries are significantly reduced from the basic response scenario, falling 10 to 20 percent for the 45 and 80 percent removal efficiency scenarios, respectively. These measures of risk reduction are assumed to be valid as proxy indicators of the overall expected reduction in risk to coastal communities of a large oil spill in the Gulf of Mexico region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal communities, demography, and employment in the Gulf of Mexico region under Alternative 1 are expected to be minor for small, medium, and large spill sizes, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills; any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Economic Status

The overall economic status of communities, industries, and individuals that rely on coastal resources for sustenance, revenue, and quality of life can be affected by an oil spill. As noted above, coastal communities can suffer direct and indirect adverse economic effects from an oil spill, as beach and fishery closures decrease revenue and eliminate jobs. More specifically, losses will be felt in commercial and recreational fisheries, by both the anglers themselves and by related industries as catch opportunities decrease or are eliminated entirely. Tourism and associated businesses will suffer economic setbacks as visits to affected coastal areas decline and purchase of area goods and services decrease because of perceived resource taint. Similarly, environmental justice issues may arise as low-income or minority communities are disproportionately affected by the spill (discussed below in more detail).

The shrimp industry is the most important sector of the commercial fishing industry in Texas. In fact, Texas has been ranked as one of the top three producers of shrimp nationally since 1950 (Maril, 2002). In 2000, approximately 73.8 million lb of shrimp were landed in Texas for a total value of $210 million, composing approximately 91 percent of the value of all commercial marine products landed in Texas (NMFS, 2002). In 1993, the blue crab harvest generated 3.9 million lb of product, valued at $8.2 million (Texas Shrimpers, 2002). According to Texas Oysters (TDA, 2001), an association of local oyster harvesters, oyster landings have a $50 million impact on the Texas economy and account for 13 percent of the national supply of this shellfish. In total, the Galveston area is responsible for 60 to 70 percent of the total Texas harvest of oysters (Texas Tourism, 2001). This year-round activity provides jobs for shuckers, packers, and shellstock shippers. Further, the local oyster harvest is important to restaurants and supermarket chains (TDA, 2001). A spill such as the one that resulted from the Apex Barge-Greek Tank Vessel *SHINOUSSA* collision can cause substantial damage to local economies; this spill closed fishing grounds through Galveston Bay for more than a month in 1990 (NOAA-HMRAD, 1992).

A small spill that is 3 or more statute mi offshore would have essentially no adverse effect on either the local or regional economies (Table 4.5-39). There is little to no risk of oiling economically important resources, and it is unlikely that any commercial fisheries or recreational areas would be affected.

A medium spill, with mechanical recovery, an *in situ* burn, and dispersant operations, could be expected to have short-term adverse economic effects as a result of oiling recreational beaches and closing fisheries and recreational areas, plus the need to supplement the normal response operation employment base, especially if shoreline oiling occurs. These adverse effects would probably be very short lived, in that cleanup operations would not require a long period of time. Further mitigating the effects is that when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources at all or at levels above the selected threshold. For a medium spill in the North Texas Shelf, such conditions prevail in only 1 percent of modeled spills when the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) is used in the cleanup. With the addition of chemical dispersion, the modeling indicates that fewer medium spills will reach shore: at 45 percent efficiency, dispersants reduce the number of medium spills reaching shore above relevant thresholds by 18 percent, and at 80 percent efficiency, by 27 percent. For these spill events, no adverse effects on shoreline are expected.

For a large spill, the adverse economic effects could be high, even with mechanical recovery, *in situ* burning, and chemical dispersion, based on the anticipated level of shoreline oiling and the likelihood that closure of commercial and recreational fishing grounds will occur. In addition, the potential level of shoreline oiling would require a much larger cleanup effort. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause the adverse socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on economic status in the Gulf of Mexico region under Alternative 1 are expected to be minor for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills; any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Vessel Transportation and Ports

Oil spills occurring 3 or more statute mi offshore are not likely to cause considerable adverse effects on vessel transportation and ports; any adverse effects would likely be of short duration. However, an oil spill can disrupt marine commerce if it occurs in and around a shipping channel or port and results in limits on watercraft movement as a means of facilitating spill response. Any interruption in the standard use of vessels or increase in travel times over water can result in hardship for coastal communities as fewer goods are exchanged, transportation costs rise, and the revenue streaming through the local economy falls. These adverse effects might be felt at a number of levels. For example, vessel operators may incur additional costs associated with delays and longer shipping distances; businesses that depend on timely receipt of feedstock or other goods may experience adverse effects such as production slowdowns; and individuals who work in adversely affected sectors may be displaced. To the extent that businesses in other locations depend on the affected industries, a longer-term disruption of vessel transportation could yield adverse effects beyond the immediate spill area. However, given substitute suppliers and shipping modes and the expected short-term nature of any disruption in vessel traffic, such adverse effects are not likely to be large.

Vessel transportation is of paramount importance for many industries on the Texas Gulf coast. The port of Galveston is a regional hub for maritime activity; in 2003, the port of Galveston handled 3.43 million tons of shipped product, hosted 582 ships and 84 barges, and provided a port of call for 208 cruise ships that took 373,345 vacationers to Mexico and the Caribbean (Board of Trustees of the Galveston Wharves, 2004). An oil spill can disrupt maritime commerce if it occurs in a shipping channel or port, or if the spill results in a moratorium on the use of watercraft in an effort to facilitate spill response. For example, on July 31, 1990, the Houston Shipping Channel was completely closed to traffic for 3 days following the Apex Barge-Greek Tank Vessel *SHINOUSSA* collision, after which only single-width barge tows were allowed to travel inbound. On August 3, the channel was opened to one-way traffic, alternating directions every 8 to 12 hours; 7 days later, the channel was clear and reopened to two-way traffic (NOAA-HMRAD, 1992). Any interruption in the standard use of vessels or an increase in travel times over water can result in hardship for coastal communities, as fewer goods are exchanged, transportation costs rise, and the revenue stream within the local economy falls.

To the extent that mechanical recovery, *in situ* burning, and chemical dispersion can reduce shoreline oiling and the geographic scope of surface water oiling, some combination of spill response options can be expected to reduce the risk to vessel transportation and ports in the Gulf of Mexico region.

Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill could affect up to 338 million m^2 and a large spill, up to 789 million m^2 of surface water above recognized thresholds (Table 4.5-39). While these adverse effects would affect the movement of cargo to and from ports, they will also affect the entities that rely on this efficient flow of goods to and from the coast. The scope of potential losses will depend on the location of the spill; however, there is the potential to reduce any sort of impediment to the flow of goods by 10 to 20 percent when dispersants are applied, depending on the assumed recovery efficiency (45 percent vs. 80 percent).

For a small spill regardless of response option, no large adverse effects on vessel transportation or ports are expected (Table 4.5-39), but there is some risk of adverse effects for medium and large spills. Therefore, the nature of the risk to vessel transportation and ports will be a function of the location, area, and pattern of surface water oiling, as well as the extent of oiling in port areas. A medium spill in the North Texas Shelf would not generally be expected to result in large adverse effects; however, there is some risk of adverse effects on vessel transportation and ports for a large spill.

While the risk to vessel transportation and ports of medium and large spills in the North Texas Shelf is limited, chemical dispersion would be expected to reduce this risk even further. At 45 and 80 percent efficiency, chemical dispersion would be expected to decrease risk by 64 and 75 percent for a medium spill and by 10 and 20 percent for a large spill, respectively, from those resources at risk when mechanical recovery and *in situ* burning are modeled. To the extent that these represent reasonable proxy measures to reduce the risk of oiling port facilities along the entire Gulf coast, the risk of port closures or the risk of other adverse effects, they will be further reduced with the addition of chemical dispersion.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on vessel transportation and ports in the Gulf of Mexico region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills; any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Fisheries

Commercial Fisheries

Commercial fisheries are vulnerable to oil spills because of both closures and perceived taint. A moratorium on fishing operations in the wake of an oil spill can lead to significant losses in revenue for the commercial fishing industry, as well as related industries, including those that supply equipment to and purchase products from commercial fleets. In addition, oil spills can lead to the closure of fisheries, decrease demand for fish from affected waters because of actual or perceived taint, and instigate alterations to fishing practices in a manner that increases operating costs and/or decreases revenues. Large spills can potentially injure fish nursery grounds and impose other risks that could reduce fish harvests in the longer term.

Commercial fishing is an important economic activity on the Texas Gulf coast. In 2000, approximately 73.8 million lb of shrimp were landed in Texas for a total value of $210 million, composing approximately 91 percent of the value of all commercial marine products landed in Texas (NMFS, 2002). According to Texas Oysters (TDA, 2001), an association of local oyster harvesters, oyster landings have a $50 million impact on the Texas economy and account for 13 percent of the national supply of this shellfish. The Apex Barge-Greek Tank Vessel *SHINOUSSA* collision on July 31, 1990 resulted in the closure of shellfish, shrimp, and finfish fisheries throughout Galveston Bay; although the ban on fin fishing lasted only a few days, the shellfish and shrimp fisheries were not reopened until September 2, 1990 (NOAA-HMRAD, 1992).

To the extent that mechanical recovery, *in situ* burning, and chemical dispersion can reduce shoreline oiling and the geographic scope of surface water oiling, some combination of spill response options can be expected to reduce the risk to regionally important fisheries in the Gulf of Mexico region.

Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill could affect up to 338 million m^2 and a large spill, up 789 million m^2 of surface water above recognized thresholds (Table 4.5-39). While adverse effects would be felt directly by commercial fishermen, local income and employment in sectors tied to this industry could also be affected. The risk to commercial fisheries shrinks by 10 to 20 percent when dispersants are applied, depending on the assumed recovery efficiency (45 percent vs. 80 percent).

For a small spill in the Gulf of Mexico region, the risk to commercial fisheries is negligible using the basic response scenario (Table 4.5-39). Any adverse effects that occur, however, would be reduced with chemical dispersion.

For a medium spill, the risk to commercial fisheries is likely to be greater than for a small spill, but the effects remain localized. A risk of economic loss to commercial fisheries will occur when waters exceed relevant thresholds. For example, fishing may not be permitted in waters swept by oil above the modeled threshold of concern. This would result in reductions in commercial fish landings for a period of time following a spill. The resulting adverse effects would be expected to reverberate through communities in the area of the spill, causing decreases in employment, income, and the viability of businesses associated with the commercial fishing industry. To the extent that substitute fishing grounds are available, spill effects on the commercial fishing economy may be less severe.

The risks to commercial fisheries of a medium spill can be mitigated significantly with chemical dispersion. At 45 and 80 percent efficiency, the risk to resources essential to commercial fisheries is dramatically reduced by 64 and 80 percent, respectively, from those resources at risk when mechanical recovery and *in situ* burning are modeled.

For a large spill, there is a substantial risk to commercial fisheries. A spill of this size may cause significant decreases in commercial fishing activities and revenues, as well as those of associated businesses. Again, to the extent that commercial fishing operations can, for a time, move to substitute fishing grounds, the potentially severe effects of even a large spill may be avoided. With chemical dispersion the percentage of risk reduction for a large spill is not as dramatic as for a medium spill. At 45 and 80 percent efficiency, chemical dispersion could be expected to reduce the risk to commercial fisheries by approximately 10 and 20 percent, respectively.

Recreational Fisheries

Similar to commercial fishing operations, recreational fisheries are at risk of closure or loss in value as a result of oil spills. These adverse effects will not generally be at the regional or national levels but could be high at the local level. For this modeling, the risks posed to recreational fishing activities are modeled in the same manner as risks to commercial fishing activities, in square meters of surface water oiled above the corresponding threshold of concern. Coastal regions offer outdoor recreational activities that residents and visitors value. For example, in 1993 there were more than 831,000 saltwater fishermen in Texas, accessing marine waters from piers, shallow wade fishing areas, private boats, and charter boats (Benefield, 2002). A subset of these fishermen would be affected in the wake of an oil spill such as the Apex Barge-Greek Tank Vessel *SHINOUSSA* collision that caused the closure of commercial fisheries. Although these individuals may not see monetary losses, recreational fishermen's social welfare will likely be affected.

For a small spill regardless of response option, adverse effects on recreational resources in the Gulf of Mexico region would likely be negligible (Table 4.5-39). The risk to recreational fisheries for a medium spill is likely to be greater than for a small spill. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill in the North Texas Shelf will sweep approximately 338 million m^2 of marine waters used by recreational fishermen. However, the risk to recreational fisheries can be mitigated significantly with chemical dispersion. With chemical dispersion a medium spill in the Texas Gulf coast will adversely affect approximately 86 million to 121 million m^2 of marine waters in the spill area used by the recreational fishing industry above the corresponding thresholds of concern (Table 4.5-39). At 45 and 80 percent efficiency, the risk to resources essential to recreational fishing is dramatically reduced by 64 and 80 percent, respectively, from those resources at risk when mechanical recovery and *in situ* burning are modeled.

For a large spill, there is a substantial risk to recreational fisheries. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a large spill presents risk to approximately 789 million m^2 of the marine waters potentially important to recreational fishermen. Although chemical dispersion would mitigate the damages, the percentage of risk reduction for a large spill is not as dramatic as for a medium spill. At 45 and 80 percent efficiency, chemical dispersion could be expected to reduce the risk to recreational fishing grounds by approximately 10 and 20 percent, respectively.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on fisheries (commercial and recreational) in the Gulf of Mexico region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills. Any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Subsistence

Potential adverse effects on marine species are a concern during spills where traditional use of subsistence resources occurs. Information on subsistence use of fish and shellfish in the Gulf of Mexico region is limited. While some residents may supplement their diets with these resources, subsistence is not known to be a prominent activity in this region, as compared to the Alaska region, where Native communities may suffer substantial economic and cultural losses due to contamination of subsistence seafood during an oil spill. Tissue tainting would be the primary concern for these subsistence resources.

The North Texas Shelf was selected for the modeling as representative of the coastal habitats, fish, and wildlife in the Gulf of Mexico region. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the severity of potential adverse effects on subsistence resources. Potential adverse effects on subsistence resources in the Gulf of Mexico region are low for small, medium, and large spills (Table 4.5-40).

Effects on subsistence resources for a small spill were determined to be low by extrapolating from the results for a medium spill. Using mechanical-only recovery for a medium spill, the modeling results showed water column exposure to dissolved aromatics to be at low concentrations (1–100 ppb) and to only occur directly outside Galveston Bay. Sediment exposure was negligible. Tainting of fish and invertebrates becomes a concern when water concentrations exceed approximately 100 ppb (Section 4.3.5.6). A very small percentage of shoreline habitats were oiled; therefore, a proportionally small percentage of subsistence resources associated with these habitats are likely to be exposed. Using mechanical-only recovery for a large spill, the modeling results were similar to those of a medium spill for water column and sediment exposure, with the exception of higher concentrations (100–10,000 ppb) of dissolved aromatics occurring mostly in nearshore areas. Less than 1 percent of shoreline habitat was oiled. The risk scores in Table 4.5-40 reflect the predicted recovery rates for subsistence resources of less than 1 year for all spill volumes (Section 4.3.5.6).

Table 4.5-40
Risk Ranking of Offshore Oil Spills[*] to Subsistence Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion in the North Texas Shelf[‡]

Spill Size	Response Option (% dispersant efficiency)	Resources Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45)	0–1	4E
	Chemical Dispersion (80)	0–1	4E
Medium (2,500 bbl)	Basic	0–1	4E
	Chemical Dispersion (45)	0–1	4E
	Chemical Dispersion (80)	0–1	4E
Large (40,000 bbl)	Basic	0–1	4E
	Chemical Dispersion (45)	0–1	4E
	Chemical Dispersion (80)	1–5	4D

Source: Adapted from Part C of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the North Texas Shelf (as discussed in the text) as representative of the Gulf of Mexico region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

With the addition of chemical dispersion at 45 and 80 percent efficiency for a medium spill, the modeling results showed water column exposure at low concentrations (1–100 ppb) in a more widespread area outside and within Galveston Bay and at high concentrations (100–10,000 ppb) in localized areas. Because of the increase in potential exposure to oil for water column resources and the decrease in potential exposure for intertidal and shoreline resources, the risk scores did not change at either dispersant efficiency.

With the addition of chemical dispersion at 45 percent efficiency for a large spill, the modeling results showed water column exposure at low (1–100 ppb) concentrations, with higher (100–1,000 ppb) concentrations in a larger area; at 80 percent efficiency, the results showed exposure at high (1–10,000 ppb) concentrations covering a larger area outside and within Galveston Bay. At 45 and 80 percent efficiency, shoreline oiling was reduced by 11 and 21 percent, respectively. A slightly higher percent of subsistence resources may be adversely affected at 80 percent efficiency than at 45 percent efficiency, but recovery should be rapid in either scenario. Although areas other than Galveston Bay in the Gulf of Mexico region were not modeled, the results are consistent with those for all other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on subsistence resources will fall within a similar range throughout the Gulf of Mexico region. While adverse effects on subsistence resources are not likely to be high on a regional level, they may be high on a local level.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subsistence resources in the Gulf of Mexico region under Alternative 1 are expected to be insignificant for small and medium spills, with or without dispersant use. For large spills, impacts are expected to be insignificant, but increase to minor with the addition of chemical dispersion at 80 percent efficiency.

Archaeological/Historic Resources

Under Alternative 1 using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), with or without the addition of chemical dispersion, adverse effects on archaeological resources in the Gulf of Mexico region would likely be negligible, regardless of spill size, because most archaeological resources in the Gulf of Mexico region are located 3 to 9 mi offshore in deepwater benthic habitats that are not at risk of becoming oiled (Section 3.4.8). Some sites may be buried under sediments on barrier islands, river channels, floodplains, and terraces, and possibly in the intertidal zone.

Similar to archaeological resources, adverse effects on historic resources are expected to be low, regardless of spill volume or response option. Most historic sites in the Gulf of Mexico region are submerged shipwrecks located near the continental shelf (Section 3.4.8), and therefore are not at risk of oiling due to depth. There are limited data that identify long-term or chronic degradation to cultural resources due to chemical dispersion. Results from several studies indicated that direct oiling caused negligible effects on cultural resources following the *EXXON VALDEZ* oil spill (Bittner, 1996; Dekin, 1993; Reger et al., 1992; Wooley and Haggarty, 1995). Mechanical-only recovery or mechanical recovery plus *in situ* burning may help reduce the amount of oil that strands on the shoreline, which will also reduce the amount of shoreline cleanup and potential disturbance to sensitive historic structures.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on archaeological and historic resources in the Gulf of Mexico region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Recreation and Tourism

The Texas Gulf coast offers a range of outdoor recreational activities that residents and visitors value. In 2000, there were 368 million person-days of travel logged in Texas; more than 20 percent of these visits were in the Galveston-Brazoria-Houston area (Texas Tourism, 2001). Of all destinations along the Texas Gulf coast, this area attracts the most visitors and is second only to Dallas-Fort Worth area for number of visitors within the entire state of Texas (Texas Tourism, 2001). In 1993 there were more than 831,000 saltwater fishermen in Texas, accessing marine waters from piers, shallow wade fishing areas, private boats, and charter boats (Benefield, 2002). In addition, several natural reserves surrounding the northern Gulf offer wildlife viewing opportunities, and millions of users come to the Texas Gulf coast beach areas each year. In fact, 67 percent of visits to the Galveston-Brazoria-Houston area represented leisure travel, and 16 percent of leisure travelers participated in nature-based activities (Texas Tourism, 2001).

Numerous beaches located along the Texas Gulf coast offer recreational opportunities such as swimming, camping, boating, windsurfing, and bird watching. These beaches serve as the primary coastal tourist attraction and recreational outlet for residents and tourists; for example, rich in plants and wildlife, Galveston Island boasts 32 mi of sandy beachfront (GIC&VB, 2002). The island generated a large portion of the almost $480 million in tourism revenues for Galveston County in 2000 (Texas Tourism, 2002).

Although less important in relative dollar terms to Texas tourism, other areas along the shoreline also offer a number of recreational opportunities. The Aransas National Wildlife Refuge, for example, offers visitors the opportunity to view some of the 300 bird species that inhabit the area (Texas Tourism, 2002). Port Lavaca also attracts bird enthusiasts, in addition to beach goers and recreational fishermen (Texas Tourism, 2002).

The 1979 *BURMAH AGATE* spill in Galveston Bay led to the accumulation of tarballs on the shores of Padre Island, a popular vacation spot for beach goers. The National Oceanic and Atmospheric Administration (NOAA) estimated that 8 bbl of oil washed up on the shores of Padre Island. An additional 6 bbl of oil reached Smith Point and Galveston Island, key recreational areas for outdoor enthusiasts and bird watchers (NOAA-HMRAD, 1992). These consequences can affect the appeal of recreational areas, deterring beach goers and affecting the abundance of wildlife. An oil spill would be expected to affect recreationists' overall social welfare; in addition, the social and economic implications of a spill would reach beyond direct effects on visitors and into the community. For example, visitors may be less likely to visit and spend money in an area perceived as affected by a spill, potentially leading to loss of business revenue and jobs (see Coastal Communities, Demography, and Employment above for more details).

To the extent that mechanical recovery, *in situ* burning, and chemical dispersion can reduce shoreline oiling and the geographic scope of surface water oiling, some combination of spill response options can be expected to reduce the risk to recreation and tourism in the Gulf of Mexico region.

For a small spill in the Gulf of Mexico region, the risk to recreation and tourism is negligible (Table 4.5-39). In many cases, a spill of this size would be expected to pose no risk to shoreline resources because the spilled oil will never reach the shoreline above a threshold of concern. In addition, because of the small surface water area exposed to oil as a result of a small spill, water-based attractions such as beach visitation may experience little or no adverse effect (Table 4.5-39).

The risk to recreation and tourism for a medium spill is likely to be greater than for a small spill. However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources at all or at levels above the selected threshold. For a medium spill in the North Texas Shelf, such conditions prevail in only 1 percent of modeled spills when mechanical recovery and *in situ* burning are modeled in the cleanup process. With dispersant application, the model indicates that fewer medium spills will reach shore. At 45 and 80 percent efficiency, dispersants reduce the number of medium spills reaching shore by 18 and 27 percent, respectively. For these spill events, no adverse effects are expected to the shoreline.

Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill in the North Texas Shelf will have a spill area above the corresponding thresholds of concern that will adversely affect approximately 9,386 m of the recreational shoreline (Table 4.5-39). Under these conditions, beaches in the spill area may be closed to visitors, and fishing and boating may not be permitted in waters exposed to oil, causing losses in revenue to the recreation and tourism sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill, affecting tourism, recreation, employment opportunities, and associated revenues.

The risk to recreation and tourism from a medium spill can be further mitigated significantly with chemical dispersion. At 45 and 80 percent efficiency, the risk to resources essential to recreation and tourism along the Texas Gulf coast is dramatically reduced by 50 and 66 percent, respectively, from those resources at risk when mechanical recovery and *in situ* burning are modeled.

For a large spill, there is a substantial risk to recreation and tourism. However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources at all or at levels above the selected threshold. With the addition of chemical dispersion at 45 and 80 percent efficiency, the modeling results indicate a 1 percent reduction in the number of large spills that reach shore above a threshold of concern. For these spill events, no adverse effects on shoreline are expected.

Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a large spill will adversely affect up to 28,531 m of sandy shoreline above recognized thresholds (Table 4.5-39). While these adverse effects would directly affect the pleasure that coastal residents and visitors derive from coastal activities, they will also indirectly affect the economic contribution that recreational resources make to local income and employment. The length of sandy shoreline adversely affected by a large spill falls by 10 to 20 percent when dispersants are applied, depending on the assumed recovery efficiency (45 percent vs. 80 percent).

A large spill may cause significant decreases in tourism, recreation, and businesses revenues associated with these industries. With chemical dispersion the percentage of risk reduction for a large spill is not as dramatic as for a medium spill, but it is still significant. Although the elimination of the risk to shoreline-dependent activities is not possible for large spills, at 45 and 80 percent efficiency, chemical dispersion could be expected to reduce effects on recreation and tourism by approximately 10 and 20 percent, respectively.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on recreation and tourism in the Gulf of Mexico region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills. Any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Environmental Justice

In some coastal areas, low-income, indigenous, and minority populations may rely on regional fisheries and other marine species in the context of participating in commercial fishery or other marine resource-based employment. These groups may experience the effects of a spill more severely than the general population, which relies on a more diverse economic base for its livelihood and on the availability of a widespread, commercially available selection of foods. Additionally, employment in marine resource-related industries may have value beyond the importance these resources hold as a food source or employment opportunity. Considering the demographic variety of the counties along the entire Gulf coast, the modeling determined that several disadvantaged populations, including low-income groups, would disproportionately benefit from some combination of spill response options—mechanical recovery, *in situ* burning, and chemical dispersion—that reduce the effect of an oil spill on the area.

In general, the demographic profiles of the coastal counties within the model area of North Texas Shelf shift toward poorer communities and larger minority populations with increasing proximity to the Mexican border. Galveston County on the Texas Gulf coast supports more minority and/or low-income communities than adjacent inland counties. Minorities represent 37 percent of the population in Galveston County: the population of the City of Galveston is more than 25 percent African American and 25 percent Hispanic, while Asians and other minorities make up an additional 5 percent of the city's population (Galveston Chamber of Commerce, 2001; Texas State Data Center and Office of the State Demographer, 2002). The poverty rate in Galveston County is below the state average and the median household income is slightly higher than the state average (U.S. Census Bureau 2000a, 2002). Chambers and Brazoria Counties have demographics similar to Galveston County: populations are predominately white, with median household incomes above the state average of $39,927. In counties further south along the coast (e.g., Matagorga, Calhoun, Aransas, Refugio, and San Patricio), however, median household income is below the state average. With the exception of Aransas County, minority groups represent an equal or larger percentage of the population in these counties than Caucasians (U.S. Census Bureau 2000a, 2002). Considering these demographics, it is possible that spill response options that reduce the length of shoreline oil and/or the surface water area oiled will disproportionately affect specific minority and poor communities residing and working in the areas modeled in the Texas Gulf coast scenario. Considering the demographic variety of the counties on the shoreline, modeling the North Texas Shelf with respect to environmental justice serves as a good proxy for the potential of oil spills at various locations along the Texas Gulf coast to disproportionately affect disadvantaged populations.

For a small spill in the Gulf of Mexico region, the risk of changes in any groups' economic status is negligible (Table 4.5-39), regardless of response option used. In many cases, a spill of this size is expected to pose no risk to shoreline resources because the spilled oil will never reach the shoreline above a threshold of concern. In addition, because of the small surface water area exposed to oil as a result of a small spill, marine-based economic factors, such as local commercial fisheries, may experience little or no effect (Table 4.5-39).

The risk to the economic status of any low-income or minority populations for a medium spill is likely to be greater than for a small spill. However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources at all or at levels above the selected threshold. For a medium spill along the entire Gulf coast, such conditions prevail in only 1 percent of modeled spills when mechanical recovery and *in situ* burning are modeled in the cleanup process. With dispersant application, the model indicates that fewer medium spills will reach shore. At 45 and 80 percent efficiency, dispersants reduce the number of medium spills reaching shore by 18 and 27 percent, respectively. For these spill events, no adverse effects on the shoreline are expected.

Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill in the Gulf of Mexico region will adversely affect approximately 9,368 m of total recreational shoreline and sweep approximately 338 million m^2 of marine waters above the corresponding thresholds (Table 4.5-39). The risk of economic and social losses will occur in areas of both sandy shoreline and fishery waters that exceed the risk-based thresholds. For example, facilities along the shoreline may be closed and fishing may not be permitted in waters exposed to oil, causing losses to the coastal economy. These effects would be expected to reverberate through communities in the spill area and have a particularly negative effect on disadvantaged populations by affecting employment and income and disrupting fishing practices. Chemical dispersion will reduce these adverse effects.

For a large spill, there is a substantial risk to low-income and minority populations that depend on coastal and marine resources. However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources at all or at levels above the selected threshold. With the addition of chemical dispersion at 45 and 80 percent efficiency, modeling results indicate a one percent reduction in the number of spills that reach shore. For these spill events, no adverse effects on the shoreline are expected.

Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a large spill will affect nearly 28,531 m of the total recreational shoreline and sweep approximately 789 million m^2 of the marine waters potentially important to commercial fisheries in the spill area (Table 4.5-39). A spill of this size may cause large decreases in water-based business activities and in the availability of food sources, as well as affect low-income communities' access to important sources of food and key resources that support their livelihoods. When dispersants are applied, the length of sandy shoreline and surface water area adversely affected by a large spill shrinks by approximately 10 to 20 percent depending on the assumed recovery efficiency (45 percent vs. 80 percent). These reductions in the risk of exposing resources to oil above relevant thresholds would be expected to result in a similar reduction in the risk to minority and low-income communities.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on environmental justice in the Gulf of Mexico region under Alternative 1 are expected to be insignificant for small, medium, and large spill sizes, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills. Any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Public Safety and Worker Health

Potential adverse effects on public safety are defined as the risk to the public from direct exposure to oil or response activities as a result of the spill. There are many areas in the Gulf of Mexico region with high-population concentrations along the coast. However, adverse effects on public safety are unlikely from oil spills that occur 3 or more statute mi offshore for any of the spill sizes considered, regardless of the response options—mechanical recovery, *in situ* burning, and/or chemical dispersion—used. The USCG has protocols to protect the public from risk during shoreline response operations, as well as on-water protocols to prevent the public from entering the response area.

Potential adverse effects on worker health are related to direct exposure to oil during response operations. In addition, operating oil spill response equipment can be dangerous, which is well recognized and is the basis for the worker certification and training requirements that are now in place. There is also a health risk from inhalation of hydrocarbon fumes for first responders, which is recognized in current safety protocols. The risk is greater as the spill size and the corresponding intensity and duration of operations increase, but is minimized if safety standards are followed. There are also protocols in place for the proper application and handling of dispersants.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on public health and worker safety in the Gulf of Mexico region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

4.5.5. Consequences in the Pacific Region

For the purpose of this PEIS, the Pacific region constitutes the coastal area in which the states of California, Oregon, and Washington border the Pacific Ocean (Figure 3.1-1). The location selected for modeling and risk assessment purposes was a site offshore of the entrance to San Francisco Bay because it is in a high-traffic area at greater risk of oil spills. Modeling results from this location were evaluated relative to the geographic area in Section E.1.2 of the technical report (French McCay et al., 2004), herein referred to as the Central California Shelf. The Central California Shelf encompasses two biogeographical provinces: the Central California Coast and San Francisco Bay. In general, the site is representative of offshore sites throughout the region and provides a basis for the modeling of potential environmental effects. The results of the modeling—used to evaluate spills of concern in this risk analysis (i.e., 3 or more statute mi offshore[27])—are presented in detail in Part E of the technical report (French McCay et al., 2004) and summarized in this section.

Table 4.5-41 presents the risk ranking for the modeling of Alternative 1 in the Pacific region using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) for three spill sizes (small, 200 bbl; medium, 2,500 bbl; and large, 40,000 bbl). The risk scores presented in the table are based on the modeling results for an average spill and on regional considerations; however, in any specific oil spill situation local concerns could be higher. Table 4.5-42 summarizes the significance of the potential beneficial and adverse environmental impacts associated with Alternative 1 in the Pacific region, based on the extrapolation of the modeling results for an average spill to the region in general.

Although dispersant pre-authorization agreement areas exist in the Pacific region (Figure 2.2-1), under the basic response scenario (current levels of mechanical recovery and in situ burning when circumstances permit) of Alternative 1 appropriate response times cannot currently be met for chemical dispersion; thus, chemical dispersion is not considered in the analysis of the Pacific region. Further, the modeling shows that in situ burning would not significantly change the level of concern identified from those obtained when using mechanical-only recovery.

For spills analyzed in this document (i.e., those that occur 3 or more statute mi offshore), using mechanical-only recovery there are likely to be minor or insignificant regional adverse impacts on all resources except for marine and coastal birds, which could be moderate, for a small spill, based on the speed with which such a spill would weather and dissipate and the small area that could be affected. For medium and large spills, adverse impacts are minor or insignificant for all resources except for marine mammals, marine and coastal birds, intertidal habitats, and areas of special concern, which could be moderate. A large spill could also cause significant, but localized, short-term socioeconomic adverse impacts. These adverse impacts occur despite the treatment or recovery of some of the oil but are reduced by these actions when they are effective.

Table 4.5-41
Risk Ranking[*] of Offshore Oil Spills[†] under Alternative 1 Using the Basic Response Scenario[‡] in the Pacific Region

	Resources of Concern												
	Physical Environment			Biological Environment								Socioeconomic Environment	
Spill Size	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals[§]**	**Marine and Coastal Birds[§]**	**Plankton and Fish[§]**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles[§]**	**Areas of Special Concern**	**Essential Fish Habitat**	**Subsistence[‖]**	**Archaeological/Historic Resources[‖]**
Small (200 bbl)	4E	4E	4E	3E	3D	4E	3E	4E	3E	3E	4E	4E	4E
Medium (2,500 bbl)	4E	4E	4E	2D	3C	4E	3D	4E	3E	3D	4E	4E	4E
Large (40,000 bbl)	4D	4E	4E	2D	3A	4E	2D	4E	3E	2D	4E	4E	4E

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] This risk ranking is a summary of risk scores for the resources considered in this PEIS. The risk scoring process is explained in Section 4.4.3.

[†] Average spills.

[‡] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[§] Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles. If such species are affected by an actual spill, the level of concern would be high.

[‖] Subsistence and archaeological/historic resources are the only socioeconomic resources that could be ranked using the risk matrix.

Table 4.5-42
Summary of Potential Adverse Regional Impacts of Offshore Oil Spills* under Alternative 1 Using the Basic Response Scenario† in the Pacific Region

	Resources of Concern																			
	Physical Environment			**Biological Environment**								**Socioeconomic Environment**								
Spill Size	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals‡**	**Marine and Coastal Birds‡**	**Plankton and Fish‡**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles‡**	**Areas of Special Concern**	**Essential Fish Habitat**	**Coastal Communities, Demography, and Employment**	**Economic Status**	**Vessel Transportation and Ports**	**Fisheries**	**Subsistence**	**Archaeological/Historic Resources**	**Recreation and Tourism**	**Environmental Justice**	**Public Safety and Worker Health**
Small (200 bbl)	Ins	Ins	Ins	Min	Mod	Ins	Min	Ins	Min	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
Medium (2,500 bbl)	Ins	Ins	Ins	Mod	Mod	Ins	Mod	Ins	Min	Mod	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
Large (40,000 bbl)	Min	Ins	Ins	Mod	Mod	Ins	Mod	Ins	Min	Mod	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins

Note: Based on Table 4.5-41. Sig, significant; Mod, moderate; Min, minor; and Ins, insignificant.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles.

4.5.5.1. *Consequences to the Physical Environment*

Water Quality

Potential adverse consequences of oil spills to water quality are related to hydrocarbon contamination, as other constituents in oils are at concentrations that would not exceed thresholds of concern. The hydrocarbons that could affect water quality are the soluble aromatics, MAHs (monoaromatic hydrocarbons) and PAHs (polynuclear aromatic hydrocarbons) (Section 4.3.1.1). Thus, evaluation of potential adverse effects is based on the degree of potential contamination by these compounds. No beneficial effects on water quality would be expected to result from an oil spill.

For oil spills in marine waters, adverse effects on water quality are generally low, whether a mechanical-only recovery or mechanical recovery plus *in situ* burning is employed. This is because of the tendency for most chemical compounds of concern to evaporate, rather than dissolve, and the rapid dilution of any chemical compounds that might enter the water column. During periods of extreme turbulence, oil generally mixes into the water column where aromatics may dissolve rapidly, but resurfacing and dilution of oil droplets result in only localized contamination at levels of concern unless the dilution volume is restricted. Overall based on the modeling and risk assessment results, it is concluded that—using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit)—adverse water-quality effects under Alternative 1 would be low in marine waters, even in the event of a large spill in the Pacific region. However, if the spill moved into shallow and confined coastal waters, adverse effects could be locally important for medium and large spills under conditions where oil is mixed into water by strong turbulence or in areas where oil collects for a few weeks to months after a spill.

The variable used to determine potential water-quality effects is "volume of water contaminated" by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer, which is less than all established water-quality criteria and thresholds of concern for effects on aquatic biota (Sections 4.3.1.1 and 4.3.2.1). The affected water volume increases with spill volume and varies with the level of physical dispersion during the time of the spill. Natural dispersion increases with stronger winds and currents, lessening the volume of water that is contaminated above the threshold of concern if in unconfined waters. Since the volume of water contaminated increases exponentially as a function of spill size, the estimated volume of water contaminated for a small spill was extrapolated from the mean medium- and large-spill model results. The estimates of the volume of contaminated water—and its variability—are generally applicable to spills of the same size throughout the Pacific region because the mixing of oil into water and the process of dilution are similar in all areas.

Coastal

San Francisco Bay is used as a representative of coastal water for analyzing the Central California Shelf, as well as the Pacific region. San Francisco Bay is approximately 1,733 km^2 in area and about 5 m deep on average, with a total volume of approximately 8,665 million m^3. The estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of the San Francisco Bay to determine the potential effects of small, medium, and large spills (Table 4.5-43). This approach yields a very conservative estimate, in that it assumes that all water column contamination would occur in coastal water.

Table 4.5-43
Risk Ranking of Offshore Oil Spills[*] to Coastal Water Quality Using the Basic Response Scenario[†] in the Central California Shelf[‡]

Spill Size	Volume of Water Contaminated (million m^3)	Area Contaminated (estimated %)	Risk Score[§]
Small (200 bbl)	$< 41 \times 10^{-6}$	5×10^{-7}	4E
Medium (2,500 bbl)	66	0.8	4E
Large (40,000 bbl)	385	4.4	4D

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Because of natural dilution, evaporation, and biological processes, contamination levels would decrease rapidly even in the case of a large spill, and recovery time would be on the order of days to weeks. Oil may be incorporated into shallow water or intertidal sediments where, through leaching, it could become a continuing source of contamination over time. However, this would generally only lead to noticeable water-quality degradation in the locality where the oil collects. This is unlikely to occur with a spill that originates offshore. Because mechanical removal would begin within the required response time under Tier I standards (beginning about 12 hours after the spill), much of the soluble components of concern to water quality would have evaporated or dissolved. Thus, mechanical recovery and *in situ* burning would have an insignificant influence on the volume of water adversely affected, and the risk score results would apply whether either response is implemented.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal water quality in the Pacific region under Alternative 1 are expected to be insignificant for small and medium spills, and minor for large spills.

Marine

In marine waters, which are 3 or more statute mi offshore, mechanical recovery and *in situ* burning currently may be used for spill response in the Pacific region; although dispersant pre-authorization agreement areas exist in the Pacific region (Figure 2.2-1), chemical dispersion is not used because appropriate response times cannot currently be met. As was done for coastal waters, the estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of the reference area, the Central California Shelf.

The Central California Shelf was selected for the modeling as representative of the marine waters in the Pacific region. The total surface area of the Central California Shelf is approximately 16,639 km^2, so the area of interest is much vaster for marine waters than for coastal waters. Water-quality effects were calculated using a spill site in relatively shallow water—30 m deep, which is much shallower than most of the Pacific region's marine waters. The results for the selected modeling location (Table 4.5-44) represent conservative estimates of adverse water-quality effects using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit).

Table 4.5-44
Risk Ranking of Offshore Oil Spills[*] to Marine Water Quality Using the Basic Response Scenario[†] in the Central California Shelf[‡]

Spill Size	Area Contaminated (estimated %)	Risk Score[§]
Small (200 bbl)	8×10^{-9}	4E
Medium (2,500 bbl)	0.1	4E
Large (40,000 bbl)	0.8	4E

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Natural dispersion of the oil would be very rapid after a spill, and recovery time would be on the order of hours to days. Leaching from oil contamination reaching the sediments would not have a large effect on marine water quality because of the large dilution volume and natural dispersing forces in marine waters. The results would apply whether a mechanical response is implemented. Since *in situ* burning would replace some of the mechanical response, and both methods remove oil that would otherwise result in water contamination, the potential water-quality effects would not change significantly if *in situ* burning was used. For a spill in water deeper than the 30 m evaluated here, the potential adverse effects would be even smaller.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine water quality in the Pacific region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Air Quality

Concentrations of hydrocarbons of concern in the air resulting from oil spills and response operations were compared with air quality standards to evaluate the potential for adverse effects (Section 4.3.1.2). The effects of an oil spill on air quality may involve all volatile components of the oil. In addition, if *in situ* burning was used, particulates and other contaminants emitted from burns could become an air quality concern. However, adverse air quality effects from oil spills are normally very localized and short lived for small, medium, and large oil spills. The addition of *in situ* burning does not significantly increase any potential adverse effects: the volume of oil that could be burned is not large, and the temporary smoke plume would be localized and rapidly diluted.

The modeling shows that results do not vary by spill location, or size in the Pacific region. Two possible sources of contamination to the atmosphere were evaluated for their potential effects on air quality: volatilization of hydrocarbons from unburned oil and emissions produced by *in situ* burning. Concentrations in the lowest 2 m of the atmosphere were compared with the U.S. Environmental Protection Agency's National Ambient Air Quality Standards (USEPA's NAAQS) and other thresholds of concern (as discussed in Section 4.3.1.2).

The results of the modeling spills show that the potential adverse effects on air quality are low for all spill sizes involving mechanical-only recovery; hence, the risk scores are virtually identical for small, medium, and large spills. Volatilized hydrocarbons would not exceed air quality standards for human health at more than 1 km from the spill site. Evaporation off the water surface and volatilization from the water column create a plume of volatile hydrocarbon gases that disperses quickly after a spill, such that the concentrations in the atmosphere at the water surface would not exceed human health thresholds of concern at any location. The recovery time for the atmosphere would be on the order of days. Thus, a low level of concern is expected for small, medium, and large spills involving mechanical-only recovery.

Mechanical recovery plus *in situ* burning would increase atmospheric pollutants by the amount emitted via burning. For small spills, it would be very unlikely that *in situ* burning would be used, as the oil would disperse too rapidly for it to be feasible (Table 4.5-45). The maximum area potentially exceeding the NAAQS or thresholds of concern is 1.6 km^2 for a medium spill and 11.1 km^2 for a large spill If humans or sensitive resources (i.e., wildlife) are within these areas, they could be affected by poor air quality for a short time, on the order of hours. Since *in situ* burning can only be used offshore in marine waters, a region of interest equivalent to the Central California Shelf (16,639 km^2) would have less than 1 percent of the area adversely affected, and the atmosphere would recover in a matter of hours. Thus, low levels of concern are expected from small, medium, and large oil spills involving *in situ* burning (Table 4.5-45).

Table 4.5-45
Risk Ranking of Offshore Oil Spills* to Air Quality
under *In Situ* Burning in the Central California Shelf†

Spill Size	Area Exceeding Threshold (km^2)	Area Contaminated (estimated %)	Risk Score‡
Small (200 bbl)	1.6	0.01	4E
Medium (2,500 bbl)	1.6	0.01	4E
Large (40,000 bbl)	11.1	0.07	4E

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

‡ The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on air quality in the Pacific region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without *in situ* burning.

4.5.5.2. Consequences to the Biological Environment

Marine Mammals

Cetaceans (whales, dolphins, and porpoises) are found throughout the Pacific region (Section 3.5.2.1, Table F.5-1) and spend their entire lives at sea. Their concentrations vary depending on seasonal migrations. Pinnipeds (seals and sea lions) are carnivorous aquatic mammals that spend the majority of their lives swimming and eating in water but venture on to land to bear their young, sunbathe, and molt. There are six pinnipeds of concern in the Pacific region that use the Channel Islands and other less-populated islands off central California as breeding-birthing grounds. These pinnipeds haul out and give birth to pups during the late-spring to mid-summer months. Thus, the severity and likelihood of adversely affecting these animals increases if an event occurs during the spring through mid-summer. The greatest risk of adverse effects would be related to surface and shoreline oiling that occurs in breeding or molting areas. The California sea otter (*Enhydra lutris nereis*) is the only species of fur-bearing marine mammal inhabiting this region, and its range is localized to an area extending from Half Moon Bay to Morro Bay. Females and pups are often found rafting in large groups, while males tend to remain in separate groups except during the mating season.

Marine mammals such as whales, dolphins, seals, and manatees are vulnerable to spilled oil since they spend considerable time at the water's surface, which increases possible contact with oil. The majority of these species remains offshore, and populations vary according to season and migration directions. Cetaceans appear able to detect and are likely to avoid floating oil or oil being recovered by mechanical means (Geraci, 1990). Studies have shown that cetacean skin is nearly impenetrable to even the highly volatile constituents of oil, indicating that contact with oil probably would be less harmful to cetaceans than often believed. However, the toxic, volatile fractions in fresh crude oils could irritate and damage cetacean soft tissues, such as the mucous membranes of the eyes and airways.

Marine mammals that are more commonly found in the nearshore regions and intertidal habitats, such as seals, sea lions, and sea otters, are of greater concern. Their use of restricted haulout areas and instinctual behavior to return to the same breeding area every year may increase the likelihood of physical contact with oil in the event of a nearby spill. Potential concerns include toxicity from ingestion of oil during grooming and adverse effects on juveniles through contact with contaminated teats when nursing. Overall, the potential adverse effects depend on the spill size and the number and species of marine mammals present.

Based on the habitat availability in the Central California Shelf, the equivalent area for 100 percent mortality for a medium spill is less than 0.001 percent of the reference area for cetaceans, 0.007 percent for pinnipeds, and 0.54 percent for fur-bearing marine mammals (sea otters). For a large spill these values increase to 0.003, 0.04, and 2.9 percent, respectively. Clearly, the overall risk to marine mammals is driven by the risk to sea otters. Pinnipeds could also come into contact with oil on the shoreline. Estimated average shoreline length oiled is approximately 18 km for a medium spill and 45 km for a large spill. The likelihood that these lengths would actually involve a pinniped haulout area is low, but also represents a potentially medium risk (see the discussion on intertidal habitats). Based on the distribution of mammals in the Pacific region, the potential level of concern was determined to be low for small spills but would increase to medium levels for medium and large spills. The results of the modeling for marine mammals for the Central California Shelf are presented in Table 4.5-46.

The addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the severity of potential adverse consequences nor increase risk to marine mammals. On-water effects are negligible except for sea otters, and shoreline oiling may potentially reach medium levels of severity, depending on the time of year and location of the spill. If mortality did occur, however, the population would probably require 1 to 3 years (for a small spill) to 3 to 7 years (for a medium or large spill) to recover.

Table 4.5-46
Risk Ranking of Offshore Oil Spills* to Marine Mammals Using the Basic Response Scenario† in the Central California Shelf‡

Spill Size	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	0–1	3E
Medium (2,500 bbl)	1–5	2D
Large (40,000 bbl)	1–5	2D

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine mammals in the Pacific region under Alternative 1 are expected to be minor for small spills, and moderate for medium and large spills.

Marine and Coastal Birds

Potential adverse effects on marine and coastal birds are usually of highest concern during an oil spill because birds are highly susceptible to the acutely toxic effects from exposure to oil. Adverse effects on birds in the Pacific region would result mostly from surface water oiling in nearshore and offshore areas where rafting seabirds concentrate, as well as oiling of beaches, mud flats, marshes, and estuarine waters used by shorebirds, waterfowl, wading birds, and raptors (Section 3.5.2.2) (see Section 4.3.2.2 for information on the main issues of concern for birds exposed to an oil spill).

The Central California Shelf was selected for the modeling as representative of the coastal habitats and wildlife in the Pacific region (Table 4.5-47). Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the potential adverse effects on birds. Potential levels of concern for birds in the Central California Shelf are medium for all spill sizes, as discussed below. However, for a small spill very little oil is likely to strand onshore in staging areas, and the natural removal rates are high along the outer coast. The potential for adverse effects increases for medium and large spills, with greatest concern for conditions where the more sheltered interior wetlands and tidal flats become heavily oiled and surface oiling occurs in areas where rafting birds congregate.

Two Western Hemispheric Shorebird Reserve Network (WHSRN) sites (one hemispheric and one regional), one Ramsar site (a wetland of international importance), and two National Wildlife Refuge sites occur in the Central California Shelf. The presence of these sites indicates that large numbers of shorebirds (WHSRN sites) and wetland birds (Ramsar sites) concentrate in the area during migration and/or nesting and wintering. Extrapolated total monthly populations of 1.4 to 1.6 million seabirds comprising over 100 species have been observed at sea along the northern and central California coast, and 0.70 to 0.85 million seabirds may be nesting in the area with high concentrations on offshore islands. Over 1.5 million shorebirds have been observed in San Francisco Bay and environs during the migratory and wintering period. Therefore, if this area were oiled during important staging, nesting, or nearshore rafting periods regional adverse effects would probably be high. Thus, the risk factor rankings were determined based on the possibility that a large number of birds may be concentrated both in marine water and on shoreline habitats that are significantly oiled. It is important to recognize that adverse effects on birds may be more or less severe depending on the time of year and locations of their habitats, as well as the extent of shoreline and surface water oiling.

Table 4.5-47
Risk Ranking of Offshore Oil Spills* to Marine and Coastal Birds
Using the Basic Response† Scenario in the Central California Shelf‡

Spill Size	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	1–5	3D
Medium (2,500 bbl)	5–10	3C
Large (40,000 bbl)	> 20	3A

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Adverse effects on birds in the Central California Shelf for a small spill were determined by extrapolating from the results obtained for a medium spill. The volume of oil released in the small spill was approximately an order of magnitude less than in the medium spill; therefore, the adverse effects on the bird population were estimated to be proportionally less but still medium because of the recovery time. The modeling of effects on birds for a medium spill under mechanical-only recovery resulted in estimates of over 5 to 10 percent of the regional bird population being potentially affected because a high percentage of beaches used as shorebird staging habitats were oiled. Also, surface water oiling (121.5 km^2) directly outside of San Francisco Bay and around the Farallon Islands corresponded to an area of high seabird biomass year-round.

The modeling of effects on birds for a large spill under mechanical-only recovery resulted in estimates of over 20 percent of the regional bird population being potentially affected because sand beaches and tidal flats used by staging shorebirds were heavily oiled. The mean water area swept by oil above a threshold of 10 microns was 659 km^2, which represents 4 percent of the total Central California Shelf and includes the same area of high seabird biomass outside of San Francisco Bay oiled for a medium spill. The risk scores in Table 4.5-47 reflect the predicted recovery rates of 1 to 3 years for most bird species, as was the case following the *EXXON VALDEZ* oil spill (Section 4.3.2.2). Although areas other than the Central California Shelf in the Pacific region were not modeled, the results are consistent with those for all other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on bird populations will fall within a similar range throughout the Pacific region. The addition of *in situ* burning does not change the significance of these adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine and coastal birds in the Pacific region under Alternative 1 are expected to be moderate for small, medium, and large spills.

Plankton and Fish

Plankton and fish, a diverse group of species, are important to the marine food web, ecosystem function, and fisheries. Adverse effects on these groups are of high concern. As described in Section 4.3.2.3, plankton and fish are adversely affected either directly or via the food web by the toxic effects of oil components that enter the water column—the soluble compounds (MAHs and PAHs) and microscopic oil droplets mixed by waves into the water (French McCay, 2002; NRC, 1985). The most important pathway of exposure is direct uptake of dissolved oil components, originating directly from surface oil or dissolving from the microscopic oil droplets in the water. Overall, as spill size increases, so do adverse effects. However, there is great variability related to the environmental conditions after a spill; plankton and fish suffer much more adverse effects in storm conditions where high waves mix unweathered oil into the water, which happened during the *NORTH CAPE* oil spill (French McCay, 2003), than in calm weather. Species and life stages vary considerably in sensitivity to toxic components, with species from relatively unpolluted and environmentally stable locations being more sensitive than those from polluted and environmentally variable areas.

In marine and open coastal environments, small, medium, and large oil spills do not cause large or long-term toxic effects to plankton and fish in the water column. The toxic effects of oil spills result from acute exposures during the time when surface oil is present and for short periods (days to weeks) afterwards. Once the source of hydrocarbons (from floating oil or the shoreline) to the water column is gone, concentrations rapidly disperse to background levels. However, there may be longer-term effects if the spill migrates to nearshore shallow areas such as enclosed embayments, estuaries, or wetlands where dilution and flushing are slow. Many fish and other organisms spawn and develop through larval and juvenile stages in these shallow areas. Fish are particularly abundant in kelp beds in the nearshore, so these areas, along with salt marshes and seagrass beds, are of most concern. California grunion

(*Leuresthes tenuis*) spawns in the intertidal zone; thus, it is particularly vulnerable to oil reaching the shoreline (see discussion of potential effects on these habitats below). Under Alternative 1 in most cases, chemical dispersion could not be used within 3 nm[28] of shore, but the dispersed oil plume could be transported by currents into this area.

The percentage of plankton and fish adversely affected by oil spills was estimated using the modeling results (technical report [French McCay et al., 2004]) of water volumes exposed to toxic oil components. Percent loss multiplied by volume exposed was integrated over time and space to calculate an equivalent volume of 100 percent loss. These volumes were translated to equivalent areas by multiplying by water depth at the spill site, allowing comparison with other resources, such as birds and shorelines, which are distributed on a per-area basis. The use of area is appropriate because plankton and fish abundance is much more uniformly distributed when expressed on a per-area basis than on a per-volume basis since the ecosystem is driven by sunlight and plant photosynthesis at the water surface (French et al., 1996; Odum, 1971). As indicated by the similar results for the four modeled spill sites in 10 to 30 m of water—offshore Delaware Bay, offshore Galveston Bay, the Florida Straits, and offshore San Francisco (Parts B, C, D, and E, respectively, of the technical report [French McCay et al., 2004])—the equivalent areas of adverse effect on plankton and fish (both average and variable) are applicable to spills of the same size in any location of similar water depth in any region considered in this PEIS. The modeled spill site was in 30 m deep water: adverse effects would be smaller for deeper waters because of greater vertical dilution of both oil components and organisms, and proportionately greater in shallower waters because of the restricted dilution potential.

The model-estimated areas are those where there is a potential to affect the most sensitive species, which are two standard deviations more sensitive than the average of all species tested (2.5th percentile in rank order of sensitivity). For species of average sensitivity (50th percentile), the areas adversely affected would be much smaller. Thus, the model-estimated areas should not be interpreted as experiencing 100 percent mortality of all plankton and fish; they are conservative estimates used for comparative purposes among response scenarios.

The Central California Shelf was selected for the modeling as representative of the Pacific region (Table 4.5-48). The adverse effects were estimated as a percentage of the total area of concern (16,639 km^2). Based on the evaluation of the volume where water quality would be affected for a small spill (Table 4.5-44), the volume of adverse effects on plankton and fish would be low for a small spill using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) (Table 4.5-48).

Table 4.5-48
Risk Ranking of Offshore Oil Spills[*] to Plankton and Fish Using the Basic Response Scenario[†] in the Central California Shelf[‡]

Spill Size	Equivalent Area Affected (km^2)	Area Affected (estimated %)	Risk Score[§]
Small (200 bbl)	< 0.039	8×10^{-11}	4E
Medium (2,500 bbl)	21	0.1	4E
Large (40,000 bbl)	29	0.2	4E

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Since the adverse effects are in a small percentage of the area of concern and less than the range of natural variability, the recovery time would be less than 1 year. Overall, based on the modeling, adverse effects on plankton and fish in the Pacific region under Alternative 1 would be localized to the immediate area around the spill site and similar in all marine water areas of the region. For large spills that might move rapidly into shallow coastal areas due to winds and currents, the concentrations of toxic components might be high enough to cause some level of concern for water column communities, especially early life history stages of fish and invertebrates using intertidal and shallow subtidal areas.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on plankton and fish in the Pacific region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Intertidal Habitats

Intertidal habitats are always of great concern during oil spills. Although much of the Pacific region can be characterized as exposed rocky shores, gravel beaches, and sand beaches with high natural removal rates, there are numerous estuaries that provide important habitats for a wide range of marine species (Section 3.5.2.4). These estuaries contain extensive areas of salt marshes and tidal flats that are at high risk of long-term damage from oil spills. For a discussion of the relative ranking of the sensitivity of intertidal habitats to spilled oil and the processes affecting oil fate and behavior on shorelines, see the explanation of the Environmental Sensitivity Index (ESI) in Section 4.3.2.4. Shoreline protection is seldom effective in these areas of large tides and strong currents. There are few effective cleanup methods for these sensitive habitats; thus, natural recovery is often the primary response. Effects on fish and wildlife will persist during this recovery period, which can be slow in the sheltered estuarine setting. There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on intertidal habitats in that larger spills tend to have higher oil loading on the shoreline and affect larger areas. The time of year of a spill is also an extremely important factor.

In the Pacific region, adverse effects of small spills on intertidal habitats are low because very little oil is likely to strand onshore, and natural removal rates are high along the outer coast. However, the potential for adverse effects increases with spill volume, with the greatest concern for conditions where the more sheltered interior wetlands and tidal flats become heavily oiled. The results of the modeling for intertidal habitats for the Central California Shelf are presented in Table 4.5-49.

Table 4.5-49
Risk Ranking of Offshore Oil Spills[*] to Intertidal Habitats Using the Basic Response Scenario[†] in the Central California Shelf[‡]

Spill Size	Habitats Affected (estimated %)	Risk Score[§]
Small (200 bbl)	0–1	3E
Medium (2,500 bbl)	1–5	3D
Large (40,000 bbl)	1–5	2D

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Adverse effects on intertidal habitats for a small spill were determined to be low by extrapolating from the results of a medium spill and expecting that rocky intertidal communities would recover within 1 to 3 years (Section 4.3.2.4). For a medium spill under mechanical-only recovery, the modeling resulted in an estimated 17.1 km of oiled shoreline. This is less than 1 percent of the total shoreline in the area, but a high percentage of the rocky shores was affected. For a large spill, the modeling resulted in an estimated 45 km of oiled shoreline. This oiled area represents less than 1 percent of the entire shoreline area in the region, but a high percentage of the important outer rocky shores in the San Francisco Bay would be affected. A large spill would also likely affect more of the sensitive and sheltered tidal flats that have longer recovery times; thus, the risk score increased to reflect the longer recovery rate of oiled tidal flats and wetlands. Although areas other than the Central California Shelf in the Pacific region were not modeled, the results are consistent with those for all other regions analyzed in this PEIS, and it is expected that the severity of adverse effects on intertidal habitats will fall within a similar range throughout the Pacific region. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on intertidal habitats in the Pacific region under Alternative 1 are expected to be minor for small spills, and moderate for medium and large spills.

Subtidal Habitats

The subtidal benthic habitat consists of the bottom substrate below the low tide level, as well as the species that live in, on, and near the substrate. This benthic community includes areas of live, sandy, muddy, and low-relief bottoms; subsurface canyons; and pinnacles. Organisms living in this area—demersal species—include corals, plants and seagrasses, benthic invertebrates (such as crabs, shrimp, snails, bivalve mollusks, and marine worms), and bottom-dwelling fish. Because subtidal benthic communities do not include the intertidal zone, they are at little risk from floating oil because, by definition, this environment is always below the surface. Kelp forests are an exception because the fronds extend all the way to the surface. The greatest risk of exposure comes from sinking oil, as well as *in situ* burn residue, or dispersed oil or the sorption of naturally dispersed or mechanically mixed oil that has become suspended on sediments and is deposited onto the ocean floor. However, significant natural dispersion of oil and sediment into the water column only occurs during large storms or for nearshore oil spills. Oil particles could adhere to bottom substrate, plants, or animals, which could result in both physical coating of organisms, as occurred in the 1993 *BRAER* spill in the Shetland Islands, and toxic effects from exposure to the chemical constituents (Section 4.3.2.5). Such adverse effects are not normally observed. Floating oil does represent a risk to kelp, especially in nearshore areas and in protected areas where oil may accumulate. Damage to the plants can occur in such areas, and animals living in the canopy may be affected.

The low degree of risk to subtidal habitats is attributed to the diluting effect of the overlying water (Section 2.2.2)—the deeper the water, the lower the risk. Chemical compounds of concern tend to evaporate rather than dissolve, and the rapid dilution of any chemical entering the water column decreases the toxicity of any oil residue potentially reaching the bottom substrate.

Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects. It might slightly increase the risk of remaining oil residues sinking to the bottom. Residual oil from *in situ* burning that reaches the bottom is expected to have little or no adverse effects on subtidal habitats since the majority of its toxic components would have either evaporated or been destroyed during burning and the volume of residue produced is so small (Section 4.3.2.5). Under the modeled conditions, the quantity of *in situ* burn residue produced would not result in a level of concern that exceeds low.

For a medium spill with mechanical-only recovery, the sediment threshold concentrations for dissolved aromatic and for total hydrocarbons were not exceeded. For a large spill only the sediment threshold for total hydrocarbon exposure was exceeded, but only in an area of less than 0.006 percent of the total reference area, and less than 0.06 percent of San Francisco Bay. Benthic habitat was also assumed to be at risk if there threshold of concern for dissolved aromatic hydrocarbons affected stationary demersal species (those living at the sediment-water interface). With mechanical-only recovery less than 0.01 percent of the Central California Shelf was affected by water column concentrations above the threshold for a medium spill. For a large spill, the percentage increased to approximately 0.01 percent. The results for the selected modeling location (Table 4.5-50) represent estimates of adverse impacts on subtidal habitats using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit).

Table 4.5-50
Risk Ranking of Offshore Oil Spills[*] to Subtidal Habitats
Using the Basic Response Scenario[†] in the Central California Shelf[‡]

Spill Size	Habitats Affected (estimated %)	Risk Score[§]
Small (200 bbl)	0–1	4E
Medium (2,500 bbl)	0–1	4E
Large (40,000 bbl)	0–1	4E

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subtidal habitats in the Pacific region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Areas of Special Concern

The potential effects on areas of special concern, such as National Marine Sanctuaries, National Parks, National Wildlife Refuges, and National Estuarine Research Reserves, are important during an oil spill since these areas are under increased scrutiny and protection. Whereas most coastal and nearshore areas have a wide range of habitats or are very similar to other areas throughout the Pacific region, areas of special concern are set aside for their uniqueness (Appendix F, Tables F.5-3 through F.5-5 and Figures F.5-1 through F.5-3). The potential risks and adverse effects associated with shoreline areas of special concern are identical to those discussed above for intertidal habitats. The risks to subtidal areas, such as those included in kelp forests in National Marine Sanctuaries, are identical to those discussed above for subtidal habitats. For this analysis, the risks to areas of special concern are assumed to be the same as those for either intertidal or subtidal habitats (Sections 4.5.5.2), whichever are greater. Since the risk to intertidal habitats is greater, those risk scores were used. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on data presented for a medium spill, the estimated average extent of shoreline oiling is 18 km; this figure increases to 45 km for a large spill. The potential risk of surface oil reaching a shoreline associated with an area of special concern is low in the Pacific region because of the number and scattered locations of these areas. The potential adverse effects on areas of special concern are low for a small spill, but become medium for medium and large spills because of increased shoreline contamination (Table 4.5-51).

Since areas of special concern are scattered along the Pacific coast, it is unlikely that they will be disproportionately adversely affected by an average spill. If an area of special concern were seriously adversely affected, it is anticipated that the recovery time for the affected area would be the same as for other intertidal habitats. These areas are most at risk from floating oil and benefit from any actions that reduce potential oiling.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on areas of special concern in the Pacific region under Alternative 1 are expected to be minor for small spills, and moderate for medium and large spills, based on the risk to intertidal habitats.

Table 4.5-51
Risk Ranking of Offshore Oil Spills* to Areas of Special Concern Using the Basic Response† Scenario in the Central California Shelf‡

Spill Size	Areas Affected (estimated %)	Risk Score§
Small (200 bbl)	0–1	3E
Medium (2,500 bbl)	1–5	3D
Large (40,000 bbl)	1–5	2D

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

4.5.5.3. Consequences to Threatened, Endangered, and Candidate Species

The Pacific region has a variety of threatened, endangered, and candidate species (Section 3.5.3). In this region. The overall risk that a threatened, endangered, or candidate species would be adversely affected, or even present in the area of a spill is low; however, killing a single individual of such a species can be considered a severe effect. Potential adverse effects on marine mammals, marine and coastal birds, or fish that are threatened, endangered, or candidate species are identical to those discussed in Section 4.5.5.2 for these groups. Potential adverse effects on mollusks were described above in subtidal habitats. In addition, potential adverse effects on the four threatened or endangered species of sea turtles were discussed in Section 4.3.3.1 and are similar to those described in Section 4.5.5.2 (Marine Mammals) for pinnipeds. Overall, the highest risk scores were calculated for coastal and marine birds and for marine mammals with other species at lower risk. Regardless of the species, the level of concern for threatened, endangered, or candidate species is higher; therefore, any adverse effects on the reproduction or survival of these species, or death, should be considered high.

Adverse effects on threatened, endangered, or candidate species in the Pacific region for any spill size are difficult to predict. Depending on the location and season, the number and type of species present will vary. Based on the overall size of the Pacific region and the low populations of threatened, endangered, or candidate species inhabiting this region, the likelihood of adversely affecting an individual of concern would be low unless the spill affects important shoreline or critical marine habitats. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on threatened, endangered, and candidate species in the Pacific region under Alternative 1 are expected to be moderate for small, medium, and large spills, based on the risk to marine mammals and to marine and coastal birds.

4.5.5.4. Consequences to Essential Fish Habitat

Virtually all waters in the Pacific region out to the limits of the U.S. Exclusive Economic Zone (EEZ) are considered Essential Fish Habitat (EFH), including most of the continental shelf. Areas such as bays, river mouths, and harbors are designated EFH for at least one life stage of at least one species and are protected by legislation (Section 3.5.4). The primary issue with respect to EFH is either (1) exposure of sensitive resources in the water column to hydrocarbon concentrations of concern, or (2) the contamination of bottom sediments, both of which could lead to either acute or chronic exposures.

Adverse effects would include either the death of individual organisms, the possibility of sublethal effects affecting long-term population viability, or degradation of habitat that reduces its availability to managed species. For this analysis, the risks to EFH are assumed to be the same as those for plankton and fish or for subtidal habitats (Section 4.5.5.2), whichever are greater. The results for plankton and fish and for subtidal habitats indicate only small effects and form the basis for the EFH risk score. Under Alternative 1, the addition of *in situ* burning does not change the consequences.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on EFH in the Pacific region under Alternative 1 are expected to be insignificant for small, medium, and large spills, based on the risk to plankton and fish and to subtidal habitats.

4.5.5.5. Consequences to the Socioeconomic Environment

As discussed in Section 4.3.5, oil spills can produce a variety of adverse social and economic effects. These adverse effects are generally not large when measured at the regional level, but instead are typically felt in communities located near resources oiled by the spill. Specifically, large adverse effects are generally limited to those industries and populations that are affected by the spill. Some of the most visible and significant effects are likely to be on water- and shore-based recreation; commercial, recreational, and subsistence fishing; and the overall well-being of the residents of coastal communities in the Pacific region. The state parks along the Pacific coast draw tourists, and local residents depend on these natural resources as recreational outlets. In 2000, there were approximately 4 million visitors to San Francisco area state parks (Visit California, 2002) and an additional 19 million visitors to the national park system in the San Francisco area (NPS, 2001b). Commercial fishing is an important economic activity for the states along the Pacific coast, generating close to $330 million in landings in 2001 (NMFS, 2004a). In addition, oil spills have the potential to affect low-income and minority populations along the Pacific coast to a greater extent than the general population.

This modeling considers the risk of adverse socioeconomic effects posed by oil spills, which can include, but are not limited to, reduced recreational activity because of beach closures, limited accessibility, or perceived taint; closure of commercial fishing grounds or hatcheries; and oiling of marine resources important to low-income and minority communities or populations that practice subsistence. In addition to these and other direct adverse effects, oil spills can have secondary effects on social and economic welfare along the coast. For example, an oil spill may cause changes in employment and firm revenues of resource-based businesses. While these effects are not quantified in this modeling, the following discussion provides absolute and relative measures of the overall risk of adverse social and economic effects of small, medium, and large spills using the basic response scenario (current levels of mechanical and *in situ* burning when circumstances permit) in the Pacific region. (Although dispersant pre-authorization agreement areas exist in the Pacific region [Figure 2.2-1], appropriate response times cannot currently be met for chemical dispersion.) The methodology is described in more detail in the Atlantic Region (Section 4.5.2.5).

There is no existing standard for "significance" related to the socioeconomic effect of oil spills (e.g., how much shoreline or surface water must be oiled to be considered a "high," "medium," or "low" effect). The significance of the effect will depend on a number of factors, including the scope of the analysis (i.e., national, regional, local), opportunities for resource substitution (e.g., an unoiled beach or fishing ground nearby, alternative ports of call), and the duration of the spill event. Generally, a spill event would be of little concern if it is not of long enough duration to affect the financial viability of local businesses, and the affected communities are able to find substitutes to replace the oiled resources.

For this PEIS, (1) the greatest effect modeled at the regional level was less than approximately 10 percent of available shoreline or surface water resources (indicating the likely presence of substitute resources), and (2) resource use following these modeled spills (e.g., vessel transportation and fishing) would be expected to resume as soon as oil recovery efforts were completed. As a result, the modeled effects under all modeled scenarios would likely be low at the regional level. As noted in the text, any adverse effects that occur would be expected to be localized in nature.

This modeling assumes that the risk posed by oil spills to the socioeconomic environment is directly related to the extent to which resources are affected above selected thresholds of concern—meters of recreational beach oiled and square meters of marine waters oiled. Comparing the absolute risk of adverse socioeconomic effects (e.g., meters of sandy shoreline oiled above a recreational threshold of concern) across spill scenarios, including variations in spill response scenarios, allows for an understanding of the relative risk of adverse socioeconomic effects across these scenarios. In this section, only basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) results are examined. Determining relative risk also allows for extrapolation of site-specific results to the entire region. For example, the risk estimates presented below are based on modeled hypothetical spills affecting the San Francisco Bay. While any given spill may exhibit distinctly different patterns of socioeconomic effect, the relative risk measures are expected to be broadly applicable to a range of spill locations along the Pacific coast, as long as the spills occur in areas in where mechanical recovery and/or *in situ* burning are feasible. In addition, the conclusions reached for the San Francisco Bay modeled area are supported by results from other areas—the relative degree of risk reduction achieved under various removal assumptions across spill size is similar in magnitude.

Table 4.5-52 highlights the effects of small, medium, and large oil spills on the Pacific region's resources by presenting estimates of resources oiled as a result of the average modeled spill in absolute (length of shoreline oiled or area of oiled surface water above the threshold of concern) and as a percentage of the total resource base in the modeled area (Central California Shelf). The threshold of concern from oiled shoreline is 10 g/m^2 and from oiled surface water is 0.01 g/m^2 (technical report [French McCay et al., 2004]). The resource area is based on an estimate of the extent to which the coastal community in the Central California Shelf potentially relies on each resource in this specific modeled area.

Table 4.5-52
Risk Ranking of Offshore Oil Spills* to Coastal Communities as a Result of Shoreline and Surface Water Oiled Using the Basic Response Scenario† in the Central California Shelf‡

	Shoreline Length		Surface Water Area	
Spill Size	**m Oiled Above Threshold§**	**Estimated % Oiled‖**	**m^2 Oiled Above Threshold§**	**Estimated % Oiled‖**
Small (200 bbl)§	N/A	N/A	N/A	N/A
Medium (2,500 bbl)	5,993	1.0	421 × 10^6	5.9
Large (40,000 bbl)	14,232	2.4	672 × 10^6	9.4

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

§ Thresholds above which some economic or social risk is expected were determined, and the length of shoreline oiled and the area of surface water oiled above this threshold for the average modeled spill are reported. The threshold of concern because of oiled shoreline and surface water is 10 g/m^2 and 0.01 g/m^2 of oil, respectively (technical report [French McCay et al., 2004]).

‖ Percentages reflect the proportion of the total modeled area above the threshold of concern.

§ A 200-bbl spill is assumed to have negligible effect.

For this modeling, the socioeconomic environment is divided into components representative of the major parameters of coastal life potentially affected by an oil spill. Absolute and relative risks are discussed for coastal communities, demography, and employment; general economic status of a coastal community; vessel transportation and ports; commercial and recreational fisheries; subsistence; archaeological and historic resources; recreation and tourism; environmental justice; and public safety and worker health.

Coastal Communities, Demography, and Employment

Coastal communities benefit from and rely on the marine environment to provide residents with sustenance, livelihoods, leisure opportunities, and shipping avenues. Individuals who live and work in close proximity to the coast derive both social and economic rewards from the natural beauty, recreational opportunities, quality of life, economic resources, and cultural attributes associated with these coastal locations. These rewards are derived from assets such as National Parks, public beaches, fishing opportunities, and commercial and tourism-related industries.

Thus, oil spills can adversely affect multiple aspects of a coastal community's economy, culture, and quality of life. These effects, in turn, can impose changes on an affected community's demographics and employment patterns. In addition to the direct employment and other economic effects associated with oil spills on marine resource-based sectors, such spills can generate secondary effects on coastal communities. For example, because of its large population and the importance of maritime activities to various Pacific coast communities, the Pacific region is at risk of experiencing the adverse effects of an oil spill. To the extent that mechanical recovery and *in situ* burning can reduce shoreline oiling and the geographic scope of water oiling, these response options will act to reduce effects on these coastal communities with a more diverse economic base.

The risk of social and economic losses occurs in areas of both sandy shoreline and marine waters that exceed the thresholds of concern. For example, beaches along the Pacific coast may be closed to visitors and fishing may not be permitted in waters exposed to oil, causing losses in revenue to both the tourism and commercial fishery sectors of the coastal economy. These effects would be expected to reverberate through communities in the spill area, causing short-term decreases in employment opportunities, income, the viability of associated businesses, and the appeal of coastal living. In addition, an oil spill may reduce the appeal of coastal living in a given area.

For a small spill along the Pacific coast, there is no risk of large adverse effects on coastal communities. In many cases, a spill of this size would be expected to pose no risk to shoreline or surface water resources because the spilled oil will never reach the threshold of concern (Table 4.5-52).

The risk to coastal communities for a medium spill is likely to be greater than for a small spill. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill in the San Francisco Bay will have a spill area[29] above the corresponding threshold of concern that will adversely affect approximately 5,993 m of shoreline and sweep approximately 421 million m^2 of marine waters used for recreation and by the commercial fishing industry, respectively (Table 4.5-52). A large spill would affect 14,232 m of sandy shoreline and 672 million m^2 of marine waters (Table 4.5-52). A spill of this size may cause significant decreases in tourism, recreation, associated business activities and revenues, commercial fishing, and quality of coastal living. However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources either at all or at levels above the selected threshold. For medium and large spills along the Pacific coast, such conditions prevail 10 and 7 percent of the time, respectively, based on the modeled spills when the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) is used in the cleanup process. For these spill events, no adverse effects on shoreline are expected.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal communities, demography, and employment in the Pacific region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills; any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Economic Status

The overall economic status of communities, industries, and individuals that rely on coastal resources for sustenance, revenue, and quality of life can be affected by an oil spill. As noted above, coastal communities can suffer direct and indirect adverse economic effects from an oil spill, as beach and fishery closures decrease revenue and eliminate jobs. More specifically, losses will be felt in commercial and recreational fisheries, by both the anglers themselves and by related industries as catch opportunities decrease or are eliminated entirely. Tourism and associated businesses will suffer economic setbacks as visits to affected coastal areas decline and purchase of area goods and services decrease because of perceived resource taint. Similarly, environmental justice issues may arise as low-income or minority communities are disproportionately affected by the spill (discussed below in more detail).

A small spill that is 3 or more statute mi offshore would have essentially no adverse effect on either the local or regional economy (Table 4.5-52). There is little to no risk of oiling of economically important resources, and it is unlikely that any commercial or recreational fisheries would be affected.

A medium spill, with mechanical recovery and *in situ* burn operations, could be expected to have short-term economic adverse effects as a result of oiled recreational beaches, closed fisheries and recreational areas, and by the need to supplement the normal response operation employment base, especially if shoreline oiling occurs. A large spill's adverse economic effects could be high for the local economy, even with mechanical recovery and *in situ* burning, based on the anticipated level of shoreline oiling and the possibility that closures of commercial and recreational fishing grounds will occur. In addition, the potential level of shoreline oiling would require a much larger cleanup effort. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause adverse socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on economic status in the Pacific region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills; any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Vessel Transportation and Ports

Oil spills occurring 3 or more statute mi offshore are not likely to cause large adverse effects on vessel transportation and ports; any adverse effects would likely be of short duration. However, an oil spill can disrupt marine commerce if it occurs in and around a shipping channel or port and results in limits on watercraft movement as a means of facilitating spill response. Any interruption in the standard use of vessels or increase in travel times over water can result in hardship for coastal communities as fewer goods are exchanged, transportation costs rise, and the revenue streaming through the local economy falls. Although the possibility exists for the affected area's trade partners to be adversely affected by interruptions in marine transportation in the spill area, the availability of substitute means of transportation, sources of goods, and products indicates that any closures would be unlikely to generate large adverse effects outside of the spill area.

Vessel transportation is of paramount importance for the retail, wholesale, and manufacturing industries along the Pacific coast. Cargo ships carrying goods to and from international production facilities in Asia Pacific rely on quick and easy access to West Coast storage facilities. During the West Coast longshoremen's dispute of 2002, it was estimated that a 10-day closure of these ports from a strike would cost the U.S. economy more than $19 billion; an estimated 40 percent of U.S. waterborne trade passes through West Coast ports (Nyhan, 2002). If an oil spill were to cause a port closure along the West Coast, the costs would not be as severe as those associated with this strike event, given that there would be alternative ports of call. However, the magnitude of damage caused by such a closure does highlight the importance of the free flow of goods into and out of all ports in the Pacific region.

For a small spill, no large adverse effects on vessel transportation or ports are expected (Table 4.5-52), but there is some risk of adverse effects from medium or large spills. Therefore, the nature of the risk to vessel transportation and ports will be a function of the location, area, and pattern of surface water oiling, as well as the extent of oiling in port areas. Medium or large spills along the Pacific coast, however, would not generally be expected to result in large adverse effects on vessel transportation and ports. Any adverse effects would likely be short lived—that is, even if shipping waters or ports are exposed to oil and are therefore closed, as soon as recovery efforts remove surface oil, these facilities would be expected to be reopened.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on vessel transportation and ports in the Pacific region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Fisheries

Commercial Fisheries

Commercial fisheries are vulnerable to oil spills because of both closures and perceived taint. A moratorium on fishing operations in the wake of an oil spill can lead to high revenue losses for the commercial fishing industry, as well as related industries, including those that supply equipment to and purchase products from commercial fleets. Commercial fishing is an important economic activity for the states along the Pacific coast, generating close to $330 million in revenues in 2001; Washington and California generated more than 70 percent of this total (NMFS, 2004a). In addition, oil spills can lead to a decreased demand for fish from affected waters because of actual or perceived taint and can instigate alterations to fishing practices in a manner that increases operating costs and/or decreases revenues.

For a small spill in the Pacific region, the risk to commercial fisheries is negligible using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) (Table 4.5-52). For a medium spill, the risk to commercial fisheries is likely to be greater than for a small spill, but the effects remain localized. A medium spill along the Pacific coast will sweep approximately 421 million m^2 of marine waters used by the commercial fishing industry above the corresponding threshold of concern (Table 4.5-52). A risk of economic loss to commercial fisheries will occur when waters exceed relevant management and/or risk-based thresholds. For example, fishing may not be permitted in waters swept by oil above the modeled threshold of concern, resulting in reductions in commercial fish landings for a period of time following a spill. The resulting adverse effects would be expected to reverberate through communities in the area of the spill, causing decreases in employment, income, and the viability of businesses associated with the commercial fishing industry. To the extent that substitute fishing grounds are available, spill effects on the commercial fishing economy may be less severe.

For a large spill, there is a substantial risk to commercial fisheries. A large spill presents risk to approximately 672 m^2 of marine waters potentially important to commercial fisheries above the corresponding threshold of concern (Table 5.4-49). A spill of this size may cause significant decreases in local commercial fishing activities and revenues. These declines may spill over to create additional adverse effects on businesses associated with the commercial fishing sector. To the extent that commercial fishing operations can, for a time, move to substitute fishing grounds, the potentially severe adverse effects of even a large spill may be avoided.

Recreational Fisheries

Similar to commercial fishing operations, recreational fisheries are at risk of closure or loss in value as a result of oil spills. These adverse effects will not generally be at the regional or national level but could be high at the local level. For this modeling, the risks posed to recreational fishing activities are modeled in the same manner as risks to commercial fishing activities, in square meters of surface water oiled above the corresponding threshold of concern. The effects of an oil spill on recreational fishery-related activities will be felt more heavily by various populations, including recreational anglers and firms that supply goods and services to recreational anglers. For example, recreational anglers fish for pleasure or sport, as opposed to monetary gain. In the wake of an oil spill, such anglers may choose to fish at a substitute location, experience a reduced quality of experience, or choose to forgo fishing entirely. The losses suffered will be related to these missed opportunities. In addition, while closing waters to recreational fishing will decrease the social welfare of recreationists, it would also be expected to affect the demand for boat rentals and other services consumed by fishing enthusiasts.

Recreational fishermen caught an estimated 34.8 million fish along the Pacific coast in 2001. California's recreational fishing activity was larger than that in Oregon and Washington: California recreational fishermen caught 24.7 million fish in 2001, while Oregon and Washington recreational fishermen caught 10.1 million (NMFS, 2001).

For a small spill, adverse effects on recreational fishing resources in the Pacific region would likely be negligible (Table 4.5-52). The risk to recreational fishing for a medium spill is likely to be greater than for a small spill. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill along the Pacific coast will sweep approximately 421 million m^2 of marine waters used for recreational fishing above the corresponding thresholds of concern (Table 4.5-52). The risk of economic loss will occur in fishery waters that exceed these thresholds. For example, fishing may not be permitted in waters exposed to oil, causing losses for boat rental companies and other establishments associated with recreational fishing.

For a large spill, there is a substantial risk to local recreational fishing waters. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a large spill presents risk to approximately 672 million m^2 of marine waters (Table 4.5-52). A spill of this size may cause decreases in recreational fishing activities and revenues, spilling over into sectors that depend on strong demand for recreational fishing goods and services.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on fisheries (commercial and recreational) in the Pacific region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills; any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Subsistence

Potential adverse effects on marine species are a concern during spills where traditional use of subsistence resources occurs. Salmon and intertidal shellfish have been the major species gathered for subsistence in the Pacific region in recent times (Section 3.5.5.5). Tissue tainting would be the primary concern for these subsistence resources.

The Central California Shelf was selected for the modeling as representative of the coastal habitats, fish, and wildlife in the Pacific region. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the severity of potential adverse effects nor increase risk to subsistence resources. Potential adverse effects on subsistence resources in the Pacific region are low for small, medium, or large spills (Table 4.5-53).

Effects on subsistence resources for a small spill were determined to be small by extrapolating from the results for a medium spill. For a medium spill, the modeling results showed water column exposure to dissolved aromatics to be at low concentrations (1–100 ppb) and to only occur in a small area directly outside of San Francisco Bay. Tainting of fish and invertebrates becomes a concern when water concentrations exceed approximately 100 ppb (Section 4.3.5.6). Sediment exposure also only occurred in a few small areas. Less than 1 percent of shoreline was oiled, including subsistence resources associated with shoreline and intertidal habitats.

Table 4.5-53
Risk Ranking of Offshore Oil Spills[*] to Subsistence Using the Basic Response Scenario[†] in the Central California Shelf[‡]

Spill Size	Resources Affected (estimated %)	Risk Score[§]
Small (200 bbl)	0–1	4E
Medium (2,500 bbl)	0–1	4E
Large (40,000 bbl)	0–1	4E

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

For a large spill, the modeling results showed water column exposure at low concentrations (1–100 ppb) in a more widespread area and for higher concentrations (100–10,000 ppb) in localized, mostly offshore, areas. Sediment exposure also occurred in very few areas. The modeling estimated that less than 1 percent of shoreline and intertidal resources were exposed to oil. The risk scores in Table 4.5-53 reflect the predicted recovery rates for subsistence resources of less than 1 year for all spill sizes (Section 4.3.5.6). Although areas other than the Central California Shelf in the Pacific region were not modeled, the results are consistent with those for all other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on subsistence resources will fall within a similar range throughout the Pacific region. While adverse effects on subsistence resources are not likely to be high on a regional level, they may be high on a local level.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subsistence resources in the Pacific region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Archaeological and Historic Resources

Under Alternative 1 using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), adverse effects on archaeological resources in the Pacific region would likely be negligible, regardless of spill size. Some archaeological artifacts occur on land along the coast, while others are likely submerged offshore (Section 3.5.5.8).

Historic structures on land are numerous, and a large number of submerged shipwrecks occur in nearshore waters. Results from several studies indicated that direct oiling caused negligible effects on cultural resources following the *EXXON VALDEZ* oil spill (Bittner, 1996; Dekin, 1993; Reger et al., 1992; Wooley and Haggarty, 1995). Mechanical-only recovery or mechanical recovery plus *in situ* burning may help reduce the amount of oil that strands on the shoreline, which will also reduce the amount of shoreline cleanup and potential disturbance to sensitive archaeological sites and historic structures. Offshore archaeological and historic resources are not at risk of becoming oiled.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on archaeological and historic resources in the Pacific region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Recreation and Tourism

Coastal regions offer outdoor recreational activities that residents and visitors value. For example, in 2000 there were approximately 4 million visitors to San Francisco area state parks (Visit California, 2002) and an additional 19 million visitors to the national park system in the San Francisco area (NPS, 2001b). An oil spill along the Pacific coast has the potential to affect visits to National Parks. In addition to the parks that could be threatened by an oil spill, the beaches along the Pacific coast, such as Venice Beach and Malibu Beach in southern California, could be affected.

An oil spill would be expected to affect recreationists' overall social welfare; in addition, the social and economic implications of a spill would reach beyond direct effects on visitors and into the community. For example, visitors may be less likely to visit and spend money in an area perceived as affected by a spill, potentially leading to loss of business revenue and jobs (see Coastal Communities, Demography, and Employment above for more details).

For a small spill in the Pacific region, the risk to recreation and tourism is negligible using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) (Table 4.5-52). In many cases, a spill of this size would be expected to pose no risk to shoreline resources because the spilled oil will never reach the shoreline above a threshold of concern.

For a medium spill, the risk to recreation and tourism is likely to be greater than for a small spill. A medium spill near the Pacific coast will adversely affect approximately 5,993 m of the total recreational shoreline above the corresponding threshold of concern (Table 4.5-52). Under these conditions, beaches along the Pacific coast in the spill area may be closed to visitors, and fishing and boating may not be permitted, causing losses in revenue to the recreation and tourism sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill, causing decreases in tourism, recreation, and associated employment and business opportunities.

For a large spill, although the nature of the risk remains the same as for a medium spill, the risk to recreation and tourism along the Pacific coast increases to nearly 14,232 m of the total recreational shoreline (Table 4.5-52). A spill of this size may cause significant decreases in tourism, recreation, associated business activities and revenues, and the quality of coastal living. As previously mentioned, with certain weather conditions and current patterns, only a portion of modeled spills is expected to reach shore, so no effects are expected.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on recreation and tourism in the Pacific region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills; any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Environmental Justice

The Pacific coast is home to a number of Native American tribes, some of whom are highly dependent on the marine resources of the Pacific coast. For example, the Makah Indian Reservation in the Northwest corner of the United States is home to the Makah, the only tribe in the United States with the right to hunt and kill whales. This tribe depends on the ocean to provide not only food, but also revenues from the sale of whales, seals, and fish. In addition to subsistence and commercial fishing activities, the tribe has established several businesses to promote tourism in the area. The village invites visitors to experience their traditional crafts, to hike the Cape Flattery Trail, and to watch salmon migrating over fish ladders at the Makah National Fish Hatchery. The village also offers the opportunity for visitors to charter boats and engage in recreational fishing (The Makah Nation, 2003). The Quinault Indian Reservation is south of the Makah Indian Reservation. More than 30 percent of this tribe was living below the poverty line in 1999, with individuals aged 18 to 64 years being the most severely affected; 32 percent of families earned less than $15,000 in the same year (U.S. Census Bureau, 2000a). The location of these tribes, their reliance on the natural resources, and their economic status may place them at disproportionate risk of suffering the adverse effect of an oil spill.

These Native American groups may experience the effects of a spill more severely than the general population, which relies on a more diverse economic base for its livelihood and on the availability of a widespread, commercially available selection of foods. Additionally, subsistence use of natural resources and employment in marine resource-related industries might have value beyond the importance these resources hold as a food source or employment opportunity. Several disadvantaged populations, including low-income and Native American groups, would be disproportionately affected by some combination of spill response options to reduce an oil spill effect.

For a small spill, the risk of significant changes in any groups' economic status is negligible, regardless of response option (Table 4.5-52). In many cases, a spill of this size would be expected to pose no risk to shoreline resources because the spilled oil will never reach the shoreline above a threshold of concern. In addition, because of the small area of surface water exposed to oil above a threshold of concern, marine-based economic factors such as local commercial or subsistence fisheries may experience little or no adverse effects.

The risk of changes in the economic status of any low-income or minority population for a medium spill is likely to be greater than for a small spill. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill in would be expected to adversely affect approximately 5,993 m of the total shoreline and sweep approximately 421 million m^2 of marine waters above corresponding thresholds of concern (Table 4.5-52).

For a large spill, there is a substantial risk of adverse effects on low-income and minority populations that depend on coastal and marine resources. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a large spill could adversely affect up to 14,232 m of sandy shoreline and 672 million m^2 of surface water above recognized thresholds (Tables 4.5-52). A spill of this size may cause significant decreases in water-based business activities and in the availability of subsistence food sources. The scope of potential losses to commercial fishing and recreation and tourism from an oil spill, with implications for populations working in these sectors, was described in more detail in previous sections. As previously mentioned, with certain weather conditions and current patterns, only a portion of modeled spills is expected to reach shore, so no effects are expected.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on environmental justice in the Pacific region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills; any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Public Safety and Worker Health

Potential adverse effects on public safety are defined as the risk to the public from direct exposure to oil or response activities as a result of the spill. There are many areas in the Pacific region with high-population concentrations along the coast. However, adverse effects on public safety are unlikely from oil spills that occur 3 or more statute mi offshore for any of the spill sizes considered, regardless of the response options—mechanical recovery and/or *in situ* burning—used. The USCG has protocols to protect the public from risk during shoreline response operations, as well as on-water protocols to prevent the public from entering the response area.

Potential adverse effects on worker health are related to direct exposure to oil during response operations. In addition, operating oil spill response equipment can be dangerous, which is well recognized and is the basis for the worker certification and training requirements that are now in place. There is also a health risk from inhalation of hydrocarbon fumes for first responders, which is recognized in current safety protocols. The risk is greater as the spill size and the corresponding intensity and duration of operations increase, but is minimized if safety standards are followed.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on public health and worker safety in the Pacific region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

4.5.6. Consequences in the Alaska Region

The coastal shoreline of Alaska measures about one-third of the total shoreline of the United States and its possessions (Section 3.6.1). Because of the Alaska region's immense size, a range of information primarily from the Gulf of Alaska (GOA) and Beaufort Sea will provide a discussion about this region for the purpose of this PEIS. Beginning south of the state, the body of water bordering the state's southern coastline and Canada's west coast is the GOA. Traveling counterclockwise, these far-reaching waters adjoin the Bering and Chukchi Seas; finally, the Beaufort Sea is located along the north coast of Alaska (Figure 3.1-1). Each of these marine environments differs through various surface currents and physical inputs from Alaskan rivers. The location selected for modeling and risk assessment purposes was in Prince William Sound because it is in a high-traffic area at greater risk for oil spills. Modeling results from this location were evaluated relative to the geographic area in Section F.1.2 of the technical report (French McCay et al., 2004), herein referred to as Prince William Sound. In general, the site is representative of offshore sites throughout the region and provides a basis for the modeling of potential effects. The results of the modeling—used to evaluate spills of concern in this risk analysis (i.e., 3 or more statute mi offshore)—are presented in Part F of the technical report (French McCay et al., 2004) and summarized in this section.

Table 4.5-54 presents the risk rankings for the modeling of Alternative 1 in the Alaska region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with or without the addition of chemical dispersion at 45 and 80 percent recovery efficiency[30] for three spill sizes (small, 200 bbl; medium, 2,500 bbl; and large, 40,000 bbl). The risk scores presented in the table are based on the modeling results for an average spill and on regional considerations; however, in any specific oil spill situation local concerns could be higher. Table 4.5-55 summarizes the significance of the potential beneficial and adverse environmental impacts associated with Alternative 1 in the Alaska region, based on the extrapolation of the modeling results for the average spill to the region in general.

Under Alternative 1, dispersant capability is available and its use is feasible in the Alaska region (Figure 2.2-1), so chemical dispersion is considered at two levels of efficiency: 45 percent and 80 percent. For spills analyzed in this document (i.e., those that occur 3 or more statute mi offshore), there are likely to be minor or insignificant regional adverse impacts on all resources for a small spill, except for marine and coastal birds, which could be moderate, based on the speed with which such a spill would weather and dissipate and the small area that could be affected, regardless of response option used. For a medium spill, adverse impacts are minor or insignificant for all resources except for marine and coastal birds, fisheries, and environmental justice, which could be moderate. For a large spill using mechanical-only recovery, there is the potential for moderate adverse impacts on marine mammals and areas of special concern, and significant adverse impacts on marine and coastal birds, intertidal habitats, fisheries, and environmental justice.

Table 4.5-54
Risk Ranking* of Offshore Oil Spills† under Alternative 1 Using the Basic Response Scenario‡ with the Addition of Chemical Dispersion in the Alaska Region

Spill Size	Response Option (% dispersant efficiency)	Resources of Concern													
		Physical Environment			Biological Environment							Socioeconomic Environment			
		Coastal Water Quality	Marine Water Quality	Air Quality	Marine Mammals§	Marine and Coastal Birds§	Plankton and Fish§	Intertidal Habitats	Subtidal Habitats	Areas of Special Concern	Essential Fish Habitat	Subsistence‖	Archaeological/Historic Resources‖	Shoreline Oiling Index#	Surface water Oiling Index#
Small (200 bbl)	Basic	4E	4E	4E	3E	3D	4E	4E	4E	4E	4E	4E	4E	N/A**	N/A**
	Chemical Dispersion (45)	4E	4E	4E	3E	3D	4E	4E	4E	4E	4E	4E	4E	N/A**	N/A**
	Chemical Dispersion (80)	4E	4E	4E	3E	3D	4E	4E	4E	4E	4E	4E	4E	N/A**	N/A**
Medium (2,500 bbl)	Basic	4E	4E	4E	3E	2C	4E	3E	4E	3E	4E	4E	4E	N/A††	1.00
	Chemical Dispersion (45)	4D	4E	4E	3E	2C	4E	4E	4E	4E	4E	4E	4E	N/A††	0.57
	Chemical Dispersion (80)	4D	4E	4E	3E	2D	4E	4E	4E	4E	4E	4E	4E	N/A††	0.55
Large (40,000 bbl)	Basic	4D	4E	4E	2D	2A	4E	1D	4E	2D	4E	4D	4E	N/A††	1.00
	Chemical Dispersion (45)	4B	4E	4E	2D	2B	4E	1E	4E	2E	4E	4D	4E	N/A††	0.66
	Chemical Dispersion (80)	4B	4E	4E	2E	2B	4E	2E	4E	2E	4E	4D	4E	N/A††	0.58

Source: Adapted from Part F of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern; yellow, a medium level of concern; and green, a low level of concern.

* This risk ranking is a summary of risk scores for the resources considered in this PEIS. The risk scoring process is explained in Section 4.4.3.

† Average spills.

‡ Current levels of mechanical recovery and *in situ* burning when circumstances permit.

§ Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, and fish. If such species are affected by an actual spill, the level of concern would be high.

‖ Subsistence and archaeological/historic resources are the only socioeconomic resources that could be ranked using the risk matrix.

\# The Socioeconomic Index is calculated using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with value equal to 1.0. Risk factors reflect the ratio of the percentage of the model area or volume oiled using the basic response scenario to the percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected with response limited to the basic response scenario.

** Index cannot be calculated for small spills since they were not modeled.

†† Length of shoreline oiled above the threshold of concern is not considered relevant: (1) the shoreline oiling results were sensitive in the modeled spill location; (2) the ability to identify shoreline with characteristics amenable to use was limited; and (3) area of surface water oiled above the threshold of concern was expected to provide a more accurate measure of expected risk, given the region's geographic characteristics.

Table 4.5-55

Summary of Potential Adverse Regional Impacts of Offshore Oil Spills* under Alternative 1 Using the Basic Response Scenario† with the Addition of Chemical Dispersion (45 or 80% Efficiency) in the Alaska Region

		Resources of Concern																		
		Physical Environment			**Biological Environment**							**Socioeconomic Environment**								
Spill Size	**Response Option (% dispersant efficiency)**	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals‡**	**Marine and Coastal Birds‡**	**Plankton and Fish‡**	**Intertidal Habitats**	**Subtidal Habitats**	**Areas of Special Concern**	**Essential Fish Habitat**	**Coastal Communities, Demography, and Employment**	**Economic Status**	**Vessel Transportation and Ports**	**Fisheries**	**Subsistence**	**Archaeological/Historic Resources|**	**Recreation and Tourism**	**Environmental Justice**	**Public Safety and Worker Health**
Small (200 bbl)	Basic	Ins	Ins	Ins	Min	Mod	Ins	Ins	Ins	Ins	Ins	Min	Min	Ins	Min	Ins	Ins	Ins	Min	Ins
	Chemical Dispersion (45 or 80)	Ins	Ins	Ins	Min	Mod	Ins	Ins	Ins	Ins	Ins	Min	Min	Ins	Min	Ins	Ins	Ins	Min	Ins
Medium (2,500 bbl)	Basic	Ins	Ins	Ins	Min	Mod	Ins	Min	Ins	Min	Ins	Min	Min	Ins	Mod	Ins	Ins	Ins	Mod	Ins
	Chemical Dispersion (45 or 80)	Min	Ins	Ins	Min	Mod	Ins	Ins	Ins	Ins	Ins	Min	Min	Ins	Mod	Ins	Ins	Ins	Mod	Ins
Large (40,000 bbl)	Basic	Min	Ins	Ins	Mod	Sig	Ins	Sig	Ins	Mod	Ins	Min	Min	Ins	Sig	Min	Ins	Ins	Sig	Ins
	Chemical Dispersion (45 or 80)	Mod	Ins	Ins	Mod	Sig	Ins	Mod	Ins	Mod	Ins	Min	Min	Ins	Sig	Min	Ins	Ins	Sig	Ins

Note: Based on Table 4.5-54. Sig, significant; Mod, moderate; Min, minor; and Ins, insignificant.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, and fish.

Chemical dispersion provides protection to all of these resources, but does increase the potential risk to coastal water quality to moderate. Such a spill could also cause significant, but localized, short-term adverse impacts on other socioeconomic resources. These adverse impacts occur despite the treatment or recovery of some of the oil, but are reduced by these actions when they are effective. The availability of a dispersant capability under this alternative particularly helps mitigate potential adverse effects on marine and coastal birds, and coastal habitat and shoreline, especially for large spills, with some increase in the risk to water quality if the dispersed oil plume enters restricted coastal waters. Further, the modeling shows that *in situ* burning would not significantly change the level of concern identified from those obtained when using mechanical-only recovery.

4.5.6.1. Consequences to the Physical Environment

Water Quality

Potential adverse consequences of oil spills to water quality are related to hydrocarbon contamination, as other constituents in oils are at concentrations that would not exceed thresholds of concern. The hydrocarbons that could affect water quality are the soluble aromatics, MAHs (monoaromatic hydrocarbons) and PAHs (polynuclear aromatic hydrocarbons) (Section 4.3.1.1). Thus, evaluation of potential adverse effects is based on the degree of potential contamination by these compounds. No beneficial effects on water quality would be expected to result from an oil spill.

For oil spills in marine waters, adverse effects on water quality are low for all spill sizes, regardless of the response option used (current levels of mechanical recovery with or without *in situ* burning and chemical dispersion). This is because of the tendency for most chemical compounds of concern to evaporate, rather than dissolve, and the rapid dilution of any chemical compounds that might enter the water column. During periods of extreme turbulence, oil generally mixes into the water column where aromatics may dissolve rapidly, but resurfacing and dilution of oil droplets result in only localized contamination at levels of concern unless the dilution volume is restricted.

Overall, based on the modeling and risk assessment results, it is concluded that when using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion, adverse water-quality effects under Alternative 1 would be low in marine waters, even in the event of a large spill in the Alaska region. However, if the spill moved into shallow and confined coastal waters, adverse effects could be locally important for medium and large spills under conditions where oil is mixed into water by strong turbulence or in areas where oil collects for a few weeks to months after a spill. Chemical dispersion would not be used in shallow and confined coastal waters (less than 3 nm[31] from shore) under Alternative 3, so it could only contribute to adverse water-quality effects in those areas if the dispersed oil plume drifted into the area before being diluted.

The variable used to determine potential water-quality effects is “volume of water contaminated” by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer, which is less than all established water-quality criteria and thresholds of concern for effects on aquatic biota (Sections 4.3.1.1 and 4.3.2.1). The affected water volume increases with spill volume and the level of physical or chemical dispersion during the time of the spill. Natural dispersion increases with stronger winds and currents, lessening the volume of water that is contaminated above the threshold of concern if in unconfined waters. Since the volume of contaminated water increases exponentially as a function of spill size, the estimated volume of contaminated water for a small spill was extrapolated from the medium- and large-spill model results. The estimates of the volume of water contaminated—and its variability—are generally applicable to spills of the same size throughout the Alaska region because the mixing of oil into water and process of dilution are similar in all areas.

Coastal

In estuaries and coastal waters within 3 statute mi of shore, mechanical-only recovery would be used under Alternative 1. Thus, the model results for the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are used to assess coastal water quality effects. If dispersants were applied offshore, the dispersed oil plume could move into these nearshore areas. Since chemical dispersion would not be used in these areas, the level and duration of exposure would be negligible because of dilution.

The Valdez Arm is used as a representative of coastal water for modeling Prince William Sound, as well as the Alaska region. The Valdez Arm is approximately 109 km^2 in area and about 200 m deep on average, with a total volume of approximately 21,800 million m^3. The estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of Prince William Sound to determine the potential effects of small, medium, and large spills (Table 4.5-56). This approach was used both with and without dispersant use, and yields very conservative estimates, in that it assumes all of the water column contamination would occur in coastal water. Since dispersants would not be employed in such areas, this would imply that the dispersed oil plume would extend more directly into coastal waters without any dilution, which will not occur.

Table 4.5-56
Risk Ranking of Offshore Oil Spills* to Coastal Water Quality Using the Basic Response Scenario† with the Addition of Chemical Dispersion in Prince William Sound‡

Spill Size	Response Option (% dispersant efficiency)	Volume of Water Contaminated (million m^3)	Area Contaminated (estimated %)	Risk Score§‡
Small (200 bbl)	Basic	$< 40 \times 10^{-6}$	2×10^{-7}	4E
	Chemical Dispersion (45 or 80)	$< 40 \times 10^{-6}$	2×10^{-7}	4E
Medium (2,500 bbl)	Basic	43	0.2	4E
	Chemical Dispersion (45)	492	2.3	4D
	Chemical Dispersion (80)	478	2.2	4D
Large (40,000 bbl)	Basic	243	1.1	4D
	Chemical Dispersion (45)	3,635	16.7	4B
	Chemical Dispersion (80)	3,687	16.9	4B

Source: Adapted from Part F of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of Prince William Sound (as discussed in the text) as representative of the Alaska region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Because of natural dilution, evaporation, and biological processes, contamination levels would decrease rapidly even in the case of a large spill, and recovery time would be on the order of days to weeks. Oil can be incorporated into shallow water or intertidal sediments where, through leaching, it could become a continuing source of contamination over time. However, this would generally only lead to noticeable water-quality degradation in the locality where the oil collects. This is unlikely to occur with a spill that originates offshore. Because mechanical removal would begin within the required response time under Tier 1 standards (beginning about 12 hours after the spill), much of the soluble components of concern to water quality would have evaporated or dissolved. Thus, mechanical recovery and *in situ* burning would have little influence on the volume of water adversely affected, and the risk score results would apply whether either response is implemented.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal water quality in the Alaska region under Alternative 1 are expected to be insignificant for small spills, with or without dispersant use. For medium and large spills, impacts are expected to be insignificant and minor, respectively, but increase to minor and moderate, respectively, with the addition of chemical dispersion.

Marine

In marine waters, which are 3 or more statute mi offshore, mechanical response, *in situ* burning, and chemical dispersion currently may be used for spill response in the Alaska region. As was done for coastal waters, the estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of the reference area, the Prince William Sound.

Prince William Sound was selected for the modeling as representative of the marine waters in the Alaska region. The total surface area of Prince William Sound is approximately 10,080 km^2, so the area of interest is much vaster for marine waters than for coastal waters. Water-quality effects were calculated using a spill site in relatively shallow water—312 m deep, which is shallower than most marine waters in Prince William Sound and the Alaska region. The results for the selected modeling location (Table 4.5-57) represent conservative estimates of adverse water-quality effects using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit).

Table 4.5-57
Risk Ranking of Offshore Oil Spills[*] to Marine Water Quality Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion in Prince William Sound[‡]

Spill Size	Response Option (% dispersant efficiency)	Area Contaminated (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	1×10^{-9}	4E
	Chemical Dispersion (45 or 80)	1×10^{-9}	4E
Medium (2,500 bbl)	Basic	0.1	4E
	Chemical Dispersion (45 or 80)	0.2	4E
Large (40,000 bbl)	Basic	0.1	4E
	Chemical Dispersion (45 or 80)	1.2	4E

Source: Adapted from Part F of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of Prince William Sound (as discussed in the text) as representative of the Alaska region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Natural oil dispersion would be very rapid after a spill, and recovery time would be on the order of hours to days. Leaching from oil contamination reaching the sediments would not have a large effect on marine water quality because of the large dilution volume and natural dispersing forces in marine waters. The results would apply whether or not a mechanical response is implemented. Since *in situ* burning would replace some of the mechanical response, and both methods remove oil that would otherwise result in water contamination, the potential water-quality effects would not change significantly if *in situ* burning was used. For a spill in water deeper than the 312 m evaluated here, the potential adverse effects would be even smaller.

With the addition of chemical dispersion, the results in Table 4.5-57 are identical for 45 and 80 percent efficiency because the amount of dispersants at 45 percent efficiency is sufficient to treat all dispersible surface oil. For a small spill, the volume of water contaminated with the addition of chemical dispersion would be the same as for the basic response scenario because, due to logistics, dispersants could only be applied after a small spill has mostly dispersed naturally. Chemical dispersion for medium or large spills increases the volume of water contaminated, but would not change the overall level of concern.

Because of natural dilution, evaporation, and biological processes, contamination levels would decrease rapidly even after a large spill, with or without chemical dispersion, and recovery time would be on the order of days to weeks. The estimates of the volume of water contaminated—and its variability—are generally applicable to spills of the same size throughout the Alaska region because natural and chemical dispersion of oil into the water column and dilution processes are similar in all areas.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine water quality in the Alaska region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without chemical dispersion.

Air Quality

Concentrations of hydrocarbons of concern in the air resulting from oil spills and response operations were compared with air quality standards to evaluate the potential for adverse effects (Section 4.3.1.2). The effects of an oil spill on air quality may involve all volatile components of the oil. In addition, if *in situ* burning was used, particulates and other contaminants emitted from burns could become an air quality concern. However, adverse air quality effects from oil spills are normally very localized and short lived for small, medium, and large oil spills. The addition of *in situ* burning does not significantly increase any potential adverse effects: the volume of oil that could be burned is not large, and the temporary smoke plume would be localized and rapidly diluted. Chemical dispersion reduces the volatilization of unburned oil to the atmosphere to only a slight extent, so that effects are essentially identical with or without dispersant use.

The modeling shows that results do not vary by spill location or size in the Alaska region. Two possible sources of contamination to the atmosphere were evaluated for their potential effects on air quality: volatilization of hydrocarbons from unburned oil and emissions produced by *in situ* burning. Concentrations in the lowest 2 m of the atmosphere were compared with the U.S. Environmental Protection Agency's National Ambient Air Quality Standards (USEPA's NAAQS) and other thresholds of concern (as discussed in Section 4.3.1.2).

The results of the modeling show that the potential adverse effects on air quality are low for all spill sizes involving mechanical-only recovery and chemical dispersion; hence, the risk scores are virtually identical for small, medium, and large spills. Volatilized hydrocarbons would not exceed air quality standards for human health at more than 1 km from the spill site. Evaporation off the water surface and volatilization from the water column create a plume of volatile hydrocarbon gases that disperses quickly after a spill, such that the concentrations in the atmosphere at the water surface would not exceed human health thresholds of concern at any location. The recovery time for the atmosphere would be on the order of days. Thus, a low level of concern is expected for small, medium, and large spills involving mechanical-only recovery and chemical dispersion (Table 4.5-58).

Table 4.5-58
Risk Ranking of Offshore Oil Spills* to Air Quality under *In Situ* Burning in Prince William Sound†

Spill Size	Area Exceeding Threshold (km^2)	Area Contaminated (estimated %)	Risk Score‡
Small (200 bbl)	1.6	0.02	🟩 4E
Medium (2,500 bbl)	1.6	0.02	🟩 4E
Large (40,000 bbl)	12.7	0.13	🟩 4E

Source: Adapted from Part F of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Calculations are based on the appropriate portions of Prince William Sound (as discussed in the text) as representative of the Alaska region for modeling.

‡ The risk scoring process is explained in Section 4.4.3.

Mechanical recovery plus *in situ* burning, with or without chemical dispersion, would increase atmospheric pollutants by the amount emitted via *in situ* burning. For small spills, it would be very unlikely that *in situ* burning would be used, as the oil would disperse too rapidly for it to be feasible (Table 4.5-58). The maximum area potentially exceeding the NAAQS or thresholds of concern is 1.6 km^2 for a medium spill and 12.7 km^2 for a large spill (Table 4.5-58). If humans or sensitive resources (i.e., wildlife) are within these areas, they could be affected by poor air quality for a short time, on the order of hours. Since *in situ* burning can only be used offshore in marine waters, a region of interest equivalent to Prince William Sound (10,080 km^2) would have less than 1 percent of its area adversely affected, and the atmosphere would recover in a matter of hours. The addition of chemical dispersion does not change the results in Table 4.5-58.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on air quality in the Alaska region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without *in situ* burning.

4.5.6.2. Consequences to the Biological Environment

Marine Mammals

Concentrations of cetaceans (whales and porpoises) in the Alaska region (Section 3.6.2.1., Table F.6-1) vary depending on seasonal migrations. Pinnipeds (seals and walruses) are carnivorous aquatic mammals that spend the majority of their lives swimming and eating in water; they venture onto land to bear their young, sunbathe, and molt. Two pinnipeds of concern in the Alaska region are the Steller sea lion (*Eumetopias jubatus*) and the harbor seal (*Phoca vitulina*). The Steller sea lion does not breed in Prince William Sound but does use a number of haulout areas located throughout the area. Harbor seals are the most common of the pinnipeds present in this region; they use tidewater glaciers and coastal shorelines as haulout areas and rookeries for bearing young. The sea otter (*Enhydra lutris*) is the only species of fur-bearing marine mammal of concern inhabiting this region. The majority of the local population is localized to the southeastern sector of Prince William Sound. Females and pups are often found rafting in large groups, while males tend to remain in separate groups, except during the mating season. The greatest threat to pinnipeds and otters is from surface water and shoreline oiling that occurs in feeding, breeding, or molting areas.

Marine mammals such as whales, dolphins, and manatees are vulnerable to spilled oil since they spend considerable time at the water's surface, which increases possible contact with oil. The majority of these species remains offshore, and populations vary according to season and migration directions. Cetaceans appear to be able to detect and are likely to avoid floating oil or oil being recovered by mechanical means (Geraci, 1990). Studies have shown that cetacean skin is nearly impenetrable to even the highly volatile constituents of oil, indicating that contact with oil probably would be less harmful to cetaceans than often believed. However, the toxic, volatile fractions in fresh crude oils could irritate and damage cetacean soft tissues, such as the mucous membranes of the eyes and airways.

Marine mammals that are more commonly found in the nearshore regions and intertidal habitats, such as pinnipeds and sea otters, are of greater concern. Their use of restricted haulout or feeding areas and instinctual behavior to return to the same breeding area every year may increase the likelihood of physical contact with oil in the event of a nearby spill. Potential concerns include toxicity from ingestion of oil during grooming, and effects on juveniles through contact with contaminated teats when nursing. Overall, the potential effects depend on the size of the spill, and the number and species of marine mammals present.

Based on the area of appropriate habitat in the Prince William Sound, the equivalent areas for 100 percent mortality using mechanical-only recovery only for cetaceans, pinnipeds, and sea otters are less than 0.001, 0.007, and 0.5 percent, respectively, of the available habitat for a medium spill. For a large spill without chemical dispersion, the values increase to 0.005, 0.05, and 3.42 percent, respectively. Chemical dispersion reduces all of these percentages except for sea otters: the values are already so low that the difference is not important. For sea otters, chemical dispersion reduced the areas by about 25 percent for a medium spill and 50 percent for a large spill, but this improvement did not change the overall level of risk, primarily because of the expected recovery time. Pinnipeds are also at risk from shoreline oiling. The likelihood that oiling would actually involve a pinniped haulout area is low, based on the predicted length of shoreline contaminated, but does contribute to the potential risk (see the discussion on intertidal habitats). This risk is also reduced by chemical dispersion. Based on the distribution of mammals in the Alaska region, the potential level of concern was determined to be low for small and medium spills but would increase to medium levels for large spills. The results of the modeling for marine mammals for Prince William Sound are presented in Table 4.5-59.

Table 4.5-59
Risk Ranking of Offshore Oil Spills[*] to Marine Mammals Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion in Prince William Sound[‡]

Spill Size	Response Option (% dispersant efficiency)	Populations Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E
Medium (2,500 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E
Large (40,000 bbl)	Basic	1–5	2D
	Chemical Dispersion (45)	1–5	2D
	Chemical Dispersion (80)	0–1	2E

Source: Adapted from Part F of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of Prince William Sound (as discussed in the text) as representative of the Alaska region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine mammals in the Alaska region under Alternative 1 are expected to be minor for small and medium spills, and moderate for large spills, with or without dispersant use.

Marine and Coastal Birds

Potential adverse effects on marine and coastal birds are usually of highest concern during an oil spill because birds are highly susceptible to the acutely toxic effects of exposure to oil. There are many areas in the Alaska region where high concentrations of birds may be found in a variety of habitats, and the remoteness of the Alaskan shoreline can make protection and cleanup of intertidal habitats very difficult. Adverse effects on birds in this region would result mostly from oiling of gravel beaches, tidal flats, and small islands that are used by shorebirds and seabirds and of surface water in marine-water habitats used by seabirds, gulls, terns, and migratory waterfowl (Section 3.6.2.2) (see Section 4.3.2.2 for information on the main issues of concern for birds exposed to an oil spill).

Prince William Sound was selected for the modeling as representative of the intertidal habitats and wildlife in the Alaska region (Table 4.5-60). Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the potential adverse effects on birds. Potential levels of concern for birds are in Prince William Sound are medium for a small spill, in that the length of shoreline oiled and the amount of oil that stranded would both be very small. However, the levels of concern increase with spill volume, with greatest concern for conditions where sheltered rocky shores and gravel beaches used by seabirds and shorebirds become heavily oiled, and where surface water oiling is extensive.

Table 4.5-60
Risk Ranking of Offshore Oil Spills* to Marine and Coastal Birds Using the Basic Response Scenario†
with the Addition of Chemical Dispersion in Prince William Sound‡

Spill Size	Response Option (% dispersant efficiency)	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	1–5	3D
	Chemical Dispersion (45 or 80)	1–5	3D
Medium (2,500 bbl)	Basic	5–10	2C
	Chemical Dispersion (45)	5–10	2C
	Chemical Dispersion (80)	1–5	2D
Large (40,000 bbl)	Basic	> 20	2A
	Chemical Dispersion (45 or 80)	10–20	2B

Source: Adapted from Part F of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern, and yellow, a medium level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of Prince William Sound (as discussed in the text) as representative of the Alaska region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

A hemispheric Western Hemisphere Shorebird Reserve Network (WHSRN) site, the Copper River Delta, is located in Prince William Sound. The presence of this site indicates that large numbers of shorebirds concentrate in the area during migration and/or nesting and wintering. Total nesting and feeding seabirds in Prince William Sound range from tens to hundreds of thousands annually. Tens of thousands of migratory shorebirds are present on gravel beaches and tidal flats in embayments and on islands. High concentrations of waterfowl nest in wetlands and stage and molt in sheltered areas. Thus, the risk rankings were determined based on the possibility that a large number of birds may be concentrated on heavily utilized beaches or in sheltered embayments and marine-water areas that are significantly oiled. It is important to recognize that adverse effects on birds may be more or less severe depending on the time of year and locations of their habitats, as well as the extent of shoreline and surface water oiling. Use of nesting and staging habitats are seasonal in the Alaska region; therefore, a spill occurring during the peak season for these sensitive life stages would result in greater adverse effects on regional bird populations than a spill occurring at a different time of year.

Under the basic response scenario, adverse effects on birds in Prince William Sound for a small spill were determined by extrapolating from the results obtained for a medium spill. The volume of oil released in the small spill was approximately an order of magnitude less than in the medium spill; therefore, the adverse effects on bird populations were estimated to be proportionally smaller. The modeling of effects on birds for a medium spill under mechanical-only recovery resulted in estimates of 5 to 10 percent of the regional bird population being adversely affected because some important shorebird staging areas were oiled. Approximately 68 km^2 of surface water were oiled above the 10-micron threshold, including waterfowl and seabird concentration areas around islands and in inlets and bays. For a large spill under mechanical-only recovery, the modeling resulted in estimates of over 20 percent of the local area bird population being affected. Two percent of the shoreline in Prince William Sound was oiled, including many important shorebird staging areas. Gravel beaches, which are used by staging shorebirds, composed 30 to 60 percent of the oiled shoreline, and heavy oiling in gravel beaches can persist for a decade. Approximately 468 km^2 of surface water was oiled above the 10-micron threshold, including waterfowl and seabird concentration areas in the northern and western areas of Prince William Sound. The risk scores in Table 4.5-60 reflect the predicted recovery rates for birds of 3 to 7 years for medium and large spills. Recovery will likely occur in 1 to 3 years for most species, but recovery times for other species, such as black oystercatchers and harlequin ducks, were longer after the *EXXON VALDEZ* oil spill and ranged from 3 to 9 years (Section 4.3.2.2). Black oystercatchers, harlequin ducks, and other species with longer recovery times are present, sometimes in high concentrations, in areas oiled under the medium and large spill scenarios. The predicted recovery rates were less for birds in a small spill because a smaller area was affected; therefore, it is unlikely that large numbers of species with longer recovery times were present.

With the addition of chemical dispersion at 45 percent efficiency for a medium spill, the length of oiled shoreline was reduced by nearly 60 percent and surface water effects were reduced by 24 percent. Adverse effects on important bird habitats were slightly reduced; but the risk score remained the same with 5 to 10 percent of the estimated regional bird population being affected. With the addition of chemical dispersion at 80 percent efficiency for a medium spill, the amount of shoreline and surface water oiling was only slightly reduced compared with the 45 percent efficiency scenario, but less-important bird habitats were oiled. Therefore, the risk score was reduced to 1 to 5 percent of the estimated bird population being affected. When dispersants at 45 and 80 percent efficiency were used on a large spill, shoreline oiling was reduced by approximately 50 and 65 percent, respectively; and similar reductions in surface water oiling occurred. Several sensitive bird habitats were still significantly oiled; therefore, the risk scores were only reduced slightly to 10 to 20 percent of the estimated bird population being affected (Table 4.5-60). On an overall regional level, adverse effects from medium and large spills to birds are reduced when chemical dispersion is modeled. The addition of *in situ* burning does not change the significance of these adverse effects.

Although areas other than Prince William Sound in the Alaska region were not modeled, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on marine and coastal birds will fall within a similar range throughout the Alaska region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine and coastal birds in the Alaska region under Alternative 1 are expected to be moderate for small and medium spill sizes, and significant for large spills, with or without dispersant use.

Plankton and Fish

Plankton and fish, a diverse group of species, are important to the marine food web, ecosystem function, and fisheries. Adverse effects on these groups are of high concern, particularly when chemical dispersion is considered as a potential response option. As described in Section 4.3.2.3 and 4.5.2.2, plankton and fish are adversely affected either directly or via the food web by the toxic effects of oil components that enter the water column—the soluble compounds (MAHs and PAHs) and microscopic oil droplets mixed by waves into the water (French McCay, 2002; NRC, 1985). The most important pathway of exposure is direct uptake of dissolved oil components, originating directly from surface oil or dissolving from the microscopic oil droplets in the water. Overall, as spill size increases, so do adverse effects. However, there is great variability related to the environmental conditions after a spill; plankton and fish suffer much more adverse effects in storm conditions where high waves mix unweathered oil into the water, which happened during the *NORTH CAPE* oil spill (French McCay, 2003), than in calm weather. In addition, many species utilize shallow waters and even the intertidal zone, where they are more likely to be exposed to oil and dissolved components when oil comes ashore. Species and life stages vary considerably in sensitivity to toxic components, with species from relatively unpolluted and environmentally stable locations being more sensitive than those from polluted and environmentally variable areas.

In marine and open coastal environments, small, medium, and large oil spills do not cause large or long-term toxic effects to plankton and fish in the water column. The toxic effects of oil spills result from acute exposure during the time when surface oil is present and for short periods (days to weeks) afterwards. Once the source of hydrocarbons (from floating oil or the shoreline) to the water column is gone, concentrations rapidly disperse to background levels. However, there may be longer-term effects if an offshore spill occurs in or migrates to nearshore shallow areas such as enclosed embayments, estuaries, or wetlands where dilution and flushing are slow. Many fish and other organisms spawn and develop through larval and juvenile stages in these shallow areas. In Alaska, Pacific herring spawns in shallow areas on macroalgae and other structural material, while pink salmon often utilize intertidal zones for spawning and larval development, making these species particularly vulnerable to oil reaching shorelines (see discussion of potential effects on these habitats below). Under Alternative 1, in most cases, chemical dispersion could not be used within 3 nm[32] of shore, but the dispersed oil plume could be transported by currents into this area.

The percentage of plankton and fish adversely affected by oil spills was estimated using the modeling results (technical report [French McCay et al., 2004]) of water volumes exposed to toxic oil components. Percent loss multiplied by volume exposed was integrated over time and space to calculate an equivalent volume of 100 percent loss. These volumes were translated to equivalent areas by multiplying them by water depth at the spill site, allowing comparison with other resources, such as birds and shorelines, which are distributed on a per-area basis. The use of area is appropriate because plankton and fish abundance is much more uniformly distributed when expressed on a per-area basis than on a per-volume basis since the ecosystem is driven by sunlight and plant photosynthesis at the water surface (French et al., 1996; Odum, 1971). As indicated by the similar results for the four modeled spill sites in 10 to 30 m of water—offshore Delaware Bay, offshore Galveston Bay, the Florida Straits, and offshore San Francisco (Parts B, C, D, and E, respectively, of the technical report [French McCay et al., 2004])—the equivalent areas of adverse effect on plankton and fish (both average and variable) are applicable to spills of the same size in any location of similar water depth in any region considered in this PEIS. In Prince William Sound, the modeled spill site was is 312 m deep water, so these results are applicable to any spill site in the Alaska region where water depth is close to 312 m. The results from the other regions' modeled spill sites, which are based on 10 to 30 m of water, would be applicable to spills in the Alaska region in similarly shallow waters. Likewise, the results for Prince William Sound are applicable to waters of about 312 m in all the regions. Adverse effects would be smaller for deeper waters because of greater vertical dilution of both oil components and organisms, and proportionally greater in shallower waters because of the restricted dilution potential.

The model-estimated areas are those where there is a potential to affect the most sensitive species, which are two standard deviations more sensitive than the average of all species tested (2.5th percentile in rank order of sensitivity). For species of average sensitivity (50th percentile), the areas adversely affected would be much less. Thus, the model-estimated areas should not be interpreted as experiencing 100 percent mortality of all plankton and fish; they are conservative estimates used for comparative purposes among response scenarios.

Prince William Sound was selected for the modeling as representative of the Alaska region (Table 4.5-61). The adverse effects were estimated as a percentage of the total area of concern (10,080 km^2). With the addition of chemical dispersion, the results for 45 percent efficiency were not significantly different from those for 80 percent efficiency because more than sufficient dispersant would be available under both conditions to disperse available surface oil for spills up to 40,000 bbl. For a small spill, based on the evaluation of the volume where water quality would be affected for a small spill (Tables 4.5-56), the volume of adverse effects on plankton and fish would be low for all response options under Alternative 1.

Table 4.5-61
Risk Ranking of Offshore Oil Spills* to Plankton and Fish Using the Basic Response Scenario† with the Addition of Chemical Dispersion in Prince William Sound‡

Spill Size	Response Option (% dispersant efficiency)	Equivalent Area Affected (km^2)	Area Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	< 0.076	1×10^{-11}	4E
	Chemical Dispersion (45 or 80)	< 0.076	1×10^{-11}	4E
Medium (2,500 bbl)	Basic	0.1	0.0006	4E
	Chemical Dispersion (45)	2.6	0.026	4E
	Chemical Dispersion (80)	2.5	0.024	4E
Large (40,000 bbl)	Basic	0.5	0.005	4E
	Chemical Dispersion (45)	29	0.29	4E
	Chemical Dispersion (80)	30	0.30	4E

Source: Adapted from Part F of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of Prince William Sound (as discussed in the text) as representative of the Alaska region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Since the adverse effects are in a small percentage of the area of concern and less than the range of natural variability, the recovery time would be less than 1 year. Overall, based on the modeling, adverse effects on plankton and fish in the Alaska region under Alternative 1—using mechanical recovery, *in situ* burning, and chemical dispersion—would be localized to the immediate area around the spill site and similar in all marine water areas of the region. For large spills that might move rapidly into shallow coastal areas due to winds and currents, the concentrations of toxic components might be high enough to cause some level of concern for water column communities, especially early life history stages for fish and invertebrates using intertidal and shallow subtidal areas. Deepwater chemical dispersion would remove oil floating on the surface that might otherwise come ashore and adversely affect shallow-water and intertidal biota, including herring and salmon in early life history stages in those habitats.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on plankton and fish in the Alaska region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Intertidal Habitats

Potential effects on intertidal habitats are always of great concern during oil spills, particularly in the Alaska region where the remoteness of the shoreline can make shoreline protection and cleanup very difficult. The Alaskan shorelines vary widely in type and degree of exposure to natural removal processes (Section 3.6.2.4). Of greatest concern are the more sheltered habitats such as sheltered rocky shores and wetlands where recovery from oil spills can take many years. Gravel beaches are of particular concern because of the potential for deep penetration of oil that can persist for decades under heavy oiling. These beaches are used as spawning substrates for important commercial fisheries such as herring and salmon; thus, persistent oil provides a pathway for chronic exposure to these sensitive life stages. The Alaska region has extensive areas of these sensitive habitats along major oil transportation routes. For a discussion of the relative ranking of the sensitivity of intertidal habitats to spilled oil and the processes affecting oil fate and behavior on shorelines, see the explanation of the Environmental Sensitivity Index (ESI) in Section 4.3.2.4. There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on intertidal habitats in that larger spills tend to have higher oil loading on the shoreline and affect larger areas.

Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed and, thus, does not reduce potential adverse effects. Tn the Alaska region, adverse effects on intertidal habitats are small for a small spill because very little oil is likely to strand onshore, and oil loading would be light in most cases. However, the potential for adverse effects increases with spill volume, with the greatest concern for conditions where sheltered rocky shores and gravel beaches become heavily oiled. Prince William Sound was selected for the modeling as representative of the intertidal habitats in the Alaska region (Table 4.5-62).

Table 4.5-62
Risk Ranking of Offshore Oil Spills[*] to Intertidal Habitats Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion in Prince William Sound[‡]

Spill Size	Response Option (% dispersant efficiency)	Habitats Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	4E
Large (40,000 bbl)	Basic	1–5	1D
	Chemical Dispersion (45)	0–1	1E
	Chemical Dispersion (80)	0–1	2E

Source: Adapted from Part F of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern; yellow, a medium level of concern; and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of Prince William Sound (as discussed in the text) as representative of the Alaska region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Adverse effects on intertidal habitats from a small spill were determined to be low by extrapolating from the results of a medium spill and expecting recovery from lightly oiled shorelines within 1 year. For a medium spill under mechanical-only recovery, the modeling resulted in approximately 24.1 km of oiled shoreline, which is less than 1 percent of the entire shoreline in Prince William Sound. However, most of this oiled shoreline consisted of rocky shores, which are expected to recover within 1 to 3 years from light-to-moderate oiling, as reflected in the risk scores in Table 4.5-62. For a large spill under mechanical-only recovery, the modeling resulted in an estimated 89.3 km of oiled shoreline. This value represents 2 percent of the entire shoreline area. Gravel beaches compose 30 to 60 percent of the oiled shoreline, depending on the spill conditions. Heavy oiling in gravel beaches can persist for at least a decade, so the risk scores in Table 4.5-62 reflect this long recovery period (Section 4.3.2.4).

With the addition of chemical dispersion at 45 percent efficiency for a medium spill, the length of oiled shoreline was reduced by nearly 60 percent—to 10.8 km—and no wetlands were affected. There was little difference in the modeled shoreline oiling between the two levels of dispersant efficiency for a medium spill. With the addition of chemical dispersion at 45 percent efficiency for a large spill, shoreline oiling was reduced by 50 percent, to less than 1 percent of the total shoreline. At 80 percent efficiency, the extent and degree of shoreline oiling was reduced by 65 percent, to 34.7 km. Less than 1 percent of the shoreline in Prince William Sound was oiled, but there were still areas of moderate oiling on gravel beaches. Moderately oiled beaches would recover within 3 to 7 years.

Although areas other than Prince William Sound in the Alaska region were not modeled, the results are consistent with those for other regions modeled in this PEIS; therefore, it is expected that the severity of adverse effects on intertidal habitats will fall within a similar range throughout the Alaska region. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on intertidal habitats in the Alaska region under Alternative 1 are expected to be insignificant from small spill sizes, with or without dispersant use. For medium and large spills, the potential adverse impacts are minor and significant, respectively, but decrease to insignificant and moderate, respectively, with the addition of chemical dispersion.

Subtidal Habitats

The subtidal (benthic) habitat consists of the bottom substrate below the low tide level, as well as the species that live in, on, and near the substrate. This benthic community in the Alaska region includes seagrass beds and kelp forests, as well as areas of live, sandy, muddy, and low-relief live bottoms, and subsurface canyons. Organisms living in this area—demersal species—include corals, plants and seagrasses, benthic invertebrates (such as crabs, shrimp, snails, bivalve mollusks, and marine worms), and bottom-dwelling fish. Because subtidal benthic communities do not include the intertidal zone, they are at little risk from floating oil because, by definition, this environment is always below the surface. Kelp forests are an exception, since the fronds may reach the surface; they are at risk from floating oil, as is the associated animal community. The greatest risk of exposure comes from sinking oil, as well as *in situ* burn residue, or dispersed oil or the sorption of naturally dispersed or mechanically mixed oil that has become suspended on sediments and is deposited onto the ocean floor. However, significant natural dispersion of oil and sediment into the water column only occurs during large storms or for nearshore oil spills. Oil particles could adhere to bottom substrate, plants, or animals, which could result in both physical coating of organisms, as occurred in the 1993 *BRAER* spill in the Shetland Islands, and toxic effects from exposure to the chemical constituents (Section 4.3.2.5). Such adverse effects are not normally observed.

The risk to fauna and flora of the subtidal benthic habitat is minimal, based on the diluting effect of the overlying water (Section 2.2.2)—the deeper the water, the lower the risk. Chemical compounds of concern tend to evaporate, rather than dissolve, and the rapid dilution of any chemical entering the water column decreases the toxicity of any oil residue potentially reaching the bottom substrate.

Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects. It might slightly increase the risk of remaining oil residues sinking to the bottom. Residual oil from *in situ* burning that reaches the bottom is expected to have little or no adverse effects on subtidal habitats since the majority of its toxic components would have either evaporated or been destroyed during burning, and the volume produced is very small (Section 4.3.2.5).

For a medium spill without chemical dispersion the sediment threshold concentrations for dissolved aromatic and for total hydrocarbons were never exceeded. For a large spill the sediment threshold for total hydrocarbon exposure was exceeded, but only in an area of less than 0.003 percent of the total reference area. Benthic habitat was also assumed to be at risk if there threshold of concern for dissolved aromatic hydrocarbons affected stationary demersal species (those living at the sediment-water interface). When mechanical-only recovery was used, less than 0.001 percent of Prince William Sound was affected by water column concentrations above the threshold for a medium spill, which increased to 0.001 percent for a large spill.

With the addition of chemical dispersion at 45 and 80 percent efficiency for medium and large spills (Table 4.5-63), the modeling results show essentially no change in sediment contamination. The exposure area of stationary demersal species to dissolved aromatic hydrocarbon concentrations above threshold remained at 0.001 percent for both medium and large spills at 45 and 80 percent efficiency.

Table 4.5-63
Risk Ranking of Offshore Oil Spills[*] to Subtidal Habitats Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion in Prince William Sound[‡]

Spill Size	Response Option (% dispersant efficiency)	Habitats Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Large (40,000 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E

Source: Adapted from Part F of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of Prince William Sound (as discussed in the text) as representative of the Alaska region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subtidal habitats in the Alaska region under Alternative 1 are expected to be insignificant for small, medium, and large spill sizes, with or without dispersant use.

Areas of Special Concern

The potential adverse effects on areas of special concern, such as National Marine Sanctuaries, National Parks, National Wildlife Refuges, and National Estuarine Research Reserves, are important during an oil spill since these areas are under increased scrutiny and protection. Whereas most coastal and nearshore areas have a wide range of habitats or are very similar to other areas along the Alaskan coast, areas of special concern are set aside for their uniqueness (Appendix F, Tables F.6-3 through F.6-6 and Figures F.6-1 through F.6-4). The potential risks associated with shoreline areas of special concern are identical to those discussed above for intertidal habitats. The risks to subtidal resources, such as those in Marine Sanctuaries, are identical to those discussed for subtidal habitats. For this analysis, the risks to areas of special concern are assumed to be the same as those for either intertidal or subtidal habitats (Sections 4.5.6.2), whichever are greater. Since the risk to intertidal habitats is greater, those risk scores were used. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on the data presented for a medium spill, the estimated average extent of shoreline oiling using mechanical-only recovery is 24 km; this figure increases to 89 km for a large spill. The potential risk of surface oil reaching a shoreline associated with an area of special concern is low in the Alaska region because of the number and scattered locations of these areas. The potential adverse effects on areas of special concern with or without dispersant use are low for a small spill but increase to medium for medium and large spills based on the extent of shoreline oiling (Table 4.5-64). It should be noted that the assumed recovery times for large spills were reduced over those reported for intertidal habitat, which were based on oiling of gravel beaches.

With the addition of chemical dispersion at 45 and 80 percent efficiency for a medium spill (Table 4.5-64), the average amount of shoreline oiling decreases by an estimated 60 percent. For a large spill shoreline oiling was reduced by 50 to 65 percent of the original amount (45 and 80 percent efficiency, respectively). While this changed the risk scores, the overall level of concern remained low for small and medium spills, and medium for large spills.

Since areas of special concern are scattered along the Alaskan coast, they are unlikely to be disproportionately affected by the average spill. If an area of special concern was affected, it is anticipated that the recovery time for the affected area would be the same as for similar intertidal habitats elsewhere. These areas are most at risk from floating oil and, therefore, benefit from any action that reduces potential shoreline oiling.

Table 4.5-64
Risk Ranking of Offshore Oil Spills[*] to Areas of Special Concern Using the Basic Response Scenario[†]
with the Addition of Chemical Dispersion in Prince William Sound[‡]

Spill Size	Response Option (% dispersant efficiency)	Areas Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	4E
Large (40,000 bbl)	Basic	1–5	2D
	Chemical Dispersion (45 or 80)	0–1	2E

Source: Adapted from Part F of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of Prince William Sound (as discussed in the text) as representative of the Alaska region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on areas of special concern in the Alaska region under Alternative 1 are expected to be insignificant for small spills and moderate for large spills, with or without dispersant use, based on the risk to intertidal habitats. For medium spills, impacts are expected to be minor, but decrease to insignificant with the addition of chemical dispersion.

4.5.6.3. Consequences to Threatened, Endangered, or Candidate Species

The Alaska region has a variety of threatened, endangered, or candidate species (Section 3.6.4). The overall regional risk that a threatened, endangered, or candidate species would be adversely affected or even present in the area of a spill is low for small spills and medium for medium spills, but increases greatly for large spills. Killing a single individual of such a species can be considered a severe effect. Potential adverse effects on marine mammals, marine and coastal birds, or fish that are threatened, endangered, or candidate species are identical to those discussed in Section 4.5.6.2 for these groups. Overall, risk scores were highest for marine and coastal birds. While the risks to these groups have been described, the level of concern for threatened, endangered, or candidate species tends to be higher. Therefore, any adverse effects that affect breeding or result in death should be considered high.

Adverse effects on threatened, endangered, or candidate species in the Alaska region for any spill size are difficult to predict. Depending on the location and season, the number and type of species present will vary. Based on the overall size of the Alaska region and the distribution of threatened, endangered, or candidate species inhabiting the region, the likelihood of affecting an individual of concern would probably be higher than in many other regions in this PEIS. The addition of chemical dispersion at 45 or 80 percent efficiency will decrease the average amount of surface oiling and shoreline oiling, which would benefit the species in these areas. No additional risk from chemical dispersion is expected for fish. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on threatened, endangered, and candidate species in the Alaska region under Alternative 1 are expected to be moderate for small and medium spills, and significant for large spills, with or without dispersant use, based on the risk to marine and coastal birds.

4.5.6.4. Consequences to Essential Fish Habitat

Virtually all waters along the Alaskan coast and out to the limits of the U.S. Exclusive Economic Zone (EEZ) are considered Essential Fish Habitat (EFH). Areas such as bays, river mouths, and harbors are designated EFH for at least one species and are protected by legislation (Section 3.6.4). The primary issue with respect to EFH is either (1) exposure of sensitive resources in the water column to hydrocarbon concentrations of concern, or (2) the contamination of bottom sediments, both of which could lead to either acute or chronic exposures.

Adverse effects would include either the death of individual organisms, the possibility of sublethal effects affecting long-term population viability, or degradation of habitat that reduces its availability to managed species. For this analysis, the risks to areas of special concern are assumed to be the same as those for either intertidal or subtidal habitats (Sections 4.5.6.2), whichever are greater. The results for plankton and fish and for subtidal habitats indicate only low effects and form the basis for the EFH risk score. Under Alternative 1, the addition of *in situ* burning does not remove enough oil to reduce potential adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on EFH in the Alaska region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without dispersant use, based on the risk to plankton and fish and to subtidal habitats.

4.5.6.5. Consequences to the Socioeconomic Environment

As discussed in Section 4.3.5, oil spills can produce a variety of adverse social and economic effects. These adverse effects are generally not high when measured at the regional level, but instead are typically felt in communities located near resources oiled by the spill. Specifically, large adverse effects are generally limited to those industries and populations that are affected by the spill. Some of the most visible and significant of these adverse effects are likely to include effects on water- and shore-based recreation, commercial fisheries, and the overall well-being of the residents of coastal communities in the Alaska region. In addition, oil spills have the potential to adversely affect low-income and minority populations living along the coast to a greater extent than the general population.

This modeling considers the risk of adverse socioeconomic effects posed by oil spills, which can include, but are not limited to, reduced recreational activity because of limited accessibility or perceived taint, closure of commercial fishing grounds or hatcheries, and oiling of marine resources that are important to low-income and minority populations that use subsistence resources. In addition to these and other direct adverse effects, oil spills may generate secondary effects on social and economic welfare along the coast. For example, an oil spill may cause changes in the employment and revenues of resource-based businesses. While these effects are not quantified in this modeling, the following discussion provides absolute and relative measures of the overall risk of adverse social and economic effects of small, medium, and large oil spills using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), with or without chemical dispersion, in the Alaska region. The methodology is described in more detail in the Atlantic region (Section 4.5.2.5).

There is no existing standard for "significance" related to the socioeconomic effect of oil spills (e.g., how much shoreline or surface water must be oiled to be considered a "high," "medium," or "low" effect). The significance of the effect will depend on a number of factors, including the scope of the analysis (i.e., national, regional, local), opportunities for resource substitution (e.g., an unoiled beach or fishing ground nearby, alternative ports of call), and the duration of the spill event. Generally, a spill event would be of low concern if it is not of long enough duration to affect the financial viability of local businesses, and the affected communities are able to find substitutes to replace the oiled resources.

For this PEIS, (1) the greatest effect modeled at the regional level was less than approximately 10 percent of available shoreline or surface water resources (indicating the likely presence of substitute resources), and (2) resource use following these modeled spills (e.g., vessel transportation and fishing) would be expected to resume as soon as oil recovery efforts were completed. As a result, the modeled effects under all modeled scenarios would likely be low at the regional level. As noted in the text, any adverse effects that occur would be expected to be localized in nature.

The risk factor reflects the ratio of the percentage of the shoreline or surface water oiled using the basic response scenario to the percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected given response options limited to mechanical recovery and *in situ* burning.

This modeling assumes that the risk posed by oil spills to the socioeconomic environment is directly related to the extent to which resources are oiled above thresholds of concern—for the Alaska region, the square meters of marine waters used for recreational activities and commercial fishing oiled above the threshold of concern. By comparing the absolute and relative degree of risk to the socioeconomic environment under various spill sizes, this modeling considers the degree of risk reduction achieved under a given spill response option (see Section 4.4.3.2 for details on the method used). The risk estimates presented Table 4.5-65 are based on modeled spills affecting Prince William Sound. While any given spill can exhibit distinctly different patterns of socioeconomic effect, these results are expected to be broadly applicable to a range of spill locations along the entire Alaskan shoreline, as long as spills occur in areas where mechanical recovery, *in situ* burning, and/or chemical dispersion are feasible. In addition, the conclusions reached for Prince William Sound are supported by results for other modeled areas—the relative degree of risk reduction achieved under various removal assumptions across spill size is similar in magnitude.

Table 4.5-65 highlights the effects of small, medium, and large oil spills on the Alaska region's socioeconomic resources by presenting estimates of resources oiled as a result of the average modeled spill in absolute terms (area of surface water oiled above the threshold of concern) and as a percentage of the total resource base in the modeled spill area (Prince William Sound). The threshold of concern due to oiled surface water is 0.01 g/m^2 (technical report [French McCay et al., 2004]). This resource area is based on an estimate of the extent to which the coastal community in the modeled area potentially relies on each resource. For the Alaska region, length of shoreline oiled above the threshold of concern is not considered relevant. A single metric was selected for this region because (1) the shoreline oiling results for the Alaska region were sensitive in the modeled spill location; (2) the ability to identify shoreline with characteristics amenable to use was limited; and (3) area of surface water oiled above the threshold of concern was expected to provide a more accurate measure of expected risk, given the region's geographic characteristics.

For this modeling, the socioeconomic environment is divided into components representative of the major parameters of coastal life potentially affected by an oil spill. Absolute and relative risk are discussed for coastal communities, demography, and employment; general economic status of a coastal community; vessel transportation and ports; commercial and recreational fisheries; archaeological and historic resources; recreation and tourism; environmental justice; and public safety and worker health.

Table 4.5-65
Risk Ranking of Offshore Oil Spills* to Coastal Communities as a Result of Surface Water Oiled Using the Basic Response Scenario† with the Addition of Chemical Dispersion in Prince William Sound‡

Spill Size	Response Option (% dispersant efficiency)	Surface Water Area		
		m^2 Oiled Above Threshold§	Estimated % Oiled‖	Risk Factor#
Small (200 bbl)**	Basic	N/A	N/A	N/A
	Chemical Dispersion (45 or 80)	N/A	N/A	N/A
Medium (2,500 bbl)	Basic	419×10^6	4.2	1.0
	Chemical Dispersion (45)	238×10^6	2.4	0.57
	Chemical Dispersion (80)	234×10^6	2.3	0.55
Large (40,000 bbl)	Basic	770×10^6	7.6	1.0
	Chemical Dispersion (45)	503×10^6	5.0	0.66
	Chemical Dispersion (80)	436×10^6	4.4	0.58

Source: Adapted from Part F of the technical report (French McCay et al., 2004).

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of Prince William Sound (as discussed in the text) as representative of the Alaska region for modeling.

§ Thresholds above which some economic or social risk is expected were determined, and the length of shoreline oiled and the area of surface water oiled above this threshold for the average modeled spill are reported. The threshold of concern because of oiled surface water is 0.01 g/m^2 of oil (technical report [French McCay et al., 2004]).

‖ Percentages reflect the proportion of the total modeled area above the threshold of concern.

A risk factor reflects the ratio of the percentage of the model area or volume oiled using the basic response scenario to the model area or percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected with response limited to the basic response scenario.

** A 200-bbl spill is assumed to have negligible effect.

Coastal Communities, Demography, and Employment

Coastal communities benefit from and rely on the marine environment to provide residents with sustenance, livelihoods, leisure opportunities, and shipping avenues. Individuals who live and work in close proximity to the coast derive both social and economic rewards from the natural beauty, recreational opportunities, quality of life, and cultural attributes associated with these coastal locations. Thus, oil spills can affect multiple aspects of a coastal community's assets, leading to adverse effects on the economic benefits of community activities. These effects, in turn, can impose changes on an affected community's demographics and employment patterns.

In addition to the direct employment and other adverse effects associated with oil spills on marine resource-based economic sectors, spills can generate secondary adverse effects on coastal communities. For example, tourist-related spending in the south-central and southwest regions of Alaska fell after the *EXXON VALDEZ* spill by 8 and 35 percent, respectively, representing a loss of approximately $19 million (McDowell Group, 1990). Commercial fishing activities were similarly affected. Such dramatic revenue declines most likely affected employment in these sectors. In addition, because goods must either be flown or shipped in to Prince William Sound, their cost is higher than in other, more accessible regions. Limitations on water access may therefore decrease the availability and increase the price of goods that are imported to the region, significantly affecting coastal communities.

To the extent that mechanical recovery, *in situ* burning, and chemical dispersion can reduce shoreline oiling and the geographic scope of surface water oiling, some combination of spill response options can be expected to reduce the risk to coastal communities in the Alaska region.

For a small spill in the Alaska region, the risk to coastal communities is low. Because of the small surface water area exposed to oil as a result of a small spill, marine-based economic factors such as local commercial or subsistence fisheries may experience little or no effect (Table 4.5-65).

Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill in Prince William Sound will have a spill area[33] above the corresponding threshold of concern that will sweep approximately 419 million m^2 of marine waters (Table 4.5-65). The risk of social and economic and social losses will occur in areas of fishery waters that exceed the thresholds of concern. For example, recreational and commercial fishing may not be permitted in waters exposed to oil, causing losses in revenue to the tourism, recreation, and commercial fishery sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill by affecting employment opportunities, earnings, and the value of coastal living.

The risk to coastal communities from a medium spill can be further mitigated with chemical dispersion. With the addition of chemical dispersion, a medium spill in Prince William Sound will sweep approximately 234 million to 238 million m^2 of marine waters in the spill area above the corresponding thresholds of concern (Table 4.5-65). At 45 and 80 percent efficiency, the risk to resources essential to tourism, recreation, and commercial fisheries is dramatically reduced, falling 43 and 45 percent, respectively, from those resources at risk when mechanical recovery and *in situ* burning are used. These estimates of expected risk reduction are assumed to be valid as proxy indicators of the overall expected reduction in risk to the well-being of residents of coastal communities of a medium oil spill along the Alaskan coast.

Large spills pose a substantial risk for coastal communities. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a large spill will present risk to approximately 770 million m^2 of the marine waters potentially important to commercial fisheries and recreational activities in the spill area. A spill of this size may cause significant decreases in tourism, recreation, associated business activities and revenues, and the quality of coastal living.

The percentage reduction in risk achieved through chemical dispersion for a large spill scenario is also significant, but slightly less dramatic than the reduction achieved for a medium spill. With the addition of chemical dispersion, a large spill in Prince William Sound will sweep approximately 436 million to 503 million m^2 of marine waters in the spill area above the corresponding thresholds of concern (Table 4.5-65). At 45 and 80 percent efficiency, the risk to resources essential to recreation, tourism, and commercial fisheries are reduced from the basic response scenario by 34 and 42 percent, respectively.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal communities, demography, and employment in the Alaska region under Alternative 1 are expected to be minor for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills; any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Economic Status

The overall economic status of communities, industries, and individuals that rely on coastal resources for sustenance, revenue, and quality of life can be affected by an oil spill. As noted above, coastal communities can suffer direct and indirect adverse economic effects from an oil spill, as beach and fishery closures decrease revenue and eliminate jobs. More specifically, losses will be felt in commercial and recreational fisheries, by both the anglers themselves and by related industries as catch opportunities decrease or are eliminated entirely. Tourism and associated businesses will suffer economic setbacks as visits to affected coastal areas decline and purchase of area goods and services decrease because of perceived resource taint. Similarly, environmental justice issues may arise as low-income or minority communities are disproportionately affected by the spill (discussed below in more detail).

The ability of Prince William Sound to provide sustainable populations of marine organisms is critical to several communities. Commercial fishing provides both direct and indirect employment opportunities for residents. In Cordova, for example, three of the ten largest employers are tied to the fishing industry, and fish processing employs the greatest number of individuals outside the government (Fried and Windisch-Cole, 1999). A study conducted by the University of Alaska, Anchorage, estimated that more than one-third of Cordova's workforce is employed in fish harvesting or processing and that about half of the households in the area have someone working in the commercial fishing industry (Fried and Windisch-Cole, 1999). The economic importance of the marine life to coastal communities, however, extends beyond Cordova to other towns, both within and outside of Prince William Sound (Boucher, 2000). Valdez is home to three fish processing plants, two of which are among the community's top ten employers (Fried and Windisch-Cole, 1999).

A small spill that is 3 or more statute mi offshore would have essentially no adverse effect on either the local or regional economies (Table 4.5-65). There is little to no risk of oiling economically important resources, and it is unlikely that any commercial fisheries or recreational areas would be affected.

A medium spill, with mechanical recovery, *in situ* burn, and dispersant operations, could be expected to have short-term adverse economic effects as a result of oiling recreational beaches and limited closing of fisheries, plus the need to supplement the normal response operation employment base, especially if shoreline oiling occurs. These adverse effects would probably be very short lived, in that cleanup operations would not require a long period of time. The risk to the economic status of coastal communities from a medium spill can be mitigated significantly with chemical dispersion. With the addition of chemical dispersion at 45 and 80 percent efficiency, the modeling indicated that the risk to economically important resources is dramatically reduced. These measures of risk reduction for Prince William Sound are assumed to be valid indicators of the overall expected risk reduction to coastal communities for this size spill in Alaskan waters. Thus, overall risk to coastal communities in the Alaska region is expected to fall when spill response options involve chemical dispersion. Coastal communities will experience reduced risks of fishery closures, decreased tourism, and any negative effects on coastal living that an oil spill might have.

For a large spill, the adverse economic effects could be high, even with mechanical recovery, *in situ* burning, and chemical dispersion, based on the likelihood that closures of commercial fisheries and recreational fishing grounds will occur. In addition, the potential level of shoreline oiling would require a much larger cleanup effort. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause the adverse socioeconomic effects to be higher. As assumed under Alternative 1, chemical dispersion will help mitigate the adverse effects of a large oil spill by reducing the surface area oiled, but it may not have the same effect on public perception.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on economic status in the Alaska region under Alternative 1 are expected to be minor for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills; any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Vessel Transportation and Ports

Oil spills occurring 3 or more statute mi offshore are not likely to cause large adverse effects on vessel transportation and ports; any adverse effects would likely be of short duration. However, an oil spill can disrupt marine commerce if it occurs in and around a shipping channel or port and results in limits on watercraft movement as a means of facilitating spill response. Any interruption in the standard use of vessels or increase in travel times over water can result in hardship for coastal communities as fewer goods are exchanged, transportation costs rise, and the revenue streaming through the local economy falls. Although the possibility exists for the affected area's trade partners to be affected by interruptions in marine transportation in the spill area, the availability of substitute suppliers and shipping modes and the expected short-term nature of any disruption in vessel traffic, such adverse effects are not likely to be large.

Vessel transportation is vital to the welfare of Alaskan communities. In Prince William Sound, specifically, only Whittier and Valdez are connected to the major highway system in Alaska. The ferry that runs between Cordova, Valdez, Whittier, Tatitlek, and Chanenga Bay provides critical transportation services (ADOT&PF, 2001). The importance of ferry services is not unique to Prince William Sound; it is common in many parts of Alaska. In addition, because goods must either be flown in or shipped to Alaska, their cost is higher than in other, more accessible regions. Limitations on water access can therefore decrease the availability and increase the price of goods that are imported to the region, significantly affecting coastal communities without immediate access to Anchorage or other major cities.

To the extent that mechanical recovery, *in situ* burning, and chemical dispersion can reduce shoreline oiling and the geographic scope of surface water oiling, some combination of spill response options can be expected to reduce the risk to vessel transportation and ports in the Alaska region.

Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill could affect up to 419 million m^2 and a large spill, up to 770 million m^2 of surface water above recognized thresholds (Tables 4.5-65). These adverse effects would affect commercial navigation in the vicinity of the spill and would likely affect income and employment either directly or indirectly relying on the swift movement of goods to and from local ports.

For a small spill regardless of response option, no high adverse effects on vessel transportation or ports are expected (Table 4.5-65), but there is some risk for medium and large spills. Therefore, the nature of the risk to vessel transportation and ports will be a function of the location, area, and pattern of surface water oiling, as well as the extent of oiling in port areas. A medium spill along the Alaskan coast would not generally be expected to result in large adverse effects; however, there is some risk to vessel transportation and ports for a large spill.

To the extent that it will shorten the cleanup period, chemical dispersion would be expected to reduce the risk to the spill area. At 45 and 80 percent efficiency, chemical dispersion would be expected to reduce the overall risk to marine traffic and of port closures by 43 to 45 percent for a medium spill and by 34 to 42 percent for a large spill, respectively, from those resources at risk when mechanical recovery and *in situ* burning are used.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on vessel transportation and ports in the Alaska region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills; any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Fisheries

Commercial Fisheries

Commercial fisheries are vulnerable to oil spills because of both closures and perceived taint. A moratorium on fishing operations in the wake of an oil spill can lead to significant losses in revenue for the commercial fishing industry, as well as related industries, including those that supply equipment to and purchase products from commercial fleets. In addition, oil spills can lead to the closure of fisheries, decrease demand for fish from affected waters because of actual or perceived taint, and instigate alterations to fishing practices in a manner that increases operating costs and/or decreases revenues. Large spills can potentially injure fish nursery grounds and impose other risks that could reduce fish harvests in the longer term.

Commercial fishing is an important economic activity in the Alaska region. In 2001, the salmon harvested from Prince William Sound yielded $45.58 million, with a total catch of 41.14 million fish, representing approximately 20 percent of Alaska's total salmon harvest (ADF&G, 2001).

To the extent that mechanical recovery, *in situ* burning, and chemical dispersion can reduce shoreline oiling and the geographic scope of surface water oiling, some combination of spill response options can be expected to reduce the risk to regionally important fisheries in the Alaska region.

Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill could affect up to 419 million m^2 and a large spill, up 770 million m^2 of surface water above recognized thresholds (Table 4.5-65). While adverse effects would be felt directly by commercial fishermen, local income and employment in sectors tied to this industry could also be affected.

For a small spill in the Alaska region, the risk to commercial fisheries is negligible using the basic response scenario (Table 4.5-65). Any adverse effects that occur, however, would be reduced with chemical dispersion.

For a medium spill, the risk to commercial fisheries is likely to be greater than for a small spill. A risk of economic loss to commercial fisheries will occur when waters exceed management and/or relevant thresholds. For example, fishing may not be permitted in waters swept by oil above the modeled threshold of concern, resulting in reductions in commercial fish landings for a period of time following the spill. The resulting adverse effects would be expected to reverberate through communities in the area of the spill, causing decreases in employment, income, and the viability of businesses associated with the commercial fishing industry. To the extent that substitute fishing grounds are available, spill effects on the commercial fishing economy may be less severe.

The risk to commercial fisheries of a medium spill can be mitigated significantly with chemical dispersion. At 45 and 80 percent efficiency, the risk to resources essential to commercial fisheries is reduced by 43 and 45 percent, respectively, from those resources at risk when mechanical recovery and *in situ* burning are used.

For a large spill, there is a substantial risk to regional commercial fisheries. A spill of this size may cause significant decreases in commercial fishing activities and revenues, as well as of associated businesses. Again, to the extent that commercial fishing operations can, for a time, move to substitute fishing grounds, the potentially severe effects of even a large spill can be avoided. With chemical dispersion, the percentage of risk reduction for a large spill scenario is slightly smaller than that for a medium spill, but is nevertheless high. At 45 and 80 percent efficiency, chemical dispersion could be expected to reduce the risk to commercial fisheries by 34 to 42 percent, respectively.

Recreational Fisheries

Fishing and camping are popular recreational activities in Prince William Sound. The prime fishing and camping sites in Prince William Sound and the Chugach National Park along the coast are accessible only by air and water. In fact, the majority of the park along the coast near Whittier was designated the Nellie Juan-College Fiord Wilderness Study Area in the Alaska National Interest Lands Conservation Act of 1980 (USDA Forest Service, 2002). Because much of this shoreline is wilderness, thus inaccessible by land, charter boats are a popular means of accessing recreational fishing waters in Prince William Sound; the number of boat charters almost doubled between 1997 and 1999 (Fried and Windisch-Cole, 1999).

For a small spill regardless of response option, adverse effects on recreational resources in the Alaska region would likely be negligible (Table 4.5-65). The risk to recreational fisheries for a medium spill is likely to be greater than for a small spill. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill near the Alaskan coast will sweep approximately 419 million m^2 of marine waters used by recreational fishermen. However, the risk to recreational fisheries can be mitigated significantly with chemical dispersion. With chemical dispersion a medium spill will adversely affect approximately 234 million to 238 million m^2 of marine waters in the spill area used by the recreational fishing industry above the corresponding thresholds of concern (Table 4.5-65). At 45 and 80 percent efficiency, the risk to resources essential to recreational fishing is reduced by 43 and 45 percent, respectively, from those resources at risk when mechanical recovery *in situ* burning are used.

For a large spill, there is a substantial risk to recreational fisheries. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a large spill presents risk to approximately 770 million m^2 of the marine waters potentially important to recreational fishermen. Although chemical dispersion would mitigate the damages, the percentage of risk reduction for a large spill is slightly smaller than for a medium spill, but is nevertheless high. At 45 and 80 percent efficiency, chemical dispersion could be expected to reduce the risk to recreational fishing grounds by 34 to 42 percent, respectively.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on fisheries (commercial and recreational) in the Alaska region under Alternative 1 are expected to be minor, moderate, and significant for small, medium, and large spills, respectively, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills. Any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Subsistence

Potential adverse effects on marine species are a concern during spills where traditional use of subsistence resources occurs. Fish, shellfish, and marine mammals are the major species gathered for subsistence in the Alaska region (Section 3.6.5.5). Tissue tainting would be the primary concern for these subsistence resources.

Prince William Sound was selected for the modeling as representative of the coastal habitats, fish, and wildlife in the Alaska region. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the severity of potential adverse effects on subsistence resources. Potential adverse effects on subsistence resources in the Alaska region are low for small and medium spills, and higher for large spills (Table 4.5-66).

Table 4.5-66
Risk Ranking of Offshore Oil Spills* to Subsistence Using the Basic Response Scenario† with the Addition of Chemical Dispersion in Prince William Sound‡

Spill Size	Response Option (% dispersant efficiency)	Resources Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Large (40,000 bbl)	Basic	1–5	4D
	Chemical Dispersion (45 or 80)	1–5	4D

Source: Adapted from Part F of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of Prince William Sound (as discussed in the text) as representative of the Alaska region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Effects on subsistence resources for a small spill were determined to be low by extrapolating from the results for a medium spill. Using mechanical-only recovery for a medium spill, the modeling results showed water column exposure to dissolved aromatics to be at low concentrations (1–100 ppb) and to only occur in a small area. Sediment exposure was negligible. Tainting of fish and invertebrates becomes a concern when water concentrations exceed approximately 100 ppb (Section 4.3.5.6). A very small percentage of shoreline habitats were oiled; therefore, a proportionally small percentage of subsistence resources associated with these habitats are likely to be exposed. Using mechanical-only recovery for a large spill, the modeling results were similar to those of a medium spill for water column and sediment exposure. Two percent of the entire shoreline area was oiled; therefore, the risk score increased for a large spill because of the likelihood of more shoreline and intertidal resources being affected. The risk scores in Table 4.5-66 reflect the predicted recovery rates for subsistence resources of less than 1 year for all spill volumes (Section 4.3.5.6).

With the addition of chemical dispersion at 45 and 80 percent efficiency for a medium spill, the modeling results showed water column exposure at low concentrations (1–100 ppb) in a more widespread area and at high concentrations (100–10,000 ppb) in localized areas. The length of oiled shoreline was reduced by nearly 60 percent when at both 45 and 80 percent efficiency. Because of the increase in potential exposure to oil for water column resources and the decrease in potential exposure for intertidal and shoreline resources, the risk scores did not change at either dispersant efficiency. With the addition of chemical dispersion at 45 and 80 percent efficiency for a large spill, the modeling results showed water column exposure at both low (1–100 ppb) and high (100–10,000 ppb) concentrations in a more widespread area. At 45 and 80 percent efficiency, shoreline oiling was reduced by 50 and 65 percent, respectively. Chemical dispersion increased water column exposure but decreased shoreline and intertidal exposure; therefore, the risk scores did not change at either dispersant efficiency. Although areas other than Prince William Sound in the Alaska region were not modeled, the results are consistent with those for all other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on subsistence resources will fall within a similar range throughout the Alaska region. On a regional level, adverse effects on subsistence resources are not expected to be high, and on a local level, a large spill may cause high adverse effects on Native Alaskan communities.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subsistence resources in the Alaska region under Alternative 1 are expected to be insignificant for small and medium spills, and minor for large spills, with or without dispersant use.

Archaeological/Historic Resources

Under Alternative 1 using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), with or without the addition of chemical dispersion, adverse effects on archaeological resources in the Alaska region would likely be negligible, regardless of spill size. Archaeological resources in this region occur on- and offshore, and submerged shipwrecks occur offshore (Section 3.6.5.7).

Over 1,000 prehistoric sites have been documented in the Gulf of Alaska. Most of these sites lie next to the shore and consist of subsistence resource-gathering areas. Historic sites consist mainly of early Russian settlements, fish and mining camps, and World War II artifacts. Some of these are located along the coast (Section 3.6.5.7). There are limited data that identify long-term or chronic degradation to cultural resources due to chemical dispersion. Results from several studies indicated that direct oiling caused negligible effects on cultural resources following the *EXXON VALDEZ* oil spill (Bittner, 1996; Dekin, 1993; Reger et al., 1992; Wooley and Haggarty, 1995). Mechanical recovery, *in situ* burning, and chemical dispersion may help reduce the amount of oil that strands on the shoreline, which will also reduce the amount of shoreline cleanup and potential disturbance to sensitive cultural resources. Offshore archaeological and historic resources are not at risk of becoming oiled, and onshore sites tend to be above the affected area but could be protected during cleanup operations.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on archaeological and historic resources in the Alaska region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Recreation and Tourism

Recreation and tourism are essential components of the Alaskan economy, generating $952 million in revenue per year and providing 18,900 jobs. Approximately 1.3 million people visit Alaska annually traveling to the state for its wildlife, outdoor recreational opportunities, and scenery (ADC&ED, 2002). An oil spill would be expected to affect recreationists' overall social welfare; in addition, the social and economic implications of a spill would reach beyond direct effects on visitors and into the community. For example, visitors may be less likely to visit and spend money in an area perceived as affected by a spill, potentially leading to loss of business revenue and jobs (see Coastal Communities, Demography, and Employment above for more details).

An analysis of the effect of the *EXXON VALDEZ* spill on the tourist industry highlights the importance of unconstrained travel within Prince William Sound to the economic health of the recreation and tourism sector. In the wake of the *EXXON VALDEZ* spill in 1989, tourism and corresponding revenues in Prince William Sound decreased. A survey conducted by the McDowell Group (1990) estimated that tourist-related spending in the south-central and southwest regions of Alaska fell after the spill by 8 and 35 percent, respectively, representing a loss of approximately $19 million; 20 percent of visitors to south-central and southwest Alaska reported changing their plans in the wake of the spill. In addition following the spill, 59 percent of businesses in the area reported cancellations, with lodges, resorts, package tour companies, guided outdoor activities, and charter and sightseeing boats feeling the greatest effects. Although the demand for lodging, food, and other services remained constant in some parts of Prince William Sound because individuals involved in the remediation efforts required them, at times the needs of the cleanup crews were so great that tourists were squeezed out of popular destinations, unable to find accommodations or charter boats. This trend dominated areas close to the spill. Further, the perceived taint of Prince William Sound extended the negative effects of the spill beyond the immediate spill area. In recreational areas at some distance from the spill, perceived taint kept visitors away, and as a result tourism-related businesses in these areas experienced greater losses than those in other areas (McDowell Group, 1990).

To the extent that mechanical recovery, *in situ* burning, and chemical dispersion can reduce the geographic scope of surface water oiling, some combination of spill response options can be expected to reduce the risk to recreation and tourism in the Alaska region.

For a small spill in the Alaska region, the risk to recreation and tourism is low. In many cases, a spill of this size would be expected to pose little or no risk to marine-based activities because the spilled oil will never reach the shoreline above a threshold of concern. Any adverse effects that occur, however, would be reduced with chemical dispersion.

The risk to recreation and tourism from a medium spill is likely to be greater than from a small spill. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill near the Alaskan coast will have a spill area above the corresponding thresholds of concern that will adversely affect approximately 419 million m^2 of marine waters used for recreation and tourism (Table 4.5-65). Under these conditions, fishing, boating, and wildlife viewing may not be permitted in waters exposed to oil, causing losses in revenue to the recreation and tourism sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill, causing decreases in tourism and recreation, and the revenue and employment associated with these industries.

The risk to recreation and tourism of a medium spill can be further mitigated significantly with chemical dispersion. With the addition of chemical dispersion at 45 and 80 percent efficiency, the risk to resources essential to recreation and tourism along the Alaskan coast is reduced by approximately 45 percent, regardless of removal efficiency.

Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a large spill will sweep approximately 770 million m^2 of marine waters used for recreation and tourism (Table 4.5-65). A large spill may cause significant decreases in tourism, recreation, and the revenues of businesses associated with these industries.

With chemical dispersion, the percentage of risk reduction for a large spill is slightly less dramatic than for a medium spill. Although eliminating the risk to shoreline-dependent activities is not possible for large spills, at 45 and 80 percent efficiency, chemical dispersion could be expected to reduce effects on recreation and tourism by 35 and 43 percent, respectively.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on recreation and tourism in the Alaska region under Alternative 1 are expected to be insignificant for small, medium, and large spill sizes, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills. Any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Environmental Justice

In some coastal areas, low-income, indigenous, and minority populations may rely on regional fisheries and other marine species in the context of participating in commercial fishery or other marine resource-based employment. These groups may experience the effects of a spill more severely than the general population, which relies on a more diverse economic base for its livelihood and on the availability of a widespread, commercially available selection of foods. Additionally, subsistence use of natural resources and employment in marine resource-related industries may have value beyond the importance these resources hold as a food source or employment opportunity.

Poverty in these populations is the best indicator of potential environmental justice issues. This modeling assumes that low-income groups would disproportionately suffer adverse socioeconomic effects from an oil spill. Low-income communities, which can be found across the Alaska region, include multiethnic as well as homogenous communities and neighborhoods. Minority groups are scattered throughout the region, but the primary population center is the Anchorage Municipality, along the coast. In addition, within Alaska there are several federally recognized tribal lands. Alaska Natives include the Tlingit, Haida, Yupik, Inupiat, Metlakatla, Eyak, Tanana, Ahtna, and Tanaina.

Of the 128,516 families that live in the Alaska region, 6.7 percent (or 8,545) have been classified as living in poverty by the U.S. Census Bureau (2000c). The average per capita and median household incomes of this region are $20,635 and $47,948, respectively. However, 20 percent of households earned less than $25,000 in 1999. Demographics with respect to environmental justice serve as a good proxy for the potential of oil spills at various locations along the Alaskan coast to disproportionately affect disadvantaged populations.

Given the heavy reliance on subsistence harvests and the large role that marine life plays in subsistence diets, oil spills have the potential to disrupt the food supply for Alaskan residents in remote locations of Prince William Sound. According to Fall and Field (1996), subsistence resource harvests fell by 57 percent in the wake of the *EXXON VALDEZ* spill in Chanenga Bay and by 56 percent in Tatitlek. In addition to compromising food intake, a spill can force residents to change their consumption pattern. Prior to 1989, marine mammals were as important to the subsistence harvest as fish for Chanenga Bay and Tatitlek residents, each representing approximately 37 percent of total harvests. In the wake of the spill, marine mammals represented only 6 percent of the subsistence food in Chanenga Bay and a similar percentage in Tatitlek, while fish became increasingly important, with this harvest's contribution to the total rising to 74 percent in 1991 and 1992 (Fall and Field, 1996). Thus, not only can a spill affect the quantity of food harvested, but the composition of the harvest, potentially interfering with the ability to secure culturally important foods. Although such foods are available in other areas, the cost of obtaining them in terms of time, effort, and money may be prohibitive.

For a small spill in the Alaska region, the risk of significant changes in any group's economic status is low, regardless of response option used. In many cases, a spill of this size is expected to pose no risk to marine waters exposed to oil above a threshold important to local commercial or subsistence fisheries (Table 4.5-65).

The risk to the economic status of indigenous and subsistence communities for a medium spill is likely to be greater than for a small spill. Using the baseline response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill in Prince William Sound would be expected to sweep approximately 419 million m^2 of marine waters potentially used by subsistence fishermen above the corresponding thresholds of concern (Table 4.5-65). The risk of economic and social losses will occur in areas of fishery waters that exceed the thresholds of concern and affect the subsistence communities that depend on them. The risk to such communities for a medium spill can be mitigated significantly by additional spill response. Assuming chemical dispersion at 45 and 80 percent efficiency, the risk to resources essential to subsistence communities along the Alaskan shoreline are reduced by 43 and 45 percent, respectively.

For a large spill, there is a substantial risk to indigenous and subsistence groups that depend on coastal and marine resources. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a large spill will affect nearly 770 million m^2 of the marine waters potentially important to subsistence communities (Table 4.5-65). A spill of this size may cause significant decreases in the availability of subsistence food sources. Chemical dispersion will mitigate the adverse effects of a spill of this size on subsistence groups. Although the elimination of the risk to shoreline-dependent activities is not possible for large spills, at 45 and 80 percent efficiency, chemical dispersion could be expected to reduce effects on recreation and tourism by 34 and 42 percent, respectively.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on environmental justice in the Alaska region under Alternative 1 are expected to be minor, moderate, and significant for small, medium, and large spills, respectively, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills. Any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Public Safety and Worker Health

Potential adverse effects on public safety are defined as the risk to the public from direct exposure to oil or response activities as a result of the spill, or through consumption of contaminated water or organisms. There are many areas in the Alaska region with high-population concentrations along the coast. However, adverse effects on public safety are unlikely from oil spills that occur 3 or more statute mi offshore for any of the spill sizes considered, regardless of the response options—mechanical recovery, *in situ* burning, and/or chemical dispersion—used. The USCG has protocols to protect the public from risk during shoreline response operations, as well as on-water protocols to prevent the public from entering the response area.

Potential adverse effects on workers' health are related to direct exposure to oil during response operations. In addition, operating oil spill response equipment can be dangerous, which is well recognized and is the basis for the worker certification and training requirements that are now in place. There is also a health risk from inhalation of hydrocarbon fumes for first responders, which is recognized in current safety protocols. The risk is greater as the spill size and the corresponding intensity and duration of operations increase, but is minimized if safety standards are followed. There are also protocols in place for the proper application and handling of dispersants.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on public health and worker safety in the Alaska region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

4.5.7. Consequences in the Oceania Region

Oceania is a collective name used for the islands scattered throughout most of the Pacific Ocean. In its broadest sense, the term embraces the entire insular region between Asia and the Americas. For the purposes of this PEIS, the Oceania region will specifically cover the tropical waters surrounding the islands of Hawaii, Guam, Commonwealth of Northern Mariana Islands (CNMI), and American Samoa (Figure 3.1-1). Midway, Jarvis, and Wake Islands are also included in some of the analysis. There was no location in this region with readily available data for modeling and risk assessment purposes, but the risks can be inferred from the range of effects observed in the five modeled locations. However, in some cases the modeling results for the Florida Straits (actually in the Atlantic region) were used because it has similar resources of concern. The results of the Florida Straits modeling are detailed in Part D of the technical report (French McCay et al., 2004).

Table 4.5-67 presents the risk ranking for the modeling of Alternative 1 in the Oceania region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) for three spill sizes (small, 200 bbl; medium, 2,500 bbl; and large, 40,000 bbl). The risk scores presented in the table are based on the modeling results for an average spill and on regional considerations; however, in any specific oil spill situation local concerns could be higher. Table 4.5-68 summarizes the significance of the potential beneficial and adverse impacts associated with Alternative 1 in the Oceania region, based on the extrapolation of the modeling results for an average spill to the region in general.

Although dispersant pre-authorization agreement areas exist in the Oceania region (Figure 2.2-1), under the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) of Alternative 1, appropriate response times cannot currently be met for chemical dispersion; thus, chemical dispersion is not considered in the analysis of the Oceania region. Further, the modeling shows that *in situ* burning would not significantly change the level of concern identified from those obtained when using mechanical-only recovery.

For spills analyzed in this document (i.e., those that occur 3 or more statute mi offshore), there are likely to be minor or insignificant adverse impacts on all resources except marine and coastal birds and intertidal habitats, which could be moderate, for a small spill using mechanical-only recovery. For medium and large spills, adverse impacts are insignificant or minimal for all resources except for marine and coastal birds and sea turtles, which could be moderate, and intertidal habitats and areas of special concern, which could be significant. For a large spill, there is the additional potential for moderate adverse impacts on subsistence and environmental justice as well. All adverse impacts occur despite the treatment or recovery of some of the oil, but are reduced by these actions when they are effective.

Table 4.5-67
Risk Ranking[*] of Offshore Oil Spills[†] under Alternative 1 Using the Basic Response Scenario[‡] in the Oceania Region

	Resources of Concern												
	Physical Environment			Biological Environment								Socioeconomic Environment	
Spill Size	Coastal Water Quality	Marine Water Quality	Air Quality	Marine Mammals[§]	Marine and Coastal Birds[§]	Plankton and Fish[§]	Intertidal Habitats	Subtidal Habitats	Sea Turtles[§]	Areas of Special Concern	Essential Fish Habitat	Subsistence[‖]	Archaeological/Historic Resources[‖]
Small (200 bbl)	4E	4E	4E	3E	3D	4E	1E	4E	3E	1E	4E	4E	4E
Medium (2,500 bbl)	4D	4E	4E	3E	3B	4D	1C	4E	3D	1C	4D	4D	4E
Large (40,000 bbl)	4C	4E	4E	3E	3A	4D	1A	3E	3C	1A	4D	4A	4E

Source: Adapted from Parts B through F of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern; yellow, a medium level of concern; and green, a low level of concern.

[*] This risk ranking is a summary of risk scores for the resources considered in this PEIS. The risk scoring process is explained in Section 4.4.3.

[†] Average spills.

[‡] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[§] Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles. If such species are affected by an actual spill, the level of concern would be high.

[‖] Subsistence and archaeological/historic resources are the only socioeconomic resources that could be ranked using the risk matrix.

Table 4.5-68
Summary of Potential Adverse Regional Impacts of Offshore Oil Spills* under Alternative 1 Using the Basic Response Scenario† in the Oceania Region

	Resources of Concern																			
	Physical Environment			**Biological Environment**								**Socioeconomic Environment**								
Spill Size	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals‡**	**Marine and Coastal Birds‡**	**Plankton and Fish‡**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles‡**	**Areas of Special Concern**	**Essential Fish Habitat**	**Coastal Communities, Demography, and Employment**	**Economic Status**	**Vessel Transportation and Ports**	**Fisheries**	**Subsistence**	**Archaeological/Historic Resources**	**Recreation and Tourism**	**Environmental Justice**	**Public Safety and Worker Health**
Small (200 bbl)	Ins	Ins	Ins	Min	Mod	Ins	Mod	Ins	Min	Mod	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
Medium (2,500 bbl)	Min	Ins	Ins	Min	Mod	Min	Sig	Ins	Mod	Sig	Min	Ins	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins
Large (40,000 bbl)	Min	Ins	Ins	Min	Mod	Min	Sig	Min	Mod	Sig	Min	Ins	Ins	Ins	Ins	Mod	Ins	Ins	Mod	Ins

Note: Based on Table 4.5-67. Sig, significant; Mod, moderate; Min, minor; and Ins, insignificant.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles.

4.5.7.1. Consequences to the Physical Environment

Water Quality

Potential adverse consequences of oil spills to water quality are related to hydrocarbon contamination, as other constituents in oils are at concentrations that would not exceed thresholds of concern. The hydrocarbons that could affect water quality are the soluble aromatics, MAHs (monoaromatic hydrocarbons) and PAHs (polynuclear aromatic hydrocarbons) (Section 4.3.1.1). Thus, evaluation of potential adverse effects is based on the degree of potential contamination by these compounds. No beneficial effects on water quality would be expected to result from an oil spill.

For oil spills in marine waters, adverse effects of water quality are generally low, whether a mechanical-only recovery or mechanical recovery plus *in situ* burning is employed. This is because of the tendency for most chemical compounds of concern to evaporate, rather than dissolve, and the rapid dilution of any chemical compounds that might enter the water column. During periods of extreme turbulence, oil generally mixes into the water column where aromatics may dissolve rapidly, but resurfacing and dilution of oil droplets result in only localized contamination at levels of concern unless the dilution volume is restricted. Overall based on the modeling and risk assessment results, it is concluded that—using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit)—adverse water-quality effects under Alternative 1 would be low in marine waters, even in the event of a large spill in the Oceania region. However, if the spill moved into shallow and confined coastal waters, adverse effects could be locally important for medium and large spills under conditions where oil is mixed into water by strong turbulence or in areas where oil collects for a few weeks to months after a spill.

The variable used to determine potential water-quality effects is "volume of water contaminated" by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer, which is less than all established water-quality criteria and thresholds of concern for effects on aquatic biota (Sections 4.3.1.1 and 5.3.2.1). The affected water volume increases with spill volume and varies with the level of physical dispersion during the time of the spill. Natural dispersion increases with stronger winds and currents, lessening the volume of water that is contaminated above the threshold of concern if in unconfined waters. Since the volume of water contaminated increases exponentially as a function of spill size, the estimated volume of water contaminated for a small spill was extrapolated from the mean medium- and large-spill model results. The estimates of the volume of water contaminated—and its variability—are generally applicable to spills of the same size throughout the Oceania region because the mixing of oil into water and process of dilution are similar in all areas.

Coastal

Florida Bay is used as a representative of coastal water for analyzing the Florida Straits, as well the Oceania region. Florida Bay is approximately 16,288 km^2 in area and about 2 m deep on average, with a total volume of approximately 32,576 million m^3. The estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of Florida Bay to determine the potential consequences of small, medium, and large spills (Table 4.5-69). This approach yields a very conservative estimate, in that it assumes all of the contamination would occur in coastal water.

Table 4.5-69
Risk Ranking of Offshore Oil Spills* to Coastal Water Quality Using the Basic Response Scenario† in the Oceania Region (Based on the Florida Straits)‡

Spill Size	Volume of Water Contaminated (million m³)	Area Contaminated (estimated %)	Risk Score§
Small (200 bbl)	$< 40 \times 10^{-6}$	8×10^{-7}	4E
Medium (2,500 bbl)	83	1.7	4D
Large (40,000 bbl)	326	6.8	4C

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Oceania region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Because of natural dilution, evaporation, and biological processes, contamination levels would decrease rapidly even in the case of a large spill, and recovery time would be on the order of days to weeks. Oil may be incorporated into shallow water or intertidal sediments where, through leaching, it could become a continuing source of contamination over time. However, this would generally only lead to noticeable water-quality degradation in the locality where the oil collects. This is unlikely to occur with a spill that originates offshore. Because mechanical removal would begin within the required response time under Tier I standards (beginning about 12 hours after the spill), much of the soluble components of concern to water quality would have evaporated or dissolved. Thus, mechanical recovery and *in situ* burning would have a low influence on the volume of water adversely affected, and the risk score results would apply whether either response is implemented.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal water quality in the Oceania region under Alternative 1 are expected to be insignificant for small spills, and minor for medium and large spills.

Marine

In marine waters, which are 3 or more statute mi offshore, mechanical response and *in situ* burning currently may be used for spill response in the Oceania region; although dispersant pre-authorization agreement areas exist in the Oceania region (Figure 2.2-1), chemical dispersion is not used because appropriate response times cannot currently be met. As was done for coastal waters, the estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of the reference area, the Florida Straits.

The Florida Straits was selected for the modeling as representative of the marine waters around the islands in the Oceania region. The total surface area of the Florida Straits is approximately 42,689 km^2, so the area of interest is much vaster for marine waters than for coastal waters. Water-quality effects were calculated using a spill site in relatively shallow water—20 m deep, which is much shallower than most of the Oceania region's marine waters. The results for the selected modeled location (Table 4.5-70) represent conservative estimates of adverse water-quality effects using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit).

Table 4.5-70
Risk Ranking of Offshore Oil Spills* to Marine Water Quality
Using the Basic Response Scenario† in the Oceania Region (Based on the Florida Straits)‡

Spill Size	Area Contaminated (estimated %)	Risk Score§
Small (200 bbl)	5×10^{-9}	4E
Medium (2,500 bbl)	0.1	4E
Large (40,000 bbl)	0.4	4E

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Oceania region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Natural dispersion of the oil would be very rapid after a spill, and recovery time would be on the order of hours to days. Leaching from oil contamination reaching the sediments would not have a large effect on marine water quality because of the large dilution volume and natural dispersing forces in marine waters. The results would apply whether or not a mechanical response is implemented. Since *in situ* burning would replace some of the mechanical response, and both methods remove oil that would otherwise result in water contamination, the potential water-quality effects would not change significantly if *in situ* burning was used. For a spill in water deeper than the 20 m evaluated here, the potential adverse effects would be even smaller.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine water quality in the Oceania region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Air Quality

Concentrations of hydrocarbons of concern in the air resulting from oil spills and response operations were compared with air quality standards to evaluate the potential for adverse effects (Section 4.3.1.2). The effects of an oil spill on air quality may involve all volatile components of the oil. In addition, if *in situ* burning was used, particulates and other contaminants emitted from burns could become an air quality concern. However, adverse air quality effects from oil spills are normally very localized and short lived for small, medium, and large oil spills. The addition of *in situ* burning does not significantly increase any potential adverse effects: the volume of oil that could be burned is not large, and the temporary smoke plume would be localized and rapidly diluted.

The modeling shows that results do not vary by spill location or size in the Oceania region. Two possible sources of contamination to the atmosphere were evaluated for their potential effects on air quality: volatilization of hydrocarbons from unburned oil and emissions produced by *in situ* burning. Concentrations in the lowest 2 m of the atmosphere were compared with the U.S. Environmental Protection Agency's National Ambient Air Quality Standards (USEPA's NAAQS) and other thresholds of concern (as discussed in Section 4.3.1.2).

The results of the modeling show that the potential adverse effects on air quality are low for all spill sizes involving mechanical-only recovery; hence, the risk scores are virtually identical for small, medium, and large spills. Volatilized hydrocarbons would not exceed air quality standards for human health at more than 1 km from the spill site. Evaporation off the water surface and volatilization from the water column create a plume of volatile hydrocarbon gases that disperses quickly after a spill, such that the concentrations in the atmosphere at the water surface would not exceed human health thresholds of concern at any location. The recovery time for the atmosphere would be on the order of days. Thus, a low level of concern is expected for small, medium, and large spills involving mechanical-only recovery.

Mechanical recovery plus *in situ* burning would increase atmospheric pollutants by the amount emitted via burning. For small spills, it would be very unlikely that *in situ* burning would be used, as the oil would disperse too rapidly for it to be feasible (Table 4.5-71). The maximum area potentially exceeding the NAAQS or thresholds of concern is 1.6 km^2 for a medium spill and 12.7 km^2 for a large spill. If humans or sensitive resources (i.e., wildlife) are within these areas, they could be affected by poor air quality for a short time, on the order of hours. Since *in situ* burning can only be used offshore in marine waters, and considering a region of interest equivalent to the Florida Straits (42,689 km^2), the area of adverse effects would be less than 1 percent, and the atmosphere would recover in a matter of hours. Thus, low levels of concern are expected from small, medium, and large oil spills involving *in situ* burning (4.5-71).

Table 4.5-71
Risk Ranking of Offshore Oil Spills* to Air Quality
under *In Situ* Burning in the Oceania Region (Based on the Florida Straits)†

Spill Size	Area Exceeding Threshold (km²)	Area Contaminated (estimated %)	Risk Score‡
Small (200 bbl)	1.6	0.004	4E
Medium (2,500 bbl)	1.6	0.004	4E
Large (40,000 bbl)	12.7	0.03	4E

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Oceania region for modeling.

‡ The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on air quality in the Oceania region under Alternative 1 are expected to be insignificant for small, medium, and large spills, with or without *in situ* burning.

4.5.7.2. Consequences to the Biological Environment

Marine Mammals

The species of cetaceans inhabiting the Oceania region (Section 3.7.2.1, Table F.7-1) have concentrations that vary depending on seasonal migrations. The only pinniped of concern in this region is the Hawaiian monk seal (*Monachus schauinslandi*); however, sightings are rare and scattered. There are no fur-bearing marine mammals of concern that inhabit this region. Thus, local populations of cetaceans, which are abundant in the Oceania region, are the primary concern during an oil spill (Section 3.7.2.1).

Cetaceans such as whales and dolphins are vulnerable to spilled oil since they spend considerable time at the water's surface, which enhances possible contact with oil. The majority of these species remains offshore, and populations vary according to season and migration directions. Cetaceans appear able to detect and are likely to avoid floating oil or oil being recovered by mechanical means (Geraci, 1990). Studies have shown that cetacean skin is nearly impenetrable to even the highly volatile constituents of oil, indicating that contact with oil probably would be less harmful to cetaceans than often believed. However, the toxic, volatile fractions in fresh crude oils could irritate and damage cetacean soft tissues, such as the mucous membranes of the eyes and airways.

The equivalent area for 100 percent mortality for cetaceans (the only marine mammals of concern) at all five modeled locations ranged from 0.08 to 0.11 km² (average area of 0.09 km²) for a medium spill and from 0.46 to 1.33 km² (average 0.85 km²) for a large spill. Relative to the surface area available, this is a very small area, much less than 1 percent. Recovery would be relatively rapid, given that only sublethal effects, if any, would be expected. The results for marine mammals in the Oceania region are presented in Table 4.5-72.

Table 4.5-72
Risk Ranking of Offshore Oil Spills* to Marine Mammals Using the Basic Response Scenario† in the Oceania Region‡

Spill Size	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	0–1	3E
Medium (2,500 bbl)	0–1	3E
Large (40,000 bbl)	0–1	3E

Source: Adapted from Parts B through F of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the five modeled locations (as discussed in the text) as representative of the Oceania region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine mammals in the Oceania region under Alternative 1 are expected to be minor for small, medium, and large spills.

Marine and Coastal Birds

Potential adverse effects on marine and coastal birds are usually of highest concern during an oil spill because birds are highly susceptible to the acutely toxic effects from exposure to oil. There are many areas in the Oceania region where high concentrations of birds may be found along the shore, particularly on small islands, in nearshore and estuarine habitats, or in offshore marine-water habitats (Section 3.7.2.2). Adverse effects on birds in this region would result mostly from oiling of small islands, wetlands, mangroves, and small marine-water habitats that serve as nesting and foraging habitats for seabirds, wading and marsh birds, shorebirds, gulls, terns, raptors, and waterfowl. Surface water oiling may also adversely affect feeding and rafting seabirds (Section 3.7.2.2; see Section 4.3.2.2 for information on the main issues of concern for birds exposed to an oil spill).

The Florida Straits was selected for the modeling as representative of the Oceania region because this area has similar types of intertidal habitats and physical settings, and the species present have similar habitat usage and behavior (Table 4.5-73). The results from the other modeled locations were also considered. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the potential adverse effects on birds. Potential levels of concern for birds in the Oceania region are medium for all spill sizes, as discussed below. However, for a small spill very little oil is likely to strand onshore, and potential exposure to floating oil is only likely to occur in a small area. The potential for adverse effects increases with spill volume, with greatest concern for conditions where mangroves and sand beaches become heavily oiled and where exposure to floating oil occurs in a large area.

Table 4.5-73
Risk Ranking of Offshore Oil Spills* to Marine and Coastal Birds Using the Basic Response Scenario† in the Oceania Region ‡

Spill Size	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	1–5	3D
Medium (2,500 bbl)	10–20	3B
Large (40,000 bbl)	> 20	3A

Source: Adapted from Parts B through F of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the five modeled locations (as discussed in the text) as representative of the Oceania region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

The Oceania region has several protected areas that likely contain high concentrations of birds in sensitive life stages, including ten National Wildlife Refuges. The majority of small islands in the area provide important nesting and roosting habitats for seabirds, while most mangroves and marshes provide important habitats for wading birds and waterfowl. Also, abundant seabirds, gulls, and terns use marine water habitats in this area, and high mortality rates are typical for these species during a spill. In the Oceania region, the risks to intertidal nesting, roosting, and foraging habitats are greater than in many other regions because a significant amount of shoreline habitat on an island or group of small islands can be affected by a spill. There may not be alternative sites for use until the habitat recovers, which would lead to a higher degree of adverse effect. Thus, the risk score was determined based on the possibility that a large number of birds in sensitive life stages may be concentrated in a relatively small area that is heavily oiled, possibly having limited opportunities for relocation to similar nearby habitats. It is important to recognize that adverse effects on birds may be more or less severe depending on the time of year and locations of their habitats, as well as the extent of shoreline and surface water oiling.

Adverse effects on birds in the Oceania region for a small spill were determined by extrapolating from the results obtained for a medium spill in several regions. The volume of oil released in the small spill was approximately an order of magnitude less than in the medium spill; therefore, the adverse effects on the bird population were estimated to be proportionally less. The modeling of effects on birds for a medium spill under mechanical-only recovery resulted in estimates of 10 to 20 percent of the regional bird population being potentially adversely affected in most of the modeled locations, including the Florida Straits. Estimates of over 20 percent of regional bird populations being potentially affected at this spill volume were only determined for regions where large percentages of species flyways are documented to occur in the modeled locations (Delaware Bay). For a large spill, the modeling resulted in estimates of over 20 percent of the local area bird population being potentially adversely affected in all modeled locations. The risk scores in Table 4.5-73 reflect the predicted recovery rates for birds of 1 to 3 years for most species, as was the case following the *EXXON VALDEZ* oil spill (Section 4.3.2.2). The estimated results for the Oceania region are consistent with those for all other regions modeled in this PEIS; therefore, it is expected that the severity of effects on bird populations will fall within a similar range throughout this region. The addition of *in situ* burning does not change the significance of these adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine and coastal birds in the Oceania region under Alternative 1 are expected to be moderate for small, medium, and large spills.

Plankton and Fish

Plankton and fish, a diverse group of species, are important to the marine food web, ecosystem function, and fisheries. Adverse effects on these groups are of great concern. As described in Section 4.3.2.3, plankton and fish are adversely affected either directly or via the food web by the toxic effects of oil components that enter the water column—the soluble compounds (MAHs and PAHs) and microscopic oil droplets mixed by waves into the water (French McCay, 2002; NRC, 1985). The most important pathway of exposure is direct uptake of dissolved oil components, originating directly from surface oil or dissolving from the microscopic oil droplets in the water. Overall, as spill size increases, so do adverse effects. However, there is great variability related to the environmental conditions after a spill; plankton and fish suffer much greater adverse effects in storm conditions where high waves mix unweathered oil into the water, which happened during the *NORTH CAPE* oil spill (French McCay, 2003), than in calm weather. In addition, many species utilize shallow waters and even the intertidal zone, where they are more likely to be exposed to oil and dissolved completely when oil comes ashore. Species and life stages vary considerably in sensitivity to toxic components, with species from relatively unpolluted and environmentally stable locations being more sensitive than those from polluted and environmentally variable areas.

In marine and open coastal environments, small, medium, and large oil spills do not cause large or long-term toxic effects to plankton and fish in the water column. The toxic effects of oil spills result from acute exposure during the time when surface oil is present and for short periods (days to weeks) afterwards. Once the source of hydrocarbons (from floating oil or the shoreline) to the water column is gone, concentrations rapidly disperse to background levels. However, there may be longer-term effects if the spill migrates to nearshore shallow areas such as enclosed embayments, estuaries, or wetlands where dilution and flushing are slow. Many fish and other organisms spawn and develop through larval and juvenile stages in these shallow areas. Juvenile fish are more abundant in salt marshes and seagrass beds than in other shallow subtidal and intertidal areas, so these areas are of most concern (see discussion of potential effects on these habitats below). Under Alternative 1 in most cases, chemical dispersion could not be used within 3 nm[34] of shore, but the dispersed oil plume could be transported by currents into this area.

The percentage of plankton and fish adversely affected by oil spills was estimated using the modeling results (technical report [French McCay et al., 2004]) of water volumes exposed to toxic oil components. Percent loss multiplied by volume exposed was integrated over time and space to calculate an equivalent volume of 100 percent loss. These volumes were translated to equivalent areas by multiplying by water depth at the spill site, allowing comparison with other resources, such as birds and shorelines, which are distributed on a per-area basis. The use of area is appropriate because plankton and fish abundance is much more uniformly distributed when expressed on a per-area basis than on a per-volume basis since the ecosystem is driven by sunlight and plant photosynthesis at the water surface (French et al., 1996; Odum, 1971). As indicated by the similar results for the four modeled spill sites in 10 to 30 m of water—offshore Delaware Bay, offshore Galveston Bay, the Florida Straits, and offshore San Francisco (Parts B, C, D, and E, respectively, of the technical report [French McCay et al., 2004])—the equivalent areas of adverse effect on plankton and fish (both average and variable) are applicable to spills of the same size in any location of similar water depth in any region considered in this PEIS. The modeled spill site was in 20 m deep water: adverse effects would be smaller for deeper waters because of greater vertical dilution of both oil components and organisms, and proportionately greater in shallower waters because of the restricted dilution potential.

The model-estimated areas are those where there is a potential to affect the most sensitive species, which are two standard deviations more sensitive than the average of all species tested (2.5th percentile in rank order of sensitivity). For species of average sensitivity (50th percentile), the areas adversely affected would be much smaller. Thus, the model-estimated areas should not be interpreted as experiencing 100 percent mortality of all plankton and fish; they are conservative estimates used for comparative purposes among response scenarios.

The Florida Straits was selected for the modeling as representative of the Oceania region (Table 4.5-74) because the geography (characterized by islands), bottom topography (steeply sloping away from shore), environmental regime (warm, trade winds, occasional severe storms) and ecosystems (subtropical-tropical, areas of coral reefs, seagrasses, etc.) are similar in the two regions. The adverse effects were estimated as a percentage of the total area of concern (42,689 km^2). Based on the evaluation of the volume where water quality would be affected for a small spill (Table 4.5-70), the volume of adverse effects on plankton and fish would be low for a small spill using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) (Table 4.5-74).

Table 4.5-74
Risk Ranking of Offshore Oil Spills[*] to Plankton and Fish
Using the Basic Response Scenario[†] in the Oceania Region (Based on the Florida Straits)[‡]

Spill Size	Equivalent Area Affected (km^2)	Area Affected (estimated %)	Risk Score[§]
Small (200 bbl)	0.082	5×10^{-11}	4E
Medium (2,500 bbl)	32	0.07	4D
Large (40,000 bbl)	72	0.2	4D

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Oceania region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Since the adverse effects are in a small percentage of the area of concern and less than the range of natural variability, the recovery time would be less than 1 year. Overall, based on the modeling, adverse effects on plankton and fish in the Oceania region under Alternative 1 would be localized to the immediate area around the spill site and similar in all marine water areas of the region. For large spills that might move rapidly into shallow coastal areas due to winds and currents, the concentrations of toxic components might be high enough to cause some level of concern for water column communities, especially early life history stages of fish and invertebrates using intertidal and shallow subtidal areas.

Based on the discussion in Part D of the technical report (French McCay et al., 2004), if the adversely affected area is marine-water habitat or for water column organisms with broad distribution over all subtidal habitats, a risk score of 4E applies. A risk score of 3C applies to coral reefs, 4E applies to seagrass, and 3D applies to hard-bottom habitat organisms. Given that many species and life stages of plankton and fish on and over coral reefs are more broadly distributed rather than restricted to the coral reefs (for example, they inhabit hard-bottom habitats as well), and that these organisms reproduce on time scales less than 1 year, the overall risk score of 4D is assigned for plankton and fish for the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit).

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on plankton and fish in the Oceania region under Alternative 1 are expected to be insignificant for small spills, and minor for medium and large spills.

Intertidal Habitats

Intertidal habitats in the Oceania region are always of great concern during oil spills, particularly when sensitive habitats such as mangroves are oiled because recovery can take decades. Mangroves and wetlands on many islands in this region are degraded and fragmented (Section 3.7.2.4), increasing the effects of an oil spill on the overall wetland functionality. Sand beaches are important ecologically and economically because of their high tourism value (Section 3.7.2.4). Sand beaches that are sea turtle nesting habitats are of great concern: adults concentrate in offshore areas prior to nesting, the nests are at risk of direct oiling, and the hatchling are at risk of oiling as they escape to sea. The Oceania region has extensive areas of these sensitive habitats. For a discussion of the relative ranking of the sensitivity of intertidal habitats to spilled oil and the processes affecting oil fate and behavior on shorelines, see the explanation of the Environmental Sensitivity Index (ESI) in Section 4.3.2.4. There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on intertidal habitats in that larger spills tend to have higher oil loading on the shoreline and affect larger areas.

In the Oceania region, the risks to intertidal habitats are greater than in many other regions because a significant amount of shoreline habitat on an island or group of small islands can be affected by a spill. Thus, there may not be alternative sites for use until the habitat recovers, which would lead to a higher degree of adverse effects.

The Florida Straits was selected for the modeling as representative of the intertidal habitats in the Oceania region because they have similar types of intertidal habitats (mangroves, coral/rocky platforms and rubble, sand beaches) and physical settings. The results from the other modeling analyses were also considered. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed and, thus, does not reduce potential adverse effects. Adverse effects on intertidal habitats in the Oceania region are medium for a small spill, in that very little oil is likely to strand onshore, and oil loading would be light in most cases. However, the potential for adverse effects increases with spill volume, with the greatest concern for conditions where mangroves and sand beaches become heavily oiled. The risk scores in Table 4.5-75 are based on estimated effects on the intertidal habitats of the Florida Straits.

Table 4.5-75
Risk Ranking of Offshore Oil Spills* to Intertidal Habitats Using the Basic Response Scenario† in the Oceania Region (Based on the Florida Straits)‡

Spill Size	Habitats Affected (estimated %)	Risk Score§
Small (200 bbl)	0–1	1E
Medium (2,500 bbl)	5–10	1C
Large (40,000 bbl)	> 20	1A

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern, and yellow, a medium level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the Florida Straits (as discussed in the text) as representative of the Oceania region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Adverse effects on intertidal habitats for a small spill were determined to be medium by extrapolating from the results of a medium spill and expecting oiled mangroves to have a long recovery period. For a medium spill under mechanical-only recovery, the effects would vary widely depending on the spill location and the wind and current patterns. Spills on the leeward side of an island are not likely to strand onshore, while spills on the windward side of an island could result in extensive oiling of intertidal habitats. The modeling in offshore areas (excluding Prince William Sound) resulted in an average length of oiled shoreline of 13.8 km (range of 9.9 to 17.5 km). This extent of shoreline oiling could represent a high percentage of an island's intertidal habitats. The risk score represents the conditions where the oil moved onshore rather than offshore and affected wetlands with a long recovery period. For a large spill, the modeling resulted in an average length of oiled shoreline in the four modeling analyses of 25.4 km (range of 27 to 56 km). This extent of shoreline oiling could represent more than 20 percent of an island's intertidal habitats. Oiled wetlands could take more than 7 years to recover. Although no specific areas in Oceania were analyzed, results from other modeled locations can be used to represent the potential effects for spills where the oil moved onshore. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on intertidal habitats in the Oceania region under Alternative 1 are expected to be moderate for small spills, and significant for medium and large spills.

Subtidal Habitats

The subtidal (benthic) habitat consists of the bottom substrate below the low tide level, as well as the species that live in, on, and near the substrate. The Oceania region is unique in that most areas lack a broad shallow shelf and instead have a very narrow band of shallow subtidal habitat. The two most important habitat types in this area are seagrass beds and coral reefs. The benthic coral community includes areas of hard substrate inhabited by dense growth of sessile forms, including interspersed algae, corals, and sponges, and sandy or muddy bottoms. Organisms living in this area—demersal species—include corals, plants and seagrasses, benthic invertebrates (such as crabs, shrimp, snails, bivalve mollusks, and marine worms), and bottom-dwelling fish. Because subtidal benthic communities do not include the intertidal zone, they are at little risk from floating oil because, by definition, this environment is always below the surface. The greatest risk of exposure comes from sinking oil, as well as *in situ* burn residue, dispersed oil, or the sorption of naturally dispersed or mechanically mixed oil that has become suspended on sediments and is deposited onto the ocean floor. However, significant natural dispersion of oil and sediment into the water column only occurs during large storms or for nearshore oil spills. Oil particles could adhere to bottom substrate, plants, or animals, which could result in both physical coating of organisms, as occurred in the 1993 *BRAER* spill in the Shetland Islands, and toxic effects from exposure to the chemical constituents (Section 4.3.2.5). Such adverse effects are not normally observed.

The risk to fauna and flora of the subtidal benthic habitat using mechanical-only recovery is minimal, based on the diluting effect of the overlying water (Section 2.2.2)—the deeper the water, the lower the risk. Relative to the results for the Florida Straits modeling location, the effects here will be substantially smaller because of the much greater water depth. This limits the exposure of demersal species to dissolved hydrocarbons, which was a concern at the Florida Straits location. Chemical compounds of concern tend to evaporate, rather than dissolve, and the rapid dilution of any chemical entering the water column decreases the toxicity of any oil residue potentially reaching the bottom substrate.

Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects. It might slightly increase the risk of remaining oil residues sinking to the bottom. Residual oil from *in situ* burning that reaches the bottom is expected to have little or no adverse effects on subtidal habitats since the majority of its toxic components would have either evaporated or been destroyed during burning and the volume of residue produced is so small (Section 4.3.2.5). Under the modeled conditions, the quantity of *in situ* burn residue produced would not result in a level of concern that exceeds low.

Based on the data for medium and large spills for the other regions' modeled locations (especially the Florida Straits), the potential adverse effects on subtidal habitat are considered to be low (Table 4.5-76).

Table 4.5-76
Risk Ranking of Offshore Oil Spills* to Subtidal Habitats Using the Basic Response Scenario† in the Oceania Region ‡

Spill Size	Habitats Affected (estimated %)	Risk Score§
Small (200 bbl)	0–1	4E
Medium (2,500 bbl)	0–1	4E
Large (40,000 bbl)	0–1	3E

Source: Adapted from Parts B through F of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the five modeled locations (as discussed in the text) as representative of the Oceania region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subtidal habitats in the Oceania region under Alternative 1 are expected to be insignificant for small and medium spills, and minor for large spills.

Areas of Special Concern

The potential adverse effect on areas of special concern, such as National Marine Sanctuaries and National Wildlife Refuges, are important during an oil spill since these areas are under increased scrutiny and protection. Whereas most coastal and nearshore areas have a wide range of habitats or are very similar to other areas throughout the Oceania region, areas of special concern are set aside for their uniqueness (Appendix F, Tables F.7-3 through F.7-5 and Figures F.7-1 through F.7-6). The potential risks associated with shoreline areas of special concern are identical to those discussed for intertidal habitats. The risks to subtidal resources, such as protected coral reefs, are identical to those discussed for subtidal habitats. For this analysis, the risks to areas of special concern are assumed to be the same as those for either intertidal or subtidal habitats (Sections 4.5.7.2), whichever are greater. Since the risk to intertidal habitats is greater, those risk scores were used. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

The potential effects on areas of special concern are medium for a small spill but may increase to high levels for medium and large spills, depending on the location of the spill (Table 4.5-77). Potential concerns associated with medium and large spills increase to high levels because of the potential to contaminate a major portion of the intertidal zone of a small island (see discussion of intertidal habitats).

Table 4.5-77
Risk Ranking of Offshore Oil Spills* to Areas of Special Concern Using the Basic Response† Scenario in the Oceania Region ‡

Spill Size	Areas Affected (estimated %)	Risk Score§
Small (200 bbl)	0–1	1E
Medium (2,500 bbl)	5–10	1C
Large (40,000 bbl)	> 20	1A

Source: Adapted from Parts B through F of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern, and yellow, a medium level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the five modeled locations (as discussed in the text) as representative of the Oceania region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Since areas of special concern are scattered throughout the Oceania region, they are unlikely to be disproportionately affected by the average spill. If an area of special concern was highly adversely affected, it is anticipated that recovery time would be the same as for other intertidal habitats. These areas are most at risk from floating oil and benefit from any actions that reduce the potential for oiling.

Although tropical areas other than the Florida Straits were not modeled, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on areas of special concern will fall within a similar range throughout the Oceania region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on areas of special concern in the Oceania region under Alternative 1 are expected to be moderate for small spills, and significant for medium and large spills, based on the risk to intertidal habitats.

4.5.7.3. Consequences to Threatened, Endangered, or Candidate Species

The Oceania region has a variety of threatened, endangered, or candidate species (Section 3.7.3). The overall regional risk that a threatened, endangered, or candidate species would be adversely affected or even present in the area of a spill is low; however, killing a single individual of such a species can be considered a severe adverse effect. Potential adverse effects on marine mammals, marine and coastal birds, or fish that are threatened, endangered, or candidate species are identical to those discussed in Section 4.7.2.2 for these groups. Potential adverse effects on the five species of threatened or endangered sea turtles (not included with other biological resources) were discussed in Section 4.3.3.1. Sea turtles are a particular concern if the spill occurs in the vicinity of a nesting beach. Overall, the highest risk scores were calculated for coastal and marine birds with other species at lower risk. Regardless of species, any effects affecting the reproduction of these species or resulting in death should be considered high.

Adverse effects on threatened, endangered, or candidate species in the Oceania region for any spill size is difficult to predict. Depending on the location and season, the number and type of species present will vary. Based on the overall size of the Oceania region and the small populations of threatened, endangered, or candidate species inhabiting this region, the likelihood of affecting an individual of concern would be low unless the spill affects important shoreline or critical marine habitats. The severity of the effect will vary depending on the sensitivity of the individuals present. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce potential adverse effects.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on threatened, endangered, and candidate species in the Oceania region under Alternative 1 are expected to be moderate for small, medium, and large spills, based on the risk to marine and coastal birds.

4.5.7.4. Consequences to Essential Fish Habitat

Virtually all waters (both water column and benthic substrate) in the Oceania region from shore to 400 m depth are Essential Fish Habitat (EFH). The primary issue with respect to EFH is either (1) exposure of sensitive resources in the water column to hydrocarbon concentrations of concern, or (2) the contamination of bottom sediments, both of which could lead to either acute or chronic exposures.

Adverse effects would include either the death of individual organisms, the possibility of sublethal effects affecting long-term population viability, or degradation of habitat that reduces its availability to managed species. For this analysis, the risks to EFH are assumed to be the same as those for plankton and fish or for subtidal habitats (Section 4.5.7.2), whichever are greater. Since the risk to plankton and fish is greater, those risk scores were used. Under Alternative 1, the addition of *in situ* burning does not remove enough oil to reduce potential adverse effects. The data presented for medium spills in Section 4.5.7.2 indicate low risk from both sediment and water column contamination. In comparison to the situation in the Florida Straits, deep water is present in most of the Oceania region very close to shore, providing a high degree of protection to EFH resources.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on EFH in the Oceania region under Alternative 1 are expected to be insignificant for small spills, and minor for medium and large spills, based on the risk to plankton and fish.

4.5.7.5. Consequences to the Socioeconomic Environment

As discussed in Section 4.3.5, oil spills can produce a variety of adverse economic and social effects. Some of the most visible and large adverse effects on the Oceania region are likely to include effects on water- and shore-based recreation, commercial fisheries, and tourism. In addition, large spills have the potential to adversely affect the well-being of the residents and economies of coastal communities, in particular low-income and minority populations to a greater extent than the general population. Individuals who rely on coastal resources for employment, income, and subsistence are at risk of experiencing disproportionately adverse effects from oil spills.

This modeling considers the risk of adverse socioeconomic effects posed by oil spills, which can include, but are not limited to, reduced recreational activity because of beach closures, limited accessibility, or perceived taint; closure of commercial fishing grounds or hatcheries, or reduced commercial harvests; and altered marine transportation patterns. In addition to these and other direct adverse effects, oil spills can have secondary adverse effects on social and economic welfare along the coast. For example, an oil spill may cause changes in employment and firm revenues of resource-based businesses. While these effects are not quantified in this modeling, the following discussion provides absolute and relative measures of the overall risk of adverse social and economic effects of small, medium, and large oil spills using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) in the Oceania region. (Although dispersant pre-authorization agreement areas exist in the Oceania region [Figure 2.2-1], appropriate response times cannot currently be met for chemical dispersion.) The methodology is described in more detail in the Atlantic Region (Section 4.5.2.5).

There is no existing standard for “significance” related to the socioeconomic effect of oil spills (e.g., how much shoreline or surface water must be oiled to be considered a “high,” “medium,” or “low” effect). The significance of the effect will depend on a number of factors, including the scope of the analysis (i.e., national, regional, local), opportunities for resource substitution (e.g., an unoiled beach or fishing ground nearby, alternative ports of call), and the duration of the spill event. Generally, a spill event would be of low concern if it is not of long enough duration to affect the financial viability of local businesses, and the affected communities are able to find substitutes to replace the oiled resources.

For this PEIS, (1) the greatest effect modeled at the regional level was less than approximately 10 percent of available shoreline or surface water resources (indicating the likely presence of substitute resources), and (2) resource use following these modeled spills (e.g., vessel transportation and fishing) would be expected to resume as soon as oil recovery efforts were completed. As a result, the modeled effects under all modeled scenarios would likely be low at the regional level. As noted in the text, any adverse effects that occur would be expected to be localized in nature.

This modeling assumes that the risk posed by oil spills to the socioeconomic environment is directly related to the extent to which resources are affected above selected thresholds of concern—for the Oceania region, the square meters of marine water oiled above the threshold of concern. Comparing the absolute risk of adverse socioeconomic effects (e.g., meters of sandy shoreline oiled above a recreational threshold of concern) across spill scenarios, including variations in spill response scenarios, allows for an understanding of the relative risk of adverse socioeconomic effects across these scenarios. In this section, only basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) results are examined. Determining relative risk also allows for extrapolation of site-specific results to the entire region. For example, the risk estimates presented below are based on modeled hypothetical spills affecting the Florida Straits. (Because of its geographic and economic similarities to the Oceania region, the Florida Straits is an appropriate surrogate for the Oceania region in this modeling.) While any given spill may exhibit distinctly different patterns of socioeconomic effect, the relative risk measures are expected to be broadly applicable to a range of spill locations, especially in island regions, as long as spills occur in areas where mechanical recovery and/or *in situ* burning are feasible. In addition, the conclusions reached for the Florida Straits are supported by results for other modeled areas—the relative degree of risk reduction achieved under various removal assumptions across spill size is similar in magnitude.

Table 4.5-78 highlights the effects of small, medium, and large oil spills on the Oceania region's socioeconomic resources by presenting estimates of resources oiled as a result of the average modeled spill in absolute terms (area of surface water oiled above the threshold of concern) and as a percentage of the total resource base in the modeled area (Florida Straits). The threshold of concern because of surface water oiled is 0.01 g/m^2 (technical report [French McCay et al., 2004]). This resource area is based on an estimate of the extent to which the coastal community in the modeled area potentially relies on each resource. For the Oceania region, length of shoreline oiled above the threshold of concern is not considered relevant. A single metric was selected for this region because (1) the shoreline oiling results from the Florida Straits were highly sensitive in the modeled spill location; (2) the ability to identify shoreline with characteristics amiable to use (i.e., sandy shore) was limited; and (3) area of surface water oiled above the threshold of concern was expected to provide a more accurate measure of expected risk, given the region's geographic characteristics.

For this modeling, the socioeconomic environment is divided into components representative of the major parameters of coastal life potentially affected by an oil spill. Absolute and relative risk are discussed for coastal communities, demography, and employment; general economic status of a coastal community; vessel transportation and ports; commercial and recreational fisheries; subsistence; archaeological and historic resources; recreation and tourism; environmental justice; and public safety and worker health.

Table 4.5-78
Risk Ranking of Offshore Oil Spills* to Coastal Communities as a Result of Surface Water Oiled Using the Basic Response Scenario† in the Oceania Region (Based on the Florida Straits)‡

Spill Size	Surface Water Area	
	m² Oiled Above Threshold§	Estimated % Oiled‖
Small (200 bbl)§	N/A	N/A
Medium (2,500 bbl)	312 × 10⁶	3.2
Large (40,000 bbl)	659 × 10⁶	6.8

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Oceania region for modeling.

§ Thresholds above which some economic or social risk is expected were determined, and the area of surface water oiled above this threshold for the average modeled spill are reported. The threshold of concern because of oiled surface water is 0.01 g/m² of oil (technical report [French McCay et al., 2004]).

‖ Percentages reflect the proportion of the total modeled area above the threshold of concern.

§ A 200-bbl spill is assumed to have negligible effect.

Coastal Communities, Demography, and Employment

Coastal communities benefit from and rely on the marine environment to provide residents with sustenance, livelihoods, leisure opportunities, and shipping avenues. Individuals who live and work in close proximity to the coast derive both social and economic rewards from the natural beauty, recreational opportunities, quality of life, economic resources, and cultural attributes associated with these coastal locations. These rewards are derived from assets such as National Parks, public beaches, fishing opportunities, and commercial and tourism-related industries.

Thus, oil spills can affect any number of a coastal community's assets, leading to adverse effects on the economic benefits of community activities. These effects, in turn, can impose changes on that community's demographic and employment patterns. In addition to direct employment and other adverse economic effects on marine resource-based economic sectors associated with oil spills, oil spills can have secondary adverse effects on coastal communities. For example, the islands of the Oceania region—Hawaii, Guam, American Samoa, and CNMI—are at risk of adverse economic and social effects from an oil spill that affects tourists because of their reliance on tourism for employment and revenues. In 2000, Hawaii logged almost 62 million visitor-days and generated $10.9 billion in tourism-related expenditures (HDBEDT, 2001a). Further, the lure of these coastal communities to their residents and visitors alike is the pristine natural surroundings. To the extent that an oil spill disrupts these amenities, coastal communities will face adverse economic effects.

The importance of marine transportation to the delivery of goods to these islands of the Oceania region implies an added vulnerability. Although there are substitute means of transportation, a disruption in waterborne commerce can be costly in terms of delivery delays. Finally, commercial fishing is important to all these communities and to American Samoa in particular. The American Samoa Office of Tourism (ASOT, 2002) estimates that the local canned tuna industry employs one-third of the island's population; tuna fishing and processing are thought to be the "backbone" of the island's private sector. Given their reliance on marine resources, coastal communities on the Oceania region's islands are likely to be more vulnerable to the adverse effects of a spill than communities located on the mainland.

For a small spill in the Oceania region, there is little risk to coastal communities (Table 4.5-78). The risk to coastal communities under the medium spill scenario is likely to be greater than under a small spill. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill will sweep approximately 312 million m^2 of marine waters in the spill area[35] above the corresponding threshold of concern (Table 4.5-78). The economic and social losses will occur in marine waters that exceed the thresholds of concern. For example, beaches in the Oceania region may be closed to visitors and fishing may not be permitted in waters exposed to oil, causing losses in revenue to the tourism and commercial and recreational fishery sectors of the coastal economy. The resulting adverse effects would be expected to reverberate through communities in the area of the spill, causing short-term decreases in employment, income, the viability of associated businesses, and the appeal of coastal living.

For a large spill, there is a substantial risk to coastal communities. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a large spill will sweep approximately 659 million m^2 of marine waters (Table 4.5-78) potentially important to commercial and recreational fishery activities in the spill area. A spill of this size would affect the pleasure that coastal residents and visitors derive from coastal activities and the economic contribution that recreational and commercial fishing resources make to local income and employment. A spill of this size may cause significant decreases in local tourism, commercial and recreational fishing sectors, and the employment and revenues they generate, as described in more detail in subsequent sections. Further, the contamination of the shoreline may adversely affect the quality of coastal living.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal communities, demography, and employment in the Oceania region under Alternative 1 are expected to be insignificant for small, medium, and large spills. The adverse impacts of a large spill would be similar to those for a medium spill and would generally be limited to the spill area—the adverse impacts would not be felt at the regional economic level. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 659 million m^2 of surface water above recognized thresholds [Table 4.5-78]); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Economic Status

The overall economic status of communities, industries, and individuals that rely on coastal resources for sustenance, revenue, and quality of life can be affected by an oil spill. As noted above, coastal communities can suffer direct and indirect adverse economic effects from an oil spill, as beach and fishery closures decrease revenue and eliminate jobs. More specifically, losses will be felt in commercial and recreational fisheries, by both anglers and by related industries as catch opportunities decrease or are eliminated entirely. Tourism and associated businesses will suffer economic setbacks as visits to affected coastal areas decline and purchase of area goods and services decrease because of perceived resource taint. Similarly, environmental justice issues may arise as low-income or minority communities are disproportionately affected by the spill (discussed below in more detail).

A small spill that is 3 or more statute mi offshore would have essentially no adverse effect on either the local or regional economies (Table 4.5-78). There is little to no risk of oiling economically important resources, and it is unlikely that any commercial fisheries or recreational areas would be affected.

A medium spill, with mechanical recovery and *in situ* burn operations, could be expected to have short-term adverse economic effects as a result of oiling recreational resources, limited closing of fisheries and recreational areas, and the need to supplement the normal response operation employment base. These adverse effects would probably be very short lived—cleanup operations would not require a long period of time and would be local in nature. A large spill's adverse economic effects could be high for the local economy, even with mechanical recovery and *in situ* burning, based on the anticipated level of marine-water oiling and the possibility that closure of commercial and recreational fishing grounds will occur. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause adverse socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on economic status in the Oceania region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 659 million m^2 of surface water above recognized thresholds [Table 4.5-78]); any adverse impacts are expected to be localized (and could be substantial)—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Vessel Transportation and Ports

Oil spills occurring 3 or more statute mi offshore are not likely to cause large adverse effects on vessel transportation and ports; any adverse effects would likely be of short duration. However, an oil spill can disrupt marine commerce if it occurs in and around a shipping channel or port and results in limits on watercraft movement as a means of facilitating spill response. Any interruption in the standard use of vessels or increase in travel times over water can result in hardship for coastal communities as fewer goods are exchanged, transportation costs rise, and the revenue streaming through the local economy falls.

This issue is particularly relevant to the islands of the Oceania region. In 2000, 5.3 million tons of cargo was transported to Honolulu, Hawaii, on 1,292 vessels, and an additional 2 million tons of cargo were transported to Honolulu from other Hawaiian Islands (HDBEDT, 2001b). In Guam, the port authority estimates that it handles 2 million tons of cargo per year with its five cargo-handling piers and 26.5 acres of container storage (PAOG, 2002). To the extent that mechanical recovery and *in situ* burning reduce the surface area of slicks above a threshold of concern, some combination of spill response options will reduce the risk to marine transportation and port facilities.

While these adverse effects would affect the ease with which vessels access ports, they will also affect the economic sectors that depend on the efficient movement of goods to and from ports. Although the possibility exists that the affected area's trade partners will be affected by interruptions in vessel transportation in the spill area, the availability of substitute means of transportation and sources of goods and products indicates that any closures would be unlikely to generate large adverse effects outside of the spill area.

For a small spill, no great adverse effects on vessel transportation or ports are expected (Table 4.5-78), but there is some risk of adverse effects for medium and large spills. Therefore, the nature of the risk to vessel transportation will be a function of the location, area, and pattern of surface water oiling, as well as the extent of oiling in port areas. A medium or large spill in the Oceania region, however, would not generally be expected to result in large adverse effects on vessel transportation and ports since any effects would likely be short lived—that is, even if shipping waters or ports are exposed to oil and are therefore closed, as soon as recovery efforts remove surface oil, these facilities would be expected to be reopened.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on vessel transportation and ports in the Oceania region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 659 million m^2 of surface water above recognized thresholds [Table 4.5-78]); any adverse impacts are expected to be localized (and could be substantial)—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Fisheries

Commercial Fisheries

Commercial fisheries are vulnerable to oil spills because of both closures and perceived taint. A moratorium on fishing operations in the wake of an oil spill can lead to high revenue losses for the commercial fishing industry, as well as related industries, including those that supply equipment to and purchase products from commercial fleets. In addition, oil spills can lead to a decreased demand for fish from affected waters because of actual or perceived taint and can instigate alterations to fishing practices in a manner that increases operating costs and/or decreases revenues.

In the Oceania region, commercial fishing is an important economic activity. Tuna dominates the catch in Hawaii and American Samoa: in 2001, 70 percent of Hawaii's total fish landings were tuna (NMFS, 2004a), and 20 percent of U.S. canned tuna is supplied by American Samoa, with almost one-third of the island's population employed in commercial operations related to this industry (ASOT, 2002). To the extent that mechanical and *in situ* burning reduce the surface area of slicks above a threshold of concern, some combination of response options will reduce the risk to regionally important fisheries.

For a small spill in the Oceania region, the risk to commercial fisheries is negligible using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) (Table 4.5-78). For a medium spill, the risk to commercial fisheries is likely to be much greater than for a small spill. A medium spill in the Oceania region will sweep approximately 312 million m^2 of marine waters used by the commercial fishing industry above the corresponding threshold of concern (Table 4.5-78). A risk of economic loss to commercial fisheries will occur when waters exceed relevant management and/or risk based-thresholds. For example, fishing may not be permitted in waters swept by oil above the modeled threshold of concern, resulting in reductions in commercial fish landings for a period of time following a spill. The resulting adverse effects would be expected to reverberate through communities in the area of the spill, causing decreases in employment, income, and the viability of businesses associated with the commercial fishing industry. To the extent that substitute fishing grounds are available, spill effects on the commercial fishing economy may be less severe.

For a large spill, there is a substantial risk of adverse effects on commercial fisheries. This risk to commercial fisheries increases with a large spill, as the size of the oiled area increases. A large spill presents risk to approximately 659 million m^2 of the marine waters potentially important to commercial fisheries above the corresponding threshold of concern (Table 5.4-75). A spill of this size may cause significant decreases in local commercial fishing activities and revenues, and may negatively affect the revenues of associated businesses. To the extent that commercial fishing operations can, for a time, move to substitute fishing grounds, the potentially severe effects of even a large spill may be avoided.

Recreational Fisheries

Similar to commercial fishing operations, recreational fisheries are at risk of closure or loss in value as a result of oil spills. These adverse effects will not generally be at the regional or national levels but could be high at the local level. For this modeling, the risks posed to recreational fishing activities are modeled in the same manner as risks to commercial fishing activities, in square meters of oiled surface water above the corresponding threshold of concern. The effects of an oil spill on recreational fishery-related activities will be felt more heavily by various populations, including recreational anglers and firms that supply goods and services to recreational anglers. For example, recreational anglers fish for pleasure or sport, as opposed to monetary gain. In the wake of an oil spill, such anglers may choose to fish at a substitute location, may experience a reduced quality of experience, or may choose to forgo fishing entirely. The losses suffered will be related to these missed opportunities. In addition, while closing waters to recreational fishing will decrease the social welfare of recreationists, it would also be expected to affect the demand for boat rentals and other services consumed by fishing enthusiasts.

For a small spill, adverse effects on recreational resources in the Caribbean region would likely be negligible (Table 4.5-78). The risk to recreational fishing activities for a medium spill is likely to be much greater than for a small spill. A medium spill will sweep approximately 312 million m^2 of marine waters used by the recreational fishermen above the corresponding threshold of concern. For a large spill, there is substantial risk to recreational fishing, approximately 659 million m^2 of the marine waters potentially important to recreational fishing in the spill area. A spill of this size may harm businesses associated with recreational fishing.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on fisheries (commercial and recreational) in the Oceania region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 659 million m^2 of surface water above recognized thresholds [Table 4.5-78]); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Subsistence

Potential adverse effects on marine species are a concern during spills where traditional use of subsistence resources occurs. Pelagic and reef fish and shellfish collected on reefs and in intertidal habitats have been the major species gathered for subsistence in the Oceania region in recent times (Section 3.7.5.5). Tissue tainting would be the primary adverse effect for these subsistence resources.

The Florida Straits was selected for the modeling as representative of subsistence resources in the Oceania region because they have similar types of species (pelagic and reef fish and invertebrates) and intertidal (mangroves, coral/rocky platforms, rubble, sand beaches) and subtidal (coral reefs/hard bottom, seagrass beds, macroalgae) habitats. The results from the other modeled locations were also considered. Under Alternative 1, the addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the severity of potential adverse effects nor increase risk to subsistence resources. Potential adverse effects on subsistence resources in the Oceania region are low for small spills (Table 4.5-79). However, the potential for adverse effects increases with spill volume, with greatest concern for conditions where nearshore habitats around small islands with subsistence communities become heavily oiled.

Table 4.5-79
Risk Ranking of Offshore Oil Spills[*] to Subsistence
Using the Basic Response Scenario[†] in the Oceania Region[‡]

Spill Size	Resources Affected (estimated %)	Risk Score[§]
Small (200 bbl)	0–1	4E
Medium (2,500 bbl)	1–5	4D
Large (40,000 bbl)	> 20	4A

Source: Adapted from Part B through F of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the five modeled locations (as discussed in the text) as representative of the Oceania region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Effects on subsistence resources for a small spill were determined to be low by extrapolating from the results for a medium spill. For a medium spill, the modeling results showed water column exposure to dissolved aromatics to be at low concentrations (1–100 ppb) and to only occur in small areas. Tainting of fish and invertebrates becomes a concern when water concentrations exceed approximately 100 ppb (Section 4.3.5.6). Sediment exposure also only occurred in a few small areas. The extent of adverse effects on intertidal resources for a medium spill using mechanical-only recovery would vary widely depending on the spill location and wind and current patterns. Modeling of medium spills in offshore areas resulted in an average length of shoreline oiled of 12.2 km (range of 9.4 through 17.5 km), which would represent a significant percentage of an island's intertidal habitats (5–10%). Accounting for both pelagic resources (which are less likely to be affected) and intertidal resources, the estimated percentage of subsistence resources adversely affected for a medium spill in the Oceania region was 1 to 5 percent. The risk scores in Table 4.5-79 reflect the predicted recovery rates for subsistence resources of less than 1 year for all spill volumes (Section 4.3.5.6).

For a large spill, the modeling results showed water column exposure at high concentrations (100–10,000 ppb) in a widespread area. (Water column exposure at high concentrations was more localized and/or farther offshore in the Pacific and Alaska regions.) Sediment exposure was negligible in all cases. The average length of shoreline oiled in the four offshore modeling analyses for a large spill was 25.4 km (range of 27 through 47 km), which would represent over 20 percent of the intertidal habitats on an island. Because subsistence use of resources makes up a substantial portion of the diets of some Native Islanders in the Pacific, and relocating to non-oiled areas may be impossible on a small island that is heavily affected by a large spill, the risk scores for pelagic resources were based on the Oceania region model, where water column exposure at high concentrations was widespread. Accounting for both intertidal and pelagic resources, the estimated risk for subsistence resources for a large spill in the Oceania region was over 20 percent. While adverse effects on subsistence resources are not likely to be high on a regional level for a small spill, they may increase with spill volume. On a local level, medium or large spills may cause high adverse effects on subsistence communities.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subsistence resources in the Oceania region under Alternative 1 are expected to be insignificant, minor, and moderate for small, medium, and large spills, respectively.

Archaeological and Historic Resources

Under Alternative 1, using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), adverse effects on archaeological and historic resources in the Oceania region are expected to be low. Known cultural resources in this region occur mostly onshore or in shallow coastal waters (Section 3.7.5.7). Results from several studies indicated that direct oiling caused negligible effects on cultural resources following the *EXXON VALDEZ* oil spill (Bittner, 1996; Dekin, 1993; Reger et al., 1992; Wooley and Haggarty, 1995). Mechanical-only recovery or mechanical recovery plus *in situ* burning may help reduce the amount of oil that strands on the shoreline, which will also reduce the amount of shoreline cleanup and potential disturbance to sensitive historic structures.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on archaeological and historic resources in the Oceania region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

Recreation and Tourism

The islands of the Oceania region provide visitors and residents the opportunity to enjoy a number of outdoor recreational activities and scenic vistas. For example, the beaches, water sports, and natural beauty of these areas make them popular with vacationers. In 2000, Hawaii logged almost 62 million visitor-days, which generated $10.9 billion in expenditures (HDBEDT, 2001a). Guam heavily depends on tourism to support its economy: In 1995, 7 million visitors arrived on Guam. The government of this island considers tourism to be "the driving force of the Guam economy." A recent government report estimated that the tourism industry generates more than 50 percent of private sector revenues (Hiles and Webb, 1996).

An oil spill would be expected to affect recreationists' overall social welfare; in addition, the social and economic implications of a spill would reach beyond direct effects on visitors and into the community. For example, visitors may be less likely to visit and spend money in an area perceived as affected by a spill, potentially leading to loss of business revenue and jobs (see Coastal Communities, Demography, and Employment).

For a small spill in the Oceania region, the risk to recreation and tourism is negligible using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) (Table 4.5-78). Because of the small surface water area exposed to oil as a result of a small spill, water-based attractions, such as beach visitation, may experience little or no adverse effects.

For a medium spill, the risk to recreation and tourism is likely to be greater than for a small spill. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium spill will adversely affect approximately 312 million m^2 of recreational waters in the spill area above the corresponding threshold of concern (Table 4.5-78). Under these conditions in the Oceania region, beaches in the spill area may be closed to visitors, and fishing and boating may not be permitted in waters exposed to oil, causing losses in revenue to the recreation and tourism sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill, causing decreases in employment, income, and the viability of businesses associated with recreation and tourism.

For a large spill, there is a substantial risk to recreation and tourism. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a large spill will adversely affect approximately 659 million m^2 of recreational waters in the spill area (Table 4.5-78). A spill of this size may cause significant decreases in tourism, recreation, associated business activities and revenues, and the quality of coastal living.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on recreation and tourism in the Oceania region under Alternative 1 are expected to be insignificant for small, medium, and large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 659 million m^2 of surface water above recognized thresholds [Table 4.5-78]); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Environmental Justice

As mentioned above, low-income, indigenous, and minority populations in some coastal areas may rely on regional fisheries and other marine resources for subsistence, as part of an artisanal economic system, or in the context of participating in a commercial fishery or other marine resource-based employment. These groups may experience the effects of a spill more severely than the general population, which relies on a more diverse economic base for its livelihood and on the availability of a widespread, commercially available selection of foods. Additionally, employment in marine resource-related industries might have value beyond the importance this resource holds as an employment opportunity.

In American Samoa, for example, 64 percent of the population earns less than $24,999 per year; the median household income of $18,357 is less than half that for the nation as a whole (U.S. Census Bureau, 2000a). Further, this small island relies heavily on commercial fishing to support its population. The tuna industry not only supports fishermen, but also offers employment to individuals in the processing and distribution of tuna.

For a small spill in the Oceania region, the risk of significant changes in any group's economic status is negligible, regardless of the response options employed (Table 4.5-78). Because of the small surface water area exposed to oil as a result of a small spill, marine-based economic factors such as local commercial or subsistence fisheries may experience little or no adverse effects.

For a medium spill, the risk of changes in the economic status of any disadvantaged population is likely to be greater than for a small spill. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a medium size spill would be expected to sweep approximately 312 million m^2 of marine waters in the spill area (Table 4.5-78). The risk of economic and social losses will occur in marine waters used for commercial, recreational, and subsistence fishing that exceeds thresholds of concern.

For a large spill, there is a substantial risk to disadvantaged populations that depend on coastal and marine resources. Using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit), a large spill would be expected to present risk to approximately 659 million m^2 of marine waters in the spill area (Table 4.5-78). A spill of this size may cause significant decreases in water-based business activities and in the availability of subsistence resources.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on environmental justice in the Oceania region under Alternative 1 are expected to be insignificant for small and medium spills, but could be moderate for large spills. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (affecting up to 659 million m^2 of surface water above recognized thresholds [Table 4.5-78]); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Public Safety and Worker Health

Potential adverse effects on public safety are defined as the risk to the public from direct exposure to oil or response activities as a result of the spill. Most areas in the Oceania region have high population concentrations along the coast. However, adverse effects on public safety are unlikely from oil spills that occur 3 or more statute mi offshore for any of the spill sizes considered, regardless of the response options—mechanical recovery and/or *in situ* burning—used. The USCG has protocols to protect the public from risk during shoreline response operations, as well as on-water protocols to prevent the public from entering the response area.

Potential adverse effects on worker health are related to direct exposure to oil during response operations. In addition, operating oil spill response equipment can be dangerous, which is well recognized and is the basis for the worker certification and training requirements that are now in place. There is also a health risk from inhalation of hydrocarbon fumes for first responders, which is recognized in current safety protocols. The risk is greater as the spill size and the corresponding intensity and duration of operations increase, but is minimized if safety standards are followed.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on public health and worker safety in the Oceania region under Alternative 1 are expected to be insignificant for small, medium, and large spills.

4.6. ENVIRONMENTAL CONSEQUENCES: ALTERNATIVE 2–INCREASE ON-WATER MECHANICAL RECOVERY CAPABILITY AND ESTABLISH AND MAINTAIN AERIAL TRACKING CAPABILITY

This section describes the potential adverse and beneficial environmental impacts associated with Alternative 2 for the resources described in Chapter 3. Under this alternative, the USCG would revise the current regulations to require a 25 percent increase in the amount of mechanical recovery equipment that vessel planholders would be required to have available to respond to an oil spill. Planholders would also be required to establish and maintain aerial tracking capabilities. There would be no other changes to the current regulations, so no dispersant application or *in situ* burn capabilities would be required. In addition, this alternative only requires the availability of response capabilities but does not mandate the use of any particular response capability (see Section 2.6.2 for more details).

Based on the requirements established by this alternative, the material presented in the *Response Plan Equipment Caps Review* (USCG, 1999), and the results of the regulatory analysis (USCG, 2008), any actual increase in mechanical response equipment would be minimal in many (if not most) regions since current equipment stockpiles are well in excess of the current requirements[36]. Further, the results of the regulatory analysis indicate that increasing the requirement by 25 percent would not result in increased efficiency (see Section 2.6.2 for additional explanation); no additional oil would be removed from the water in the event of a mechanical-only recovery. As shown in Table 4.5-1, *in situ* burn capabilities would continue to be available in all six geographic regions considered in this PEIS, and dispersant capabilities would be available and their use for response operations feasible only as currently pre-authorized in the Gulf of Mexico and Alaska regions. Thus, potential adverse and beneficial impacts on the environment under Alternative 2 would be equivalent to those under Alternative 1, which will not be repeated here (see Section 4.5 for complete discussion).

4.7. ENVIRONMENTAL CONSEQUENCES: ALTERNATIVE 3–INCREASE ON-WATER MECHANICAL RECOVERY CAPABILITY, ESTABLISH ON-WATER DISPERSANT APPLICATION CAPABILITY (OPTION A), ESTABLISH *IN SITU* BURN CREDIT, AND ESTABLISH AND MAINTAIN AERIAL TRACKING CAPABILITY

4.7.1. Introduction

This section addresses the potential beneficial and adverse environmental impacts associated with Alternative 3 for the resources described in Chapter 3. Based on the analysis of this alternative presented in Section 2.8.3, there would be no effect on the opportunities for mechanical recovery or *in situ* burning; further, the effectiveness of both response options would not change. The key change would be to ensure the uniform availability of dispersant capability in the four regions—Atlantic, Caribbean, Pacific, and Oceania—where appropriate response times cannot currently be met. For Alternative 3, dispersant Option A (Table 2.6-1) requires slightly less delivery capacity under Tier 1 (0–12 hours) than Option B under Alternatives 4 and 5. For the purpose of this analysis, the USCG estimated how much oil could be treated during response operations based only on Option B (Appendix D). This was done to simplify the analysis and to ensure that exposure to dispersants and dispersed oil in the water column was considered at the highest potential levels.

This requirement would apply only to planholders of tank vessels operating 3 or more nm from shore[37] where chemical dispersion has been pre-authorized in accordance with the National Contingency Plan. The oil spill response community would continue to rely primarily on mechanical recovery equipment to remove as much oil from surface water as possible, but would also have access to chemical dispersion in the four geographic regions—Atlantic, Caribbean, Pacific, and Oceania—where appropriate response times cannot currently be met under the Alternative 1. Chemical dispersion and *in situ* burning would be used infrequently in all regions.

Under this alternative, it is assumed that all response options discussed under Alternative 1 are available, and dispersant capability is also uniformly available in the four geographic regions where appropriate response times cannot currently be met. This section focuses on the incremental changes in the potential adverse environmental effects in these four regions with the addition of chemical dispersion. Table 4.7-1 shows the response options available under Alternative 3 for each geographic region analyzed in this PEIS.

Table 4.7-1
Response Options for Each Region under Alternative 3

Region	Mechanical Recovery	Chemical Dispersion	*In Situ* Burning
Atlantic	Yes	Yes	Yes
Caribbean	Yes	Yes	Yes
Gulf of Mexico	Yes	Yes	Yes
Pacific	Yes	Yes	Yes
Alaska	Yes	Yes	Yes
Oceania	Yes	Yes	Yes

Source: Adapted from USCG, 2008.

As explained in Section 4.4, the modeling and risk assessment performed to determine the significance of potential adverse effects of Alternative 3 are based on the assumption that a spill has occurred (no beneficial effects are expected from an oil spill). (To interpret the risk scores listed in the tables in Sections 4.5 and 4.7, Figure 4.4-2 is reproduced on the inside back cover for quick reference.) Potential effects on all resources within each geographic region are based on the analysis of three representative spill sizes—small (200 bbl), medium (2,500 bbl), and large (40,000 bbl). Effects for the small spill are extrapolated from the modeling results for the medium and large spills. The determination of potential adverse effects from oil spills under Alternative 3 was based on the use of a concentration threshold for adverse effects: 10 g/m^2 for oiled shoreline and 0.01 g/m^2 for oiled surface water (technical report [French McCay et al., 2004]).

It is important to note that, in terms of potential adverse environmental consequences, the results of mechanical-only recovery and mechanical plus *in situ* burn response are very similar, with air quality being the only resource showing a quantifiable difference between the two response options. This is because the physical limitations for skimming and collecting the oil floating on the water are essentially the same for the two response options. As discussed in Section 4.4.2.3, oil collected by *in situ* burning represents an equivalent reduction in oil that is recovered, so shoreline, water surface, and water column effects remain unchanged.

Under Alternative 3, it is assumed that the response options for each region are available and utilized in response operations (for detailed results of the modeling and risk assessment, see the technical report [French McCay et al., 2004]).

Because Alternative 3 does not affect existing response options in the Gulf of Mexico or Alaska regions, these two regions are not discussed here (see Sections 4.5.4 and 4.5.6). For the Atlantic, Caribbean, Pacific, and Oceania regions, the analysis focuses on the changes that occur to the Alternative 1 basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion. The results of the analysis in Sections 4.5.2, 4.5.3, 4.5.5., and 4.5.7 are summarized for each resource, followed by a discussion of the potential adverse environmental effects from the addition of chemical dispersion.

4.7.2. Consequences in the Atlantic Region

For the purpose of this PEIS, the Atlantic region will specifically cover the waters extending from the Gulf of Maine to the Florida Straits (Figure 3.1-1). The location selected for modeling and risk assessment purposes was a site offshore Delaware Bay because it is in a high-traffic area at greater risk for oil spills. Modeling results from this location were evaluated relative to the geographic area in Section B.1.2 of the technical report (French McCay et al., 2004), herein referred to as the Mid-Atlantic Shelf. The Mid-Atlantic Shelf encompasses three biogeographical provinces: New York-New Jersey Shelf, Delaware Bay, and Delmarva Shelf. In general, the Mid-Atlantic Shelf is representative of offshore sites throughout the region and provides a basis for the modeling of potential environmental effects. The results of the modeling—used to evaluate spills of concern in this risk analysis (i.e., 3 or more statute mi offshore)—are presented in detail in Part B of the technical report (French McCay et al., 2004) and summarized in this section.

Table 4.7-2 presents the risk ranking for the modeling of Alternative 3 in the Atlantic region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion at 45 and 80 percent recovery efficiency[38] for three spill sizes (small, 200 bbl; medium, 2,500 bbl; and large, 40,000 bbl). (Based on the discussion of Alternative 3 presented in Section 2.8.3, a 25 percent increase in mechanical recovery capability would not change the effectiveness of the basic response scenario under Alternative 1.) The risk scores presented in the table are based on the modeling results for an average spill and on regional considerations; however, in any specific oil spill situation local concerns could be higher. Table 4.7-3 summarizes the significance of the potential beneficial and adverse environmental impacts associated with Alternative 3 in the Atlantic region, based on the extrapolation of the modeling results for the average spill to the region in general.

Without the addition of chemical dispersion, the results are unchanged from the basic response scenario (see the discussion in Section 4.5.2). In summary, there is a minor or insignificant regional adverse impact to all resources, except for moderate impacts on marine and coastal birds, for small and medium spills, and moderate impacts on intertidal habitats and areas of special concern for 80 percent dispersant efficiency for large spills. Further, as explained in the introduction to Section 4.7, the modeling shows that *in situ* burning would not significantly change the level of concern identified from those obtained when using mechanical-only recovery.

Under the available response options of Alternative 3, the addition of chemical dispersion helps mitigate, but does not eliminate, potential adverse impacts on marine and coastal birds, intertidal habitats, and areas of special concern for medium and large spills without significantly increasing the risk to water column or subtidal resources. There is a slight increase in the risk score for coastal water quality when chemical dispersion is used on large spills.

Table 4.7-2
Risk Ranking* of Offshore Oil Spills† under Alternative 3 Using the Basic Response Scenario‡ with the Addition of Chemical Dispersion (Option A) in the Atlantic Region

		Resources of Concern														
		Physical Environment			Biological Environment								Socioeconomic Environment			
Spill Size	**Response Option (% dispersant efficiency)**	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals§**	**Marine and Coastal Birds§**	**Plankton and Fish§**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles§**	**Areas of Special Concern**	**Essential Fish Habitat**	**Subsistence‖**	**Archaeological/Historic Resources‖**	**Shoreline Oiling Index#**	**Surface water Oiling Index#**
Small (200 bbl)	Basic	4E	4E	4E	3E	3D	4E	4E	4E	3E	4E	4E	4E	4E	N/A**	N/A**
	Chemical Dispersion (45)	4E	4E	4E	3E	3D	4E	4E	4E	3E	4E	4E	4E	4E	N/A**	N/A**
	Chemical Dispersion (80)	4E	4E	4E	3E	3D	4E	4E	4E	3E	4E	4E	4E	4E	N/A**	N/A**
Medium (2,500 bbl)	Basic	4E	4E	4E	3E	3D	4E	3E	4E	3E	3E	4E	4E	4E	1.00	1.00
	Chemical Dispersion (45)	4E	4E	4E	3E	3E	4E	4E	4E	3E	4E	4E	4E	4E	0.18	0.11
	Chemical Dispersion (80)	4E	4E	4E	3E	3E	4E	4E	4E	3E	4E	4E	4E	4E	0.17	0.09
Large (40,000 bbl)	Basic	4D	4E	4E	3E	3B	4E	2D	4E	3E	2D	4E	4E	4E	1.00	1.00
	Chemical Dispersion (45)	4C	4E	4E	3E	3D	4E	3E	4E	3E	3E	4E	4D	4E	0.29	0.23
	Chemical Dispersion (80)	4C	4E	4E	3E	3C	4E	2E	4E	3E	2E	4E	4D	4E	0.28	0.19

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

* This risk ranking is a summary of risk scores for the resources considered in this PEIS. The risk scoring process is explained in Section 4.4.3.

† Average spills.

‡ Current levels of mechanical recovery and *in situ* burning when circumstances permit.

§ Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles. If such species are affected by an actual spill, the level of concern would be high.

‖ Subsistence and archaeological/historic resources are the only socioeconomic resources that could be ranked using the risk matrix.

\# The Socioeconomic Index is calculated using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with value equal to 1.0. Risk factors reflect the ratio of the percentage of the model area or volume oiled using the basic response scenario to the percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected with response limited to the basic response scenario.

** Index cannot be calculated for small spills since they were not modeled.

†† Length of shoreline oiled above the threshold of concern is not considered relevant: (1) the shoreline oiling results were highly sensitive in the modeled spill location; (2) the ability to identify shoreline with characteristics amenable to use was limited; and (3) area of surface water oiled above the threshold of concern was expected to provide a more accurate measure of expected risk, given the region's geographic characteristics.

Table 4.7-3

Summary of Potential Adverse Regional Impacts of Offshore Oil Spills* under Alternative 3 Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A, 45 or 80% Efficiency) in the Atlantic Region

		Resources of Concern																			
		Physical Environment			Biological Environment								Socioeconomic Environment								
Spill Size	**Response Option (% dispersant efficiency)**	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals‡**	**Marine and Coastal Birds‡**	**Plankton and Fish‡**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles‡**	**Areas of Special Concern**	**Essential Fish Habitat**	**Coastal Communities, Demography, and Employment**	**Economic Status**	**Vessel Transportation and Ports**	**Fisheries**	**Subsistence**	**Archaeological/Historic Resources**	**Recreation and Tourism**	**Environmental Justice**	**Public Safety and Worker Health**
Small (200 bbl)	Basic	Ins	Ins	Ins	Min	Mod	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
	Chemical Dispersion (45 or 80)	Ins	Ins	Ins	Min	Mod	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
Medium (2,500 bbl)	Basic	Ins	Ins	Ins	Min	Mod	Ins	Min	Ins	Min	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
	Chemical Dispersion (45 or 80)	Ins	Ins	Ins	Min	Min	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
Large (40,000 bbl)	Basic	Min	Ins	Ins	Min	Mod	Ins	Mod	Ins	Min	Mod	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
	Chemical Dispersion (45 or 80)	Min	Ins	Ins	Min	Mod	Ins	Mod§	Ins	Min	Mod§	Ins	Ins	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins

Note: Based on Table 4.7-2. Sig, significant; Mod, moderate; Min, minor; and Ins, insignificant.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles.

§ Since there are different levels of concern at 45 and 80 percent dispersant efficiency, the highest level of concern is shown in this table.

4.7.2.1. Consequences to the Physical Environment

Water Quality

Potential adverse consequences of oil spills to water quality are related to hydrocarbon contamination, as other constituents in oils are at concentrations that would not exceed thresholds of concern. The hydrocarbons that could affect water quality are the soluble aromatics, MAHs (monoaromatic hydrocarbons) and PAHs (polynuclear aromatic hydrocarbons) (Sections 4.3.1.1 and 4.5.2.1), even with chemical dispersion. Thus, evaluation of potential adverse effects is based on the degree of potential contamination by these compounds. Under Alternative 3, chemical dispersion could increase soluble aromatic hydrocarbon concentrations in areas where dispersants are applied. No beneficial effects on water quality would be expected to result from an oil spill.

For oil spills in marine waters, adverse effects on water quality are low for small, medium, and large oil spills, regardless of the response option used (mechanical recovery with or without *in situ* burning and chemical dispersion). This is because of the tendency for most chemical compounds of concern to evaporate, rather than dissolve, and the rapid dilution of any chemical compounds that might enter the water column, even after periods of extreme turbulence that induce relatively high dissolution rates. Dispersants would be applied to surface oil after much of the evaporation of the toxic components occurs because of logistics (i.e., greater than 12 hours after the spill), such that the resulting increase of concentrations of toxic components in the water column would be relatively small.

Overall, based on the modeling and risk assessment results, it is concluded that—using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion—adverse water-quality effects under Alternative 3 would be low in marine waters, even in the event of a large spill in the Atlantic region. If an offshore spill moved into shallow and confined coastal waters, adverse effects could be locally important for medium and large spills under conditions where oil is mixed into water by strong turbulence. Chemical dispersion would not be used in shallow and confined coastal waters (less than 3 statute mi from shore) under Alternative 3, so it could only contribute to adverse water-quality effects in those areas if the dispersed oil plume drifted into the area before being diluted.

The variable used to determine the potential effects on water quality is "volume of water contaminated" by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer, which is less than all established water-quality criteria and thresholds of concern for effects on aquatic biota (Sections 4.3.1.1 and 4.3.2.1). The affected water volume increases with spill volume and the level of physical or chemical dispersion during the time of the spill. Natural dispersion increases with stronger winds and currents, lessening the volume of water that is contaminated above the threshold of concern if in unconfined waters. Since the volume of water contaminated increases exponentially as a function of spill size, the estimated volume of water contaminated for a small spill was extrapolated from the mean medium- and large-spill model results. Potential adverse water-quality effects in the Atlantic region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.2.1 and summarized in Tables 4.5-4 and 4.5-5 for coastal and marine waters, respectively (the results for coastal and marine water quality are included in Tables 4.7-4 and 4.7-5 for comparison).

Coastal

In estuaries and coastal waters within 3 statute mi of shore, mechanical-only recovery would be used under Alternative 3. In marine waters 3 or more statute mi from shore, the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion could be used under Alternative 3 in the Atlantic region. If dispersants were applied offshore, the dispersed oil plume could move into these nearshore areas. Since chemical dispersion would not be used in these areas, the level and duration of exposure would be negligible because of dilution.

Delaware Bay is used as a representative of coastal water for analyzing the Mid-Atlantic Shelf, as well as the Atlantic region. Delaware Bay is approximately 2,669 km^2 in area and about 10 m deep on average, with a total volume of approximately 26,690 million m^3. The estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of Delaware Bay to determine the potential consequences of small, medium, and large spills (Table 4.7-4). This approach was used both with and without dispersant use, and yields a very conservative estimate in that it assumes all of the contamination would occur in coastal water. Since dispersants could not be employed in such areas, this would imply that the dispersed oil plume moved directly into coastal waters without dilution, which will not occur.

Because of natural dilution, evaporation, and biological processes, contamination levels would decrease rapidly even in the case of a large spill, and recovery time would be on the order of days to weeks. Oil may be incorporated into shallow water or intertidal sediments where, through leaching, it could become a continuing source of contamination over time. However, this would generally only lead to noticeable water-quality degradation in the locality where the oil collects. This is unlikely to occur with a spill that originates offshore. Because mechanical removal would begin within the required response time under Tier I standards (beginning about 12 hours after the spill), much of the soluble components of concern to water quality would have evaporated or dissolved. Thus, mechanical recovery and *in situ* burning would have little influence on the volume of water adversely affected, and the risk score results would apply whether either response is implemented.

Table 4.7-4
Risk Ranking of Offshore Oil Spills* to Coastal Water Quality Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A) in the Mid-Atlantic Shelf‡

Spill Size	Response Option (% dispersant efficiency)	Volume of Water Contaminated (million m³)	Area Contaminated (estimated %)	Risk Score§
Small (200 bbl)	Basic	$< 42 \times 10^{-6}$	8×10^{-8}	4E
	Chemical Dispersion (45 or 80)	$< 42 \times 10^{-6}$	8×10^{-8}	4E
Medium (2,500 bbl)	Basic	130	0.5	4E
	Chemical Dispersion (45 or 80)	230	0.9	4E
Large (40,000 bbl)	Basic	698	2.6	4D
	Chemical Dispersion (45)	1,797	6.7	4C
	Chemical Dispersion (80)	1,781	6.7	4C

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal water quality in the Atlantic region under Alternative 3 are expected to be insignificant for small and medium spill sizes, and minor for large spill sizes, with or without dispersant use.

Marine

The Mid-Atlantic Shelf was selected for the modeling as representative of the marine waters in the Atlantic region. The total surface area of the Mid-Atlantic Shelf is approximately 68,541 km², so the area of interest is much vaster for marine waters than for coastal waters. Water-quality effects were calculated using a spill site in relatively shallow water—18 m deep, which is much shallower than most of the Atlantic region's marine waters. The results for the selected modeling location (Table 4.7-5) represent conservative estimates of adverse water quality effects—adverse effects would be reduced in deeper waters because of the larger dilution volume—using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion.

Table 4.7-5
Risk Ranking of Offshore Oil Spills[*] to Marine Water Quality Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Mid-Atlantic Shelf[‡]

Spill Size	Response Option (% dispersant efficiency)	Area Contaminated (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	2×10^{-9}	4E
	Chemical Dispersion (45 or 80)	2×10^{-9}	4E
Medium (2,500 bbl)	Basic	0.01	4E
	Chemical Dispersion (45 or 80)	0.02	4E
Large (40,000 bbl)	Basic	0.6	4E
	Chemical Dispersion (45)	0.15	4E
	Chemical Dispersion (80)	0.14	4E

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Because of natural dilution, evaporation, and biological processes, oil contamination levels would decrease rapidly even after a large spill, with or without chemical dispersion, and recovery time would be on the order of days to weeks. The estimated volume of contaminated water—and its variability—are generally applicable to spills of the same size throughout the Atlantic region because natural and chemical oil dispersion into the water column and dilution processes are similar in all areas.

The results in Table 4.7-5 are nearly identical (with some uncertainty reflected in the variability of the results) for 45 and 80 percent efficiency because the amount of dispersants used at 45 percent efficiency is sufficient to treat all dispersible surface oil, for spills up to 40,000 bbl. For a small spill, the volume of water contaminated would be the same as under Alternative 1 because, due to logistics, dispersants could only be applied after a small spill has mostly dispersed naturally. Chemical dispersion for medium or large spills increases the volume of water contaminated—and the percentage of the area of concern—that would be adversely affected by about a factor of two, which is still a small volume relative to that of the entire modeled area. *In situ* burning (in combination with mechanical recovery and chemical dispersion) would not significantly change the volume contaminated or the effect on water quality since it would substitute for some of the mechanical response.

Based on the modeling results (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine water quality in the Atlantic region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Air Quality

Concentrations of hydrocarbons of concern in the air resulting from oil spills and response operations were compared with air quality standards to evaluate the potential for adverse effects (Section 4.3.1.2). The effects of an oil spill on air quality may involve all volatile components of the oil. In addition, if *in situ* burning was used, particulates and other contaminants emitted from burns could become an air quality concern. However, adverse air quality effects from oil spills are normally very localized and short lived for small, medium, and large oil spills. The addition of *in situ* burning does not significantly increase any potential adverse effects: the volume of oil that could be burned is not large, and the temporary smoke plume would be localized and rapidly diluted. Chemical dispersion reduces the volatilization of unburned oil to the atmosphere to only a slight extent, so that effects are essentially identical with or without dispersant use.

Potential adverse effects on air quality in the Atlantic region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.2.1 and summarized in Table 4.5-6. Two possible sources of atmospheric contamination were evaluated for their potential effects on air quality: volatilization of hydrocarbons from unburned oil and emissions produced by *in situ* burning. Concentrations in the lowest 2 m of the atmosphere were compared with the U.S. Environmental Protection Agency's National Ambient Air Quality Standards (USEPA's NAAQS) and other thresholds of concern (as discussed in Section 4.3.1.2).

As discussed in Section 4.5.2.1, the results of the modeling show that the potential adverse effects on air quality are low for all spill sizes involving mechanical-only recovery; hence, the risk scores are virtually identical for medium and large spills. Volatilized hydrocarbons would not exceed air quality standards for human health at more than 1 km from the spill site. Evaporation off the water surface and volatilization from the water column create a plume of volatile hydrocarbon gases that disperses quickly after a spill, such that the concentrations in the atmosphere at the water surface would not exceed human health thresholds of concern at any location. The recovery time for the atmosphere would be on the order of days. Thus, a low level of concern is expected for small, medium, and large spills involving mechanical-only recovery.

Under Alternative 3, the addition of chemical dispersion does not change the results from those under Alternative 1 (Table 4.5-6), which were already low. Chemical dispersion would disperse some of the volatile hydrocarbons into the water resulting in the volatile hydrocarbons entering the atmosphere over a larger area than would occur without chemical dispersion. Thus, dispersants further dilute hydrocarbon concentrations in the atmosphere. The modeling shows that results are low for a spill of any size involving some combination of mechanical response and chemical dispersion at any spill site in the Atlantic region. Adverse effects of *in situ* burning on air quality are summarized in Table 4.5-6; these results apply whether chemical dispersion is modeled on unburned oil, and they do not vary by the location of the burn. Thus, the results for Alternative 1 apply to Alternative 3 for all areas in the Atlantic region. The modeling was performed for weather conditions where dilution in the air would be relatively slow, so the estimated adverse effects are overestimated for other conditions.

Mechanical recovery plus *in situ* burning, with or without chemical dispersion, would increase atmospheric pollutants by the amount emitted via *in situ* burning. For small spills, it would be very unlikely that *in situ* burning would be used, as the oil would disperse too rapidly for it to be feasible (Table 4.5-6). The maximum area potentially exceeding the NAAQS or thresholds of concern is 1.6 km^2 for a medium spill and 15.8 km^2 for a large spill (Table 4.5-6). If humans or sensitive resources (i.e., wildlife) are within these areas, they could be affected by poor air quality for a short time, on the order of hours. Since *in situ* burning can only be used offshore in marine waters, a region of interest equivalent to the Mid-Atlantic Shelf (68,541 km^2) would have less than 1 percent of its area adversely affected, and the atmosphere would recover in a matter of hours. The addition of chemical dispersion does not change the results under Alternative 1 in Table 4.5-6.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on air quality in the Atlantic region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without *in situ* burning.

4.7.2.2. Consequences to the Biological Environment

Marine Mammals

Potential adverse effects on marine mammals in the Atlantic region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.2.2 and summarized in Table 4.5-7 (the results in Table 4.5-7 are included in Table 4.7-6 for comparison). Extensive marine mammal populations are not at risk in the Atlantic region. The likelihood of a spill affecting an area where these populations are found is low unless a spill occurs in the immediate vicinity of a haulout area, which is reflected in the low risk scores. There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on marine mammals in that larger spills tend to spread across a larger surface water area and have higher shoreline oil loading. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery.

Under Alternative 3 for small, medium, and large spills, the contaminated surface water area is small when compared with the overall surface water area in the Mid-Atlantic Shelf (68,541 km^2), so the likelihood of marine mammals becoming oiled at the surface is minimal. Very little oil is likely to strand onshore, and oil loading would be light in most cases. Thus, the potential risk of oiling a haulout area or breeding grounds is small. Potential adverse effects increase as spill volume increases, with greatest concern for conditions where haulout areas, bays, estuaries, and known breeding grounds could become heavily oiled. If a local population of marine mammals is affected, it is estimated that it would take 1 to 3 years to recover. The results of the modeling for marine mammals for the Mid-Atlantic Shelf are presented in Table 4.7-6.

Table 4.7-6
Risk Ranking of Offshore Oil Spills[*] to Marine Mammals Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Mid-Atlantic Shelf[‡]

Spill Size	Response Option (% dispersant efficiency)	Populations Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E
Medium (2,500 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E
Large (40,000 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

The addition of chemical dispersion is only expected to minimally reduce adverse effects on marine mammals. There would be a beneficial reduction in the amount of oil that strands onshore (Section 4.3.2.4), and the equivalent area of 100 percent mortality would also be reduced, but these values were already low. Based on the estimated minimal risk associated with adversely affecting marine mammals during any spill, chemical dispersion would produce low adverse effects similar, if not identical, to those of a mechanical response.

Although areas other than the Mid-Atlantic Shelf in the Atlantic region were not modeled, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on marine mammals will fall within a similar range throughout the Atlantic region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine mammals in the Atlantic region under Alternative 3 are expected to be minor for small, medium, and large spills, with or without dispersant use.

Marine and Coastal Birds

Potential adverse effects on marine and coastal birds in the Atlantic region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.2.2 and summarized in Table 4.5-8 (the results in Table 4.5-8 are included in Table 4.7-7 for comparison). There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on birds in that larger spills tend to have higher oil loading on the shoreline and affect larger areas. It is important to recognize that birds are not uniformly distributed spatially or temporally in the Atlantic region, and potential adverse effects depend on the types and locations of habitats affected and the number of individuals present at the time of the event. The addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the severity of potential adverse effects or increase the risk to marine and coastal birds.

Under Alternative 3 for a small spill, very little oil is likely to strand onshore, and the oil loading would be light in most cases. However, potential adverse effects on marine and coastal birds increase if sand beaches, wetlands, and tidal flats in nesting and staging areas become heavily oiled (see Section 3.2.2.2. Chemical dispersion is expected to reduce adverse effects on these habitats by reducing the amount of oil that strands onshore (Section 4.3.2.4). The risk scores in Table 4.7-7 reflect the predicted recovery rates of 1 to 3 years for most bird species, as was the case following the *EXXON VALDEZ* oil spill (Section 4.3.2.2).

For a small spill, shoreline oiling was expected to be light, but if birds are affected, recovery could still take 1 to 3 years. For a medium spill using 80 percent efficiency, the extent of shoreline oiling was reduced by nearly 85 percent. The area of equivalent mortality due to surface water oiling was reduced by over 65 percent. In addition, chemical dispersion doubled the number of times that no oil stranded onshore, from 17 (Alternative 1) to 34 (Alternative 3) out of the 100 model runs (technical report [French McCay et al., 2004]). Adverse effects on marine and coastal birds in this region are more likely to result from shoreline oiling than from surface water oiling because of the large concentrations of birds on beaches, wetlands, and tidal flats during staging periods (Section 4.5.2.2). The results for 45 percent efficiency were the same as for 80 percent efficiency (Table 4.7-7); some important waterbird nesting areas were still oiled, but adverse effects on heavily used shorebird sites and wetlands were reduced.

Table 4.7-7
Risk Ranking of Offshore Oil Spills* to Marine and Coastal Birds Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A) in the Mid-Atlantic Shelf‡

Spill Size	Response Option (% dispersant efficiency)	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	1–5	3D
	Chemical Dispersion (45 or 80)	1–5	3D
Medium (2,500 bbl)	Basic	1–5	3D
	Chemical Dispersion (45 or 80)	0–1	3E
Large (40,000 bbl)	Basic	10–20	3B
	Chemical Dispersion (45)	1–5	3D
	Chemical Dispersion (80)	5–10	3C

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

For a large spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by 70 percent. The area of equivalent mortality due to surface water oiling was reduced by over 83 percent. In addition, chemical dispersion increased the number of times that no oil stranded onshore, from 19 (Alternative 1) to 35 (Alternative 3) out of 100 model runs (technical report [French McCay et al., 2004]). However, wetlands made up 60 percent of the shoreline oiled, including important nesting and staging areas for wading birds and waterfowl; the reduced area of total shoreline oiling was not sufficient to lower the estimated risk to birds in the modeling at 80 percent dispersant efficiency. For a large spill using 45 percent dispersant efficiency, the extent of shoreline oiling was reduced by 72 percent from Alternative 1; in particular, adverse effects on important shorebird staging and waterbird nesting areas in the Mid-Atlantic Shelf were reduced.

The difference in estimated risk scores by dispersant efficiency for large oil spills was unique to the Mid-Atlantic Shelf model. For large oil spills in other regions modeled in this PEIS, adverse effects on birds were estimated to be the same regardless of dispersant efficiency. Therefore, it is expected that the severity of adverse effects on birds for a medium oil spill will typically be reduced with chemical dispersion at either efficiency and will be reduced in some situations for a large oil spill. The reduction of adverse effects on birds when chemical dispersion is used is contingent upon whether the reduction of adverse shoreline effects coincides with heavily used habitats. On an overall regional level, adverse effects of medium oil spills are reduced when chemical dispersion is modeled. For a large oil spill, adverse effects are not consistently reduced when chemical dispersion is modeled, but may be less than when mechanical-only recovery is modeled.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine and coastal birds in the Atlantic region under Alternative 3 are expected to be moderate for small and large spills, with or without dispersant use. For medium spills, impacts are expected to be moderate, but are reduced to minor with the addition of chemical dispersion.

Plankton and Fish

Plankton and fish, a diverse group of species, are important to the marine food web, ecosystem function, and fisheries. Adverse effects on these groups are of high concern, particularly when chemical dispersion is considered as a potential response option. As described in Sections 4.3.2.3 and 4.5.2.2, plankton and fish are adversely affected either directly or via the food web by the toxic effects of oil components that enter the water column—the soluble compounds (MAHs and PAHs) and microscopic oil droplets mixed by waves into the water (French McCay, 2002; NRC, 1985). The most important pathway of exposure is direct uptake of dissolved oil components, originating directly from surface oil or dissolving from the microscopic oil droplets in the water. Overall, adverse effects increase the larger the spill size. However, there is great variability related to the environmental conditions after a spill; plankton and fish suffer much more adverse effects in storm conditions where high waves mix unweathered oil into the water, which happened during the *NORTH CAPE* oil spill (French McCay, 2003), than in calm weather. In addition, many species utilize shallow waters and even the intertidal zone, where they are more likely to be exposed to oil and dissolved components when oil comes ashore. Species and life stages vary considerably in sensitivity to toxic components, with species from relatively unpolluted and environmentally stable locations being more sensitive than those from polluted and environmentally variable areas.

In marine and open coastal environments, small, medium, and large oil spills do not cause large or long-term toxic effects to plankton and fish in the water column. The toxic effects of oil spills result from acute exposure during the time when surface oil is present and for short periods (days to weeks) afterwards. Once the source of hydrocarbons (from floating oil or the shoreline) to the water column is gone, concentrations rapidly disperse to background levels.

There may be longer-term effects if an offshore spill migrates to nearshore shallow areas such as enclosed embayments, estuaries, or wetlands where dilution and flushing are slow. Many fish and other organisms spawn and develop through larval and juvenile stages in these shallow areas. Juvenile fish are more abundant in salt marshes and seagrass beds than in other shallow subtidal and intertidal areas, so these areas are of most concern (see discussion of potential effects on these habitats below). Under Alternative 3, chemical dispersion could not be used within 3 nm[39] of shore; therefore, it would not contribute to adverse effects on plankton and fish in these areas.

The percentage of plankton and fish adversely affected by oil spills was estimated using the modeling results (technical report [French McCay et al., 2004]) of water volumes exposed to toxic oil components. Percentage loss multiplied by volume exposed was integrated over time and space to calculate an equivalent volume of 100 percent loss. These volumes were translated to equivalent areas by multiplying by water depth at the spill site, allowing comparison with other resources, such as birds and shorelines, which are distributed on a per-area basis. The use of area is appropriate because plankton and fish abundance is much more uniformly distributed when expressed on a per-area basis than on a per-volume basis since the ecosystem is driven by sunlight and plant photosynthesis at the water surface (French et al., 1996; Odum, 1971). As indicated by the similar results for the four modeled spill sites in 10 to 30 m of water—offshore Delaware Bay, offshore Galveston Bay, the Florida Straits, and offshore San Francisco Bay (Parts B, C, D, and E, respectively, of the technical report [French McCay et al., 2004])—the equivalent areas of adverse effect on plankton and fish (both average and variable) are applicable to spills of the same size in any location of similar water depth in any region considered in this PEIS. The modeled spill site was 18 m deep water: adverse effects would be smaller for deeper waters because of greater vertical dilution of both oil components and organisms, and proportionately greater in shallower waters because of the restricted dilution potential and generally higher organism abundance.

The model-estimated areas are those where there is a potential to affect the most sensitive species, which are two standard deviations more sensitive than the average of all species tested (2.5th percentile in rank order of sensitivity). For species of average sensitivity (50th percentile), the areas adversely affected would be much smaller. Thus, the model-estimated areas should not be interpreted as experiencing 100 percent mortality of all plankton and fish; they are conservative estimates used for comparative purposes among response scenarios.

Potential adverse effects on plankton and fish in the Atlantic region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.2.2 and summarized in Table 4.5-9 (the results in Table 4.5-9 are included in Table 4.7-8 for comparison). The Mid-Atlantic Shelf was selected the modeling as representative of the Atlantic region. The adverse effects were estimated as a percentage of the total area of concern (68,541 km^2).

Under Alternative 3, the results for 45 percent dispersant efficiency were not significantly different from those for 80 percent dispersant efficiency because more than sufficient dispersant would be available under both conditions to disperse available surface oil for spills up to 40,000 bbl (with some variability, as reflected in the results in Table 4.7-8). For a small spill, based on the evaluation of the volume where water quality would be affected (Tables 4.5-4 and 4.5-5), the volume of adverse effects on plankton and fish would be negligible for all response options under Alternative 3. The volumes and areas of adverse effect are about three times larger than those events without chemical dispersion.

Table 4.7-8
Risk Ranking of Offshore Oil Spills* to Plankton and Fish Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A) in the Mid-Atlantic Shelf‡

Spill Size	Response Option (% dispersant efficiency)	Equivalent Area Affected (km²)	Area Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	< 1	3×10^{-11}	4E
	Chemical Dispersion (45 or 80)	< 1	4×10^{-11}	4E
Medium (2,500 bbl)	Basic	4	0.005	4E
	Chemical Dispersion (45 or 80)	9	0.013	4E
Large (40,000 bbl)	Basic	53	0.08	4E
	Chemical Dispersion (45)	156	0.23	4E
	Chemical Dispersion (80)	155	0.23	4E

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Since the adverse effects are in a small percentage of the area of concern and less than the range of natural variability, the recovery time would be less than 1 year. Overall, based on the modeling, adverse effects on plankton and fish in the Atlantic region under Alternative 3 would be localized to the immediate area around the spill site and similar in all marine-water areas of the region.

Even without chemical dispersion, concentrations of toxic components could become high enough to cause concern for plankton and fish for medium or large spills if the slick moved into shallow coastal areas and embayments under conditions where storm-generated waves mixed large amounts of fresh oil into the water column. Under Alternative 3, chemical dispersion could not be used within 3 nm[40] of shore or in enclosed coastal lagoons; therefore, it would not contribute to such risk, and might even reduce concerns by dispersing portions of the slick before it can enter shallow waters.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on plankton and fish in the Atlantic region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Intertidal Habitats

Potential adverse effects on intertidal habitats in the Atlantic region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.2.2 and summarized in Table 4.5-10 (the results in Table 4.5-10 are included in Table 4.7-9 for comparison). There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on intertidal habitats in that larger spills tend to have higher oil loading on the shoreline and affect larger areas. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery.

Under Alternative 3 for a small spill, very little oil is likely to strand onshore, and the oil loading would be light in most cases. However, the potential for adverse effects on intertidal habitats increase as spill volume increases, with greatest concern if marshes and tidal flats become heavily oiled. Chemical dispersion is expected to reduce adverse effects on these habitats by reducing the amount of oil that strands onshore (Section 4.3.2.4). The risk scores in Tables 4.5-10 and 4.7-9 were based on estimated adverse effects on the intertidal habitats of Delaware Bay because even large spills usually will not affect large shoreline areas. For example, the maximum percentage of shoreline oiled under the large spill scenarios was only 0.02 percent of the shoreline area in the entire Mid-Atlantic Shelf.

Adverse effects on intertidal habitats for a small spill were determined to be low by extrapolating from the results of a medium spill and expecting recovery from light oiling to usually be rapid for all habitat types. For a medium spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by nearly 85 percent, from 11.6 km under Alternative 1 to 1.8 km under Alternative 3. Most shoreline oiling was very light and restricted to outer sand beaches, which were expected to recover within 1 year. In addition, chemical dispersion doubled the number of times that no oil stranded onshore, from 17 (Alternative 1) to 34 (Alternative 3) out of 100 model runs (technical report [French McCay et al., 2004]). The results for the 45 percent dispersant efficiency were the same as for 80 percent dispersant efficiency (Table 4.7-9). Most importantly, there was no wetland oiling under any chemical dispersion scenario, including worst case scenarios.

Table 4.7-9
Risk Ranking of Offshore Oil Spills* to Intertidal Habitats Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A) in the Mid-Atlantic Shelf‡

Spill Size	Response Option (% dispersant efficiency)	Habitats Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	4E
Large (40,000 bbl)	Basic	1–5	2D
	Chemical Dispersion (45)	0–1	3E
	Chemical Dispersion (80)	0–1	2E

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

For a large spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by 70 percent, from 29.2 km under Alternative 1 to 8.6 km under Alternative 3. In addition, chemical dispersion increased the number of times that no oil stranded onshore, from 19 (Alternative 1) to 35 (Alternative 3) out of the 100 model runs (technical report [French McCay et al, 2004]). However, wetlands made up 60 percent of the shoreline oiled, so the recovery rate was still expected to be 3 to 7 years (Section 4.3.2.4). For a large spill using 45 percent dispersant efficiency, the extent of shoreline oiling was reduced by 72 percent from Alternative 1, with adverse effects mostly to sand beaches.

Although areas other than Delaware Bay in the Atlantic region were not modeled, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on intertidal habitats will fall within a similar range throughout the Atlantic region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on intertidal habitats in the Atlantic region under Alternative 3 are expected to be insignificant for small spills, with or without dispersant use. For medium spills, impacts are expected to be minor, but are reduced to insignificant with the addition of chemical dispersion. For large spillss, impacts are expected to be moderate, but are reduced to minor with the addition of chemical dispersion at 45 percent efficiency. There is no change in impact at 80 percent efficiency[41]. On an overall regional level for medium or large spills, adverse impacts are reduced when chemical dispersion is modeled.

Subtidal Habitats

Potential adverse effects on subtidal habitats in the Atlantic region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.2.2 and summarized in Table 4.5-11 (the results in Table 4.5-11 are included in Table 4.7-10 for comparison). The addition of *in situ* burning does not change the potential adverse effects from those with mechanical-only recovery.

The risk to fauna and flora of the subtidal benthic habitat is minimal, based on the diluting effect of the overlying water (Section 2.2.2)—the deeper the water, the lower the risk. Chemical compounds of concern tend to evaporate, rather than dissolve, and the rapid dilution of any chemical entering the water column decreases the toxicity of any oil residue potentially reaching the bottom substrate.

Adverse effects on subtidal habitats under the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are small for a small spill because the contaminated area of sediment or bottom-water contamination is small when compared with the overall subtidal habitat area present in the Atlantic region (Table 4.7-10).

Chemical dispersion is not expected to change the already small adverse effects on subtidal habitats. There would be an increase in the amount of oil that is dispersed into the water column (Section 4.3.2.5). Given the available depth for mixing and dilution, this does not increase the risk.

Adverse effects on subtidal habitats for a small spill were determined to be low by extrapolating from the results of a medium spill. For a medium spill using 45 or 80 percent dispersant efficiency, sediment concentrations still never exceeded the threshold of concern for either dissolved aromatic hydrocarbons or total hydrocarbons. Water column exposure to dissolved aromatic hydrocarbons was unchanged from mechanical-only recovery (<0.001 percent of the reference area). For a large spill, sediment contamination was unchanged from the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit). Exposure of demersal species increased slightly over the basic response scenario, but at either dispersant efficiency the equivalent area of 100 percent mortality was still less than 0.06 percent of the reference area (Table 4.7-10).

Table 4.7-10
Risk Ranking of Offshore Oil Spills[*] to Subtidal Habitats Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Mid-Atlantic Shelf[‡]

Spill Size	Response Option (% dispersant efficiency)	Habitats Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Large (40,000 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Green represents a level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Although areas other than the Mid-Atlantic Shelf in the Atlantic region were not modeled, the results are consistent with those for many other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on subtidal habitats will fall within a similar range throughout the Atlantic region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subtidal habitats in the Atlantic region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Areas of Special Concern

For this analysis, the risks to areas of special concern are the same as those for either intertidal or subtidal habitats (Section 4.7.2.2), whichever are greater. Since the risk to intertidal habitats is greater, those risk scores were used. Potential adverse effects on areas of special concern in the Atlantic region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.2.2 and summarized in Table 4.5-12 (the results in Table 4.5-12 are included in Table 4.7-11 for comparison). There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on areas of special concern in that larger spills tend to have higher oil loading on the shoreline and affect larger areas. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery. Since areas of special concern are scattered along the Atlantic coast, they are unlikely to be disproportionately affected by the average spill, and recovery would be similar to that for other intertidal habitats.

Adverse effects on areas of special concern for a small spill were determined to be low by extrapolating from the results of a medium spill and expecting recovery from light oiling to usually be rapid for all habitat types. For a medium spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by over 90 percent, from 11.6 km under Alternative 1 to 1.8 km under Alternative 3. Most shoreline oiling was very light and was restricted to outer sand beaches that are expected to recover within 1 year. The results for the 45 percent dispersant efficiency were the same as for 80 percent dispersant efficiency (Table 4.7-11).

Table 4.7-11

Risk Ranking of Offshore Oil Spills[*] to Areas of Special Concern Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Mid-Atlantic Shelf[‡]

Spill Size	Response Option (% dispersant efficiency)	Areas Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	4E
Large (40,000 bbl)	Basic	1–5	2D
	Chemical Dispersion (45)	0–1	3E
	Chemical Dispersion (80)	0–1	2E

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

For a large spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by 73 percent, from 29 km under Alternative 1 to 8.6 km under Alternative 3. Therefore, the risk ranking was reduced to reflect this reduction in shoreline oiling. However, wetlands composed 60 percent of the shoreline oiled, so the recovery rate is still expected to be 3 to 7 years (Section 4.3.2.4). For a large spill using 45 percent dispersant efficiency, the extent of shoreline oiling was reduced by 82 percent from Alternative 1, and in this case adverse effects were mostly on sand beaches. Overall, information on subsistence use of fish and shellfish in the Mid-Atlantic Shelf is limited. While some residents may supplement their diets with these resources, subsistence is not known to be a prominent activity in this area, as compared to Alaska, where Native communities may suffer substantial economic and cultural losses due to contamination of subsistence seafood during an oil spill. Chemical dispersion could reduce shoreline effects for a large oil spill, but the potential benefit depends on the specific fate of the untreated oil.

Although areas other than the Mid-Atlantic Shelf in the Atlantic region were not modeled, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on areas of special concern will fall within a similar range throughout the Atlantic region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on areas of special concern in the Atlantic region under Alternative 3 are expected to be insignificant for small spills, with or without dispersant use, based on the risk to intertidal habitats. For medium spills, impacts are expected to be minor, but are reduced to insignificant with the addition of chemical dispersion. For large spillss, impacts are expected to be moderate, but are reduced to minor with the addition of chemical dispersion at 45 percent efficiency. There is no change in impact at 80 percent efficiency[42].

4.7.2.3. Consequences to Threatened, Endangered, or Candidate Species

Potential adverse effects on threatened, endangered, or candidate species in the Atlantic region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.2.3. Potential adverse effects on marine mammals, marine and coastal birds, fish, or sea turtles that are threatened, endangered, or candidate species are identical to those discussed in Section 4.7.2.2 for these groups. There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on threatened, endangered, or candidate species in that larger spills tend to spread across a larger surface water area and have higher shoreline oil loading. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery.

When chemical dispersion is used under Alternative 3 for small, medium, and large spills, the contaminated surface water area is reduced, especially when compared with the overall surface water area in the Mid-Atlantic Shelf (68,541 km^2). Thus, the likelihood of threatened, endangered, or candidate species becoming oiled at the surface is reduced from the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit). Less oil is likely to strand onshore, and the oil loading would be light in most cases. Potential adverse effects increase as spill volume increases, with greatest concern for conditions where haulout areas, bays, estuaries, and known breeding grounds of these species become heavily oiled. Although populations are sporadic and vary with migration, if a threatened, endangered, or candidate species were present in the area of an oil spill, the resulting adverse effects could be low. The severity of the effect varies depending on the sensitivity of the individuals present. Overall, risk scores were highest for marine and coastal birds. While they were reduced from the levels in Alternative 1, they remained medium.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on threatened, endangered, and candidate species in the Atlantic region under Alternative 3 are expected to be moderate for small and large spills, with or without dispersant use, based on the risk to marine and coastal birds. For medium spills, impacts are expected to be moderate, but are reduced to minor with the addition of chemical dispersion.

4.7.2.4. *Consequences to Essential Fish Habitat*

For this analysis, the risks to Essential Fish Habitat (EFH) are assumed to be the same as those for plankton and fish or for subtidal habitats (Section 4.7.2.2), whichever are greater. The risk to both resources was determined to be low, regardless of response option used. Potential adverse effects on EFH in the Atlantic region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.2.4.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on EFH in the Atlantic region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use, based on the risk to plankton and fish and to subtidal habitats.

4.7.2.5. *Consequences to the Socioeconomic Environment*

As discussed in Section 4.3.5, oil spills can produce a variety of adverse social and economic effects. These adverse effects are generally not large when measured at the regional levels, but instead are typically felt in communities located near resources oiled by the spill. Specifically, large adverse effects are generally limited to those industries and populations that are affected by the spill. Some of the most visible and large effects are likely to include effects on water- and shore-based recreation, commercial and recreational fisheries, and tourism. In addition, large-scale spills hold the potential to adversely affect the well-being of the residents and economies of coastal communities. Individuals who rely on coastal resources for employment and income are at risk of experiencing disproportionately adverse effects from oil spills.

This modeling considers the risk of adverse socioeconomic effects posed by oil spills, which can include, but are not limited to reduced recreational activity because of beach closures, limited accessibility, or perceived taint; closure of commercial fishing grounds or hatcheries, or reduced commercial harvests; and altered marine transportation patterns. In addition to these and other direct adverse effects, oil spills can have secondary adverse effects on social and economic welfare along the coast. For example, an oil spill may cause changes in employment and firm revenues of resource-based businesses. While these effects are not quantified in this modeling, the following discussion provides absolute and relative measures of the overall risk of adverse social and economic effects of small, medium, and large oil spills using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion in the Atlantic region.

This modeling evaluates the effects of oil spills based on the risk of adverse effects on various factors of the socioeconomic environment rather than changes in monetary benefits. The methodology assumes that the risk posed by oil spills to the socioeconomic environment is directly related to the extent to which coastal resources (e.g., sandy recreational beach, marine waters used for commercial fishing) are oiled above selected effect thresholds. That is, the proportion of total shoreline or surface water oiled above selected thresholds in the modeled spill area is used to represent the risk of socioeconomic effects (see Section 4.4.3.2 for details on the method used).

Comparing the absolute risk of adverse socioeconomic effects (e.g., meters of sandy shoreline oiled above a recreational threshold of concern) across spill scenarios, including variations in spill response scenarios, allows for an understanding of the relative risk of adverse socioeconomic effects across these scenarios. In this section, the results of Alternative 3—basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion—are examined. Determining relative risk also allows for extrapolation of site-specific results to the entire region. For example, some of the risk estimates presented below are based on modeled hypothetical spills affecting the Mid-Atlantic Shelf. While any given spill may exhibit distinctly different patterns of socioeconomic effect, the relative risk measures reported for the Mid-Atlantic Shelf modeling scenario are expected to be broadly applicable to a range of spill locations along the Atlantic coast. In addition, the conclusions reached for the Mid-Atlantic Shelf are supported by results for other modeled areas.

Extrapolating results from modeled spills in specific areas to other coastal sites is more valid for measures of relative risk of losses than absolute measures of monetary losses. For example, if a given level of additional oil spill response in the waters off the New Jersey coast causes a 30 percent reduction in shoreline resources oiled (and, therefore, recreational beach use affected), that 30 percent can be applied to any site along the Atlantic coast. If losses to New Jersey beaches were evaluated in terms of dollars, however, seasonal and visitation differences between New Jersey and other states such as Maine would prevent accurate application of those monetary losses. For this reason, there is precedent in applying relative risk in evaluating potential changes to response regulations; for example, environmental performance of double-hull tanker design alternatives was evaluated based on risk of environmental and socioeconomic effects of oil spills (Transportation Research Board, 2001).

This methodology was used to evaluate socioeconomic risks and differs from that used to address the risks posed to other ecological resources. The rationale behind this deviation is based on the fact that this methodology is judged to most accurately reflect the threat to these resources while facilitating comparisons across specific modeled areas and generalizations to broader contexts (see Section 4.4). In addition, the socioeconomic risk metric closely parallels the measure of proportion of resource affected that was quantified in the preceding sections for ecological resources. The risk matrix used for ecological resources defines risk based on the percentage of the resource potentially affected in combination with the time to recovery (Figure 4.4-2). While the percentage of the resource affected is relevant to the modeling of socioeconomic effects, the time to recovery is difficult to define in a socioeconomic context. The time necessary for socioeconomic recovery is subject to factors outside the influence of oil spill cleanup operations, such as national economic trends, recreational preferences, consumption patterns, and public perceptions. Changes in these factors, which are independent of the oil spill, could affect the time to recovery; thus, assigning "time to recovery" would be arbitrary.

There is no existing standard for "significance" related to the socioeconomic effect of oil spills (e.g., how much shoreline or surface water must be oiled to be considered a "high," "medium," or "low" effect). The significance of the effect will depend on a number of factors, including the scope of the analysis (i.e., national, regional, local), opportunities for resource substitution (e.g., an unoiled beach or fishing ground nearby, alternative ports of call), and the duration of the spill event. Generally, a spill event would be of low concern if it is not of long enough duration to affect the financial viability of local businesses, and the affected communities are able to find substitutes to replace the oiled resources.

For this PEIS, (1) the greatest effects modeled at the regional level was less than approximately 10 percent of available shoreline or surface water resources (indicating the likely presence of substitute resources), and (2) resource use following these modeled spills (e.g., vessel transportation and fishing) would be expected to resume as soon as oil recovery efforts were completed. As a result, the modeled effects under all modeled scenarios would likely be low at the regional level. As noted in the text, any adverse effects that occur would be expected to be localized in nature.

The risk factor reflects the ratio of the percentage of the shoreline or surface water oiled using the basic response scenario to the percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected given response options limited to mechanical recovery and *in situ* burning. Under Alternative 1, a risk factor of 1.0 is assigned to medium and large spills (small spills are assumed to have a negligible effect), indicating that no additional response options are taken in this modeled area.

In estuaries and coastal waters within 3 statute mi of shore, mechanical-only recovery would be used under Alternative 3. In marine waters 3 or more statute mi from shore, the basic response scenario with the addition of chemical dispersion could be used under Alternative 3 in the Atlantic region. Potential adverse effects on coastal communities in the Atlantic region for oiled shoreline and oiled surface water using the basic response scenario are presented in Section 4.5.2.5 and summarized in Table 4.5-13 (the results in Table 4.5-13 are included in Table 4.7-12 for comparison). These tables highlight the effects of small, medium, and large oil spills on the Atlantic region's socioeconomic resources by presenting estimates of resources oiled as a result of the average modeled spill in absolute terms (length of shoreline oiled or area of surface water oiled above the threshold of concern) and as a percentage of the total resource base in the modeled area (Mid-Atlantic Shelf). The threshold of concern because of oiled shoreline is 10 g/m^2 and of surface water oiled is 0.01 g/m^2 (technical report [French McCay et al., 2004]). Table 4.7-12 summarizes potential adverse effects on coastal communities in the Atlantic region under Alternative 3—the basic response scenario with the addition of chemical dispersion. Both the shoreline oiling index and the surface water oiling index are greatly reduced for both medium and large spills. This means that, in general, chemical dispersion will decrease the severity of social or economic effects, as discussed below. This is of greatest potential benefit on a local, rather than a regional, basis.

This modeling assumes that the risk posed to the socioeconomic environment by oil spills is directly related to the extent to which resources are affected above selected thresholds of concern—for the Atlantic region, the meters of recreational beach oiled and the square meters of marine waters oiled above the threshold of concern. Comparing the absolute risk of adverse socioeconomic consequences across spill scenarios, including variations in spill response scenarios, allows for an understanding of the relative risk of adverse socioeconomic consequences across spill scenarios. Determining relative risk allows for extrapolation of site-specific results to the entire region. For example, the risk estimates presented in Table 4.7-12 are based on modeled hypothetical spills affecting the Mid-Atlantic Shelf, which is an appropriate surrogate for the Atlantic region in this modeling. While any given spill may exhibit distinctly different patterns of socioeconomic consequence, the relative risk measures are expected to be broadly applicable to a range of spill locations, especially in island regions, as long as the spills occur in areas where chemical dispersion is feasible. In addition, the conclusions reached for the Mid-Atlantic Shelf are supported by results for other modeled areas—the relative degree of risk reduction achieved under various removal assumptions across spill size is similar in magnitude.

For this modeling, the socioeconomic environment is divided into components representative of the major parameters of coastal life potentially affected by an oil spill. Absolute and relative risk are discussed for coastal communities, demography, and employment; general economic status of a coastal community; vessel transportation and ports; commercial and recreational fisheries; archaeological and historic resources; recreation and tourism; environmental justice; and public safety and worker health.

Table 4.7-12

Risk Ranking of Offshore Oil Spills[*] to Coastal Communities as a Result of Shoreline and Surface Water Oiled Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Mid-Atlantic Shelf[‡]

		Shoreline Length			**Surface Water Area**		
Spill Size	**Response Option (% dispersant efficiency)**	**m Oiled Above Threshold[§]**	**Estimated % Oiled[‖]**	**Risk Factor[#]**	**m^2 Oiled Above Threshold[§]**	**Estimated % Oiled[‖]**	**Risk Factor[#]**
Small (200 bbl)[**]	Basic	N/A	N/A	N/A	N/A	N/A	N/A
	Chemical Dispersion (45 or 80)	N/A	N/A	N/A	N/A	N/A	N/A
Medium (2,500 bbl)	Basic	7,122	1.2	1.0	810×10^{6}	0.55	1.0
	Chemical Dispersion (45)	1,346	0.22	0.18	87×10^{6}	0.06	0.11
	Chemical Dispersion (80)	1,205	0.20	0.17	73×10^{6}	0.05	0.09
Large (40,000 bbl)	Basic	17,458	2.9	1.0	$1,155 \times 10^{6}$	0.79	1.0
	Chemical Dispersion (45)	5,253	0.86	0.29	268×10^{6}	0.18	0.23
	Chemical Dispersion (80)	5,022	0.83	0.28	219 × 106	0.15	0.19

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

[§] Thresholds above which some economic or social risk is expected were determined, and the length of shoreline oiled and the area of surface water oiled above this threshold for the average modeled spill are reported. The threshold of concern because of oiled shoreline and surface water is 10 g/m^2 and 0.01 g/m^2 of oil, respectively (technical report [French McCay et al., 2004]).

[‖] Percentages reflect the proportion of the total modeled area above the threshold of concern.

[#] Risk factor reflects the ratio of the percentage of the model area or volume oiled using the basic response scenario to the model area or percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected with response limited to the basic response scenario.

[**] A 200-bbl spill is assumed to have negligible effect.

Coastal Communities, Demography, and Employment

Oil spills affect the pleasure that coastal residents and visitors derive from coastal activities and the economic contribution that resources make to local income and employment. To the extent that the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion can reduce shoreline oiling and surface water oiling, this combination of spill response options will act to reduce adverse effects on coastal communities.

As a result of oiling, beaches in the immediate vicinity of a spill may be closed to visitors, and fishing may not be permitted in waters exposed to oil, causing losses in revenue to both the tourism and commercial and recreational fishery sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill, causing short-term decreases in recreation and tourism; commercial and recreational fishing; and the employment opportunities, income, and businesses these industries support. In addition, an oil spill may temporarily reduce the appeal of coastal living in a given area.

For a small spill along the Atlantic coast, there is no risk of large adverse effects on coastal communities. In many cases, a spill of this size would be expected to pose no risk to shoreline or surface water resources because the spilled oil will never reach the threshold of concern (Table 4.7-12).

While the risk to coastal communities increases with spill size, the effects remain localized. With chemical dispersion, a medium spill in the Mid-Atlantic Shelf will have a spill area[43] above the corresponding thresholds of concern that will adversely affect approximately 1,205 to 1,346 m of shoreline and sweep approximately 73 to 87 million m^2 of marine waters used for recreation and by the commercial fishing industry, respectively (Table 4.7-12). A large spill will affect approximately 5,022 to 5,253 m of shoreline and sweep approximately 219 to 268 million m^2 of marine waters (Table 4.7-12). However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources either at all or at levels above the selected threshold of concern. For medium and large spills along the Mid-Atlantic Shelf shoreline, such conditions prevail approximately 75 and 55 percent of the time, respectively, based on modeled spills when the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion is used in the cleanup, regardless of dispersant efficiency. For these spill events, no adverse effects on the shoreline are expected.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal communities, demography, and employment in the Atlantic region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills: regionally less than 1 percent of sandy shoreline and 0.2 percent of surface water would be affected, even for the largest spills modeled. Any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Economic Status

The overall economic status of communities, industries, and individuals that rely on coastal resources for sustenance, revenue, and quality of life can be affected by an oil spill. As noted above, coastal communities can suffer direct and indirect adverse economic effects from an oil spill, as beach and fishery closures decrease revenue and eliminate jobs. More specifically, losses will be felt in commercial and recreational fisheries, by both the anglers themselves and by related industries as catch opportunities decrease or are eliminated entirely. Tourism and associated businesses will suffer economic setbacks as visits to affected coastal areas decline and purchase of area goods and services decrease because of perceived resource taint. Similarly, environmental justice issues may arise as low-income or minority communities are disproportionately affected by the spill (discussed below in more detail).

A small spill 3 or more statute mi offshore would have essentially no adverse effect on either the local or regional economies (Table 4.7-12). There is little to no risk of oiling economically important resources, and it is unlikely that any commercial fisheries or recreational areas would be affected.

While the risk increases as spill size increases, the effects remain localized. With chemical dispersion, a medium spill in the Mid-Atlantic Shelf will have a spill area above the corresponding thresholds of concern that will adversely affect approximately 1,205 to 1,346 m of shoreline and sweep approximately 73 to 87 million m^2 of marine waters used for recreation and by the commercial fishing industry, respectively, (Table 4.7-12). A large spill will affect approximately 5,022 to 5,253 m of shoreline and sweep approximately 219 to 268 million m^2 of marine waters (Table 4.7-12). However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources either at all or at levels above the selected threshold of concern. For medium and large spills along the Atlantic coast, such conditions prevail approximately 75 and 55 percent of the time, respectively, based on modeled spills when the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion is used in the cleanup, regardless of dispersant efficiency. For these spill events, no adverse effects on shoreline are expected.

Despite chemical dispersion, a medium or large spill could be expected to have short-term adverse economic effects as a result of oiling recreational beaches, closures of commercial and recreational fishing grounds, and degradation of the appeal of coastal locations. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on economic status in the Atlantic region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills: regionally less than 1 percent of sandy shoreline and 0.2 percent of surface water would be affected, even for the largest spills modeled. Any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Vessel Transportation and Ports

Oil spills occurring 3 or more statute mi offshore are not likely to cause large adverse effects to vessel transportation and ports. Local resources would easily handle whatever response operations are implemented. However, an oil spill can disrupt marine commerce if it occurs in and around a shipping channel or port and results in limits on watercraft movement as a means of facilitating spill response. Since vessel transportation is of paramount importance for many industries along the Atlantic coast, any interruption in the standard use of vessels or increase in travel times over water can result in hardship for coastal communities as fewer goods are exchanged, transportation costs rise, and the revenue streaming through the local economy falls. These adverse effects might be felt at a number of levels. For example, vessel operators may incur additional costs associated with delays and longer shipping distances; businesses that depend on timely receipt of feedstock or other goods may experience adverse effects such as production slowdowns; and individuals who work in adversely affected sectors may be displaced. To the extent that businesses in other locations depend on the affected industries, a longer-term disruption of vessel transportation could yield adverse effects beyond the immediate spill area. However, given substitute suppliers and shipping modes and the expected short-term nature of any disruption in vessel traffic, such adverse effects are not likely to be high.

For a small spill, no large adverse effects on vessel transportation or ports are expected (Table 4.7-12). While the risk to the vessel transportation industry increases with spill size, the effects remain localized. With chemical dispersion a medium spill in the Mid-Atlantic Shelf will have a spill area above the corresponding thresholds of concern that will adversely affect approximately 73 to 87 million m^2 of surface water area; a large spill, approximately 219 to 268 million m^2 of surface water area (Table 4.7-12). However, a spill occurring under specific location, weather, and tidal conditions could adversely affect vessel transportation and ports and the industries and communities that depend on this traffic. Any adverse effects on vessel transportation and ports would likely be short lived—that is, even if shipping waters or ports are exposed to oil and are therefore closed, as soon as recovery efforts remove surface oil, these facilities would be expected to be reopened.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on vessel transportation and ports in the Atlantic region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills: regionally less than 0.2 percent of surface water would be affected, even for the largest spills modeled. Any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Fisheries

Commercial Fisheries

Commercial fisheries are vulnerable to oil spills because of both closures and perceived taint. A moratorium on fishing operations in the wake of an oil spill can lead to significant revenue losses for the commercial fishing industry, as well as related industries, including those that supply equipment to and purchase products from commercial fleets. By contaminating key waters, an oil spill may disrupt employment in commercial fisheries and related sectors of the economy. In addition, oil spills can lead to a decreased demand for fish from affected waters because of actual or perceived taint and can instigate alterations to fishing practices in a manner that increases operating costs and/or decreases revenues. Large spills can potentially injure fish nursery grounds and impose other risks that could reduce fish harvests in the longer term.

For a small spill in the Atlantic region, the risk to commercial fisheries is negligible (Table 4.7-12). While the risk to the commercial fishing industry increases with spill size, the effects remain localized. With chemical dispersion a medium spill along the Atlantic coast will have a spill area above the corresponding thresholds of concern that will adversely affect approximately 73 to 87 million m^2 marine waters used by the commercial fishing industry (Table 4.7-12). A large spill will present risk above the corresponding threshold of concern to approximately 219 to 268 million m^2 of marine waters potentially important to commercial fisheries (Table 4.7-12).

A risk of economic loss to commercial fisheries will occur when waters exceed relevant management and/or risk-based thresholds. For example, fishing may not be permitted in waters swept by oil above the modeled threshold, resulting in reductions in commercial fish landings for a period of time following a spill. The resulting adverse effects would be expected to reverberate through communities in the area of the spill, causing decreases in employment, income, and the viability of businesses associated with the commercial fishing industry. To the extent that substitute fishing grounds are available, spill effects on the commercial fishing economy may be less severe.

Recreational Fisheries

Similar to commercial fishing operations, recreational fisheries are at risk of closure or loss in value as a result of oil spills. These adverse effects will not generally be at the regional or national levels but could be high at the local level. For this modeling, the risks posed to recreational fishing activities are modeled in the same manner as risks to commercial fishing activities, in square meters of surface water oiled above the corresponding threshold of concern. The effects of an oil spill on recreational fishery-related activities will be felt more heavily by various populations, including recreational anglers and firms that supply goods and services to recreational anglers. For example, recreational anglers fish for pleasure or sport, as opposed to monetary gain. In the wake of an oil spill, such anglers may choose to fish at a substitute location, may experience a reduced quality of experience, or may choose to forgo fishing entirely. The losses suffered will be related to these missed opportunities. In addition, while closing waters to recreational fishing will decrease the social welfare of recreationists, it would also be expected to affect the demand for boat rentals and other services consumed by fishing enthusiasts.

For a small spill, adverse effects on recreational fishing resources in the Atlantic region would likely be negligible (Table 4.7-12). Medium and large spills may cause decreases in local recreational fishing activities and in the revenues generated from these activities.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on fisheries (commercial and recreational) in the Atlantic region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills: regionally less than 0.2 percent of surface water would be affected, even for the largest spills modeled. Any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Subsistence

Potential adverse effects on subsistence resources in the Atlantic region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.2.5 and summarized in Table 4.5-14 (the results in Table 4.5-14 are included in Table 4.7-13 for comparison). The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery alone.

Under Alternative 3, potential adverse effects on subsistence resources in the Atlantic region are low for small, medium, and large spills. Chemical dispersion may increase adverse effects on subsistence resources by increasing water column exposure to dissolved aromatics; however, effects on intertidal subsistence resources may be reduced because chemical dispersion is expected to reduce the amount of oil that strands in intertidal habitats (Section 4.3.2.4). The risk ranking using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion is presented in Table 4.7-13.

Table 4.7-13
Risk Ranking of Offshore Oil Spills[*] to Subsistence Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Mid-Atlantic Shelf[‡]

Spill Size	Response Option (% dispersant efficiency)	Resources Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Large (40,000 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	1–5	4D

Source: Adapted from Part B of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Mid-Atlantic Shelf (as discussed in the text) as representative of the Atlantic region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Effects on subsistence resources for a small spill were determined to be low by extrapolating from the results for a medium spill. With the addition of chemical dispersion at 45 percent efficiency for a medium spill, the modeling results showed water column exposure at low concentrations (1–100 ppb) in a more widespread area outside Delaware Bay and at high concentrations (100–10,000 ppb) in localized areas. Sediment exposure was expected to be negligible. The risk scores in Table 4.7-13 reflect the predicted recovery rates for subsistence resources of less than 1 year for all spill volumes (Section 4.3.5.6).

With the addition of chemical dispersion at 45 percent efficiency for a large spill, the modeling results showed water column exposure at both low concentrations (1–100 ppb) covering a small area outside of Delaware Bay and high concentrations (100–10,000 ppb) occurring directly outside the bay. Sediment exposure was expected to be negligible. With the addition of chemical dispersion at 80 percent efficiency, water column exposure of dissolved aromatics covered a larger area than at 45 percent efficiency; otherwise, the results were similar at 45 and 80 percent efficiency.

Although areas other than the Mid-Atlantic Shelf in the Atlantic region were not modeled, the results are consistent with those for all other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on subsistence resources will fall within a similar range throughout the Atlantic region. Adverse effects on subsistence resources are not likely to be high on a regional level, but may be high on a local level.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subsistence in the Atlantic region under Alternative 3 are expected to be insignificant for small and medium spills, with or without dispersant use. For large spills, impacts are expected to be insignificant, but increase to minor with the addition of chemical dispersion.

Archaeological and Historic Resources

Potential adverse effects on archaeological and historic resources in the Atlantic region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.2.5.

Under Alternative 3, adverse effects on archaeological resources in the Atlantic region would likely be negligible, regardless of spill size, because most archaeological resources in this region are buried under offshore sediments and are not at risk of becoming oiled or coming in contact with dispersants (Section 3.2.5.6). Similar to archaeological resources, adverse effects on historic resources are expected to be negligible, regardless of spill volume or response option. Most historic sites in the Atlantic region are either located on land and protected from oiling by bulwarks or other barriers, or are submerged shipwrecks that are typically not well preserved due to strong currents and wave action in the region (Section 3.2.5.6). Chemical dispersion may help reduce the amount of oil that strands on the shoreline, which will reduce the amount of shoreline cleanup and potential disturbance to sensitive historic structures. There are limited data that identify long-term or chronic degradation to cultural resources due to chemical dispersion.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on archaeological and historic resources in the Atlantic region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Recreation and Tourism

Oil spills can adversely affect a coastal community's recreational and tourism assets. There are parks, seashores, beaches, and recreational fishing areas that line the Atlantic coast, and both residents of and visitors to the Atlantic coast appreciate the recreational opportunities offered to them by these resources. An oil spill would be expected to cause significant local decreases in tourism, recreation, associated business revenues, and the quality of coastal living. An oil spill would be expected to affect recreationists' overall social welfare; in addition, the social and economic implications of a spill would reach beyond direct effects on visitors and into the community. For example, visitors may be less likely to visit and spend money in an area perceived as affected by a spill, potentially leading to loss of business revenue and jobs (see Coastal Communities, Demography, and Employment above and in Section 4.5.2.5 for more details).

For a small spill along the Atlantic coast, the adverse effects on recreation and tourism are negligible (Table 4.7-12). There is little to no risk of oiling economically important resources, and it is unlikely that any fisheries or recreational areas would be affected.

While the risk to recreation and tourism increases with spill size, the effects remain localized. With chemical dispersion, a medium spill in the Mid-Atlantic Shelf will have a spill area above the corresponding thresholds of concern that will adversely affect approximately 1,205 to 1,346 m of shoreline and sweep approximately 73 to 87 million m^2 of marine waters used for recreation and by the commercial fishing industry, respectively (Table 4.7-12). A large spill will affect approximately 5,022 to 5,253 m of shoreline and sweep approximately 219 to 268 million m^2 of marine waters (Table 4.7-12). However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources either at all or at levels above the selected threshold of concern. For medium and large spills along the Mid-Atlantic coast, such conditions prevail approximately 75 and 55 percent of the time, respectively, based on modeled spills when the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion is used in the cleanup, regardless of dispersant efficiency. For these spill events, no adverse effects on shoreline are expected.

Despite chemical dispersion, a medium or large spill could be expected to have short-term adverse economic effects as a result of oiling recreational beaches, closures of commercial and recreational fishing grounds, and degradation of the appeal of coastal locations. While the physical effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on recreation and tourism in the Atlantic region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills: regionally less than 1 percent of sandy shoreline and 0.2 percent of surface water would be affected, even for the largest spills modeled. Any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Environmental Justice

As mentioned above, low-income, indigenous, and minority populations in some coastal areas may rely on regional fisheries and other marine resources in the context of participating in commercial fishery or other marine resource-based employment. Many individuals from these groups rely on recreation- and tourism-related jobs, and the security of their employment depends on the ability of the coast to attract visitors. To the extent that an oil spill deters visits and reduces demand for hotels, restaurants, and other tourism- and recreation-related services, the economic status of low-income and minority groups may be affected. These groups may experience the effects of a spill more severely than the general population, which relies on a more diverse economic base for its livelihood and on the availability of a widespread, commercially available selection of foods. Additionally, employment in marine resource-related industries might have value beyond the importance this resource holds as an employment opportunity.

A small spill 3 or more statute mi offshore would have essentially no effect on either the local or regional economies (Table 4.7-12). While the risk increases with spill size, the effects remain localized. With chemical dispersion a medium spill in the Mid-Atlantic Shelf will have a spill area above the corresponding thresholds of concern that will adversely affect approximately 1,205 to 1,346 m of shoreline and sweep approximately 73 to 87 million m^2 of marine waters (Table 4.7-12). A large spill will affect approximately 5,022 to 5,253 m of shoreline and sweep approximately 219 to 268 million m^2 of marine waters (Table 4.7-12). However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources at all or at levels above the selected threshold of concern. For medium and large spills along the Mid-Atlantic coast, such conditions prevail approximately 75 and 55 percent of the time, respectively, based on modeled spills when the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion is used in the cleanup, regardless of dispersant efficiency. For these spill events, no adverse effects on shoreline are expected.

As a result of oiling, beaches in the immediate vicinity of a spill may be closed to visitors, and fishing may not be permitted in waters exposed to oil, causing losses in revenue to both the tourism and commercial and recreational fishery sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill and disproportionately affect low-income and minority populations, causing decreases in employment opportunities. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on environmental justice in the Atlantic region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills: regionally less than 1 percent of sandy shoreline and 0.2 percent of surface water would be affected, even for the largest spills modeled. Any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Public Safety and Worker Health

Potential adverse effects on public safety are defined as the risk to the public from direct exposure to oil or response activities as a result of the spill. There are many areas in the Atlantic region with high population concentrations along the coast. However, adverse effects on public safety are unlikely from oil spills that occur 3 or more statute mi offshore for any of the spill sizes considered, regardless of the response options—mechanical recovery, *in situ* burning, and/or chemical dispersion—used. The USCG has protocols to protect the public from risk during shoreline response operations, as well as on-water protocols to prevent the public from entering the response area.

Potential adverse effects on worker health are related to direct exposure to oil during response operations. In addition, operating oil spill response equipment can be dangerous, which is well recognized and is the basis for the worker certification and training requirements that are now in place. There is also a health risk from inhalation of hydrocarbon fumes for first responders, which is recognized in current safety protocols. The risk is greater as the spill size and the corresponding intensity and duration of operations increase, but is minimized if safety standards are followed.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on public health and worker safety in the Atlantic region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

4.7.3. Consequences in the Caribbean Region

For the purpose of this PEIS, the Caribbean region consists of the tropical waters of the Caribbean Sea and Atlantic Ocean and is enclosed to the south by Venezuela, Colombia, and Panama; to the west by Belize, Honduras, Nicaragua, and Costa Rica; and to the north, it wraps toward the southeast with the Greater and Lesser Antilles Islands, beginning with Cuba and ending with Trinidad and Tobago. The tropical waters of the southwestern Atlantic Ocean are off the north shores of Puerto Rico and the U.S. Virgin Islands (the U.S.-affiliated islands discussed in this section), and the tropical waters of the Caribbean Sea are off their south and west shores (Figure 3.1-1). There was no location in this region for modeling and risk assessment purposes. However, the Florida Straits, which is actually in the Atlantic region, was selected for modeling because it contains very similar habitats (mangroves, seagrass beds, coral reefs) and amenity resources as the Caribbean region. The Florida Straits results were used to evaluate effects in the Caribbean region. Modeling results from this location were evaluated relative to the geographic area in Section D.1.2 of the technical report (French McCay et al., 2004), herein referred to as the Florida Straits. The Florida Straits encompasses two biogeographical provinces: Florida Straits and Florida Bay. The results of the modeling—used to evaluate spills of concern in this risk analysis (i.e., 3 or more statute mi offshore)—are presented in Part D of the technical report (French McCay et al., 2004) and summarized in this section.

Table 4.7-14 presents the risk ranking for the modeling of Alternative 3 in the Caribbean region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion at 45 and 80 percent recovery efficiency[44] for the three spill sizes (small, 200 bbl; medium, 2,500 bbl; and large, 40,000 bbl). (Based on the discussion of Alternative 3 presented in Section 2.8.3, a 25 percent increase in mechanical recovery capability would not change the effectiveness of the basic response scenario under Alternative 1.) The risk scores presented in Table 4.7-14 are based on the modeling results for an average spill and on regional considerations; however, in any specific oil spill situation local concerns could be higher. Table 4.7-15 summarizes the significance of the potential beneficial and adverse environmental impacts associated with Alternative 3 in the Caribbean region, based on the extrapolation of the modeling results for the average spill to the region in general.

Table 4.7-14
Risk Ranking[*] of Offshore Oil Spills[†] under Alternative 3 Using the Basic Response Scenario[‡] with the Addition of Chemical Dispersion (Option A) in the Caribbean Region

		Resources of Concern														
		Physical Environment			**Biological Environment**								**Socioeconomic Environment**			
Spill Size	**Response Option (% dispersant efficiency)**	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals[§]**	**Marine and Coastal Birds[§]**	**Plankton and Fish[§]**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles[§]**	**Areas of Special Concern**	**Essential Fish Habitat**	**Subsistence[‖]**	**Archaeological/Historic Resources[‖]**	**Shoreline Oiling Index[#]**	**Surface water Oiling Index[#]**
Small (200 bbl)	Basic	4E	4E	4E	3E	3D	4E	1E	4E	3E	1E	4E	4E	4E	N/A[**]	N/A[**]
	Chemical Dispersion (45)	4E	4E	4E	3E	3D	4E	1E	4E	3E	1E	4E	4D	4E	N/A[**]	N/A[**]
	Chemical Dispersion (80)	4E	4E	4E	3E	3D	4E	1E	4E	3E	1E	4E	4D	4E	N/A[**]	N/A[**]
Medium (2,500 bbl)	Basic	4D	4E	4E	3E	3B	4D	1D	3D	3E	1D	3D	4E	4E	N/A[††]	1.00
	Chemical Dispersion (45)	4D	4E	4E	3E	3D	4D	2E	3D	3E	3D	3D	4D	4E	N/A[††]	0.31
	Chemical Dispersion (80)	4D	4E	4E	3E	3D	4D	3E	3D	3E	3D	3D	4D	4E	N/A[††]	0.31
Large (40,000 bbl)	Basic	4C	4E	4E	3D	3A	4D	1C	3C	3D	1C	3C	4E	4E	N/A[††]	1.00
	Chemical Dispersion (45)	4A	4E	4E	3D	3B	4D	1D	3C	3E	1D	3C	4D	4E	N/A[††]	0.50
	Chemical Dispersion (80)	4A	4E	4E	3D	3B	4D	1D	3C	3E	1D	3C	4D	4E	N/A[††]	0.43

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern; yellow, a medium level of concern; and green, a low level of concern.

[*] This risk ranking is a summary of risk scores for the resources considered in this PEIS. The risk scoring process is explained in Section 4.4.3.

[†] Average spills.

[‡] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[§] Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles. If such species are affected by an actual spill, the level of concern would be high.

[‖] Subsistence and archaeological/historic resources are the only socioeconomic resources that could be ranked using the risk matrix.

[#] The Socioeconomic Index is calculated using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with value equal to 1.0. Risk factors reflect the ratio of the percentage of the model area or volume oiled using the basic response scenario to the percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected with response limited to the basic response scenario.

[**] Index cannot be calculated for small spills since they were not modeled.

[††] Length of shoreline oiled above the threshold of concern is not considered relevant: (1) the shoreline oiling results were highly sensitive in the modeled spill location; (2) the ability to identify shoreline with characteristics amenable to use was limited; and (3) area of surface water oiled above the threshold of concern was expected to provide a more accurate measure of expected risk, given the region's geographic characteristics.

Table 4.7-15

Summary of Potential Adverse Regional Impacts of Offshore Oil Spills* Under Alternative 3 Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A, 45 or 80% Efficiency) in the Caribbean Region

		Resources of Concern																			
		Physical Environment			**Biological Environment**								**Socioeconomic Environment**								
Spill Size	**Response Option (% dispersant efficiency)**	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals‡**	**Marine and Coastal Birds‡**	**Plankton and Fish‡**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles‡**	**Areas of Special Concern**	**Essential Fish Habitat**	**Coastal Communities, Demography, and Employment**	**Economic Status**	**Vessel Transportation and Ports**	**Fisheries**	**Subsistence**	**Archaeological/Historic Resources**	**Recreation and Tourism**	**Environmental Justice**	**Public Safety and Worker Health**
Small (200 bbl)	Basic	Ins	Ins	Ins	Min	Mod	Ins	Mod	Ins	Min	Mod	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
	Chemical Dispersion (45 or 80)	Ins	Ins	Ins	Min	Mod	Ins	Mod	Ins	Min	Mod	Ins	Ins	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins
Medium (2,500 bbl)	Basic	Min	Ins	Ins	Min	Mod	Min	Sig	Mod	Min	Sig	Mod	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
	Chemical Dispersion (45 or 80)	Min	Ins	Ins	Min	Mod	Min	Mod§	Mod	Min	Mod	Mod	Ins	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins
Large (40,000 bbl)	Basic	Min	Ins	Ins	Mod	Mod	Min	Sig	Mod	Mod	Sig	Mod	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Mod	Ins
	Chemical Dispersion (45 or 80)	Mod	Ins	Ins	Mod	Mod	Min	Sig	Mod	Min	Sig	Mod	Ins	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins

Note: Based on Table 4.7-14. Sig, significant; Mod, moderate; Min, minor; and Ins, insignificant.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles.

§ Since there are different levels of concern at 45 and 80 percent dispersant efficiency, the highest level of concern is shown in this table.

Without the addition of chemical dispersion, the results are unchanged from the basic response scenario (see the discussion in Section 4.5.3). In summary, there is a minor or insignificant regional adverse impact to all resources, except for moderate impacts on marine and coastal birds for any spill size; moderate impacts on intertidal habitats for small and medium spills and significant impacts for large spills, respectively; and moderate impacts on sea turtles for large spills. Concern is particularly high for mangrove forests. A large spill could also cause significant, but localized, adverse, short-term socioeconomic impacts. All adverse impacts occur despite the treatment or recovery of some oil, but are reduced by those actions when they are effective. Further, as explained in the introduction to Section 4.7, the modeling shows that *in situ* burning would not significantly change the level of concern identified from those obtained when using mechanical-only recovery.

Under the available response options of Alternative 3, the addition of chemical dispersion helps mitigate, but does not eliminate, potential adverse impacts on marine and coastal birds, marine mammals, and coastal habitat and shoreline, especially for larger spills, without significantly increasing the risk to water column or subtidal resources. There is an increase in the risk score for coastal water quality when dispersants are used on large spills. Chemical dispersion also greatly reduces the likelihood of adverse impacts on socioeconomic resources.

4.7.3.1. Consequences to the Physical Environment

Water Quality

Potential adverse consequences of oil spills to water quality are related to hydrocarbon contamination, as other constituents in oils are at concentrations that would not exceed thresholds of concern. The hydrocarbons that could affect water quality are the soluble aromatics, MAHs (monoaromatic hydrocarbons) and PAHs (polynuclear aromatic hydrocarbons) (Sections 4.3.1.1 and 4.5.3.1), even with dispersant use. Thus, evaluation of potential adverse effects is based on degree of potential contamination by these compounds. Under Alternative 3, dispersant use could increase soluble aromatic hydrocarbon concentrations in areas where dispersants are applied. No beneficial effects on water quality would be expected to result from an oil spill.

For oil spills in marine waters, adverse effects on water quality are low for small and medium oil spills, and medium for large oil spills, regardless of the response option used (mechanical with or without *in situ* burning and chemical dispersion). This is because of the tendency for most chemical compounds of concern to evaporate, rather than dissolve, and the rapid dilution of any chemical compounds that might enter the water column, even after periods of extreme turbulence that induce relatively high dissolution rates. Dispersants would be applied to surface oil after much of the evaporation of the toxic components occurs because of logistics (i.e., greater than 12 hours after the spill), such that the resulting increase of concentrations of toxic components in the water column would be relatively small.

Overall, based on the modeling and risk assessment results, it is concluded that—using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion—adverse water-quality effects under Alternative 3 would be low to medium in marine waters, even in the event of a large spill in the Caribbean region. If an offshore spill moved into shallow and confined coastal waters, adverse effects could be locally important for medium and large spills under conditions where oil is mixed into water by strong turbulence or in areas where oil collects for a few weeks to months after a spill. Chemical dispersion would not be used in shallow and confined coastal waters (less than 3 nm[45] from shore) under Alternative 3, so it could only contribute to adverse water-quality effects in those areas if the dispersed oil plume drifted into the area before being diluted.

The variable used to determine the potential effects on water quality is "volume of water contaminated" by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer, which is less than all established water-quality criteria and thresholds of concern for effects on aquatic biota (Sections 4.3.1.1 and 4.3.2.1). The affected water volume increases with spill volume and the level of physical or chemical dispersion during the time of the spill. Natural dispersion increases with stronger winds and currents, lessening the volume of water that is contaminated above the threshold of concern if in unconfined waters. Since the volume of water contaminated increases exponentially as a function of spill size, the estimated volume contaminated for a small spill was extrapolated from the mean medium- and large-spill model results. Potential adverse water-quality effects in the Caribbean region with using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.3.1 and summarized in Tables 4.5-17 and 4.5-18 for coastal and marine waters, respectively (the results for coastal and marine water quality are included in Table 4.7-16 and 4.7-17 for comparison).

Coastal

In estuaries and coastal waters within 3 statue mi of shore, mechanical-only recovery would be used under Alternative 3. In marine waters 3 or more statute mi from shore, the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion could be used under Alternative 3 in the Caribbean region. If dispersants were applied offshore, the dispersed oil plume could move into these nearshore areas. Since chemical dispersion would not be used in these areas, the level and duration of exposure would be negligible because of dilution.

Florida Bay is used as a representative of coastal water for analyzing the Florida Straits, as well the Caribbean region. Florida Bay is approximately 16,288 km^2 in area and about 2 m deep on average, with a total volume of approximately 32,576 million m^3. The estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of Florida Bay to determine the potential consequences of small, medium, and large spills (Table 4.7-16). This approach was used both with and without dispersant use, and yields a very conservative estimate in that it assumes all of the contamination would occur in coastal water. Since dispersants could not be employed in such areas, this would imply that the dispersed oil plume moved directly into coastal waters without dilution, which will not occur.

Table 4.7-16
Risk Ranking of Offshore Oil Spills[*] to Coastal Water Quality Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Florida Straits[‡]

Spill Size	Response Option (% dispersant efficiency)	Volume of Water Contaminated (million m^3)	Area Contaminated (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	$< 40 \times 10^{-6}$	8×10^{-7}	4E
	Chemical Dispersion (45 or 80)	$< 40 \times 10^{-6}$	8×10^{-7}	4E
Medium (2,500 bbl)	Basic	83	1.7	4D
	Chemical Dispersion (45)	166	3.5	4D
	Chemical Dispersion (80)	167	3.5	4D
Large (40,000 bbl)	Basic	326	6.8	4C
	Chemical Dispersion (45)	1,153	24.0	4A
	Chemical Dispersion (80)	1,095	22.8	4A

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Because of natural dilution, evaporation, and biological processes, contamination levels would decrease rapidly even in the case of a large spill, and recovery time would be on the order of days to weeks. Oil may be incorporated into shallow water or intertidal sediments where, through leaching, it could become a continuing source of contamination over time. However, this would generally only lead to noticeable water-quality degradation in the locality where the oil collects. This is unlikely to occur with a spill that originates offshore. Because mechanical removal would begin within the required response time under Tier I standards (beginning about 12 hours after the spill), many of the soluble components of concern to water quality would have evaporated or dissolved. Thus, mechanical recovery and *in situ* burning would have a small influence on the volume of water adversely affected, and the risk score results would apply whether either response is implemented.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal water quality in the Caribbean region under Alternative 3 are expected to be insignificant for small spills and minor for medium spills, without or without dispersant use. For large spills, impacts are expected to be minor, but increase to moderate with the addition of chemical dispersion.

Marine

The Florida Straits was selected for the modeling as representative of the marine waters around the islands in the Caribbean region, because the geography (islands), bottom topography (steeply dropping off away from shore), environmental conditions (warm trade winds, intermittent severe storms), and ecosystems (subtropical-tropical, areas of coral reefs, seagrasses) are similar. The total surface area of the Florida Straits is approximately 42,689 km^2, so the area of interest is much vaster for marine waters than for coastal waters. Water-quality effects were calculated using a spill site in relatively shallow water—20 m deep, which is much shallower than most of the Caribbean region's marine waters. The results for the selected modeling location (Table 4.7-17) represent conservative estimates of adverse water-quality effects—adverse effects would be reduced in deeper waters because of the larger dilution volume—using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion.

Because of natural dilution, evaporation, and biological processes, contamination levels would decrease rapidly even after a large spill, with or without chemical dispersion, and recovery time would be on the order of days to weeks. The estimates of the volume of contaminated water—and its variability—are generally applicable to spills of the same size throughout the Caribbean region because natural and chemical dispersion of oil into the water column and dilution processes are similar in all areas.

The results in Table 4.7-17 are nearly the same for 45 and 80 percent efficiency because the amount of dispersant used at 45 percent efficiency is sufficient to treat all dispersible surface oil, for spills up to 40,000 bbl. For a small spill, the volume of water contaminated would be the same as under Alternative 1 because, due to logistics, dispersants could only be applied after a small spill has mostly dispersed naturally. Chemical dispersion for medium or large spills increases the volume of water contaminated—and the percentage of the area of concern—that would be adversely affected by about a factor of three, which is still a small volume relative to that of the entire modeled area. *In situ* burning (in combination mechanical recovery and chemical dispersion) would not significantly change the volume contaminated or the effect on water quality since it would substitute for some of the mechanical response.

Table 4.7-17
Risk Ranking of Offshore Oil Spills* to Marine Water Quality Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A) in the Florida Straits ‡

Spill Size	Response Option (% dispersant efficiency)	Area Contaminated (estimated %)	Risk Score§
Small (200 bbl)	Basic	5×10^{-9}	4E
	Chemical Dispersion (45 or 80)	5×10^{-9}	4E
Medium (2,500 bbl)	Basic	0.1	4E
	Chemical Dispersion (45)	0.02	4E
	Chemical Dispersion (80)	0.02	4E
Large (40,000 bbl)	Basic	0.4	4E
	Chemical Dispersion (45)	0.14	4E
	Chemical Dispersion (80)	0.13	4E

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine water quality in the Caribbean region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Air Quality

Concentrations of hydrocarbons of concern in the air resulting from oil spills and response operations were compared with air quality standards to evaluate the potential for adverse effects (see Section 4.3.1.2). The effects of an oil spill on air quality may involve all volatile components of the oil. In addition, if *in situ* burning was used, particulates and other contaminants emitted from burns could become an air quality concern. However, adverse air quality effects from oil spills are normally very localized and short lived for small, medium, and large oil spills. The addition of *in situ* burning does not significantly increase any potential adverse effects: the volume of oil that could be burned is not large, and the temporary smoke plume would be localized and rapidly diluted. Chemical dispersion reduces the volatilization of unburned oil to the atmosphere to only a slight extent, so that effects are essentially identical with or without dispersant use.

Potential adverse effects on air quality in the Caribbean region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.3.1 and summarized in Table 4.5-19. Two possible sources of contamination to the atmosphere were evaluated for their potential effects on air quality: volatilization of hydrocarbons from unburned oil and emissions produced by *in situ* burning. Concentrations in the lowest 2 m of the atmosphere were compared with the U.S. Environmental Protection Agency's National Ambient Air Quality Standards (USEPA's NAAQS) and other thresholds of concern (as discussed in Section 4.3.1.2).

As discussed in Section 4.5.3.1, the results of the modeling show that the potential adverse effects on air quality are low for all spill sizes involving mechanical-only recovery; hence, the risk scores are virtually identical for medium and large spills. Volatilized hydrocarbons would not exceed air quality standards for human health at more than 1 km from the spill site. Evaporation off the water surface and volatilization from the water column create a plume of volatile hydrocarbon gases that disperses quickly after a spill, such that the concentrations in the atmosphere at the water surface would not exceed human health thresholds of concern at any location. The recovery time for the atmosphere would be on the order of hours to days. Thus, a low level of concern is expected for small, medium, and large spills involving mechanical-only recovery.

Under Alternative 3, the addition of chemical dispersion does not change the results from those under Alternative 1. Chemical dispersion would disperse some of the volatile hydrocarbons into the water resulting in the volatile hydrocarbons entering the atmosphere over a larger area than would occur without chemical dispersion. Thus, dispersants further dilute hydrocarbon concentrations in the atmosphere. The modeling shows that concentrations are low for a spill of any size involving some combination of mechanical response and chemical dispersion at any spill site in the Caribbean region. Adverse effects of *in situ* burning on air quality are summarized in Table 4.5-19; these results apply whether chemical dispersion would be used on unburned oil, and they do not vary by the location of the burn. Thus, the results for Alternative 1 apply to Alternative 3 for all areas in the Caribbean region. The modeling was performed for weather conditions where dilution in the air would be relatively slow, so the estimated adverse effects are overestimated for other conditions.

Mechanical recovery plus *in situ* burning, with or without chemical dispersion, would increase atmospheric pollutants by the amount emitted via *in situ* burning. For small spills, it would be very unlikely that *in situ* burning would be used, as the oil would disperse too rapidly for it to be feasible (Table 4.5-19). The maximum area potentially exceeding the NAAQS or thresholds of concern is 1.6 km^2 for a medium spill and 12.7 km^2 for a large spill (Table 4.5-19). If humans or sensitive resources (i.e., wildlife) are within these areas, they could be affected by poor air quality for a short time, on the order of hours. Since *in situ* burning can only be used offshore in marine waters, a region of interest equivalent to the Florida Bay-Florida Keys area (42,689 km^2) would have less than 1 percent of its area affected, and the atmosphere would recover in a matter of hours. The addition of chemical dispersion does not change the results under Alternative 1 in Table 4.5-19.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on air quality in the Caribbean region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without *in situ* burning.

4.7.3.2. Consequences to the Biological Environment

Marine Mammals

Potential adverse effects on marine mammals in the Caribbean region using the basic response option (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.3.2 and summarized in Table 4.5-20 (the results in Table 4.5-20 are included in Table 4.7-18 for comparison). In the Caribbean region, marine mammal populations of concern are limited to cetaceans, which are widely distributed, and many are not common. There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on marine mammals in that larger spills tend to spread across a larger surface water area and have higher shoreline oil loading. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery.

Under Alternative 3 for small spills, the contaminated surface water area is small when compared with the overall surface water area in the Caribbean region, so the likelihood of cetaceans becoming oiled at the surface is minimal and the exposure would have little effect in any case. Very little oil is likely to strand onshore, and oil loading would be light in most cases. Potential adverse effects increase as spill volume increases, with greatest concern for bays, estuaries, and known breeding grounds. If a local population of marine mammals is affected, it is estimated that it would take 1 to 3 years to recovery. The results of the modeling for marine mammals are presented in Table 4.7-18.

The addition of chemical dispersion is only expected to have minimal effects on the adverse effects on marine mammals. There would be a reduction in the amount of oil that strands onshore (Section 4.3.2.4), and the equivalent area of 100 percent mortality would also be reduced. Based on the estimated minimal risk associated with adversely affected marine mammals during a small spill, chemical dispersion would produce small adverse effects similar, if not identical, to those of a mechanical response.

For medium and large spills, the risk to cetaceans remains very low, but the extent of shoreline oiling becomes a factor for mammals that may be in the intertidal zone or very near the shore. For a large spill the affected shoreline area could lead to more than 1 percent of such populations being affected, which was the basis for an increased level of concern. Chemical dispersion would reduce the risk, but would not be expected to change the overall risk ranking.

Table 4.7-18
Risk Ranking of Offshore Oil Spills* to Marine Mammals Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A) in the Florida Straits ‡

Spill Size	Response Option (% dispersant efficiency)	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E
Medium (2,500 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E
Large (40,000 bbl)	Basic	1–5	3D
	Chemical Dispersion (45 or 80)	1–5	3D

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Although areas other than the Florida Straits in the Caribbean region were not modeled, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on marine mammals will fall within a similar range throughout the Caribbean region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine mammals in the Caribbean region under Alternative 3 are expected to be minor for small and medium spills, and moderate for large spillss, with or without dispersant use.

Marine and Coastal Birds

Potential adverse effects on marine and coastal birds in the Caribbean region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.3.2 and summarized in Table 4.5-21 (the results in Table 4.5-21 are included in Table 4.7-19 for comparison). There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on birds because larger spills tend to have higher oil loading on the shoreline and affect larger areas. Potential adverse effects increase with spill volume, with the greatest concern for conditions where mangroves and sand beaches become heavily oiled and potential exposure to floating oil occurs in a large area. The addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the severity of potential adverse effects or increase the risk to marine and coastal birds.

Under Alternative 3 for a small spill, very little oil is likely to strand onshore, and the oil loading would be light in most cases. During oil spills in the Caribbean region, the potential adverse effects on intertidal nesting, roosting, and foraging habitats for birds are of particular concern because a significant amount of shoreline habitat on an island or group of small islands can be oiled by a spill. As a consequence, there may not be alternative sites for use until the habitat recovers, particularly in mangrove habitats, which would lead to a high degree of adverse effects on birds. Chemical dispersion is expected to reduce adverse effects on these habitats primarily by reducing the amount of oil that strands onshore (Section 4.3.2.4). Surface water oiling may also adversely affect feeding, rafting, and diving birds and waterfowl (Section 3.1.2.2), and chemical dispersion is expected to reduce the extent of surface slicks that birds encounter. The risk scores in Table 4.7-19 reflect the predicted recovery rates of 1 to 3 years for most bird species, as was the case following the *EXXON VALDEZ* oil spill (Section 4.3.2.2).

For a small spill, shoreline oiling was expected to be light and to not persist. For a medium spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by 72 percent. The area of surface water oiling was reduced by 55 percent. In addition, chemical dispersion nearly doubled the number of times that no oil stranded onshore, from 10 (Alternative 1) to 19 (Alternative 3) out of the 100 model runs (technical report [French McCay et al., 2004]). Also, the extent of oiled mangroves was very small. The results for 45 percent dispersant efficiency were similar to those for 80 percent efficiency (Table 4.7-19); some important nesting sites were still oiled, but the reduction in shoreline length and surface water area oiled would likely reduce adverse effects on birds.

Table 4.7-19
Risk Ranking of Offshore Oil Spills* to Marine and Coastal Birds Using the Basic Response Scenario†
with the Addition of Chemical Dispersion (Option A) in the Florida Straits‡

Spill Size	Response Option (% dispersant efficiency)	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	1–5	3D
	Chemical Dispersion (45 or 80)	1–5	3D
Medium (2,500 bbl)	Basic	10–20	3B
	Chemical Dispersion (45 or 80)	1–5	3D
Large (40,000 bbl)	Basic	> 20	3A
	Chemical Dispersion (45 or 80)	10–20	3B

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

For a large spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by 62 percent. The area of surface water oiling was reduced by 75 percent. In addition, chemical dispersion increased the number of times that no oil stranded onshore, from 12 (Alternative 1) to 18 (Alternative 3) out of 100 model runs (technical report [French McCay et al., 2004]). However, oil loading in mangrove habitats was high. The results for 45 percent dispersant efficiency were essentially the same as those for 80 percent dispersant efficiency (Table 4.5-17).

Although areas other than the Florida Straits for the Caribbean region were not analyzed, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on birds will typically be reduced with chemical dispersion at either efficiency. The reduction of adverse effects on birds with chemical dispersion is contingent upon whether the reduction of adverse shoreline effects coincides with heavily used habitats.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine and coastal birds in the Caribbean region under Alternative 3 are expected to be moderate for small, medium, and large spills, with or without dispersant use. On an overall regional level for medium and large spills, even though chemical dispersion reduces the risk score, the expected impacts remain moderate because of the extent of oiling.

Plankton and Fish

Plankton and fish, a diverse group of species, are important to the marine food web, ecosystem function, and fisheries. Adverse effects on these groups are of high concern, particularly when chemical dispersion is considered as a potential response option. As described in Section 4.3.2.3 and 4.5.3.2, plankton and fish are adversely affected either directly or via the food web by the toxic effects of oil components that enter the water column—the soluble compounds (MAHs and PAHs) and microscopic oil droplets mixed by waves into the water (French McCay, 2002; NRC, 1985). The most important pathway of exposure is direct uptake of dissolved oil components, originating directly from surface oil or dissolving from the microscopic oil droplets in the water. Overall, adverse effects increase the larger the spill size. However, there is great variability related to the environmental conditions after the spill; plankton and fish suffer much more adverse effects in storm conditions where high waves mix unweathered oil into the water, which happened during the *NORTH CAPE* oil spill (French McCay, 2003), than in calm weather. In addition, many species utilize shallow waters and even the intertidal zone, where they are more likely to be exposed to oil and dissolved components when oil comes ashore. Species and life stages vary considerably in sensitivity to toxic components, with species from relatively unpolluted and environmentally stable locations more sensitive than those from polluted and environmentally variable areas.

In marine and open coastal environments, small, medium, and large oil spills do not cause large or long-term toxic effects to plankton and fish in the water column. The toxic effects of oil spills result from acute exposures during the time when surface oil is present and for short periods (days to weeks) afterwards. Once the source of hydrocarbons (from floating oil or the shoreline) to the water column is gone, concentrations rapidly dilute to background levels.

There may be longer-term effects if an offshore spill migrates to nearshore shallow areas such as enclosed embayments, estuaries, or wetlands where dilution and flushing are slow. Many fish and other organisms spawn and develop through larval and juvenile stages in these shallow areas. Juvenile fish are more abundant in wetlands, coral reefs, and seagrass beds than in other shallow subtidal and intertidal areas, so these areas are of most concern (see discussion of potential effects on these habitats below). Under Alternative 3, chemical dispersion could not be used within 3 nm[46] of shore; therefore, it would not contribute to adverse effects on plankton and fish in these areas.

The percentage of plankton and fish adversely affected by oil spills was estimated using the modeling results (technical report [French McCay et al., 2004]) of water volumes exposed to toxic oil components. Percentage loss multiplied by volume exposed was integrated over time and space to calculate an equivalent volume of 100 percent loss. These volumes were translated to equivalent areas by multiplying by water depth at the spill site, allowing comparison with other resources, such as birds and shorelines, which are distributed on a per-area basis. The use of area is appropriate because plankton and fish abundance is much more uniformly distributed when expressed on a per-area basis than on a per-volume basis since the ecosystem is driven by sunlight and plant photosynthesis at the water surface (French et al., 1996; Odum, 1971). As indicated by the similar results for the four modeled spill sites in 10 to 30 m of water—offshore Delaware Bay, offshore Galveston Bay, the Florida Straits, and offshore San Francisco Bay (Parts B, C, D, and E, respectively, of the technical report [French McCay et al., 2004])—the equivalent areas of adverse effect on plankton and fish (both average and variable) are applicable to spills of the same size in any location of similar water depth in any region considered in this PEIS. The modeled spill site was 20 m deep water: adverse effects would be smaller for deeper waters because of greater vertical dilution of both oil components and organisms, and proportionately greater in shallower waters because of the restricted dilution potential and generally higher organism abundance.

The model-estimated areas are those where there is a potential to affect the most sensitive species, which are two standard deviations more sensitive than the average of all species tested (2.5th percentile in rank order of sensitivity). For species of average sensitivity (50th percentile), the areas adversely affected would be much less. Thus, the model-estimated areas should not be interpreted as experiencing 100 percent mortality of all plankton and fish; they are conservative estimates used for comparative purposes among response scenarios.

Potential adverse effects on plankton and fish in the Caribbean region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.3.2 and summarized in Table 4.5-22 (the results in Table 4.5-22 are included in Table 4.7-20 for comparison). The Florida Straits was selected for the modeling as representative of the Caribbean region, because the geography (characterized by islands), bottom topography (steeply sloping off away from shore), environmental regime (warm trade winds, occasional severe storms), and ecosystems (subtropical-tropical, areas of coral reefs, seagrasses, etc.) are similar in the two regions.

Under Alternative 3 the results for 45 percent dispersant efficiency were not significantly different than those for 80 percent dispersant efficiency because more than sufficient dispersant would be available under both conditions to disperse available surface oil for spills up to 40,000 bbl (with some variability, as reflected in the results in Table 4.7-20). For a small spill, based on the evaluation of the volume where water quality would be affected (Tables 4.5-17 and 4.5-18), the volume of adverse effect on plankton and fish would be negligible for all response options under Alternative 3. For medium and large spills, the volumes and areas of adverse effect are up to three times larger than those without chemical dispersion.

Table 4.7-20
Risk Ranking of Offshore Oil Spills[*] to Plankton and Fish Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Florida Straits[‡]

Spill Size	Response Option (% dispersant efficiency)	Equivalent Area Affected (km^2)	Area Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0.082	5×10^{-11}	4E
	Chemical Dispersion (45 or 80)	0.082	5×10^{-10}	4E
Medium (2,500 bbl)	Basic	32	0.07	4D
	Chemical Dispersion (45 or 80)	41	0.10	4D
Large (40,000 bbl)	Basic	72	0.02	4D
	Chemical Dispersion (45)	233	0.55	4D
	Chemical Dispersion (80)	222	0.52	4D

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Since the adverse effects occur in a small percentage of the area of concern and are less than the range of natural variability, the recovery time would be less than 1 year. Overall, based on the modeling, adverse effects on plankton and fish in the Caribbean region under Alternative 3 would be localized to the immediate area around the spill site and similar in all marine water areas of the region.

Even without chemical dispersion, concentrations of toxic components could become high enough to cause levels of concern for plankton and fish for medium or large spills if the slick moved into shallow coastal areas and embayments under conditions where storm-generated waves mix large amounts of fresh oil into the water column. Under Alternative 3, chemical dispersion could not be used within 3 nm[47] of shore or in enclosed coastal lagoons; therefore, it would not contribute to such risk, and might even reduce concerns by dispersing portions of the slick before it can enter shallow waters.

Based on the discussion in Part D of the technical report (French McCay et al., 2004), if the adversely affected area is marine water habitat or for water column organisms with broad distribution over all subtidal habitats, a risk score of 4E applies. A risk score of 3C applies to coral reefs, 4E to seagrass, and 3D to hard-bottom habitat organisms. The risk scores do not change with chemical dispersion. Given that many species and life stages of plankton and fish on and over coral reefs are more broadly distributed rather than restricted to the coral reefs (for example, they inhabit hard-bottom habitats as well), and that these organisms reproduce on time scales of less than 1 year, the overall risk score of 4D is assigned for plankton and fish for the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) with or without dispersant use.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on plankton and fish in the Caribbean region under Alternative 3 are expected to be insignificant for small spills, and minor for medium and large spills, with or without dispersant use.

Intertidal Habitats

Potential adverse effects on intertidal habitats in the Caribbean region using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.3.2 and summarized in Table 4.5-23 (the results in Table 4.5-23 are included in Table 4.7-21 for comparison). Potential adverse effects on intertidal habitats during oil spills in the Caribbean region are of particular concern because of their relatively small extent, a high degree of historical loss and degradation, and their ecological importance (Section 3.3.2.4). Reducing oil effects on mangroves is of high priority because of their very long recovery rates, which can be more than 20 years (Section 4.3.2.4). There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on intertidal habitats in that larger spills tend to have higher oil loading on the shoreline, which can kill mangroves, and affect larger areas. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery.

Under Alternative 3 for a small spill, very little oil is likely to strand onshore, and oil loading would be light in most cases. However, potential for adverse effects on intertidal habitats increases as spill volume increases, with greatest concern where mangroves and sand beaches become heavily oiled. Chemical dispersion is expected to reduce adverse effects on these habitats by reducing the amount of oil that strands onshore (Section 4.3.2.4). The risk scores in Tables 4.5-23 and 4.7-21 were based on estimated adverse effects on intertidal habitats of the Florida Straits.

Table 4.7-21
Risk Ranking of Offshore Oil Spills[*] to Intertidal Habitats Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Florida Straits[‡]

Spill Size	Response Option (% dispersant efficiency)	Habitats Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	1E
	Chemical Dispersion (45 or 80)	0–1	1E
Medium (2,500 bbl)	Basic	1–5	1D
	Chemical Dispersion (45)	0–1	2E
	Chemical Dispersion (80)	0–1	3E
Large (40,000 bbl)	Basic	5–10	1C
	Chemical Dispersion (45 or 80)	1–5	1D

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern, and yellow, a medium level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Adverse effects on intertidal habitats for a small spill were determined to be medium by extrapolating from the results of a medium spill and expecting mangroves to recover quickly under light oiling. For a medium spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by 72 percent, from nearly 10 km under Alternative 1 to 2.7 km under Alternative 3. In addition, chemical dispersion nearly doubled the number of times that no oil stranded onshore, from 10 (Alternative 1) to 19 (Alternative 3) out of the 100 model runs (technical report [French McCay et al., 2004]). The extent of oiled mangroves was very small and oil loading was light, with recovery estimated to take 1 to 3 years. The results for 45 percent dispersant efficiency were similar to those for 80 percent dispersant efficiency (Table 4.7-21), except that oil loading on mangroves was higher with a longer recovery time.

For a large spill using 80 percent dispersant efficiency, the length of oiled shoreline was reduced by 62 percent, but the oil loadings on mangrove habitat were high enough to predict recovery at greater than 7 years. The number of times that no oil stranded onshore increased from 12 (Alternative 1) to 18 (Alternative 3) out of the 100 model runs (technical report [French McCay et al., 2004]). The results for 45 percent dispersant efficiency were essentially the same as those for 80 percent dispersant efficiency (Table 4.7-21).

Although areas other than the Florida Straits for the Caribbean region were not modeled, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on intertidal habitats will fall within a similar range throughout the Caribbean region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on intertidal habitats in the Caribbean region under Alternative 3 are expected to be moderate for small spills and significant for large spills, with or without dispersant use. For large spills, even though chemical dispersion reduces the risk score, the expected impacts remain significant because of the extent of oiling. For medium spills, adverse impacts are expected to be significant but are reduced to moderate and minor levels of concern when chemical dispersion is used—the benefits increase with increasing efficiency.

Subtidal Habitats

Potential adverse effects on subtidal habitats in the Caribbean region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.3.2 and summarized in Table 4.5-24 (the results in Table 4.5-24 are included in Table 4.7-22 for comparison). In the Caribbean region, there is particular concern for the possible effects to coral reefs and seagrass beds near the shoreline. The addition of *in situ* burning does not change the potential adverse impacts from those with mechanical-only recovery.

Usually, subtidal habitats are protected by the diluting effect of the overlying water (Section 2.2.2)—the deeper the water, the lower the risk. Chemical compounds of concern tend to evaporate rather than dissolve, and the rapid dilution of any chemical entering the water column decreases the toxicity of any oil residue potentially reaching the bottom substrate.

Subtidal habitat can be affected either by contamination of the sediment or by exposure of demersal organisms to dissolved hydrocarbons. In the case of the the Florida Straits model, the threshold concentration for dissolved aromatic hydrocarbons was never exceeded for a medium spill regardless of response option used. For a large spill it was exceeded when dispersants were used, only in an area of less than 0.001 percent of even the small area of Florida Bay. The total hydrocarbon threshold was exceeded for both spill sizes, but the equivalent area of 100 percent mortality was never more than 0.005 percent of the total area. Table 4.7-22 presents the results for subtidal habitats in the Caribbean region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion.

Table 4.7-22
Risk Ranking of Offshore Oil Spills[*] to Subtidal Habitats Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Florida Straits[‡]

Spill Size	Response Option (% dispersant efficiency)	Habitats Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	1–5	3D
	Chemical Dispersion (45 or 80)	1–5	3D
Large (40,000 bbl)	Basic	5–10	3C
	Chemical Dispersion (45 or 80)	5–10	3C

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Exposure of demersal organisms to dissolved aromatic hydrocarbons is also a potential risk, and of the three key habitats—seagrass beds, coral reefs, and hard-bottom communities—coral reefs were at the greatest risk of exposure. Model results for a medium spill indicated that 4.6 percent of coral reef habitat could be affected under the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit). Chemical dispersion at 45 or 80 percent efficiency increased the risk, but not substantially (4.9 and 4.8 percent, respectively). For a large spill the model estimate was that 5.0 percent of the coral reef habitat could be affected under the basic response scenario. Again, chemical dispersion increased the risk, but very little (both values were 5.6 percent). Recovery from the short-term exposures likely under these scenarios should occur in 1 year or less for small spills, and should not exceed 1 to 3 years for medium and large spills.

These results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on subtidal habitats will fall within a similar range throughout the Caribbean region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subtidal habitats in the Caribbean region under Alternative 3 are expected to be insignificant for small spills, and moderate for medium and large spills, with or without dispersant use.

Areas of Special Concern

For this analysis, the risks to areas of special concern are assumed to be the same as those for either intertidal or subtidal habitats (Section 4.7.3.2), whichever are greater. Potential adverse effects on areas of special concern in the Caribbean region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.3.2 and summarized in Table 4.5-25 (the results in Table 4.5-25 are included in Table 4.7-23 for comparison). There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on areas of special concern in that larger spills tend to have higher oil loading on the shoreline and affect larger areas. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse consequences from those with mechanical-only recovery alone.

Under Alternative 3 the risk to intertidal habitats was the higher of the two for small or large spills, but the pattern for medium spills was inconsistent in that chemical dispersion reduced the risk to intertidal habitats to the point that the risk to subtidal habitats was now the greater of the two. This is the only modeled location where this occurred and reflects the sensitive nature of the shallow subtidal habitat in the region. Chemical dispersion is expected to reduce adverse effects on shoreline areas of special concern by reducing the amount of oil that strands onshore (Section 4.3.2.4) but would not increase the risk to subtidal areas (Table 4.7-23). This is also potentially beneficial for habitats like coral reefs and seagrass beds because they are at risk from oil that erodes offshore.

Although areas other than the Florida Straits were not modeled, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on areas of special concern will fall within a similar range throughout the Caribbean region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on areas of special concern in the Caribbean region under Alternative 3 are expected to be insignificant for small spill sizes. For medium spills, the potential impacts are strongly influenced by chemical dispersion, which reduces intertidal impacts on the point where the moderate impacts on subtidal habitats become relatively more important. The subtidal habitat impacts are not affected by chemical dispersion. For large spills the potential impacts are significant for intertidal habitats regardless of response option used, although there was a reduction in the affected area with chemical dispersion. Subtidal impacts were unchanged and less than those for intertidal habitats. On an overall regional level for medium and large spills, adverse impacts on areas of special concern are reduced when chemical dispersion is used.

Table 4.7-23
Risk Ranking of Offshore Oil Spills* to Areas of Special Concern Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A) in the Florida Straits‡

Spill Size	Response Option (% dispersant efficiency)	Areas Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	0–1	1E
	Chemical Dispersion (45 or 80)	0–1	1E
Medium (2,500 bbl)	Basic	1–5	1D
	Chemical Dispersion (45 or 80)	1–5	3D
Large (40,000 bbl)	Basic	5–10	1C
	Chemical Dispersion (45 or 80)	1–5	1D

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

4.7.3.3. Consequences to Threatened, Endangered, or Candidate Species

Potential adverse effects on threatened, endangered, or candidate species in the Caribbean region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.3.3. Potential adverse effects on marine mammals, marine and coastal birds, fish, or sea turtles that are threatened, endangered, or candidate species are identical to those discussed in Section 4.7.3.2 for these groups. There is often a direct relationship between the volume of oil spilled and the potential for adverse effect on threatened, endangered, or candidate species in that larger spills tend to spread across a larger surface water area and have higher shoreline oil loading. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse consequences from those with mechanical-only recovery.

With the addition of chemical dispersion under Alternative 3 for a small spill, the contaminated surface water area is small when compared with the overall surface water area in the Caribbean region, so the likelihood of threatened, endangered, or candidate species becoming oiled at the surface is minimal. Very little oil is likely to strand onshore, and the oil loading would be light in most cases. Potential adverse effects increase as spill volume increases, with greatest concern for bays, estuaries, and known breeding grounds. Although populations are sporadic and vary with migration, if a threatened, endangered, or candidate species were present in the area of an oil spill, the resulting adverse effects could be great. The severity of the effect varies depending on the sensitivity of the individuals present. Overall, risk scores were highest for marine and coastal birds. Chemical dispersion is expected to reduce adverse effects on threatened, endangered, or candidate species by reducing both the amount of oil that strands onshore (Section 4.3.2.4) and the amount of floating oil.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on threatened, endangered, and candidate species in the Caribbean region under Alternative 3 are expected to be moderate for small, medium, and large spills, with or without dispersant use, based on the risk to marine and coastal birds. On an overall regional level for medium and large spills, even though chemical dispersion reduces the risk score, the expected impacts remain moderate because of the extent of oiling.

4.7.3.4. Consequences to Essential Fish Habitat

For this analysis, the risks to Essential Fish Habitat (EFH) are assumed to be the same as those for plankton and fish or for subtidal habitats (Section 4.7.3.2), whichever are greater. Since the risk to subtidal habitats is greater, those risk scores were used. Potential adverse effects on EFH in the Caribbean region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.3.4.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on EFH in the Caribbean region under Alternative 3 are expected to be insignificant for small spills, and moderate for medium and large spills, with or without dispersant use, based on the risk to subtidal habitats.

4.7.3.5. Consequences to the Socioeconomic Environment

As discussed in Section 4.3.5, oil spills can produce a variety of adverse social and economic effects. These adverse effects are generally not large when measured at the regional levels, but instead are typically felt in communities located near resources oiled by the spill. Specifically, large adverse effects are generally limited to those industries and populations that are affected by the spill. Some of the most visible and large effects are likely to include effects on water- and shore-based recreation, commercial and recreational fisheries, and tourism. In addition, large-scale spills hold the potential to adversely affect the overall well-being of the residents and economies of coastal communities. Oil spills have the potential to adversely affect low-income and minority populations living in the Caribbean region to a greater extent than the general population.

This modeling considers the risk of adverse socioeconomic effects posed by oil spills, which can include, but are not limited to, reduced recreational activity because of beach closures, limited accessibility, or perceived taint; closure of commercial fishing grounds or hatcheries, or reduced commercial harvests; and altered marine transportation patterns. In addition to these and other direct adverse effects, oil spills can have secondary adverse effects on social and economic welfare along the coast. For example, an oil spill may cause changes in employment and firm revenues of resource-based businesses. While these effects are not quantified in this modeling, this discussion provides absolute and relative measures of the overall risk of adverse social and economic effects of small, medium, and large oil spills using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) in the Caribbean region. The methodology is described in more detail in the Atlantic region (Section 4.7.2.5).

There is no existing standard for "significance" related to the socioeconomic effect of oil spills (e.g., how much shoreline or surface water must be oiled to be considered a "high," "medium," or "low" effect). The significance of the effect will depend on a number of factors, including the scope of the analysis (i.e., national, regional, local), opportunities for resource substitution (e.g., an unoiled beach or fishing ground nearby, alternative ports of call), and the duration of the spill event. Generally, a spill event would be of low concern if it is not of long enough duration to affect the financial viability of local businesses, and the affected communities are able to find substitutes to replace the oiled resources.

For this PEIS, (1) the greatest effect modeled at the regional level was less than approximately 10 percent of available shoreline or surface water resources (indicating the likely presence of substitute resources), and (2) resource use following these modeled spills (e.g., vessel transportation and fishing) would be expected to resume as soon as oil recovery efforts were completed. As a result, the effects under all modeled scenarios would likely be small at the regional level. As noted in the text, any adverse effects that did occur would be expected to be localized in nature.

The risk factor reflects the ratio of the percentage of the oiled surface water using the basic response scenario to the percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected given response options limited to mechanical recovery and *in situ* burning. Under Alternative 1, a risk factor of 1.0 is assigned to medium and large spills (small spills are assumed to have a negligible effect), indicating that no additional response options are taken in this modeled area.

In estuaries and coastal waters within 3 statute mi from shore, mechanical-only recovery would be used under Alternative 3. In marine waters 3 or more statute mi from shore, the basic response scenario with the addition of chemical dispersion could be used under Alternative 3 in the Caribbean region. Potential adverse effects to coastal communities in the Caribbean region using the basic response scenario are presented in Section 4.5.3.5 and summarized in Table 4.5-26 (the results in Table 4.5-26 are included in Table 4.7-24 for comparison) for oiled surface water. Table 4.7-24 highlights the effects of small, medium, and large oil spills on the Caribbean region's socioeconomic resources by presenting estimates of resources oiled as a result of the average modeled spill in absolute terms (area of surface water oiled above the threshold of concern) and as a percentage of the total resource base in the modeled area. The threshold of concern for oiled surface water is 0.01 g/m^2 (technical report [French McCay et al., 2004]). This resource area is based on an estimate of the extent to which the coastal community in the modeled area potentially relies on each resource. For the Caribbean region, the length of oiled shoreline above the threshold of concern is not considered relevant. A single metric was selected for this region since (1) shoreline oiling results from the Florida Keys area were highly sensitive in the modeled spill location; (2) the ability to identify shoreline with characteristics amiable to use (i.e., sandy shore) was limited; and (3) area of oiled surface water above the threshold of concern was expected to provide a more accurate measure of expected risk, given the region's geographic characteristics.

Table 4.7-24
Risk Ranking of Offshore Oil Spills* to Coastal Communities as a Result of Surface Water Oiled Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A) in the Florida Straits‡

Spill Size	Response Option (% dispersant efficiency)	Surface Water Area		
		m² Oiled Above Threshold§	Estimated % Oiled‖	Risk Factor#
Small (200 bbl)**	Basic	N/A	N/A	N/A
	Chemical Dispersion (45 or 80)	N/A	N/A	N/A
Medium (2,500 bbl)	Basic	312×10^6	3.2	1.0
	Chemical Dispersion (45)	101×10^6	1.0	0.31
	Chemical Dispersion (80)	99×10^6	1.0	0.31
Large (40,000 bbl)	Basic	659×10^6	6.8	1.0
	Chemical Dispersion (45)	332×10^6	3.4	0.50
	Chemical Dispersion (80)	282×10^6	2.9	0.43

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

[§] Thresholds above which some economic or social risk is expected were determined, and the area of surface water oiled above this threshold for the average modeled spill is reported. The threshold of concern because of oiled surface water is 0.01 g/m² of oil (technical report [French McCay et al., 2004]).

[‖] Percentages reflect the proportion of the total modeled area above the threshold of concern.

[#] A risk factor reflects the ratio of the percentage of the model area or volume oiled using the basic response scenario to the model area or percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected with response limited to the basic response scenario.

[**] A 200-bbl spill is assumed to have negligible effect.

This modeling assumes that the risk posed to the socioeconomic environment by oil spills is directly related to the extent to which resources are affected above selected thresholds of concern—for the Caribbean region, the square meters of marine water oiled above the threshold of concern. Comparing the absolute risk of adverse socioeconomic effects across spill scenarios, including variations in spill response scenarios, allows for an understanding of the relative risk of adverse socioeconomic effects across spill scenarios. Determining relative risk allows for extrapolation of site-specific results to the entire region. For example, the risk estimates presented Table 4.7-24 are based on modeled spills affecting the Florida Straits, which is an appropriate surrogate for the Caribbean region in this modeling. While any given spill may exhibit distinctly different patterns of socioeconomic effects, the relative risk measures are expected to be broadly applicable to a range of spill locations, especially in island regions, as long as the spills occur in areas where chemical dispersion is feasible. In addition, the conclusions reached for the Florida Straits are supported by results for other modeled areas—the relative degree of risk reduction achieved under various removal assumptions across spill sizes is similar in magnitude.

For this modeling, the socioeconomic environment is divided into components representative of the major parameters of coastal life potentially affected by an oil spill. Absolute and relative risk are discussed for coastal communities, demography, and employment; general economic status of a coastal community; vessel transportation and ports; commercial and recreational fisheries; archaeological and historic resources; recreation and tourism; environmental justice; and public safety and worker health.

Coastal Communities, Demography, and Employment

Coastal communities benefit from and rely on the marine environment to provide residents with sustenance, livelihoods, leisure opportunities, and shipping avenues. Individuals who live and work in close proximity to the coast derive both social and economic rewards from the natural beauty, recreational opportunities, quality of life, economic resources, and cultural attributes associated with these coastal locations. These rewards are derived from assets such as National Parks, public beaches, fishing opportunities, and commercial and tourism-related industries.

Thus, oil spills can affect any number of a coastal community's assets, leading to adverse effects on the economic benefits of community activities. These effects, in turn, can impose changes on that community's demographic and employment patterns. In addition to direct employment and other adverse economic effects on marine resource-based economic sectors associated with oil spills, oil spills can have secondary adverse effects on coastal communities. For example, because the Caribbean region relies on tourism for employment and earnings, plus the importance of maritime activities to various Caribbean coastal communities, coastal communities in this region are at risk from oil spills that affect tourism. Further, the importance of water transportation in delivering goods to the region's islands implies a heightened risk from an oil spill. Given their reliance on marine resources, coastal communities on Caribbean islands are likely to be more vulnerable to the adverse effects of a spill than communities located on the mainland, which have a more diverse economic base.

As a result of oiling, beaches in the immediate vicinity of a spill may be closed to visitors, and fishing may not be permitted in waters exposed to oil, causing revenue losses to the tourism and commercial and recreational fishery sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill, causing short-term decreases in recreation and tourism; commercial and recreational fishing; and the employment opportunities, income, and businesses these industries support. In addition, an oil spill may temporarily reduce the appeal of coastal living in a given area.

To the extent that mechanical recovery, *in situ* burning and chemical dispersion can reduce shoreline oiling and the geographic scope of surface water oiling, this combination of spill response options will act to reduce adverse effects on coastal communities. The scope of potential losses is described in more detail in subsequent sections.

For a small spill in the Caribbean region, the risk to coastal communities is negligible (Table 4.7-24). Because of the small surface water area exposed to oil as a result of a small spill, marine-based economic factors such as local commercial or recreational fisheries may experience little or no effect.

While the risks to coastal communities increase with spill size, the effects remain localized. With chemical dispersion medium and large spills in the Caribbean region will have a spill area[48] above the corresponding thresholds of concern that will sweep approximately 99 to 101 million m^2 and 282 to 332 million m^2, respectively, of marine waters used by commercial fisheries and recreation activities (Table 4.7-24).

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal communities, demography, and employment in the Caribbean region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 3.4 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spills.

Economic Status

The overall economic status of communities, industries, and individuals that rely on coastal resources for sustenance, revenue, and quality of life can be affected by an oil spill. As noted above, coastal communities can suffer direct and indirect adverse economic effects due to an oil spill, as beach and fishery closures decrease revenue and eliminate jobs. More specifically, losses affect commercial and recreational fisheries: both the anglers themselves and related industries as catch opportunities decrease or are eliminated entirely. Tourism and associated businesses will suffer economic setbacks as visits to affected coastal areas decline and purchase of area goods and services decrease because of perceived taint. Similarly, environmental justice issues may arise as low-income or minority communities are disproportionately affected by the spill (discussed below in more detail).

A small spill that is 3 or more statute mi offshore would have essentially no adverse effects on either the local or regional economies (Table 4.7-24). There is little to no risk of oiling economically important resources, and it is unlikely that any commercial or recreational fisheries would be affected.

While the risk increases as spill size increases, the effects remain localized. With chemical dispersion, medium and large spills will sweep 99 to 101 million m^2 and 282 to 332 million m^2 of marine waters, respectively, regardless of dispersant recovery efficiency (Table 4.7-24).

Despite chemical dispersion, a medium or large spill could be expected to have short-term adverse economic effects as a result of oiled recreational beaches, closures of commercial and recreational fishing grounds, and degradation of the appeal of coastal locations. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on economic status in the Caribbean region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 3.4 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spills.

Vessel Transportation and Ports

Oil spills occurring 3 or more statute mi offshore are not likely to cause large adverse effects on vessel transportation and ports. Local resources would easily handle whatever response operations are implemented. However, an oil spill can disrupt marine commerce if it occurs in and around a shipping channel or port and results in limits on watercraft movement as a means of facilitating spill response. Vessel transportation is of paramount importance to the Caribbean region's trade and tourism industries. Ports on each Caribbean island provide berths for the cruise ships that visit their shores, bringing tourists and revenue to the islands. Disruption of transportation and cruises is as detrimental as disruption of the movement of cargo ships, which is also critical to island imports and exports. Any interruption in the standard use of vessels or increase in travel times over water can result in hardship for coastal communities, as fewer goods are exchanged, transportation costs rise, and the revenue streaming through the local economy falls. These adverse effects might be felt at a number of levels. For example, vessel operators may incur additional costs associated with delays and longer shipping distances; businesses that depend on timely receipt of feedstock or other goods may experience adverse effects such as production slowdowns; and individuals who work in adversely affected sectors may be displaced. To the extent that businesses in other locations depend on the affected industries, a longer-term disruption of vessel transportation could yield adverse effects beyond the immediate spill area. However, given alternative ports of call, substitute suppliers and shipping modes, and the expected short-term nature of any disruption in vessel traffic, such adverse effects are not likely to be large.

For a small spill, no high adverse effects on vessel transportation or ports are expected (Table 4.7-24). While the risk to the vessel transportation industry increases with spill size, the effects remain localized. With chemical dispersion medium and large spills will sweep 99 to 101 million m^2 and 282 to 332 million m^2 of marine waters, respectively, regardless of dispersant recovery efficiency (Table 4.7-24). However, a spill occurring under specific location, weather, and tidal conditions could adversely affect vessel transportation and ports and the industries and communities that depend on this traffic. Any adverse effects on vessel transportation and ports would likely be short lived—that is, even if shipping waters or ports are exposed to oil and are therefore closed, as soon as recovery efforts remove surface oil, these facilities would be expected to be reopened.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review, potential regional adverse impacts on vessel transportation and ports in the Caribbean region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 3.4 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spills.

Fisheries

Commercial Fisheries

Commercial fisheries are vulnerable to oil spills because of both closures and perceived taint. A moratorium on fishing operations in the wake of an oil spill can lead to high losses for the commercial fishing industry, as well as related industries, including those that supply equipment to and purchase products from commercial fleets. By contaminating key waters, an oil spill may also disrupt employment in the commercial fisheries and related sectors of the economy. In addition, oil spills can lead to a decreased demand for fish from affected waters because of actual or perceived taint and can instigate alterations to fishing practices in a manner that increases operating costs and/or decreases revenues. Large spills can potentially injure fish nursery grounds and impose other risks that could reduce fish harvests in the longer term.

For a small spill in the Caribbean region, the risk to commercial fisheries is low (Table 4.7-24). While the risk to the commercial fishing industry increases with spill size, the effects remain localized. With chemical dispersion medium and large spills will adversely affect 99 to 101 million m^2 and 282 to 332 million m^2, respectively, of marine waters used by the commercial fishing industry, regardless of dispersant recovery efficiency (Table 4.7-24).

A risk of economic loss to the marine fishery will occur when waters exceed relevant management and/or thresholds of concern. For example, fishing may not be permitted in waters swept by oil above the modeled threshold, resulting in reductions in commercial fish landings for a period of time following a spill.

The resulting adverse effects would be expected to reverberate through communities in the area of the spill, causing decreases in employment, income, and the viability of businesses associated with the commercial fishing industry. To the extent that substitute fishing grounds are available, spill effects on the commercial fishing economy may be less severe.

Recreational Fisheries

Similar to commercial fishing operations, recreational fisheries are at risk of closure or loss in value as a result of oil spills. These adverse effects will not generally be regional or national in nature, but could be high at the local level. For this modeling, the risks posed to recreational fishing activities are modeled in the same manner as risks to commercial fishing, in square meters of surface water oiled above the corresponding threshold of concern. The effects of an oil spill on recreational fishery-related activities will be felt more heavily by various populations, including recreational anglers, commercial tour boat operators, and firms that supply goods and services to recreational anglers. For example, recreational anglers fish for pleasure or sport, as opposed to monetary gain. In the wake of an oil spill, such anglers may choose to fish at a substitute location, may experience a reduced quality of experience, or may choose to forgo fishing entirely. The losses suffered will be related to these missed opportunities. In addition, while closing waters to recreational fishing will decrease the social welfare of recreationists, it would also be expected to affect the demand for boat rentals and other services consumed by fishing enthusiasts.

For a small spill, adverse effects on recreational fishing resources in the Caribbean region would likely be negligible (Table 4.7-24). Medium and large spills may cause decreases in local recreational fishing activities and in the revenues generated from these activities.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on fisheries (commercial and recreational) in the Caribbean region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 3.4 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Subsistence

Potential adverse effects on subsistence resources in the Caribbean region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.3.5 and summarized in Table 4.5-27 (the results in Table 4.5-27 are included in Table 4.7-25 for comparison). The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery alone.

Under Alternative 3, potential adverse effects on subsistence resources in the Caribbean region are low for small, medium, and large spills. Dispersant use may increase adverse effects on subsistence resources by increasing water column exposure to dissolved aromatics; however, effects on intertidal subsistence resources may be reduced because chemical dispersion is expected to reduce the amount of oil that strands in intertidal habitats (Section 4.3.2.4). The risk ranking using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion is presented in Table 4.7-25.

Table 4.7-25
Risk Ranking of Offshore Oil Spills* to Subsistence Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A) in the Florida Straits‡

Spill Size	Response Option (% dispersant efficiency)	Resources Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	1–5	4D
Medium (2,500 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	1–5	4D
Large (40,000 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	1–5	4D

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Caribbean region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Effects on subsistence resources for a small spill were determined to be small by extrapolating from the results for a medium spill. With the addition of chemical dispersion at 45 percent efficiency for a medium spill, the modeling results showed water column exposure at low concentrations (1–100 ppb) occurring west of Long Key and at high concentrations (100–10,000 ppb) occurring along the lower Florida Keys. Sediment exposure was expected to be negligible.

With the addition of chemical dispersion at 45 percent efficiency for a large spill, the modeling results showed water column exposure at both low concentrations (1–100 ppb) occurring west of Lower Matecumbie Key and high concentrations (100–10,000 ppb) occurring along the lower Florida Keys west of Little Big Pine Key. Sediment exposure was expected to be negligible. The modeling showed similar results at 80 percent efficiency, with the exception of minimal sediment exposure in the lower Florida Keys.

Although areas other than the Florida Straits for the Caribbean region were not modeled, the results are consistent with those for all other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on subsistence resources will fall within a similar range throughout the Caribbean region. Adverse effects on subsistence resources are not likely to be high on a regional level, but may be high on a local level.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subsistence in the Caribbean region under Alternative 3 are expected to be insignificant for small, medium, and large spills, but increase to minor with the addition of chemical dispersion.

Archaeological and Historic Resources

Potential adverse effects on archaeological and historic resources in the Caribbean region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.4.5.

Under Alternative 3, adverse effects on archaeological resources in the Caribbean region would likely be negligible, regardless of spill size, because most archaeological artifacts and some shipwrecks are buried under sediment and coral formations, and therefore would not become oiled or come in contact with dispersants (Section 3.2.5.6). Similar to archaeological resources, adverse effects on historic sites such as forts and walls, which are located on land, are protected from oiling and dispersants by barriers and proximity to shore. Submerged shipwrecks in nearshore waters are not likely to become oiled. Chemical dispersion may help reduce the amount of oil that strands on the shoreline, which will also reduce the amount of shoreline cleanup and potential disturbance to sensitive historic structures. There are limited data that identify long-term or chronic degradation to cultural resources due to chemical dispersion.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on archaeological/historic resources in the Caribbean region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Recreation and Tourism

Oil spills can adversely affect a coastal community's recreational and tourism assets. The tropical islands of the Caribbean region provide visitors and residents with the opportunity to enjoy a number of outdoor recreational activities and scenic vistas. Beaches, National Parks, and marine sanctuaries are key attractions in the Caribbean region for water recreation and wildlife viewing. An oil spill would be expected to affect recreationists' overall social welfare; in addition, the social and economic implications of a spill would reach beyond these direct effects on visitors and into the community. For example, visitors may be less likely to visit and spend money in an area perceived as affected by a spill, potentially leading to loss of business revenue and jobs (see Coastal Communities, Demography, and Employment above and in Section 4.5.3.5 for more details).

For a small spill in the Caribbean region, the risk to recreation and tourism is negligible (Table 4.7-24). There is little to no risk of oiling economically important resources, and it is unlikely that any fisheries or recreational areas would be affected.

While the risks to recreation and tourism increase with spill size, the effects remain localized. With chemical dispersion, medium and large spills will sweep 99 to 101 million m^2 and 282 to 332 million m^2, respectively, of marine waters, regardless of dispersant recovery efficiency (Table 4.7-24).

Despite chemical dispersion, a medium or large spill could be expected to have short-term adverse economic effects as a result of oiling recreational beaches, closures of fishing grounds, and degradation of the appeal of coastal locations. While the physical effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on recreation and tourism in the Caribbean region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 3.4 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Environmental Justice

As mentioned above, low-income, indigenous, and minority populations in some coastal areas may rely on regional fisheries and other marine resources in the context of participating in commercial fishing or other marine resource-based employment. Many individuals from these groups rely on recreation- and tourism-related jobs, and the security of their employment depends on the ability of the coast to attract visitors. To the extent that an oil spill deters visits and reduces demand for hotel, restaurants, and other tourism- and recreation-related services, the economic status of low-income and minority groups may be affected. These groups may experience the effects of a spill more severely than the general population, which relies on a more diverse economic base for its livelihood and on the availability of a widespread, commercially available selection of foods. Additionally, employment in marine resource-related industries might have value beyond the importance this resource holds as an employment opportunity.

A small spill that is 3 or more statute mi offshore in the Caribbean region results in a small risk of adverse changes in any group's economic status, regardless of response options used (Table 4.7-24). Because of the small surface water area exposed to oil as a result of a small spill, marine-based economic factors such as local commercial fisheries may experience little or no adverse effects. While the risk to coastal communities increases with spill size, the effects remain localized. With chemical dispersion medium and large spills sweep 99 to 101 million m^2 and 282 to 332 million m^2, respectively, of marine waters, regardless of dispersant recovery efficiency (Table 4.7-24).

As a result of this oiling, beaches in the immediate vicinity of a spill may be closed to visitors, and fishing may not be permitted in waters exposed to oil, causing losses in revenue to both the tourism and commercial and recreational fishery sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill and disproportionately affect low-income and minority populations, causing decreases in employment opportunities. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause socioeconomic effect to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on environmental justice in the Caribbean region under Alternative 3 are expected to be insignificant for small and medium spills, with or without dispersant use. For large spills, impacts are expected to be moderate, but are reduced to insignificant with the addition of chemical dispersion. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 3.4 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Public Safety and Worker Health

Potential adverse effects on public safety are defined as the risk to the public from direct exposure to oil or response activities as a result of the spill, or through consumption of contaminated water or organisms. There are many areas in the Caribbean region with high population concentrations along the coast. However, adverse effects on public safety are unlikely from oil spills that occur 3 or more statute mi offshore for any of the spills considered, regardless of the response options—mechanical recovery, *in situ* burning, and/or chemical dispersion—used. The USCG has protocols to protect the public from risk during shoreline response operations, as well as on-water protocols to prevent the public from entering the response area.

Potential adverse effects on worker health are related to direct exposure to oil during response operations. In addition, operating oil spill response equipment can be dangerous, which is well-recognized and is the basis for the worker certification and training requirements that are now in place. There is also a health risk from inhalation of hydrocarbon fumes for first responders, which is recognized in current safety protocols. The risk is greater as the spill size and the corresponding intensity and duration of operations increase, but it is minimized if safety standards are followed. There are also protocols in place for the proper application and handling of dispersants.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on public health and worker safety in the Caribbean region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

4.7.4. Consequences in the Pacific Region

For the purpose of this PEIS, the Pacific region constitutes the coastal area in which the states of California, Oregon, and Washington border the Pacific Ocean (Figure 3.1-1). The location selected for modeling and risk assessment purposes was a site offshore of the entrance to San Francisco Bay because it is in a high-traffic area at greater risk of oil spills. Modeling results from this location were evaluated relative to the geographic area in Section E.1.2 of the technical report (French McCay et al., 2004), herein referred to as the Central California Shelf. The Central California Shelf encompasses two biogeographical provinces: the Central California Coast and San Francisco Bay. In general, the site is representative of offshore sites throughout the region and provides a basis for the modeling of potential environmental effects. The results of the modeling—used to evaluate spills of concern in this risk analysis (i.e., 3 or more statute mi offshore)—are presented in detail in Part E of the technical report (French McCay et al., 2004) and summarized in this section.

Table 4.7-26 presents the risk ranking for the modeling of Alternative 3 in the Pacific region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion at 45 and 80 percent recovery efficiency[49] for the three spill sizes (small, 200 bbl; medium, 2,500 bbl; and large, 40,000 bbl). (Based on the discussion of Alternative 3 presented in Section 2.8.3, a 25 percent increase in mechanical recovery capability would not change the effectiveness of the basic response scenario under Alternative 1.) The risk scores presented in Table 4.7-26 are based on the modeling results for an average spill and on regional considerations; however, in any specific oil spill situation local concerns could be higher. Table 4.7-27 summarizes the significance of the potential beneficial and adverse environmental impacts associated with Alternative 3 in the Pacific region, based on the extrapolation of the modeling results for the average spill to the region in general.

Table 4.7-26
Risk Ranking[*] of Offshore Oil Spills[†] under Alternative 3 Using the Basic Response Scenario[‡] with the Addition of Chemical Dispersion (Option A) in the Pacific Region

		Resources of Concern														
		Physical Environment			**Biological Environment**								**Socioeconomic Environment**			
Spill Size	**Response Option (Option A, % dispersant efficiency)**	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals[§]**	**Marine and Coastal Birds[§]**	**Plankton and Fish[§]**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles[§]**	**Areas of Special Concern**	**Essential Fish Habitat**	**Subsistence[‖]**	**Archaeological/Historic Resources[‖]**	**Shoreline Oiling Index[#]**	**Surface water Oiling Index[#]**
Small (200 bbl)	Basic	4E	4E	4E	3E	3D	4E	3E	4E	3E	3E	4E	4E	4E	N/A[**]	N/A[**]
	Chemical Dispersion (45)	4E	4E	4E	3E	4E	4E	4E	4E	3E	4E	4E	4E	4E	N/A[**]	N/A[**]
	Chemical Dispersion (80)	4E	4E	4E	3E	4E	4E	4E	4E	3E	4E	4E	4E	4E	N/A[**]	N/A[**]
Medium (2,500 bbl)	Basic	4E	4E	4E	2D	3C	4E	3D	4E	3E	3D	4E	4E	4E	1.00	1.00
	Chemical Dispersion (45)	4D	4E	4E	2E	3D	4E	3E	4E	3E	3E	4E	4E	4E	0.40	0.64
	Chemical Dispersion (80)	4D	4E	4E	2E	3D	4E	3E	4E	3E	3E	4E	4D	4E	0.39	0.63
Large (40,000 bbl)	Basic	4D	4E	4E	2D	3A	4E	2D	4E	3E	2D	4E	4E	4E	1.00	1.00
	Chemical Dispersion (45)	4A	4E	4E	2D	3B	3D	2D	4E	3E	2D	3D	4D	4E	0.58	0.70
	Chemical Dispersion (80)	4A	4E	4E	2D	3B	3D	2D	4E	3E	2D	3D	4D	4E	0.50	0.64

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] This risk ranking is a summary of risk scores for the resources considered in this PEIS. The risk scoring process is explained in Section 4.4.3.

[†] Average spills.

[‡] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[§] Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles. If such species are affected by an actual spill, the level of concern would be high.

[‖] Subsistence and archaeological/historic resources are the only socioeconomic resources that could be ranked using the risk matrix.

[#] The Socioeconomic Index is calculated using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with value equal to 1.0. Risk factors reflect the ratio of the percentage of the model area or volume oiled using the basic response scenario to the percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected with response limited to the basic response scenario.

[**] Index cannot be calculated for small spills since they were not modeled.

Table 4.7-27

Summary of Potential Adverse Regional Impacts of Offshore Oil Spills* under Alternative 3 Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A, 45 or 80% Efficiency) in the Pacific Region

		Resources of Concern																			
		Physical Environment			**Biological Environment**								**Socioeconomic Environment**								
Spill Size	**Response Option (% dispersant efficiency)**	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals‡**	**Marine and Coastal Birds‡**	**Plankton and Fish‡**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles‡**	**Areas of Special Concern**	**Essential Fish Habitat**	**Coastal Communities, Demography, and Employment**	**Economic Status**	**Vessel Transportation and Ports**	**Fisheries**	**Subsistence**	**Archaeological/Historic Resources**	**Recreation and Tourism**	**Environmental Justice**	**Public Safety and Worker Health**
Small (200 bbl)	Basic	Ins	Ins	Ins	Min	Mod	Ins	Min	Ins	Min	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
	Chemical Dispersion (45 or 80)	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
Medium (2,500 bbl)	Basic	Ins	Ins	Ins	Mod	Mod	Ins	Mod	Ins	Min	Mod	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
	Chemical Dispersion (45 or 80)	Min	Ins	Ins	Mod	Mod	Ins	Min	Ins	Min	Min	Ins	Ins	Ins	Ins	Ins	Min§	Ins	Ins	Ins	Ins
Large (40,000 bbl)	Basic	Min	Ins	Ins	Mod	Mod	Ins	Mod	Ins	Min	Mod	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
	Chemical Dispersion (45 or 80)	Mod	Ins	Ins	Mod	Mod	Mod	Mod	Ins	Min	Mod	Mod	Ins	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins

Note: Based on Table 4.7-26. Sig, significant; Mod, moderate; Min, minor; and Ins, insignificant.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles.

§ Since there are different levels of concern at 45 and 80 percent dispersant efficiency, the highest level of concern is shown in this table.

Without the addition of chemical dispersion, the results are unchanged from the basic response scenario (see the discussion in Section 4.5.4). In summary, there is a minor or insignificant adverse regional impact to all resources, except for moderate impacts on marine mammals and marine and coastal birds for all spill sizes, and to coastal water quality, plankton and fish, intertidal habitats, areas of special concern, and Essential Fish Habitat for large spills. A large spill could also cause significant, but localized, adverse, short-term socioeconomic impacts. Adverse impacts occur despite the treatment or recovery of some of oil, but are reduced by those actions when they are effective. Further, as explained in the introduction to Section 4.7, the modeling shows that *in situ* burning would not significantly change the level of concern identified from those obtained when using mechanical-only recovery.

Under the available response options of Alternative 3, the addition of chemical dispersion helps mitigate, but does not eliminate, potential adverse impacts on marine mammals, marine and coastal birds, and coastal habitat and shoreline, especially for larger spills, without significantly increasing the risk to water column or subtidal resources. Chemical dispersion also greatly reduces the likelihood of adverse effects to socioeconomic resources.

4.7.4.1. Consequences to the Physical Environment

Water Quality

Potential adverse consequences of oil spills to water quality are related to hydrocarbon contamination, as other constituents in oils are at concentrations that would not exceed thresholds of concern. The hydrocarbons that could affect water quality are the soluble aromatics, MAHs (monoaromatic hydrocarbons) and PAHs (polynuclear aromatic hydrocarbons) (Sections 4.3.1.1 and 4.5.4.1), even with chemical dispersion. Thus, evaluation of potential adverse effects is based on degree of potential contamination by these compounds. Under Alternative 3, chemical dispersion could increase soluble aromatic hydrocarbon concentrations in areas where dispersants are applied. No beneficial effects on water quality would be expected to result from an oil spill.

For oil spills in marine waters, adverse effects on water quality are low for small, medium, and large oil spills, regardless of the response option used (mechanical recovery with or without *in situ* burning and chemical dispersion). This is because of the tendency for most chemical compounds of concern to evaporate, rather than dissolve, and the rapid dilution of any chemical compounds that might enter the water column, even after periods of extreme turbulence that induce relatively high dissolution rates. Dispersants would be applied to surface oil after much of the evaporation of the toxic components occurs because of logistics (i.e., greater than 12 hours after the spill), such that the resulting increase of concentrations of toxic components in the water column would be relatively small.

Overall, based on the modeling and risk assessment results, it is concluded that—using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion—adverse water-quality effects under Alternative 3 would be low in marine waters, even in the event of a large spill in the Pacific region. If an offshore spill moved into shallow and confined coastal waters, adverse effects could be locally important for medium and large spills under conditions where oil is mixed into water by strong turbulence or in areas where oil collects for a few weeks to months after a spill. Chemical dispersion would not be used in shallow and confined coastal waters (less than 3 nm[50] from shore) under Alternative 3, so could only contribute to adverse water-quality effects in those areas if the dispersed oil plume drifted into the area before being diluted.

The variable used to determine the potential effects on water quality is "volume of water contaminated" by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer, which is less than all established water-quality criteria and thresholds of concern for effects on aquatic biota (Sections 4.3.1.1 and 4.3.2.1). The affected water volume increases with spill volume and the level of physical or chemical dispersion during the time of the spill. Natural dispersion increases with stronger winds and currents, lessening the volume of contaminated water that is above the threshold of concern if in unconfined waters. Since the volume of water contaminated increases exponentially as a function of spill size, the estimated volume contaminated for a small spill was extrapolated from the mean medium- and large-spill model results. Potential adverse water-quality effects in the Pacific region with using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.4.1 and summarized in Tables 4.5-43 and 4.5-44 for coastal and marine waters, respectively (the results for coastal and marine water quality are included in Tables 4.7-28 and 4.7-29 for comparison).

Coastal

In estuaries and coastal waters within 3 statute mi of shore, mechanical-only recovery would be used under Alternative 3. In marine waters 3 or more statute mi from shore, the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion could be used under Alternative 3 in the Pacific region. If dispersants were applied offshore, the dispersed oil plume could move into these nearshore areas. Since chemical dispersion would not be used in these areas, the level and duration of exposure would be negligible because of dilution.

San Francisco Bay is used as a representative of coastal water for analyzing the Central California Shelf, as well as the Pacific region. San Francisco Bay is approximately 1,733 km^2 in area and about 5 m deep on average, with a total volume of approximately 8,665 million m^3. The estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) were compared with the total volume of the San Francisco Bay to determine the potential consequences of small, medium, and large spills (Table 4.7-28). This approach was used both with and without dispersant use, and yields a very conservative estimate in that it assumes all of the contamination would occur in coastal water. Since dispersants could not be employed in such areas, this would imply that the dispersed oil plume moved directly into coastal waters without dilution, which will not occur.

Table 4.7-28
Risk Ranking of Offshore Oil Spills[*] to Coastal Water Quality Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Central California Shelf[‡]

Spill Size	Response Option	Volume of Water	Area Contaminated	Risk Score[§]

	(% dispersant efficiency)	**Contaminated (million m³)**	**(estimated %)**	
Small (200 bbl)	Basic	$< 41 \times 10^{-6}$	5×10^{-7}	4E
	Chemical Dispersion (45 or 80)	$< 41 \times 10^{-6}$	5×10^{-7}	4E
Medium (2,500 bbl)	Basic	66	0.8	4E
	Chemical Dispersion (45)	397	4.6	4D
	Chemical Dispersion (80)	373	4.3	4D
Large (40,000 bbl)	Basic	385	4.4	4D
	Chemical Dispersion (45)	2,495	28.8	4A
	Chemical Dispersion (80)	2,554	29.5	4A

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Because of natural dilution, evaporation, and biological processes, contamination levels would decrease rapidly even in the case of a large spill, and recovery time would be on the order of days to weeks. Oil may be incorporated into shallow water or intertidal sediments where, through leaching, it could become a continuing source of contamination over time. However, this would generally only lead to noticeable water-quality degradation in the locality where the oil collects. This is unlikely to occur with a spill that originates offshore. Because mechanical removal would begin within the required response time under Tier I standards (beginning about 12 hours after the spill), much of the soluble components of concern to water quality would have evaporated or dissolved. Thus, mechanical recovery and *in situ* burning would have a small influence on the volume of water adversely affected, and the risk score results would apply whether either response is implemented.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal water quality in the Pacific region under Alternative 3 are expected to be insignificant for small spills, without or without dispersant use. For medium and large spills, impacts are expected to be insignificant and minor, respectively, but increase to minor and moderate, respectively, with the addition of chemical dispersion.

Marine

The Central California Shelf was selected for the modeling as representative of the marine waters in the Pacific region. The total surface area of the Central California Shelf is approximately 16,639 km², so the area of interest is much vaster for marine waters than for coastal waters. Water-quality effects were calculated using a spill site in relatively shallow water—30 m deep, which is much shallower than most of the Pacific region's marine waters. The results for the selected modeling location (Table 4.7-29) represent conservative estimates of adverse water-quality effects using the basic response scenario (current levels of *in situ* burning when circumstances permit) with the addition of chemical dispersion.

Because of natural dilution, evaporation, and biological processes, oil contamination levels would decrease rapidly even after a large spill, with or without chemical dispersion, and recovery time would be on the order of days to weeks. The estimated volume of contaminated water—and its variability—are generally applicable to spills of the same size throughout the Pacific region because natural and chemical oil dispersion into the water column and dilution processes are similar in all areas.

The results in Table 4.7-29 are nearly the same (with some uncertainty reflected in the variability of the results) for 45 and 80 percent efficiency because the amount of dispersant at 45 percent efficiency is sufficient to treat all dispersible surface oil, for spills up to 40,000 bbl. For a small spill, the volume of water contaminated would be the same as under Alternative 1 because, due to logistics, dispersants could only be applied after a small spill has mostly dispersed naturally. Chemical dispersion for medium or large spills increases the volume of water contaminated—and the percentage of the area of concern—that would be adversely affected by about a factor of six, which is still a small volume relative to that of the entire modeled area. *In situ* burning (in combination mechanical recovery and chemical dispersion) would not significantly change the volume contaminated or the effect on water quality since it would substitute for some of the mechanical response.

Table 4.7-29
Risk Ranking of Offshore Oil Spills[*] to Marine Water Quality Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Central California Shelf[‡]

Spill Size	Response Option (% dispersant efficiency)	Area Contaminated (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	8×10^{-9}	4E
	Chemical Dispersion (45 or 80)	8×10^{-9}	4E
Medium (2,500 bbl)	Basic	0.1	4E
	Chemical Dispersion (45)	0.08	4E
	Chemical Dispersion (80)	0.07	4E
Large (40,000 bbl)	Basic	0.8	4E
	Chemical Dispersion (45)	0.50	4E
	Chemical Dispersion (80)	0.51	4E

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine water quality in the Pacific region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Air Quality

Concentrations of hydrocarbons of concern in the air resulting from oil spills and response operations were compared with air quality standards to evaluate the potential for adverse effects (see Section 4.3.1.2). The effects of an oil spill on air quality may involve all volatile components of the oil. In addition, if *in situ* burning was used, particulates and other contaminants emitted from burns could become an air quality concern. However, adverse air quality effects from oil spills are normally very localized and short lived for small, medium, and large oil spills. The addition of *in situ* burning does not significantly increase any potential adverse effects: the volume of oil that could be burned is not large, and the temporary smoke plume would be localized and rapidly diluted. Chemical dispersion reduces the volatilization of unburned oil to the atmosphere to only a slight extent, so that effects are essentially identical with or without dispersant use.

Potential adverse effects on air quality in the Pacific region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.4.1 and summarized in Table 4.5-45. Two possible sources of contamination to the atmosphere were evaluated for their potential effects on air quality: volatilization of hydrocarbons from unburned oil and emissions produced by *in situ* burning. Concentrations in the lowest 2 m of the atmosphere were compared with the U.S. Environmental Protection Agency's National Ambient Air Quality Standards (USEPA's NAAQS) and other thresholds of concern (as discussed in Section 4.3.1.2).

As discussed in Section 4.5.3.1, the results of the modeling show that the potential adverse effects on air quality are low for all spill sizes involving mechanical-only recovery; hence, the risk scores are virtually identical for medium and large spills. Volatilized hydrocarbons would not exceed air quality standards for human health at more than 1 km from the spill site. Evaporation off the water surface and volatilization from the water column create a plume of volatile hydrocarbon gases that disperses quickly after a spill, such that the concentrations in the atmosphere at the water surface would not exceed human health thresholds of concern at any location. The atmospheric recovery time would be on the order of hours to days. Thus, a low level of concern is expected for small, medium, and large spills involving mechanical-only recovery.

Under Alternative 3, the addition of chemical dispersion does not change the results from those under Alternative 1. Chemical dispersion would disperse some of the volatile hydrocarbons into the water resulting in the volatile hydrocarbons entering the atmosphere over a larger area than would occur without chemical dispersion. Thus, dispersants further dilute hydrocarbon concentrations in the atmosphere. The modeling shows that results are low for a spill of any size involving some combination of mechanical response and chemical dispersion at any spill site in the Pacific region. Adverse effects of *in situ* burning on air quality are summarized in Table 4.5-45; these results apply whether or not chemical dispersion is used on unburned oil, and they do not vary by the location of the burn. Thus, the results for Alternative 1 apply to Alternative 3 for all areas in the Pacific region. The modeling was performed for weather conditions where dilution in the air would be relatively slow, so the estimated adverse effects are overestimated for other conditions.

Mechanical recovery plus *in situ* burning, with or without chemical dispersion, would increase atmospheric pollutants by the amount emitted via *in situ* burning. For small spills, it would be very unlikely that *in situ* burning would be used, as the oil would disperse too rapidly for it to be feasible (Table 4.5-45). The maximum area potentially exceeding the NAAQS or thresholds of concern is 1.6 km^2 for a medium spill and 11.1 km^2 for a large spill (Table 4.5-45). If humans or sensitive resources (i.e., wildlife) are within these areas, they could be affected by poor air quality for a short time, on the order of hours. Since *in situ* burning can only be used offshore in marine waters, a region of interest equivalent to the Central California Shelf (16,639 km^2) would have less than 1 percent of its area affected, and the atmosphere would recover in a matter of hours. The addition of chemical dispersion does not change the results under Alternative 1 in Table 4.5-45.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on air quality in the Pacific region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without *in situ* burning.

4.7.4.2. Consequences to the Biological Environment

Marine Mammals

Potential adverse effects on marine mammals in the Pacific region using the basic response option (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.4.2 and summarized in Table 4.5-46 (the results in Table 4.5-46 are included in Table 4.7-30 for comparison). Potential adverse effects on marine mammals are a serious issue in the Pacific region. There is a wide range of species, many of which would be at serious risk if a spill occurred in areas that they use. There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on marine mammals because larger spills tend to spread across a larger surface water area and have higher shoreline oil loading. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery.

Under Alternative 3 for a small spill, the contaminated surface water area is small when compared with the overall surface water area in the Pacific region, so the likelihood of marine mammals becoming oiled at the surface or on a contaminated shoreline is minimal. Very little oil is likely to strand onshore, and oil loading would be light in most cases. Thus, the potential risk of oiling a haulout area or breeding ground is small. Potential adverse effects increase as spill volume increases, with greatest concern for conditions where haulout areas, bays, estuaries, and known breeding grounds could become heavily oiled. If a local population of marine mammals is affected, it is estimated that it would take 1 to 3 years to recovery. Effective chemical dispersion could reduce this risk, but would not change the overall risk score. The results of the modeling for marine mammals are presented in Table 4.7-30.

Based on the area of appropriate habitat in the Central California Shelf, the equivalent areas for 100 percent mortality using mechanical-only recovery only for cetaceans, pinnipeds, and sea otters are less than 0.001, 0.007, and 0.54 percent, respectively, of the available habitat for a medium spill. For a large spill without chemical dispersion the values increase to 0.003, 0.04, and 2.90 percent, respectively. Chemical dispersion reduces all of these percentages, but except for sea otters the values are already so low that the difference is not important. For sea otters, chemical dispersion at 45 or 80 percent efficiency reduced the areas by approximately 35 and 48 percent for medium and large spills, respectively, but this improvement did not change the overall level of risk, primarily because of the expected recovery time. Pinnipeds are also at risk from shoreline oiling. The likelihood that oiling would actually involve a pinniped haulout area is low, based on the predicted length of shoreline contaminated, but does contribute to the potential risk (see the discussion on intertidal habitats). This risk is also reduced by chemical dispersion. Based on the distribution of mammals in the Pacific region, the potential level of concern was determined to be low for small spills but would increase to medium levels for medium and large spills.

Table 4.7-30
Risk Ranking of Offshore Oil Spills[*] to Marine Mammals Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Central California Shelf[‡]

Spill Size	Response Option (% dispersant efficiency)	Populations Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E
Medium (2,500 bbl)	Basic	1–5	2D
	Chemical Dispersion (45 or 80)	0–1	2E
Large (40,000 bbl)	Basic	1–5	2D
	Chemical Dispersion (45 or 80)	1–5	2D

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the test) as representative of the Pacific region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine mammals in the Pacific region under Alternative 3 are expected to be minor for small spills, and moderate for medium and large spills, with or without dispersant use. On an overall regional level, for medium or large spills, adverse impacts are reduced when chemical dispersion is used but remain moderate.

Marine and Coastal Birds

Potential adverse effects on marine and coastal birds in the Pacific region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.4.2 and summarized in Table 4.5-47 (the results in Table 4.5-47 are included in Table 4.7-31 for comparison). There is often a direct relationship between the volume of spilled oil and the potential for adverse effects on birds; larger spills tend to have higher oil loading on the shoreline and affect larger areas. Potential adverse effects increase with spill volume; the greatest concern is for conditions when the more-sheltered interior wetlands and tidal flats become heavily oiled, and surface oiling occurs in areas where rafting birds congregate. The addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the severity of potential adverse effects or increase the risk to marine and coastal birds.

Under Alternative 3 for a small spill very little oil is likely to strand onshore, and oil loading would be light in most cases. Chemical dispersion is expected to reduce adverse effects on these habitats primarily by reducing the amount of oil that strands onshore (Section 4.3.2.4). Surface water oiling may also adversely affect rafting seabirds (Section 3.4.2.2), and chemical dispersion is expected to reduce the extent of surface slicks that birds encounter. The risk scores in Table 4.7-31 reflect the predicted recovery rates of 1 to 3 years for most bird species, as was the case following the *EXXON VALDEZ* oil spill (Section 4.3.2.2). For a small spill, predicted recovery rates were estimated to be less than 1 year because very small percentages of bird populations were estimated to be affected.

For a small spill, shoreline oiling was expected to be light and to not persist. For a medium spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by 45 percent compared with Alternative 1. The area of surface water oiling was reduced by 44 percent. There was little oiling of wetlands, but sand and gravel beaches used by shorebirds were more heavily oiled. The results for the 45 percent dispersant efficiency were similar to those for 80 percent dispersant efficiency (Table 4.7-31); some important staging, nesting, and feeding areas for shorebirds, waterfowl, and seabirds were still oiled, but the reduction in shoreline length and surface water area oiled would likely reduce adverse effects on birds.

Table 4.7-31
Risk Ranking of Offshore Oil Spills* to Marine and Coastal Birds Using the Basic Response Scenario†
with the Addition of Chemical Dispersion (Option A) in the Central California Shelf‡

Spill Size	Response Option (% dispersant efficiency)	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	1–5	3D
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	5–10	3C
	Chemical Dispersion (80)	1–5	3D
Large (40,000 bbl)	Basic	> 20	3A
	Chemical Dispersion (45 or 80)	10–20	3B

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

For a large spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by 48 percent compared with Alternative 1. The area of surface water oiling was reduced by 49 percent. In addition, chemical dispersion increased the number of times that no oil stranded onshore, from 1 (Alternative 1) to 4 (Alternative 3) out of 100 model runs (technical report [French McCay et al., 2004]). Oiling of wetlands and tidal flats used by shorebirds and waterfowl and offshore islands used by seabirds occurred but was less extensive when chemical dispersion was used. The results for the 45 percent dispersant efficiency were similar to those for 80 percent dispersant efficiency (Table 4.7-31).

Although areas other than the Central California Shelf in the Pacific region were not analyzed, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on birds will typically be reduced with chemical dispersion at either efficiency. The reduction of adverse effects on birds when chemical dispersion is used is contingent upon whether the reduction of adverse shoreline effects coincides with heavily used habitats.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine and coastal birds in the Pacific region under Alternative 3 are expected to be moderate for medium and large spills, with or without dispersant use. For small spills, impacts are expected to be moderate, but are reduced to insignificant with the addition of chemical dispersion. On an overall regional level for medium and large spills, adverse impacts are reduced when chemical dispersion is used but remain moderate.

Plankton and Fish

Plankton and fish, a diverse group of species, are important to the marine food web, ecosystem function, and fisheries. Adverse effects on these groups are of high concern, particularly when chemical dispersion is considered as a potential response option. As described in Section 4.3.2.3 and 4.5.4.2, plankton and fish are adversely affected either directly or via the food web by the toxic effects of oil components that enter the water column—the soluble compounds (MAHs and PAHs) and microscopic oil droplets mixed by waves into the water (French McCay, 2002; NRC, 1985). The most important pathway of exposure is direct uptake of dissolved oil components, originating directly from surface oil or dissolving from the microscopic oil droplets in the water. Overall, adverse effects increase the larger the spill size. However, there is great variability related to the environmental conditions after the spill; plankton and fish suffer many more adverse effects in storm conditions where high waves mix unweathered oil into the water, which happened during the *NORTH CAPE* oil spill (French McCay, 2003), than in calm weather. In addition, many species utilize shallow waters and even the intertidal zone, where they are more likely to be exposed to oil and dissolved components when oil comes ashore. Species and life stages vary considerably in sensitivity to toxic components, with species from relatively unpolluted and environmentally stable locations more sensitive than those from polluted and environmentally variable areas.

In marine and open coastal environments, small, medium, and large oil spills do not cause large or long-term toxic effects to plankton and fish in the water column. The toxic effects of oil spills result from acute exposures during the time when surface oil is present and for short periods (days to weeks) afterwards. Once the source of hydrocarbons (from floating oil or the shoreline) to the water column is gone, concentrations rapidly dilute to background levels.

There may be longer-term effects if an offshore spill migrates to nearshore shallow areas such as enclosed embayments, estuaries, or wetlands where dilution and flushing are slow. Many fish and other organisms spawn and develop through larval and juvenile stages in these shallow areas. Juvenile fish are more abundant in salt marshes and seagrass and kelp beds than in other shallow subtidal and intertidal areas, so these areas are of most concern (see discussion of potential effects on these habitats below). Under Alternative 3, chemical dispersion could not be used within 3 nm[51] of shore; therefore, it would not contribute to adverse effects on plankton and fish in these areas.

The percentage of plankton and fish adversely affected by spills was estimated using the modeling results (technical report [French McCay et al., 2004]) of water volumes exposed to toxic oil components. Percent loss multiplied by water volume exposed was integrated over time and space to calculate an equivalent volume of 100 percent loss. These volumes were translated to equivalent areas by multiplying by water depth at the spill site, allowing comparison with other resources such as birds and shorelines, which are distributed on a per-area basis. The use of area is appropriate because plankton and fish abundance is much more uniformly distributed when expressed on a per-area basis than on a per-volume basis since the ecosystem is driven by sunlight and plant photosynthesis at the water surface (French et al., 1996; Odum, 1971). As indicated by similar results for the four modeled spill sites in 10 to 30 m of water—offshore Delaware Bay, offshore Galveston Bay, the Florida Straits, and offshore San Francisco Bay (Parts B, C, D, and E, respectively of the technical report [French McCay et al., 2004])—the equivalent areas of adverse effect on plankton and fish (both the average and variable) are applicable to spills of the same size in any location of similar water depth in any region considered in the PEIS. The modeled spill site was 30 m deep water: adverse effects would be smaller for deeper waters because of greater vertical dilution of both oil components and organisms, and proportionately greater in shallower waters because of the restricted dilution potential and generally higher organism abundance.

The model-estimated areas are those where there is a potential to affect the most sensitive species, which are two standard deviations more sensitive than the average of all species tested (2.5th percentile in rank order of sensitivity). For species of average sensitivity (50th percentile), the areas adversely affected would be much smaller. Thus, the model-estimated areas should not be interpreted as experiencing 100 percent mortality of all plankton and fish; they are conservative estimates used for comparative purposes among response scenarios.

Potential adverse effects on plankton and fish in the Pacific region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.4.2 and summarized in Table 4.5-48 (the results in Table 4.5-48 are included in Table 4.7-32 for comparison).

The Central California Shelf, containing the waters between Point Conception and Cape Mendocino, was selected as representative of the Pacific region.

Under Alternative 3, the results for 45 percent dispersant efficiency were not significantly different than those for 80 percent dispersant efficiency because more than sufficient dispersant would be available under both conditions to disperse available surface oil for spills up to 40,000 bbl (with some variability, as reflected in the results in Table 4.7-32). For a small spill, based on the evaluation of the volume where water quality would be affected (Tables 4.5-16 and 4.5-17), the volume of adverse effect on plankton and fish would be negligible for all response options under Alternative 3. For medium and large spills, the volumes and areas of adverse effect are up to four and ten times higher, respectively, than those without chemical dispersion.

Table 4.7-32

Risk Ranking of Offshore Oil Spills[*] to Plankton and Fish Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Central California Shelf[‡]

Spill Size	Response Option (% dispersant efficiency)	Equivalent Area Affected (km^2)	Area Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	< 0.039	8×10^{-11}	4E
	Chemical Dispersion (45 or 80)	< 0.039	8×10^{-11}	4E
Medium (2,500 bbl)	Basic	21	0.1	4E
	Chemical Dispersion (45)	29	0.17	4E
	Chemical Dispersion (80)	28	0.17	4E
Large (40,000 bbl)	Basic	29	0.2	4E
	Chemical Dispersion (45)	272	1.6	3D
	Chemical Dispersion (80)	279	1.7	3D

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Since the adverse effects are in a small percentage of the area of concern and less than the range of natural variability, the recovery time would be less than 1 year. Overall, based on the modeling, adverse effects on plankton and fish in the Pacific region under Alternative 3 would be localized to the immediate area around the spill site and similar in all marine water areas of the region.

Even without chemical dispersion, concentrations of toxic components could become high enough to cause concern for plankton and fish for medium or large spills if the slick moved into shallow coastal areas and embayments under conditions where storm-generated waves mix large amounts of fresh oil into the water column. Under Alternative 3, chemical dispersion could not be used within 3 nm[52] of shore in enclosed coastal lagoons; therefore, it would not contribute to such risk, and might even reduce concerns by dispersing portions of the slick before it can enter shallow waters.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on plankton and fish in the Pacific region under Alternative 3 are expected to be insignificant for small and medium spills, with or without dispersant use. For large spills, impacts are expected to be insignificant, but increase to moderate with the addition of chemical dispersion.

Intertidal Habitats

Potential adverse effects on intertidal habitats in the Pacific region using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.4.2 and summarized in Table 4.5-49 (the results in Table 4.5-49 are included in Table 4.7-33 for comparison). There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on intertidal habitats in that larger spills tend to have higher oil loading on the shoreline and affect larger areas. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery.

Under Alternative 3 for a small spill, very little oil is likely to strand onshore, and the oil loading would be light in most cases. However, the potential for adverse effects on intertidal habitats increase as spill volume increases, with greatest concern where marshes and tidal flats become heavily oiled. Chemical dispersion is expected to reduce adverse effects on these habitats by reducing the amount of oil that strands onshore (Section 4.3.2.4). The risk scores in Table 4.7-33 were based on adverse effects on the intertidal habitats of the Central California Shelf.

Table 4.7-33
Risk Ranking of Offshore Oil Spills* to Intertidal Habitats Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A) in the Central California Shelf‡

Spill Size	Response Option (% dispersant efficiency)	Habitats Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	1–5	3D
	Chemical Dispersion (45 or 80)	0–1	3E
Large (40,000 bbl)	Basic	1–5	2D
	Chemical Dispersion (45 or 80)	1–5	2D

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Adverse effects on intertidal habitats for a small spill were determined to be small by extrapolating from the results of a medium spill and expecting recovery from light oiling to be rapid for all habitat types. For a medium spill using 80 percent dispersant efficiency, the length of oiled shoreline was reduced by 45 percent, from 17.1 km under Alternative 1 to 7.7 km under Alternative 3, which is less than 1 percent of the total shoreline in the area but 1 percent of the rocky shores. The results for the 45 percent dispersant efficiency were essentially the same as those for 80 percent dispersant efficiency (Table 4.7-33). There was very little oiling of wetlands under any chemical dispersion scenario for a medium spill. The habitats that were oiled—rocky shores and sand and gravel beaches—are expected to recover in 1 to 3 years.

For a large spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by 48 percent, from 45 km under Alternative 1 to 23.6 km under Alternative 3. However, approximately 1 km of wetlands was oiled, so the recovery rate was still expected to be 3 to 7 years (Section 4.3.2.4). The number of times that no oil stranded onshore increased from 1 (Alternative 1) to 4 (Alternative 3) out of the 100 model runs (technical report [French McCay et al., 2004]). The results for 45 percent dispersant efficiency were very similar to those for 80 percent dispersant efficiency (Table 4.5-28).

Although areas other than the Central California Shelf in the Pacific region were not modeled, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on intertidal habitats will fall within a similar range throughout the Pacific region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on intertidal habitats in the Pacific region under Alternative 3 are expected to be moderate for large spills, with or without dispersant use. For small and medium spills, impacts are expected to be minor and moderate, respectively, but are reduced to insignificant and minor, respectively, with the addition of chemical dispersion.

Subtidal Habitats

Potential adverse effects on subtidal habitats in the Pacific region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.4.2 and summarized in Table 4.5-50 (the results in Table 4.5-50 are included in Table 4.7-34 for comparison). In the Pacific region, there is particular concern for the possible effects to kelp beds near the shoreline. The addition of *in situ* burning does not change the potential adverse effects from those with mechanical-only recovery.

The risk to fauna and flora of the subtidal benthic habitat is minimal, based on the diluting effect of the overlying water (Section 2.2.2)—the deeper the water, the lower the risk. Chemical compounds of concern tend to evaporate, rather than dissolve, and the rapid dilution of any chemical entering the water column decreases the toxicity of any oil residue potentially reaching the bottom substrate.

Under Alternative 3, the addition of chemical dispersion does not increase the potential adverse consequences. For a medium spill without chemical dispersion the sediment threshold concentrations for dissolved aromatic and for total hydrocarbons were never exceeded. For a large spill the sediment threshold for total hydrocarbon exposure was exceeded, but only in an area of less than 0.006 percent of the total reference area. Benthic habitat was also assumed to be at risk if the threshold of concern for dissolved aromatic hydrocarbons affected stationary demersal species (those living at the sediment-water interface). With mechanical-only recovery less than 0.01 percent of the Central California Shelf was affected by water column concentrations above the threshold for a medium spill. For a large spill, the percentage increased to 0.01 percent.

With the addition of chemical dispersion at 45 and 80 percent efficiency for medium and large spills (Table 4.7-34), the modeling results show that sediment contamination still did not occur for dissolved aromatic hydrocarbons, but very low levels were noted for total hydrocarbon (less than 0.001 percent for medium spills and approximately 0.003 percent for large spills). The area of exposure of stationary demersal species to dissolved aromatic hydrocarbon concentrations above the threshold remained at 0.001 percent for medium spills, but increased to approximately 0.15 percent for large spills, which is a very low level of exposure.

Table 4.7-34
Risk Ranking of Offshore Oil Spills* to Subtidal Habitats Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A) in the Central California Shelf‡

Spill Size	Response Option (% dispersant efficiency)	Habitats Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Large (40,000 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

These results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on subtidal habitats will fall within a similar range throughout the Pacific region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subtidal habitats in the Pacific region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Areas of Special Concern

For this analysis, the risks to areas of special concern are assumed to be the same as those for either intertidal or subtidal habitats (Section 4.7.4.2), whichever are greater. Since the risk to intertidal habitats is greater, those risk scores were used. Potential adverse effects on areas of special concern in the Pacific region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.4.2 and summarized in Table 4.5-51 (the results in Table 4.5-51 are included in Table 4.7-35 for comparison). There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on areas of special concern in that larger spills tend to have higher oil loading on the shoreline and affect larger areas. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those of mechanical-only recovery.

Adverse effects on areas of special concern for a small spill were determined to be low by extrapolating from the results of a medium spill and expecting recovery from light oiling to usually be rapid for all habitat types. For a medium spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by approximately 56 percent, from approximately 18 km under Alternative 1 to approximately 8 km under Alternative 3. The results for the 45 percent dispersant efficiency were essentially the same as for the 80 percent dispersant efficiency (Table 4.7-35).

Table 4.7-35
Risk Ranking of Offshore Oil Spills[*] to Areas of Special Concern Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Central California Shelf[‡]

Spill Size	Response Option (% dispersant efficiency)	Areas Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	1–5	3D
	Chemical Dispersion (45 or 80)	0–1	3E
Large (40,000 bbl)	Basic	1–5	2D
	Chemical Dispersion (45 or 80)	1–5	2D

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

For a large spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by 48 percent. Therefore, the risk ranking was reduced to reflect a potential reduction in recovery time. Under the 45 percent dispersant efficiency, the shoreline area oiled was similar.

Although other areas in the Pacific region were not modeled, the results are consistent with those for many other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on areas of special concern will fall within a similar range throughout the Pacific region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on areas of special concern in the Pacific region under Alternative 3 are expected to be moderate for large spills, with or without dispersant use, based on the risk to intertidal habitats. For small and medium spills, impacts are expected to be minor and moderate, respectively, but are reduced to insignificant and minor, respectively, with the addition of chemical dispersion.

4.7.4.3. Consequences to Threatened, Endangered, or Candidate Species

Potential adverse effects on threatened, endangered, or candidate species in the Pacific region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.4.3. Potential adverse effects on marine mammals, marine and coastal birds, fish, and sea turtles that are threatened, endangered, or candidate species are identical to those discussed in Section 4.7.4.2 for these groups. There was no modeling data generated that directly addressed the potential risks or presence of threatened, endangered, or candidate species in the Pacific region; therefore, the potential risk level to threatened, endangered, or candidate species was estimated based on data extrapolated from the marine mammal and marine and coastal bird analysis. There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on threatened, endangered, or candidate species in that larger spills tend to spread across a larger surface water area and have higher shoreline oil loading. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery.

When chemical dispersion is used under Alternative 3 for a small spill, the contaminated surface water area is small when compared with the overall surface water area in the Pacific region, so the likelihood of threatened, endangered, or candidate species becoming oiled at the surface is minimal. Very little oil is likely to strand onshore, and the oil loading would be light in most cases. Thus, the potential risk of oiling these species' breeding habitat is small. Potential adverse effects increase as spill volume increases, with greatest concern for conditions where bays, estuaries, known breeding grounds of pinnipeds, sea otter habitats, or breeding areas for protected marine and coastal birds become heavily oiled. Although populations are sporadic and vary with migration, if a threatened, endangered, or candidate species were present in the area of an oil spill, the resulting adverse effects could be low. The severity of the effect varies depending on the sensitivity of the individuals present. Chemical dispersion is expected to reduce the adverse effects to threatened, endangered, or candidate species by reducing both the amount of oil that strands onshore (Section 4.3.2.4) and the amount of floating oil.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on threatened, endangered, and candidate species in the Pacific region under Alternative 3 are expected to be moderate for medium and large spills, with or without dispersant use, based on the risk to marine mammals and to marine and coastal birds. For small spills, impacts are expected to be moderate, but are reduced to minor with the addition of chemical dispersion.

4.7.4.4. Consequences to Essential Fish Habitat

For this analysis, the risks to Essential Fish Habitat (EFH) are assumed to be the same as those for plankton and fish or for subtidal habitats (Section 4.7.4.2), whichever are greater. Since the risk to plankton and fish is greater, those risk scores were used. Potential adverse effects on EFH in the Pacific region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.4.4. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on EFH in the Pacific region under Alternative 3 are expected to be insignificant for small and medium spills, with or without dispersant use, based on the risk to plankton and fish. For large spills, impacts are expected to be insignificant, but increase to moderate with the addition of chemical dispersion.

4.7.4.5. Consequences to the Socioeconomic Environment

As discussed in Section 4.3.5, oil spills can produce a variety of social and economic effects. These adverse effects are generally not large when measured at the regional levels, but instead are typically felt in communities located near resources oiled by the spill. Specifically, severe adverse effects are generally limited to those industries and populations that are affected by the spill. Some of the most visible and large effects on the Pacific region are likely to include effects on water- and shore-based recreation, commercial and recreational fisheries, and tourism. In addition, large-scale spills hold the potential to adversely affect the overall well-being of the residents and economies of coastal communities. Oil spills have the potential to adversely affect low-income and minority populations living along the Pacific coast to a greater extent than the general population.

This modeling considers the risk of adverse socioeconomic effects posed by oil spills, which can include, but are not limited to, reduced recreational activity because of beach closures, limited accessibility, or perceived taint; closure of commercial fishing grounds or hatcheries, or reduced commercial harvests; and altered marine transportation patterns. In addition to these and other direct adverse effects, oil spills can have secondary adverse effects on social and economic welfare along the coast. For example, an oil spill may cause changes in employment and firm revenues of resource-based businesses. While these effects are not quantified in this modeling, the following discussion provides absolute and relative measures of the overall risk of adverse social and economic effects of small, medium, and large oil spills using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) in the Pacific region. The methodology is described in more detail in the Atlantic region (Section 4.7.2.5).

There is no existing standard for "significance" related to the socioeconomic effect of oil spills (e.g., how much shoreline or surface water must be oiled to be considered a "high," "medium," or "low" effect). The significance of the effect will depend on a number of factors, including the scope of the analysis (i.e., national, regional, local), opportunities for resource substitution (e.g., an unoiled beach or fishing ground nearby, alternative ports of call), and the duration of the spill event. Generally, a spill event would be of low concern if it is not of long enough duration to affect the financial viability of local businesses, and the affected communities are able to find substitutes to replace the oiled resources.

For this PEIS, (1) the greatest effect modeled at the regional level was less than approximately 10 percent of available shoreline or surface water resources (indicating the likely presence of substitute resources), and (2) resource use following these modeled spills (e.g., vessel transportation and fishing) would be expected to resume as soon as oil recovery efforts were completed. As a result, the modeled effects under all modeled scenarios would likely be low at the regional level. As noted in the text, any adverse effects that did occur would be expected to be localized in nature.

The risk factor reflects the ratio of the percentage of the surface water oiled using the basic response scenario to the percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected given response options limited to mechanical recovery and *in situ* burning. Under Alternative 1, a risk factor of 1.0 is assigned to medium and large spills (small spills are assumed to have a negligible effect), indicating that no additional response options are taken in this modeled area.

In estuaries and coastal waters within 3 statute mi from shore, mechanical-only recovery would be used under Alternative 3. In marine waters 3 or more statute mi from shore, the basic response scenario with the addition of chemical dispersion could be used under Alternative 3 in the Pacific region. Potential adverse effects on coastal communities in the Pacific region using the basic response scenario are presented in Section 4.5.4.5 and summarized in Table 4.5-52 (the results in Table 4.5-52 are included in Table 4.7-36 for comparison) for shoreline and surface water oiled. Table 4.7-36 highlights the effects of small, medium, and large oil spills on the Pacific region's resources by presenting estimates of resources oiled as a result of the average modeled spill in absolute terms (meters of recreational beach oiled and square meters of marine waters used for commercial fishing oiled above the threshold of concern) and as a percentage of the total resource base in the modeled area. For oiled shoreline, the threshold of concern is 10 g/m^2 and for oiled surface water is 0.01 g/m^2 (technical report [French McCay et al., 2004]). This resource area is based on an estimate of the extent to which the coastal community in the modeled area potentially relies on each resource.

This modeling assumes that the risk posed to the socioeconomic environment by oil spills is directly related to the extent to which resources are affected above selected thresholds of concern—for the Pacific region, meters of shoreline and square meters of marine water oiled above the threshold of concern. Comparing the absolute risk of adverse socioeconomic effects across spill scenarios, including variations in spill response scenarios, allows for an understanding of the relative risk of adverse socioeconomic effects across spill scenarios. Determining relative risk allows for extrapolation of site-specific results to the entire region. For example, the risk estimates presented in Table 4.7-36 are based on modeled spills affecting San Francisco Bay. While any given spill may exhibit distinctly different patterns of socioeconomic effect, the relative risk measures are expected to be broadly applicable to a range of spill locations along the Pacific coast, as long as the spills occur in areas where chemical dispersion is feasible. In addition, the conclusions reached for the San Francisco Bay modeled area are supported by results for other modeled areas—the relative degree of risk reduction achieved under various removal assumptions across spill size is similar in magnitude.

For this modeling, the socioeconomic environment is divided into components representative of the major parameters of coastal life potentially affected by an oil spill. Absolute and relative risk are discussed for coastal communities, demography, and employment; general economic status of a coastal community; vessel transportation and ports; commercial and recreational fisheries; archaeological and historic resources; recreation and tourism; environmental justice; and public safety and worker health.

Coastal Communities, Demography, and Employment

Oil spills affect the pleasure that coastal residents and visitors derive from coastal activities and the economic contribution that resources make to local income and employment. To the extent that mechanical recovery, *in situ* burning and chemical dispersion can reduce shoreline oiling and the geographic scope of surface water oiling, this combination of spill response options will act to reduce adverse effects on coastal communities. The scope of potential losses is described in more detail in subsequent sections.

As a result of oiling, beaches in the immediate vicinity of a spill may be closed to visitors, and fishing may not be permitted in waters exposed to oil, causing losses in revenue to both the tourism and commercial and recreational fishery sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill, causing short-term decreases in recreation and tourism; commercial and recreational fishing; and the employment opportunities, income, and businesses these industries support. In addition, an oil spill may temporarily reduce the appeal of coastal living in a given area.

Table 4.7-36

Risk Ranking of Offshore Oil Spills[*] to Coastal Communities as a Result of Shoreline and Surface Water Oiled Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Central California Shelf[‡]

Spill Size	Response Option (% dispersant efficiency)	Shoreline Length			Surface Water Area		
		m Oiled Above Threshold[§]	Estimated % Oiled[‖]	Risk Factor[#]	m^2 Oiled Above Threshold[§]	Estimated % Oiled[‖]	Risk Factor[#]
Small (200 bbl)[**]	Basic	N/A	N/A	N/A	N/A	N/A	N/A
	Chemical Dispersion (45 or 80)	N/A	N/A	N/A	N/A	N/A	N/A
Medium (2,500 bbl)	Basic	5,993	1.0	1.0	421×10^6	5.9	1.0
	Chemical Dispersion (45)	2,410	0.40	0.40	273×10^6	3.8	0.64
	Chemical Dispersion (80)	2,376	0.39	0.39	265×10^6	3.7	0.63
Large (40,000 bbl)	Basic	14,232	2.4	1.0	672×10^6	9.4	1.0
	Chemical Dispersion (45)	8,612	1.4	0.58	476×10^6	6.6	0.70
	Chemical Dispersion (80)	7,538	1.2	0.50	432×10^6	6.0	0.64

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

[§] Thresholds above which some economic or social risk is expected were determined, and the length of shoreline oiled and the area of surface water oiled above this threshold for the average modeled spill are reported. The threshold of concern because of oiled shoreline and surface water is 10 g/m^2 and 0.01 g/m^2 of oil, respectively (technical report [French McCay et al., 2004]).

[‖] Percentages reflect the proportion of the total modeled area above the threshold of concern.

[#] A risk factor reflects the ratio of the percentage of the model area or volume oiled using the basic response scenario to the model area or percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected with response limited to the basic response scenario.

[**] A 200-bbl spill is assumed to have negligible effect.

For a small spill along the Pacific coast, there is no risk of large adverse effects on coastal communities. In many cases, a spill of this size would be expected to pose no risk to shoreline or surface water resources because the spilled oil will never reach the threshold of concern (Table 4.7-36).

While the risk to coastal communities increases with spill size, the effects remain localized. With chemical dispersion a medium spill will have a spill area[53] above the corresponding thresholds of concern that will adversely affect 2,376 to 2,410 m of shoreline and 265 to 273 million m^2 of marine waters (Table 4.7-36). A large spill will affect 7,538 to 8,612 m of shoreline and 432 to 476 million m^2 of marine waters (Table 4.7-36). However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources either at all or at levels above the selected threshold. For medium and large spills along the Pacific coast, such conditions prevail in 44 to 52 percent and 13 to 18 percent of the time, respectively, based on modeled spills when the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion is used in the cleanup, regardless of dispersant efficiency. For these spill events, no adverse effects on shoreline are expected.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal communities, demography, and employment in the Pacific region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 1.4 percent of shoreline and 6.6 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Economic Status

The overall economic status of communities, industries, and individuals that rely on coastal resources for sustenance, revenue, and quality of life can be affected by an oil spill. As noted above, coastal communities can suffer direct and indirect economic adverse effects due to an oil spill, as beach and fishery closures decrease revenue and eliminate jobs. More specifically, losses will be felt in commercial and recreational fisheries, by both the anglers themselves and by related industries as catch opportunities decrease or are eliminated entirely. Tourism and associated businesses will suffer economic setbacks as visits to affected coastal areas decline and purchase of area goods and services decrease because of perceived taint. Similarly, environmental justice issues may arise as low-income or minority communities are disproportionately affected by the spill (discussed below in more detail).

A small spill that is 3 or more statute mi offshore would have essentially no adverse effects on either the local or regional economies (Table 4.7-36). There is little to no risk of oiling of economically important resources, and it is unlikely that any commercial or recreational fisheries would be affected.

While the risk increases with spill size, the effects remain localized. With chemical dispersion a medium spill will adversely affect 2,376 to 2,410 m of shoreline and 265 to 273 million m^2 of marine waters (Table 4.7-36). A large spill will affect 7,538 to 8,612 m of shoreline and 432 to 476 million m^2 of marine waters (Table 4.7-36). However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources either at all or at levels above the selected threshold. For medium and large spills along the Pacific coast, such conditions prevail in 44 to 52 percent and 13 to 18 percent of the time, respectively, based on modeled spills when the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion is used in the cleanup, regardless of dispersant efficiency. For these spills, no adverse effects on shoreline are expected.

Despite chemical dispersion, a medium or large spill could be expected to have short-term adverse economic effects because of oiled recreational beaches, commercial and recreational fishing ground closures, and degradation of the appeal of coastal locations. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on economic status in the Pacific region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 1.4 percent of shoreline and 6.6 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Vessel Transportation and Ports

Oil spills occurring 3 or more statute mi offshore are not likely to cause great adverse effects on vessel transportation and ports. However, an oil spill can disrupt marine commerce if it occurs in and around a shipping channel or port and results in limits on watercraft movement as a means of facilitating spill response. Vessel transportation is of paramount importance for many industries along the Pacific coast. Any interruption in the standard use of vessels or an increase in travel times over water can result in hardship for coastal communities, as fewer goods are exchanged, transportation costs rise, and the revenue streaming through the local economy falls. These adverse effects might be felt at a number of levels. For example, vessel operators may incur additional costs associated with delays and longer shipping distances; businesses that depend on timely receipt of feedstock or other goods may experience adverse effects such as production slowdowns; and individuals who work in adversely affected sectors may be displaced. To the extent that businesses in other locations depend on the affected industries, a longer-term disruption of vessel transportation could yield adverse effects beyond the immediate spill area. However, given alternative ports of call, substitute suppliers and shipping modes, and the expected short-term nature of any disruption in vessel traffic, such adverse effects are not likely to be high.

For a small spill, no great adverse effects on vessel transportation or ports are expected (Table 4.7-36). While the risk to the vessel transportation industry increases with spill size, the effects remain localized. With chemical dispersion medium and large spills will sweep 265 to 273 million m^2 and 432 to 476 million m^2 of marine waters, respectively, regardless of dispersant recovery efficiency (Table 4.7-36). However, a spill occurring under specific location, weather, and tidal conditions could adversely affect vessel transportation and ports and the industries and communities that depend on this traffic. Any adverse effects on vessel transportation and ports would likely be short lived—that is, even if shipping waters or ports are exposed to oil and are therefore closed, as soon as recovery efforts remove surface oil, these facilities would be expected to be reopened.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on vessel transportation and ports in the Pacific region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 6.6 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Fisheries

Commercial Fisheries

Commercial fisheries are vulnerable to oil spills because of both closures and perceived taint. A moratorium on fishing operations in the wake of an oil spill can lead to great losses for the commercial fishing industry, as well as related industries, including those that supply equipment to and purchase products from commercial fleets. By contaminating key waters, an oil spill may also disrupt employment in the commercial fisheries and related sectors of the economy. In addition, oil spills can lead to a decreased demand for fish from affected waters because of actual or perceived taint, and can instigate alterations to fishing practices in a manner that increases operating costs and/or decreases revenues. Large spills can potentially injure fish nursery grounds and impose other risks that could reduce fish harvests in the longer term.

For a small spill in the Pacific region, the risk to commercial fisheries is negligible (Table 4.7-36). While the risk to commercial fishing increases with spill size, the effects remain localized. With chemical dispersion, medium and large spills will adversely affect 265 to 273 million m^2 and 432 to 476 million m^2, respectively, of marine waters used by the commercial fishing industry, regardless of dispersant recovery efficiency (Table 4.7-36).

A risk of economic loss to the marine fishery will occur when waters exceed relevant management thresholds of concern. For example, fishing may not be permitted in waters swept by oil above the modeled threshold. These changes would result in reductions in commercial fish landings for a period of time following a spill. The resulting adverse effects would be expected to reverberate through communities in the area of the spill, causing decreases in employment, income, and the viability of businesses associated with the commercial fishing industry. To the extent that substitute fishing grounds are available, spill effects on the commercial fishing economy may be less severe.

Recreational Fisheries

Similar to commercial fishing operations, recreational fisheries are at risk of closure or loss in value as a result of oil spills. These adverse effects will not generally be regional or national in nature, but could be high at the local level. For this modeling, the risks posed to recreational fishing activities are modeled in the same manner as risks to commercial fishing -- in square meters of surface water oiled above the corresponding threshold of concern. The effects of an oil spill on recreational fishery-related activities will be felt more heavily by various populations, including recreational anglers, commercial tour boat operators, and firms that supply goods and services to recreational anglers. For example, recreational anglers fish for pleasure or sport, as opposed to monetary gain. In the wake of an oil spill, such anglers may choose to fish at a substitute location, may experience a reduced quality of experience, or may choose to forgo fishing entirely. The losses suffered will be related to these missed opportunities. In addition, while closing waters to recreational fishing will decrease the social welfare of recreationists, it would also be expected to affect the demand for boat rentals and other services consumed by fishing enthusiasts.

For a small spill, adverse effects on recreational fishing resources in the Pacific region would likely be negligible (Table 4.7-36). Medium and large spills may cause decreases in local recreational fishing activities and in the revenues generated from these activities.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on fisheries (commercial and recreational) in the Pacific region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 6.6 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Subsistence

Potential adverse effects on subsistence resources in the Pacific region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.4.5 and summarized in Table 4.5-53 (the results in Table 4.5-53 are included in Table 4.7-37 for comparison). The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery alone.

Under Alternative 3, potential adverse effects on subsistence resources in the Pacific region are low for small, medium, and large spills. Chemical dispersion may increase adverse effects on subsistence resources by increasing water column exposure to dissolved aromatics; however, effects on intertidal subsistence resources may be reduced because chemical dispersion is expected to reduce the amount of oil that strands in intertidal habitats (Section 4.3.2.4). The risk ranking using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion is presented in Table 4.7-37.

Table 4.7-37
Risk Ranking of Offshore Oil Spills* to Subsistence Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A) in the Central California Shelf‡

Spill Size	Response Option (% dispersant efficiency)	Resources Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	0–1	4E
	Chemical Dispersion (45)	0–1	4E
	Chemical Dispersion (80)	1–5	4D
Large (40,000 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	1–5	4D

Source: Adapted from Part E of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Central California Shelf (as discussed in the text) as representative of the Pacific region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Effects on subsistence resources for a small spill were determined to be small by extrapolating from the results for a medium spill. With the addition of chemical dispersion at 45 percent efficiency for a medium spill, the modeling results showed water column exposure at low concentrations (1–100 ppb) in a more widespread area and at high concentrations (100–10,000 ppb) in localized areas outside San Francisco Bay. Sediment exposure occurred in small areas. The length of oiled shoreline was reduced by 45 percent at 45 percent dispersant efficiency. Because of the increase in potential exposure to oil for water column resources and the decrease in potential exposure for intertidal and shoreline resources, the risk scores did not change at 45 percent dispersant efficiency. With the addition of chemical dispersion at 80 percent efficiency for a medium spill, the modeling results showed water column exposure at low concentrations (1–100 ppb) in a more widespread area than at 45 percent dispersant efficiency and at high concentrations (100–10,000 ppb) in localized areas both inside and outside San Francisco Bay. Reductions in shoreline oiling were similar to those for 45 percent dispersant efficiency, and sediment oiling was minimal. Because water column exposure at both low and high concentrations occurred in more widespread areas, the risk score in Table 4.5-32 increased at 80 percent dispersant efficiency. The risk scores in Table 4.7-37 reflect the predicted recovery rates for subsistence resources of less than 1 year for all spill volumes (Section 4.3.5.6).

With the addition of chemical dispersion at 45 and 80 percent efficiency for a large spill, the modeling results showed water column exposure at both low concentrations (1–100 ppb) and high concentrations (100–10,000 ppb) in more widespread areas than under Alternative 1. Sediment exposure occurred in several areas in San Francisco Bay. The length of oiled shoreline was reduced by 48 percent when 80 percent dispersant efficiency was used, and the results were very similar at 45 percent dispersant efficiency. Because water column exposure at both low and high concentrations and sediment exposure in San Francisco Bay occurred in more widespread areas, the risk score increased when chemical dispersion was used for a large spill.

Although areas other than the Central California Shelf in the Pacific region were not modeled, the results are consistent with those for all other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on subsistence resources will fall within a similar range throughout the Pacific region. On an overall regional level, adverse effects on subsistence resources are not likely to be high. On a local level, a large spill may cause high adverse effects on subsistence communities.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subsistence in the Pacific region under Alternative 3 are expected to be insignificant for small spills, with or without dispersant use. For medium spills, impacts are expected to be insignificant, but increase to minor with the addition of chemicals dispersion, depending on dispersant efficiency. For large spills, impacts are expected to be insignificant, but increase to minor levels of concern with the addition of chemical dispersion.

Archaeological/Historic Resources

Potential adverse effects on archaeological and historic resources in the Pacific region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.4.5.

Under Alternative 3, adverse effects on archaeological and historic resources in the Pacific region are expected to be negligible, regardless of spill size. Some archaeological artifacts occur on land along the coast, while others are likely submerged offshore (Section 3.4.8). Chemical dispersion may help reduce the amount of oil that strands on the shoreline, which will also reduce the amount of shoreline cleanup and potential disturbance to sensitive archaeological sites and historic structures. Offshore archaeological and historic resources are not at risk of becoming oiled or coming in contact with dispersants. There are limited data that identify long-term or chronic degradation to cultural resources due to chemical dispersion.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on archaeological and historic resources in the Pacific region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Recreation and Tourism

Oil spills can adversely affect a coastal community's recreational and tourism assets. Parks, seashores, beaches, and recreational fishing areas line the Pacific coast, and both residents of and visitors to the Pacific coast appreciate the recreational opportunities offered to them by these resources. An oil spill would be expected to affect recreationists' overall social welfare; in addition, the social and economic implications of a spill would reach beyond these direct effects on visitors and into the community. For example, visitors may be less likely to visit and spend money in an area perceived as affected by a spill, potentially leading to loss of business revenue and jobs (see Coastal Communities, Demography, and Employment above and in Section 4.5.4.5 for more details).

For a small spill in the Pacific region, the risk to recreation and tourism is negligible (Table 4.7-36). There is little to no risk of oiling economically important resources, and it is unlikely that any fisheries or recreational areas would be affected.

While the risk to recreation and tourism increases with spill size, the effects remain localized. With chemical dispersion a medium spill will adversely affect 2,376 to 2,410 m of shoreline and 265 to 273 million m^2 of marine waters (Table 4.7-36). A large spill will affect 7,538 to 8,612 m of shoreline and 432 to 476 million m^2 of marine waters (Table 4.7-36). However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources either at all or at levels above the selected threshold. For medium and large spills along the Pacific coast, such conditions prevail in 44 to 52 percent and 13 to 18 percent of the time, respectively, based on modeled spills when the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion is used in the cleanup, regardless of dispersant efficiency. For these spill events, no adverse effects on shoreline are expected.

Despite chemical dispersion, a medium or large spill could be expected to have short-term adverse economic effects as a result of oiling of recreational beaches, closures of fishing grounds, and degradation of the appeal of coastal locations. While the physical effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause socioeconomic effects to be greater.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on recreation and tourism in the Pacific region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 1.4 percent of shoreline and 6.6 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Environmental Justice

As mentioned above, low-income, indigenous, and minority populations in some coastal areas may rely on regional fisheries and other marine resources for subsistence, as part of an artisanal economic system, in the context of participating in commercial fishing or other marine resource-based employment. Many individuals from these groups rely on recreation- and tourism-related jobs, and the security of their employment depends on the ability of the coast to attract visitors. To the extent that an oil spill deters visits and reduces demand for hotel, restaurants, and other tourism- and recreation-related services, the economic status of low-income and minority groups may be affected. These groups may experience the effects of a spill more severely than the general population, which relies on a more diverse economic base for its livelihood and on the availability of a widespread, commercially available selection of foods. Additionally, subsistence use of natural resources and employment in marine resource-related industries might have value beyond the importance this resource holds as an employment opportunity.

A small spill that is 3 or more statute mi offshore in the Pacific region, the risk of adverse changes in any group's economic status is low, regardless of response options used (Table 4.7-36). There is little to no risk of oiling, and it is unlikely that any economically important resources would be affected.

While the risk increases with spill size, the effects remain localized. With chemical dispersion a medium spill will adversely affect 2,376 to 2,410 m of shoreline and 265 to 273 million m^2 of marine waters (Table 4.7-36). A large spill will affect 7,538 to 8,612 m of shoreline and 432 to 476 million m^2 of marine waters (Table 4.7-36). However, when certain weather conditions and current patterns are combined with specific spill response options, spilled oil is not expected to reach shoreline resources either at all or at levels above the selected threshold. For medium and large spills along the Pacific coast, such conditions prevail in 44 to 52 percent and 13 to 18 percent of the time, respectively, based on modeled spills when the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion is used in the cleanup, regardless of dispersant efficiency. For these spill events, no adverse effects on shoreline are expected.

As a result of this oiling, beaches in the immediate vicinity of a spill may be closed to visitors, and fishing may not be permitted in waters exposed to oil. These changes would cause losses in revenue to both the tourism and commercial and recreational fishery sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill and disproportionately affect low-income and minority populations, causing decreases in employment opportunities and limited or no access to subsistence fishing areas. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on environmental justice in the Pacific region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 1.4 percent of shoreline and 6.6 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Public Safety and Worker Health

Potential adverse effects on public safety are defined as the risk to the public from direct exposure to oil or response activities as a result of the spill, or through consumption of contaminated water or organisms. There are many areas in the Pacific region with high population concentrations along the coast. However, adverse effects on public safety are unlikely from oil spills that occur 3 or more statute mi offshore for any of the spill sizes considered, regardless of the response options—mechanical recovery, *in situ* burning, and/or chemical dispersion—used. The USCG has protocols to protect the public from risk during shoreline response operations, as well as on-water protocols to prevent the public from entering the response area.

Potential adverse effects on worker health are related to direct oil exposure during response operations. In addition, operating oil spill response equipment can be dangerous, which is well recognized and is the basis for the worker certification and training requirements that are now in place. There is also a health risk from inhalation of hydrocarbon fumes for first responders, which is recognized in current safety protocols. The risk is greater as the spill size and the corresponding intensity and duration of operations increase, but is minimized if safety standards are followed. There are also protocols in place for the proper application and handling of dispersants.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on public health and worker safety in the Pacific region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

4.7.5. Consequences in the Oceania Region

Oceania is a collective name used for the islands scattered throughout most of the Pacific Ocean. In its broadest sense, the term embraces the entire insular region between Asia and the Americas. For the purposes of this PEIS, the Oceania region will specifically cover the tropical waters surrounding the islands of Hawaii, Guam, Commonwealth of Northern Mariana Islands (CNMI), and American Samoa (Figure 3.1-1). Midway, Jarvis, and Wake Islands are also included in some of the analyses. There was no location in this region for modeling and risk assessment purposes, but risks can be inferred from the range of effects observed in the five modeled locations. However, in some cases the modeling results for the Florida Straits (in the Atlantic region) were used because it has similar resources of concern. The results of the Florida Straits modeling—used to evaluate spills of concern in this risk analysis (i.e., 3 or more statute mi offshore)—are detailed in Part D of the technical report (French McCay et al., 2004).

Table 4.7-38 presents the risk ranking for the modeling of Alternative 3 in the Oceania region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion at 45 and 80 percent recovery efficiency[54] for the three spill sizes (small, 200 bbl; medium, 2,500 bbl; and large, 40,000 bbl). (Based on the discussion of Alternative 3 presented in Section 2.8.3, a 25 percent increase in mechanical recovery capability would not change the effectiveness of the basic response scenario under Alternative 1.) The risk scores presented in Table 4.7-38 are based on the modeling results for an average spill and on regional considerations; however, in any specific oil spill situation local concerns could be higher. Table 4.7-39 summarizes the significance of the potential beneficial and adverse environmental impacts associated with Alternative 3 in the Oceania region, based on the extrapolation of the modeling results for the average spill to the region in general.

Without the addition of chemical dispersion, the results are unchanged from the basic response scenario (see the discussion in Section 4.7.3). In summary, there is a minor or insignificant adverse regional impact to all resources except for moderate impacts on marine and coastal birds for medium and large spills; moderate and significant impacts on intertidal habitats for medium and large spills, respectively; and moderate impacts on sea turtles and subsistence for large spills. A large spill could also cause significant, but localized, adverse, short-term socioeconomic impacts. All adverse impacts occur despite the treatment or recovery of some oil, but are reduced by those actions when they are effective. Further, as explained in the introduction to Section 4.7, the modeling shows that *in situ* burning would not significantly change the level of concern identified from those obtained when using mechanical-only recovery.

Table 4.7-38
Risk Ranking[*] of Offshore Oil Spills[†] under Alternative 3 Using the Basic Response Scenario[‡] with the Addition of Chemical Dispersion (Option A) in the Oceania Region

Spill Size	Response Option (% dispersant efficiency)	Resources of Concern														
		Physical Environment			Biological Environment								Socioeconomic Environment			
		Coastal Water Quality	Marine Water Quality	Air Quality	Marine Mammals[§]	Marine and Coastal Birds[§]	Plankton and Fish[§]	Intertidal Habitats	Subtidal Habitats	Sea Turtles[§]	Areas of Special Concern	Essential Fish Habitat	Subsistence[‖]	Archaeological/Historic Resources[‖]	Shoreline Oiling Index[#]	Surface water Oiling Index[#]
Small (200 bbl)	Basic	4E	4E	4E	3E	3D	4E	1E	4E	3E	1E	4E	4E	4E	N/A[**]	N/A[**]
	Chemical Dispersion (45)	4E	4E	4E	3E	4E	4E	4E	4E	3E	4E	4E	4E	4E	N/A[**]	N/A[**]
	Chemical Dispersion (80)	4E	4E	4E	3E	4E	4E	4E	4E	3E	4E	4E	4E	4E	N/A[**]	N/A[**]
Medium (2,500 bbl)	Basic	4D	4E	4E	3E	3B	4D	1C	4E	3D	1C	4D	4D	4E	N/A[††]	1.00
	Chemical Dispersion (45)	4D	4E	4E	3E	3C	4D	2D	4E	3E	2D	4D	4D	4E	N/A[††]	0.31
	Chemical Dispersion (80)	4D	4E	4E	3E	3C	4D	2D	4E	3E	2D	4D	4C	4E	N/A[††]	0.31
Large (40,000 bbl)	Basic	4C	4E	4E	3E	3A	4D	1A	3E	3C	1A	4D	4A	4E	N/A[††]	1.00
	Chemical Dispersion (45)	4C	4E	4E	3E	3B	4D	1C	3E	3D	1C	4D	4A	4E	N/A[††]	0.50
	Chemical Dispersion (80)	4C	4E	4E	3E	3B	4D	1C	3E	3D	1C	4D	4A	4E	N/A[††]	0.43

Source: Adapted from Parts B through F of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern; yellow, a medium level of concern; and green, a low level of concern.

[*] This risk ranking is a summary of risk scores for the resources considered in this PEIS. The risk scoring process is explained in Section 4.4.3.

[†] Average spills.

[‡] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[§] Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles. If such species are affected by an actual spill, the level of concern would be high.

[‖] Subsistence and archaeological/historic resources are the only socioeconomic resources that could be ranked using the risk matrix.

[#] The Socioeconomic Index is calculated using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with value equal to 1.0. Risk factors reflect the ratio of the percentage of the model area or volume oiled using the basic response scenario to the percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected with response limited to the basic response scenario.

[**] Index cannot be calculated for small spills since they were not modeled.

[††] Length of shoreline oiled above the threshold of concern is not considered relevant: (1) the shoreline oiling results were sensitive in the modeled spill location; (2) the ability to identify shoreline with characteristics amenable to use was limited; and (3) area of surface water oiled above the threshold of concern was expected to provide a more accurate measure of expected risk, given the region's geographic characteristics.

Table 4.7-39

Summary of Potential Adverse Regional Impacts of Offshore Oil Spills* under Alternative 3 Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A, 45 or 80% Efficiency) in the Oceania Region

		Resources of Concern																			
		Physical Environment			Biological Environment								Socioeconomic Environment								
Spill Size	**Response Option (% dispersant efficiency)**	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals‡**	**Marine and Coastal Birds‡**	**Plankton and Fish‡**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles‡**	**Areas of Special Concern**	**Essential Fish Habitat**	**Coastal Communities, Demography, and Employment**	**Economic Status**	**Vessel Transportation and Ports**	**Fisheries**	**Subsistence**	**Archaeological/Historic Resources**	**Recreation and Tourism**	**Environmental Justice**	**Public Safety and Worker Health**
Small (200 bbl)	Basic	Ins	Ins	Ins	Min	Mod	Ins	Mod	Ins	Min	Mod	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
	Chemical Dispersion (45 or 80)	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins	Ins
Medium (2,500 bbl)	Basic	Min	Ins	Ins	Min	Mod	Min	Sig	Ins	Mod	Sig	Min	Ins	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins
	Chemical Dispersion (45 or 80)	Min	Ins	Ins	Min	Mod	Min	Mod	Ins	Min	Mod	Min	Ins	Ins	Ins	Ins	Min	Ins	Ins	Ins	Ins
Large (40,000 bbl)	Basic	Min	Ins	Ins	Min	Mod	Min	Sig	Min	Mod	Sig	Min	Ins	Ins	Ins	Ins	Mod	Ins	Ins	Mod	Ins
	Chemical Dispersion (45 or 80)	Min	Ins	Ins	Min	Mod	Min	Sig	Min	Mod	Sig	Min	Ins	Ins	Ins	Ins	Mod	Ins	Ins	Ins	Ins

Note: Based on Table 4.7-38. Sig, significant; Mod, moderate; Min, minor; and Ins, insignificant.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles.

Under the available response options of Alternative 3, the addition of chemical dispersion helps mitigate, but does not eliminate, potential adverse impacts on marine and coastal birds, marine mammals, and coastal habitat and shoreline, especially for larger spills, without significantly increasing the risk to water column or subtidal resources. Chemical dispersion also greatly reduces the likelihood of adverse effects to socioeconomic resources.

4.7.5.1. Consequences to the Physical Environment

Water Quality

Potential adverse consequences of oil spills to water quality are related to hydrocarbon contamination, as other constituents in oils are at concentrations that would not exceed thresholds of concern. The hydrocarbons that could affect water quality are the soluble aromatics, MAHs (monoaromatic hydrocarbons) and PAHs (polynuclear aromatic hydrocarbons) (Sections 4.3.1.1 and 4.5.7.1), even with chemical dispersion. Thus, evaluation of potential adverse effects is based on degree of potential contamination by these compounds. Under Alternative 3, chemical dispersion could increase soluble aromatic hydrocarbon concentrations in areas where dispersants are applied. No beneficial effects on water quality would be expected to result from an oil spill.

For oil spills in marine waters, adverse effects on water quality are low for small, medium, and large oil spills, regardless of the response options used (mechanical with or without *in situ* burning and chemical dispersion). This is because of the tendency for most chemical compounds of concern to evaporate, rather than dissolve, and the rapid dilution of any chemical compounds that might enter the water column, even after periods of extreme turbulence that induce relatively high dissolution rates. Dispersants would be applied to surface oil after much of the evaporation of the toxic components occurs because of logistics (i.e., greater than 12 hours after the spill), such that the resulting increase of concentrations of toxic components in the water column would be relatively small.

Overall based on the modeling and risk assessment results, it is concluded that—using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion—adverse water-quality effects under Alternative 3 would be small in marine waters, even in the event of a large spill in the Oceania region. If an offshore spill moved into shallow and confined coastal waters, adverse effects could be locally important for medium and large spills under conditions where oil is mixed into water by strong turbulence or in areas where oil collects for a few weeks to months after a spill. Chemical dispersion would not be used in shallow and confined coastal waters (less than 3 nm[55] from shore) under Alternative 3, so it could not contribute to adverse water-quality effects in those areas if the dispersed oil plume drifted into the area before being diluted.

The variable used to determine the potential effects on water quality is "volume of water contaminated" by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer. That benchmark is less than all established water-quality criteria and thresholds of concern for effects on aquatic biota (Sections 4.3.1.1 and 4.3.2.1). The affected water volume increases with spill volume and the level of physical or chemical dispersion during the time of the spill. Natural dispersion increases with stronger winds and currents, lessening the volume of water that is contaminated above the threshold of concern if in unconfined waters. Since the volume of water contaminated increases exponentially as a function of spill size, the estimated volume contaminated for a small spill was extrapolated from the mean medium- and large-spill model results. Potential adverse water-quality effects in the Oceania region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.7.1 and summarized in Tables 4.5-69 and 4.5-70 for coastal and marine waters, respectively (the results for coastal and marine water quality are included in Tables 4.7-40 and 4.7-41 for comparison).

Coastal

In estuaries and coastal waters within 3 statute mi of shore, mechanical-only recovery would be used under Alternative 3. In marine waters 3 or more statute mi from shore, the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion could be used under Alternative 3 in the Oceania region. If dispersants were applied offshore, the dispersed oil plume could move into these nearshore areas. Since chemical dispersion would not be used in these areas, the level and duration of exposure would be negligible because of dilution.

Florida Bay is used as a representative of coastal water for analyzing the Florida Straits, as well the Oceania region. The risk scores are based on this modeling location, but are modified to reflect differences in water depth. Deep water occurs much closer to shore in the Oceania region, and there is much more rapid dilution. Florida Bay is approximately 16,288 km^2 in area and about 2 m deep on average, with a total volume of approximately 32,576 million m^3. The estimated total volume and area contaminated by more than 1 ppb of dissolved aromatic concentration for 1 hour or longer and by other chemicals of concern (regardless of location) was compared with the total volume of Florida Bay to determine the potential consequences of small, medium, and large spills (Table 4.7-40). This approach was used both with and without dispersant use, and yields a very conservative estimate in that it assumes all of the contamination would occur in coastal water. Since dispersants could not be employed in such areas, this would imply that the dispersed oil plume moved directly into coastal waters without dilution, which will not occur.

Table 4.7-40
Risk Ranking of Offshore Oil Spills* to Coastal Water Quality Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A) in the Oceania Region (Based on the Florida Straits)‡

Spill Size	Response Option (% dispersant efficiency)	Volume of Water Contaminated (million m³)	Area Contaminated (estimated %)	Risk Score§
Small (200 bbl)	Basic	$< 40 \times 10^{-6}$	8×10^{-7}	4E
	Chemical Dispersion (45 or 80)	$< 40 \times 10^{-6}$	8×10^{-7}	4E
Medium (2,500 bbl)	Basic	83	1.7	4D
	Chemical Dispersion (45)	166	3.5	4D
	Chemical Dispersion (80)	167	3.5	4D
Large (40,000 bbl)	Basic	326	6.8	4C
	Chemical Dispersion (45)	1,153	24.0	4C
	Chemical Dispersion (80)	1,095	22.8	4C

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Oceania region for modeling, but the calculations are modified to reflect differences in water depth.

§ The risk scoring process is explained in Section 4.4.3.

Because of natural dilution, evaporation, and biological processes, contamination levels would decrease rapidly even in the case of a large spill, and recovery time would be on the order of days to weeks. Oil may be incorporated into shallow water or intertidal sediments where, through leaching, it could become a continuing source of contamination over time. However, this would generally only lead to noticeable water-quality degradation in the locality where the oil collects. This is unlikely to occur with a spill that originates offshore. Because mechanical removal would begin within the required response time under Tier I standards (beginning about 12 hours after the spill), much of the soluble components of concern to water quality would have evaporated or dissolved. Thus, mechanical recovery and *in situ* burning would have a small influence on the volume of water adversely affected, and the risk score results would apply whether either response is implemented.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal water quality in the Oceania region under Alternative 3 are expected to be insignificant for small spills, and minor for medium and large spills, without or without dispersant use.

Marine

The Florida Straits was selected for the modeling as representative of the marine waters around the islands in the Oceania region. The total surface area of the Florida Straits is approximately 42,689 km^2, so the area of interest is much vaster for marine waters than for coastal waters. Water-quality effects were calculated using a spill site in relatively shallow water—20 m deep, which is much shallower than most of the Oceania region’s marine waters. The results for the selected modeled location (Table 4.7-41) represent conservative estimates of adverse water-quality effects using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion.

Table 4.7-41
Risk Ranking of Offshore Oil Spills[*] to Marine Water Quality
Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A)
in the Oceania Region (Based on the Florida Straits)[‡]

Spill Size	Response Option (% dispersant efficiency)	Area Contaminated (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	5×10^{-9}	4E
	Chemical Dispersion (45 or 80)	4×10^{-9}	4E
Medium (2,500 bbl)	Basic	0.1	4E
	Chemical Dispersion (45)	0.02	4E
	Chemical Dispersion (80)	0.02	4E
Large (40,000 bbl)	Basic	0.4	4E
	Chemical Dispersion (45)	0.14	4E
	Chemical Dispersion (80)	0.13	4E

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Oceania region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Because of natural dilution, evaporation, and biological processes, oil contamination levels would decrease rapidly even after a large spill, with or without chemical dispersion, and recovery time would be on the order of days to weeks. The estimates of the volume of water contaminated—and its variability—are generally applicable to spills of the same size throughout the Oceania region because natural and chemical dispersion of oil into the water column and dilution processes are similar in all areas.

The results in Table 4.7-14 are nearly the same (with some uncertainty reflected in the variability of the results) for 45 and 80 percent efficiency because the amount of dispersant at 45 percent efficiency is sufficient to treat all dispersible surface oil, for spills up to 40,000 bbl. For a small spill, the volume of water contaminated would be the same as under Alternative 1 because, due to logistics, dispersants could only be applied after a small spill has mostly dispersed naturally. Chemical dispersion for medium or large spills increases the volume of water contaminated—and the percentage of the area of concern—that would be adversely affected by about a factor of three, which is still a small volume relative to that of the entire modeled area. *In situ* burning (in combination with mechanical recovery and chemical dispersion) would not significantly change the volume contaminated or the effect on water quality since it would substitute for some of the mechanical response.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine water quality in the Oceania region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Air Quality

Concentrations of hydrocarbons of concern in the air resulting from oil spills and response operations were compared with air quality standards to evaluate the potential for adverse effects (see Section 4.3.1.2). The effects of an oil spill on air quality may involve all volatile components of the oil. In addition, if *in situ* burning was used, particulates and other contaminants emitted from burns could become an air quality concern. However, adverse air quality effects from oil spills are normally very localized and short lived for small, medium, and large oil spills. The addition of *in situ* burning does not significantly increase any potential adverse effects: the volume of oil that could be burned is not large, and the temporary smoke plume would be localized and rapidly diluted. Chemical dispersion reduces the volatilization of unburned oil to the atmosphere to only a slight extent, so that effects are essentially identical with or without dispersant use.

Potential adverse effects on air quality in the Oceania region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.7.1 and are summarized in Table 4.5-71. Two possible sources of contamination to the atmosphere were evaluated for their potential effects on air quality: volatilization of hydrocarbons from unburned oil and emissions produced by *in situ* burning. Concentrations in the lowest 2 m of the atmosphere were compared with the U.S. Environmental Protection Agency's National Ambient Air Quality Standards (USEPA's NAAQS) and other thresholds of concern (as discussed in Section 4.3.1.2).

As discussed in Section 4.5.3.1, the results of the modeling show that the potential adverse effects on air quality are low for all spill sizes involving mechanical-only recovery; hence, the risk scores are virtually identical for medium and large spills. Volatilized hydrocarbons would not exceed air quality standards for human health at more than 1 km from the spill site. Evaporation off the water surface and volatilization from the water column create a plume of volatile hydrocarbon gases that disperses quickly after a spill, such that the concentrations in the atmosphere at the water surface would not exceed human health thresholds of concern at any location. The recovery time for the atmosphere would be on the order of hours to days. Thus, a low level of concern is expected for small, medium, and large spills involving mechanical-only recovery.

Under Alternative 3, the addition of chemical dispersion does not change the results from those under Alternative 1. Chemical dispersion would disperse some of the volatile hydrocarbons into the water, resulting in the volatile hydrocarbons entering the atmosphere over a larger area than would occur without chemical dispersion. Thus, dispersants further dilute hydrocarbon concentrations in the atmosphere. The modeling shows that results are low for a spill of any size involving some combination of mechanical response and chemical dispersion at any spill site in the Oceania region. Adverse effects of *in situ* burning on air quality are summarized in Table 4.5-71; these results apply whether chemical dispersion is used on unburned oil, and they do not vary by the location of the burn. Thus, the results for Alternative 1 apply to Alternative 3 for all areas in the Oceania region. The modeling was performed for weather conditions where dilution in the air would be relatively slow, so the estimated adverse effects are overestimated for other conditions.

Mechanical recovery plus *in situ* burning, with or without chemical dispersion, would increase atmospheric pollutants by the amount emitted via *in situ* burning. For small spills, it would be very unlikely that *in situ* burning would be used, as the oil would disperse too rapidly for it to be feasible (Table 4.5-71). The maximum area potentially exceeding the NAAQS or thresholds of concern is 1.6 km^2 for a medium spill and 12.7 km^2 for a large spill (Table 4.5-71). If humans or sensitive resources (i.e., wildlife) are within these areas, they could be affected by poor air quality for a short time, on the order of hours. Since *in situ* burning can only be used offshore in marine waters, a region of interest equivalent to the Florida Bay-Florida Keys area (42,689 km^2) would have less than 1 percent of its area affected, and the atmosphere would recover in a matter of hours. The addition of chemical dispersion does not change the results under Alternative 1 in Table 4.5-71.

Based on the modeling results (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on air quality in the Oceania region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without *in situ* burning.

4.7.5.2. Consequences to the Biological Environment

Marine Mammals

Potential adverse effects on marine mammals in the Oceania region using the basic response option (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.7.2 and summarized in Table 4.5-72 (the results in Table 4.5-72 are included in Table 4.7-42 for comparison). Potential effects on marine mammals are less important in the Oceania region than in some other regions because the only species of concern are cetaceans, which are not particularly sensitive to oil. There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on marine mammals in that larger spills tend to spread across a larger surface water area and have higher shoreline oil loading. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery.

Under Alternative 3 for a small spill, the contaminated surface water area is small compared with the overall surface water area present in the Oceania region, so the likelihood of cetaceans becoming oiled at the surface is minimal. The equivalent area for 100 percent mortality using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) for cetaceans at all five modeled locations (the only marine mammals of concern) ranged from 0.08 to 0.11 km^2 (average area of 0.09 km^2) for a medium spill and from 0.46 to 1.33 km^2 (average area of 0.85 km^2) for a large spill. Relative to the surface area available, this is a very small area, much less than 1 percent. Chemical dispersion reduces the already low exposure even more. Recovery would be relatively rapid, but could exceed 1 year, given that only sublethal effects, if any, would be expected. The results of the modeling for marine mammals are presented in Table 4.7-42.

Table 4.7-42

Risk Ranking of Offshore Oil Spills[*] to Marine Mammals Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Oceania Region[‡]

Spill Size	Response Option (% dispersant efficiency)	Populations Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E
Medium (2,500 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E
Large (40,000 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E

Source: Adapted from Parts B through F of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the five modeled locations (as discussed in the text) as representative of the Oceania region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Based on the modeling results (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine mammals in the Oceania region under Alternative 3 are expected to be minor for small, medium, and large spills, with or without dispersant use. On an overall regional level, adverse impacts for medium and large spills are reduced when chemical dispersion is used.

Marine and Coastal Birds

Potential adverse effects on marine and coastal birds in the Oceania region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.7.2 and summarized in Table 4.5-73 (the results in Table 4.5-73 are included in Table 4.7-43 for comparison). There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on birds; larger spills tend to have higher oil loading on the shoreline and affect larger areas. The addition of *in situ* burning does not change the amount of oil removed, so it does not reduce the severity of potential adverse effects or increase the risk to marine and coastal birds.

Under Alternative 3 for a small spill, very little oil is likely to strand onshore, and the oil loading would be light in most cases. During oil spills in the Oceania region, the potential adverse effects on intertidal nesting, roosting, and foraging habitats for birds are of particular concern because a significant amount of shoreline habitat on an island or group of small islands can be oiled by a spill. As a consequence, there may not be alternative sites for use until the habitat recovers, particularly mangroves and sand beaches, which would lead to a high degree of adverse effects on birds. Chemical dispersion is expected to reduce adverse effects to these habitats primarily by reducing the amount of oil that strands onshore (Section 4.3.2.4). Surface water oiling may also adversely affect feeding and rafting seabirds (Section 3.1.2.2), and chemical dispersion is expected to reduce the extent of surface slicks that birds encounter. The risk scores in Table 4.7-43 reflect the predicted recovery rates of 1 to 3 years for most bird species, as was the case following the *EXXON VALDEZ* oil spill (Section 4.3.2.2).

For a small spill, shoreline oiling was expected to be light and to not persist. For a medium spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by 67 percent compared with Alternative 1 and would likely represent 1 to 5 percent of an island's habitat. Considering all modeled areas at 80 percent dispersant efficiency, the oiled surface water area was reduced by an average of 50 percent compared with Alternative 1. In addition, for the Florida Straits modeling scenario, chemical dispersion nearly doubled the number of times that no oil stranded onshore, from 10 (Alternative 1) to 19 (Alternative 3) out of the 100 model runs (technical report [French McCay et al., 2004]). The results for 45 percent dispersant efficiency were similar to those for 80 percent efficiency in most modeled areas; in all cases, some important staging, nesting, and foraging sites were still oiled, but the reduction in shoreline length and surface water area oiled would likely reduce adverse effects on birds.

Table 4.7-43
Risk Ranking of Offshore Oil Spills* to Marine and Coastal Birds Using the Basic Response Scenario† with the Addition of Chemical Dispersion (Option A) in the Oceania Region‡

Spill Size	Response Option (% dispersant efficiency)	Populations Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	1–5	3D
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	10–20	3B
	Chemical Dispersion (45 or 80)	5–10	3C
Large (40,000 bbl)	Basic	> 20	3A
	Chemical Dispersion (45 or 80)	10–20	3B

Source: Adapted from Parts B through F of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the five modeled locations (as discussed in the text) as representative of the Oceania region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

For a large spill using 80 percent dispersant efficiency, the extent of shoreline oiling was reduced by 44 percent compared with Alternative 1. Considering all modeled areas at 80 percent dispersant efficiency, the area of surface water oiling was reduced by an average of 60 percent compared with Alternative 1. In addition for the Florida Straits modeling scenario, chemical dispersion increased the number of times that no oil stranded onshore, from 12 (Alternative 1) to 18 (Alternative 3) out of 100 model runs (technical report [French McCay et al., 2004]). The results for 45 percent dispersant efficiency were similar to those for 80 percent efficiency (Table 4.7-43). Considering that shoreline and surface water oiling was reduced in all modeled areas, the risk scores for birds decreased for both dispersant efficiencies in the Oceania region. In some regions (e.g., Atlantic and Gulf of Mexico), risk scores did not decrease with chemical dispersion for large spills because of heavy oil loadings in sensitive staging and nesting areas. Adverse effects on birds may be more or less severe depending on the time of year and locations of their habitats, as well as the extent of shoreline and surface water oiling.

The Florida Straits modeling was evaluated as representative of the bird fauna of the Oceania region because of similar intertidal habitats and physical settings, and the species present have similar habitat use and behavior. The estimated results for the Oceania region are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of effects on bird populations will typically be reduced with chemical dispersion. The reduction of adverse effects on birds with chemical dispersion is contingent on whether the reduction of adverse shoreline effects coincides with heavily used habitats.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on marine and coastal birds in the Oceania region under Alternative 3 are expected to be moderate for medium and large spills, with or without dispersant use. For small spills, impacts are expected to be moderate, but are reduced to insignificant with the addition of chemical dispersion. On an overall regional level for medium and large spills, even though chemical dispersion reduces the risk score, the expected impacts remain moderate because of the extent of oiling.

Plankton and Fish

Plankton and fish, a diverse group of species, are important to the marine food web, ecosystem function, and fisheries. Adverse effects on these groups are of high concern, particularly when chemical dispersion is considered as a potential response option. As described in Section 4.3.2.3 and 4.5.3.2, plankton and fish are adversely affected either directly or via the food web by the toxic effects of oil components that enter the water column—the soluble compounds (MAHs and PAHs) and microscopic oil droplets mixed by waves into the water (French McCay, 2002; NRC, 1985). The most important pathway of exposure is direct uptake of dissolved oil components, originating directly from surface oil or dissolving from the microscopic oil droplets in the water. Overall, adverse effects increase the larger the spill size. However, there is great variability related to the environmental conditions after the spill; plankton and fish suffer much more adverse effects in storm conditions where high waves mix unweathered oil into the water, which happened during the *NORTH CAPE* oil spill (French McCay, 2003), than in calm weather. In addition, many species utilize shallow waters and even the intertidal zone, where they are more likely to be exposed to oil and dissolved components when oil comes ashore. Species and life stages vary considerably in sensitivity to toxic components, with species from relatively unpolluted and environmentally stable locations more sensitive than those from polluted and environmentally variable areas.

In marine and open coastal environments, small, medium, and large oil spills do not cause large or long-term toxic effects to plankton and fish in the water column. The toxic effects of oil spills result from acute exposures during the time when surface oil is present and for short periods (days to weeks) afterwards. Once the source of hydrocarbons (from floating oil or the shoreline) to the water column is gone, concentrations rapidly dilute to background levels.

There may be longer-term effects if an offshore spill migrates to nearshore shallow areas such as enclosed embayments, estuaries, or wetlands where dilution and flushing are slow. Many fish and other organisms spawn and develop through larval and juvenile stages in these shallow areas. Juvenile fish are more abundant in wetlands, coral reefs, and seagrass beds than in other shallow subtidal and intertidal areas, so these areas are of most concern (see discussion of potential effects on these habitats below). Under Alternative 3, chemical dispersion could not be used within 3 nm[56] of shore; therefore, it would not contribute to adverse effects on plankton and fish in these areas.

The percentage of plankton and fish adversely affected by spills was estimated using the modeling results (technical report [French McCay et al., 2004]) of water volumes exposed to toxic oil components. Percentage loss multiplied by volume exposed was integrated over time and space to calculate an equivalent volume of 100 percent loss. These volumes were translated to equivalent areas by multiplying them by water depth at the spill site, allowing comparison with other resources such as birds and shorelines, which are distributed on a per-area basis. The use of area is appropriate because plankton and fish abundance is much more uniformly distributed when expressed on a per-area basis than on a per-volume basis since the ecosystem is driven by sunlight and plant photosynthesis at the water surface (French et al., 1996; Odum, 1971). As indicated by similar results for the four modeled spill sites in 10 to 30 m of water—offshore Delaware Bay, offshore Galveston Bay, the Florida Straits, and offshore San Francisco Bay (Parts B, C, D, and E, respectively of the technical report [French McCay et al., 2004])—the equivalent areas of adverse effect on plankton and fish (both the average and variable) are applicable to spills of the same size in any location of similar water depth in any region considered in the PEIS. The modeled spill site was 20 m deep water: adverse effects would be smaller for deeper waters because of greater vertical dilution of both oil components and organisms, and proportionately greater in shallower waters because of the restricted dilution potential and generally higher organism abundance.

The model-estimated areas are those where there is a potential to affect the most sensitive species, which are two standard deviations more sensitive than the average of all species tested (2.5th percentile in rank order of sensitivity). For species of average sensitivity (50th percentile), the areas adversely affected would be much smaller. Thus, the model-estimated areas should not be interpreted as experiencing 100 percent mortality of all plankton and fish; they are conservative estimates used for comparative purposes among response scenarios.

Potential adverse effects on plankton and fish in the Oceania region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.7.2 and summarized in Table 4.5-74 (the results in Table 4.5-74 are included in Table 4.7-44 for comparison). The Florida Straits was selected for the modeling as representative of the Oceania region, because the geography (characterized by islands), bottom topography (steeply sloping off away from shore), environmental regime (warm trade winds, occasional severe storms), and ecosystems (subtropical-tropical, areas of coral reefs, seagrasses, etc.) are similar in the two regions.

Under Alternative 3 the results for 45 percent dispersant efficiency were not significantly different than those for 80 percent dispersant efficiency because more than sufficient dispersant would be available under both conditions to disperse available surface oil for spills up to 40,000 bbl (with some variability, as reflected in the results in Table 4.7-44). For a small spill, based on the evaluation of the volume where water quality would be affected (Tables 4.5-69 and 4.5-70), the volume of adverse effect on plankton and fish would be negligible for all response options under Alternative 3. For medium and large spills, the volumes and areas of adverse effect are up to three times larger than those without chemical dispersion.

Table 4.7-44
Risk Ranking of Offshore Oil Spills[*] to Plankton and Fish
Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A)
in the Oceania Region (Based on the Florida Straits)[‡]

Spill Size	Response Option (% dispersant efficiency)	Equivalent Area Affected (km^2)	Area Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0.082	5×10^{-11}	4E
	Chemical Dispersion (45 or 80)	0.082	5×10^{-11}	4E
Medium (2,500 bbl)	Basic	32	0.07	4D
	Chemical Dispersion (45 or 80)	41	0.10	4D
Large (40,000 bbl)	Basic	72	0.2	4D
	Chemical Dispersion (45)	233	0.55	4D
	Chemical Dispersion (80)	222	0.52	4D

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Oceania region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Since the adverse effects are in a small percentage of the area of concern and less than the range of natural variability, the recovery time would be less than 1 year. Overall, based on the modeling, adverse effects on plankton and fish in the Oceania region under Alternative 3 would be localized to the immediate area around the spill site and similar in all marine-water areas of the region.

Even without chemical dispersion, concentrations of toxic components could become high enough to cause some level of concern for plankton and fish for medium or large spills if the slick moved into shallow coastal areas and embayments under conditions where storm-generated waves mix large amounts of fresh oil into the water column. Under Alternative 3, chemical dispersion could not be used within 3 nm[57] of shore or in enclosed coastal lagoons; therefore, it would not contribute to such risk, and might even reduce concerns by dispersing portions of the slick before it can enter shallow waters.

Based on the discussion in Part D of the technical report (French McCay et al., 2004), if the adversely affected area is marine-water habitat or for water column organisms with broad distribution over all subtidal habitats, a risk score of 4E applies. A risk score of 3C applies to coral reefs, 4E applies to seagrass, and 3D applies to hard-bottom habitat organisms. The risk scores do not change with chemical dispersion. Given that many species and life stages of plankton and fish on and over coral reefs are more broadly distributed rather than restricted to the coral reefs (for example, they inhabit hard-bottom habitats as well), and that these organisms reproduce on time scales less than 1 year, the overall risk score of 4D is assigned for plankton and fish for the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) with or without dispersant use.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on plankton and fish in the Oceania region under Alternative 3 are expected to be insignificant for small spills, and minor for medium and large spills, with or without dispersant use.

Intertidal Habitats

Potential adverse effects on intertidal habitats in the Oceania region using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.7.2 and summarized in Table 4.5-75 (the results in Table 4.5-75 are included in Table 4.7-45 for comparison). Potential adverse effects on intertidal habitats during oil spills in the Oceania region are of particular concern because of the relative scarcity of intertidal resources, a high degree of historical loss and degradation, and their ecological importance (Section 3.7.2.4). There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on intertidal habitats in that larger spills tend to have higher oil loading on the shoreline, which can kill mangroves, and affect larger areas. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery.

Under Alternative 3 for a small spill, very little oil is likely to strand onshore, and the oil loading would be light in most cases. However, the potential for adverse effects on intertidal habitats increases as spill volume increases, with greatest concern where mangroves and sand beaches become heavily oiled. Chemical dispersion is expected to reduce adverse effects on these habitats by reducing the amount of oil that strands onshore (Section 4.3.3.4). The risk scores in Tables 4.5-75 and 4.7-45 were based on estimated adverse effects on the intertidal habitats of the Florida Straits. The Florida Straits was selected for the modeling as representative of the intertidal habitats in the Oceania region because they have similar types of intertidal habitats (mangroves, coral/rocky platforms and rubble, sand beaches) and physical settings. Adjustments were made to the risk scores because in the Oceania region the risks to intertidal habitats are greater than in many other regions; a significant amount of shoreline habitat on an island or group of small islands can be affected by a spill. Thus, there may not be alternative sites for use until the habitat recovers, which would lead to a higher degree of adverse effects.

Table 4.7-45
Risk Ranking of Offshore Oil Spills[*] to Intertidal Habitats
Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A)
in the Oceania Region (Based on the Florida Straits)[‡]

Spill Size	Response Option (% dispersant efficiency)	Habitats Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	1E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	5–10	1C
	Chemical Dispersion (45 or 80)	1–5	2D
Large (40,000 bbl)	Basic	> 20	1A
	Chemical Dispersion (45 or 80)	5–10	1C

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Red represents a high level of concern; yellow, a medium level of concern; and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Oceania region for modeling, but the calculations are modified because a significant amount of shoreline habitat on an island or group of small islands can be affected by a spill and there may not be alternative sites for use until the habitat recovers, which would lead to a higher degree of adverse effects.

[§] The risk scoring process is explained in Section 4.4.3.

Adverse effects on intertidal habitats for a small spill were determined to be small by extrapolating from the results of a medium spill and expecting lightly oiled habitats to recover quickly. For a medium spill with the addition of chemical dispersions, the effects on intertidal habitats would vary widely depending on the spill location and the wind and current patterns: spills on the leeward side of an island are not likely to strand onshore, while spills on the windward side could result in oiling of intertidal habitats. At 80 percent dispersant efficiency, the modeling in offshore areas resulted in a reduction in the length of shoreline oiling by 67 percent under Alternative 1, to 4.5 km under Alternative 3. In addition for the Florida Straits modeling scenario, chemical dispersion nearly doubled the number of times that no oil stranded onshore, from 10 (Alternative 1) to 19 (Alternative 3) out of the 100 model runs (technical report [French McCay et al., 2004]). The extent of oiling of intertidal habitats would likely represent 1 to 5 percent of these habitats for an island. Chemical dispersion also resulted in lighter oil loading; thus, recovery was estimated to take 1 to 3 years. The results for 45 percent dispersant efficiency were similar to those for 80 percent dispersant efficiency (Table 4.7-45), except that oil loading on mangroves would be higher with a longer recovery time.

For a large spill using 80 percent efficiency, the length of oiled shoreline was reduced by 44 percent, but the oil loadings on mangrove habitat were high enough to expect recovery at greater than 7 years. (The risk score in Table 4.7-45 was reduced to reflect the reduction in shoreline oiling but not the recovery rate of oiled mangroves.) For the Florida Straits modeling, the number of times that no oil stranded onshore increased from 12 (Alternative 1) to 18 (Alternative 3) out of the 100 model runs (technical report [French McCay et al., 2004]). The results for 45 percent efficiency—with the length of shoreline reduced by an average of 39 percent—were similar to those for 80 percent dispersant efficiency (Table 4.7-45).

Although no specific sites in the Oceania region were modeled, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on intertidal habitats will fall within a similar range throughout the Oceania region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on intertidal habitats in the Oceania region under Alternative 3 are expected to be significant for large spills, with or without dispersant use. For large spills, even though chemical dispersion reduces the risk score, the expected impacts remain significant because of the extent of oiling. For small and medium spills, impacts are expected to be moderate and significant, respectively, but are reduced to insignificant and moderate, respectively, with the addition of chemical dispersion.

Subtidal Habitats

Potential adverse effects on subtidal habitats in the Oceania region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.7.2 and summarized in Table 4.5-76 (the results in Table 4.5-76 are included in Table 4.7-46 for comparison). In the Oceania region, there is particular concern for the possible effects to shallow coral reefs near the shoreline. The addition of *in situ* burning does not change the potential adverse impacts from those with mechanical-only recovery.

The risk to subtidal benthic habitat using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) was minimal (Table 4.7-46), based on the diluting effects of the overlying water (Section 2.2.2)—the deeper the water, the lower the risk. Chemical compounds of concern tend to evaporate rather than dissolve, and the rapid dilution of any chemical entering the water column decreases the toxicity of any oil residue potentially reaching the bottom substrate. Relative to the results in the Florida Straits modeling location, the effects will be substantially smaller because of the much greater water depth in most of the reference area. This limits the exposure of demersal species to dissolved hydrocarbons, which was a concern in the Florida Straits.

Table 4.7-46
Risk Ranking of Offshore Oil Spills[*] to Subtidal Habitats Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Oceania Region[‡]

Spill Size	Response Option (% dispersant	Habitats Affected (estimated %)	Risk Score[§]

	efficiency)		
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Large (40,000 bbl)	Basic	0–1	3E
	Chemical Dispersion (45 or 80)	0–1	3E

Source: Adapted from Parts B through F of the technical report (French McCay et al., 2004).

Note: Green represents a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the five modeled locations (as discussed in the text) as representative of the Oceania region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Chemical dispersion would not appreciably increase adverse effects on subtidal habitats. There would be an increase in the amount of oil that is dispersed into the water column (Section 4.3.2.5), but the volume available for dilution would prevent high exposures. The results at all modeled locations for hydrocarbon contamination in the sediments also indicates that this is low.

These results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on subtidal habitats will fall within a similar range throughout the Oceania region.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subtidal habitats in the Oceania region under Alternative 3 are expected to be insignificant for small and medium spills, and minor for large spills, with or without dispersant use. On an overall regional level, for medium and large spills, adverse impacts are not changed with the addition of chemical dispersion.

Areas of Special Concern

For this analysis, the risks to areas of special concern are assumed to be the same as those for either intertidal or subtidal habitats (Section 4.7.5.2), whichever are greater. Since the risk to intertidal habitats is greater, those risk scores were used. Potential adverse effects on areas of special concern in the Oceania region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.7.2 and summarized in Table 4.5-77 (the results in Table 4.5-77 are included in Table 4.7-47 for comparison). There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on areas of special concern in that larger spills tend to have higher oil loading on the shoreline and affect larger areas. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery alone.

Since areas of special concern are scattered among the islands and along their coasts, they are unlikely to be disproportionately adversely affected by the average spill. If an area of special concern was highly adversely affected, it is anticipated that the recovery time for the affected area would be the same as for other intertidal habitats. These areas are most at risk from floating oil and benefit from any actions that reduce potential oiling.

As the volume of spilled oil increases, the potential risk that an area of special concern may be oiled also increases. For small spills the risk to intertidal habitat was medium using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) (Table 4.7-47), but effective chemical dispersion reduced this risk to a low level. For medium and large spills, the level of concern increased to high because of the possibility of affecting large shoreline areas. Chemical dispersion would reduce potential adverse effects for a medium spill to a medium level, but for large spills the potential impacts would remain high, although lessened (Section 4.3.2.4). This is also potentially beneficial for nearshore subtidal habitats like coral reefs and seagrass beds because they are at risk from oil that erodes offshore.

Although tropical areas other than the Florida Straits were not modeled, the results are consistent with those for other regions analyzed in this PEIS; therefore, it is expected that the severity of adverse effects on areas of special concern will fall within a similar range throughout the Oceania region.

Table 4.7-47
Risk Ranking of Offshore Oil Spills* to Areas of Special Concern Using the Basic Response Scenario†
with the Addition of Chemical Dispersion (Option A) in the Oceania Region‡

Spill Size	Response Option (% dispersant efficiency)	Areas Affected (estimated %)	Risk Score§
Small (200 bbl)	Basic	0–1	1E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	5–10	1C
	Chemical Dispersion (45 or 80)	1–5	2D
Large (40,000 bbl)	Basic	> 20	1A
	Chemical Dispersion (45 or 80)	5–10	1C

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

* Average spills.

† Current levels of mechanical recovery and *in situ* burning when circumstances permit.

‡ Calculations are based on the appropriate portions of the five modeled locations (as discussed in the text) as representative of the Oceania region for modeling.

§ The risk scoring process is explained in Section 4.4.3.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on areas of special concern in the Oceania region under Alternative 3 are expected to be significant for large spills, with or without dispersant use, based on the risk to intertidal habitats. For small and medium spills, impacts are expected to be moderate and significant, respectively, but are reduced to insignificant and moderate, respectively, with the addition of chemical dispersion. On an overall regional level for medium and large spills, adverse impacts are reduced when chemical dispersion is used.

4.7.5.3. Consequences to Threatened, Endangered, or Candidate Species

Potential adverse effects on threatened, endangered, or candidate species in the Oceania region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.7.3. Potential adverse effects on marine mammals, marine and coastal birds, fish, or sea turtles that are threatened, endangered, or candidate species are identical to those discussed in Section 4.7.5.2 for these groups.

There are a number of very rare species that could be affected if the shoreline oiling occurred in an important habitat area. There is often a direct relationship between the volume of oil spilled and the potential for adverse effects on threatened, endangered, or candidate species in that larger spills tend to spread across a larger surface water area and have higher shoreline oil loading. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse consequences from those with mechanical-only recovery.

When chemical dispersion is used under Alternative 3 for a small spill, the contaminated surface water area is small when compared with the overall surface water area in the Oceania region, so the likelihood of threatened, endangered, or candidate species becoming oiled at the surface is low. Very little oil is likely to strand onshore, and the oil loading would be light in most cases, but because of the limited shoreline habitat, potential risk would still be medium. Effective dispersant application could eliminate this risk. Potential adverse effects increase as spill volume increases, with greatest concern for shoreline breeding areas for these species. Although populations are sporadic and vary with migration, if a threatened, endangered, or candidate species is present in the area of an oil spill, the resulting adverse effect could be great. The severity of the effects varies depending on the sensitivity of the individuals present. Overall, risk scores were highest for marine and coastal birds. Chemical dispersion is expected to reduce adverse effects on threatened, endangered, or candidate species by reducing both the amount of oil that strands onshore (Section 4.3.2.4) and the amount of floating oil. Chemical dispersion will not increase the risk to protected fish or invertebrates because it is restricted to offshore areas where rapid dilution will occur, even for large spills.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on threatened, endangered, and candidate species in the Oceania region under Alternative 3 are expected to be moderate for medium and large spills, with or without dispersant use, based on the risk to marine and coastal birds. For small spills, impacts are expected to be moderate, but are reduced to insignificant with the addition of chemical dispersion. On an overall regional level for medium and large spills, even though chemical dispersion reduces the risk score, the expected impacts remain moderate because of the extent of oiling.

4.7.5.4. Consequences to Essential Fish Habitat

For this analysis, the risks to Essential Fish Habitat (EFH) are assumed to be the same as those for plankton and fish or for subtidal habitats (Section 4.7.5.2), whichever are greater. The results for the two resources were very similar, but the risk to plankton and fish was slightly greater overall, so those risk scores were used. Potential adverse effects on EFH in the Oceania region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.7.4.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on EFH in the Oceania region under Alternative 3 are expected to be insignificant for small spills, and minor for medium and large spills, with or without dispersant used, based on the risk to plankton and fish.

4.7.5.5. Consequences to the Socioeconomic Environment

As discussed in Section 4.3.5, oil spills can produce a variety of adverse economic and social effects. These adverse effects are generally not high when measured at the regional levels, but instead are typically felt in communities located near resources oiled by the spill. Specifically, large adverse effects are generally limited to those industries and populations that are affected by the spill. Some of the most visible and high effects are likely to include effects on water- and shore-based recreation, commercial and recreational fisheries, and tourism. In addition, large-scale spills hold the potential to adversely affect the overall well-being of the residents and economies of coastal communities. Oil spills have the potential to adversely affect low-income and minority populations living in the Oceania region to a greater extent than the general population.

This modeling considers the risk of adverse socioeconomic effects posed by oil spills, which can include, but are not limited to, reduced recreational activity because of beach closures, limited accessibility, or perceived taint; closure of commercial fishing grounds or hatcheries, or reduced commercial harvests; and altered marine transportation patterns. In addition to these and other direct adverse effects, oil spills can have secondary adverse effects on social and economic welfare along the coast. For example, an oil spill may cause changes in employment and firm revenues of resource-based businesses. While these effects are not quantified in this modeling, the following discussion provides absolute and relative measures of the overall risk of adverse social and economic effects of small, medium, and large oil spills using the basic response scenario (mechanical recovery and *in situ* burning when circumstances permit) in the Oceania region. The methodology is described in more detail in the Atlantic region (Section 4.7.2.5).

There is no existing standard for “significance” related to the socioeconomic effect of oil spills (e.g., how much shoreline or surface water must be oiled to be considered a “high,” “medium,” or “low” effect). The significance of the effect will depend on a number of factors, including the scope of the analysis (i.e., national, regional, local), opportunities for resource substitution (e.g., an unoiled beach or fishing ground nearby, alternative ports of call), and the duration of the spill event. Generally, a spill event would be of low concern if it is not of long enough duration to affect the financial viability of local businesses, and the affected communities are able to find substitutes to replace the oiled resources.

For this PEIS, (1) the greatest effect modeled at the regional level was less than approximately 10 percent of available shoreline or surface water resources (indicating the likely presence of substitute resources), and (2) resource use following these modeled spills (e.g., vessel transportation and fishing) would be expected to resume as soon as oil recovery efforts were completed. As a result, the effects under all modeled scenarios would likely be low at the regional level. As noted in the text, any adverse effects that did occur would be expected to be localized in nature.

The risk factor reflects the ratio of the percentage of the surface water oiled using the basic response scenario to the percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected given response options limited to mechanical recovery and *in situ* burning. Under Alternative 1, a risk factor of 1.0 is assigned to medium and large spills (small spills are assumed to have a negligible effect), indicating that no additional response options are taken in this modeled area.

In estuaries and coastal waters within 3 statute mi from shore, mechanical-only recovery would be used under Alternative 3. In marine waters 3 or more statute mi from shore, the basic response scenario with the addition of chemical dispersion could be used under Alternative 3 in the Oceania region. Potential adverse effects of spills to the coastal communities in the Oceania region with only mechanical recovery, or in combination with *in situ* burning, were presented in Section 4.5.7.5 and summarized in Table 4.5-78 (the results in Table 4.5-78 are included in Table 4.7-48 for comparison) for surface water oiled. Table 4.7-21 highlights the effects of small, medium, and large oil spills on the Oceania region's socioeconomic resources by presenting estimates of resources oiled as a result of the average modeled spill in absolute terms (area of surface water oiled above the threshold of concern) and as a percentage of the total resource base in the modeled area. The threshold of concern because of oiled surface water is 0.01 g/m^2 (technical report [French McCay et al., 2004]). This resource area is based on an estimate of the extent to which the coastal community in the modeled area potentially relies on each resource. For the Oceania region, length of shoreline oiled above the threshold of concern is not considered relevant. A single metric was selected for this region since (1) shoreline oiling results from the Florida Straits were highly sensitive in the modeled spill location; (2) the ability to identify shoreline with characteristics amenable to use (i.e., sandy shore) was limited; and (3) area of surface water oiled above the threshold of concern was expected to provide a more accurate measure of expected risk, given the region's geographic characteristics.

This modeling assumes that the risk posed to the socioeconomic environment by oil spills is directly related to the extent to which resources are affected above selected thresholds of concern—for the Oceania region, the square meters of marine water oiled above the threshold of concern. Comparing the absolute risk of adverse socioeconomic effects across spill scenarios, including variations in spill response scenarios, allows for an understanding of the relative risk of adverse socioeconomic effects across spill scenarios. Determining relative risk allows for extrapolation of site-specific results to the entire region. For example, the risk estimates presented in Table 4.7-21 are based on modeled hypothetical spills affecting the Florida Straits, which is an appropriate surrogate for the Oceania region in this modeling. While any given spill may exhibit distinctly different patterns of socioeconomic effect, the relative risk measures are expected to be broadly applicable to a range of spill locations, especially in island regions, as long as the spills occur in areas where chemical dispersion is feasible. In addition, the conclusions reached for the Florida Straits are supported by results for other modeled areas—the relative degree of risk reduction achieved under various removal assumptions across spill size is similar in magnitude.

Table 4.7-48
Risk Ranking of Offshore Oil Spills[*] to Coastal Communities as a Result of Surface Water Oiled Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Oceania Region (Based on the Florida Straits)[‡]

Spill Size	Response Option (% dispersant efficiency)	Surface Water Area		
		m^2 Oiled Above Threshold[§]	Estimated % Oiled[‖]	Risk Factor[#]
Small (200 bbl)[**]	Basic	N/A	N/A	N/A
	Chemical Dispersion (45 or 80)	N/A	N/A	N/A
Medium (2,500 bbl)	Basic	312×10^6	3.2	1.0
	Chemical Dispersion (45)	101×10^6	1.0	0.31
	Chemical Dispersion (80)	99×10^6	1.0	0.31
Large (40,000 bbl)	Basic	659×10^6	6.8	1.0
	Chemical Dispersion (45)	332×10^6	3.4	0.50
	Chemical Dispersion (80)	282×10^6	2.9	0.43

Source: Adapted from Part D of the technical report (French McCay et al., 2004).

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the Florida Straits (as discussed in the text) as representative of the Oceania region for modeling.

[§] Thresholds above which some economic or social risk is expected were determined, and the area of surface water oiled above this threshold for the average modeled spill are reported. The threshold of concern because of oiled surface water is 0.01 g/m^2 of oil (technical report [French McCay et al., 2004]).

[‖] Percentages reflect the proportion of the total modeled area above the threshold of concern.

[#] A risk factor reflects the ratio of the percentage of the model area or volume oiled using the basic response scenario to the model area or percentage oiled with the addition of chemical dispersion. For example, a risk factor of 0.20 would imply a degree of risk equal to one-fifth that expected with response limited to the basic response scenario.

[**] A 200-bbl spill is assumed to have negligible effect.

For this modeling, the socioeconomic environment is divided into components representative of the major parameters of coastal life potentially affected by an oil spill. Absolute and relative risk are discussed for coastal communities, demography, and employment; general economic status of a coastal community; vessel transportation and ports; commercial and recreational fisheries; archaeological and historic resources; recreation and tourism; environmental justice; and public safety and worker health.

Coastal Communities, Demography, and Employment

Coastal communities benefit from and rely on the marine environment to provide residents with sustenance, livelihoods, leisure opportunities, and shipping avenues. Individuals who live and work in close proximity to the coast derive both social and economic rewards from the natural beauty, recreational opportunities, quality of life, economic resources, and cultural attributes associated with these coastal locations.

Thus, oil spills can affect multiple aspects of a coastal community's economy, culture, and quality of life. These effects in turn can impose changes on an affected community's demographics and employment patterns.

Oil spills can affect any number of a coastal community's assets, leading to adverse effects on the economic benefits of community activities. These effects, in turn, can impose changes on that community's demographic and employment patterns. In addition to direct employment and other adverse economic effects on marine resource-based economic sectors associated with oil spills, oil spills can have secondary adverse effects on coastal communities. For example, because the Oceania region relies on tourism for employment and earnings, plus the importance of maritime activities to various coastal communities, coastal communities in this region are at risk of experiencing adverse effects from oil spills that affect tourism. Further, the importance of water transportation in delivering goods to the region's islands implies a heightened risk of adverse effects from an oil spill. Given their reliance on marine resources, coastal communities on Oceanic islands are likely to be more vulnerable to the adverse effects of a spill than communities located on the mainland, which have a more diverse economic base.

As a result of oiling, beaches in the immediate vicinity of a spill may be closed to visitors, and fishing may not be permitted in waters exposed to oil, causing losses in revenue to both the tourism and commercial and recreational fishery sectors of the coastal economy. These effects would be expected to reverberate through communities in the area of the spill, causing short-term decreases in recreation and tourism; commercial and recreational fishing; and the employment opportunities, income, and businesses these industries support. In addition, an oil spill may temporarily reduce the appeal of coastal living in a given area.

To the extent that mechanical recovery, *in situ* burning and chemical dispersion can reduce shoreline oiling and the geographic scope of surface water oiling, this combination of spill response options will act to reduce adverse effects on coastal communities. The scope of potential losses is described in more detail in subsequent sections.

For a small spill in the Oceania region, the risk of great adverse effects on coastal communities is negligible. Because of the small surface water area exposed to oil as a result of a small spill, marine-based economic factors such as local commercial or recreational fisheries may experience little or no effect (Table 4.7-48).

While the risk to coastal communities increases with spill size, the effects remain localized. With chemical dispersion medium and large spills in the Oceania region will have a spill area[58] above the corresponding thresholds of concern that will sweep approximately 99 to 101 million m^2 and 282 to 332 million m^2, respectively, of marine waters used by commercial fisheries and recreational activities (Table 4.7-21).

Based on the modeling results (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on coastal communities, demography, and employment in the Oceania region under Alternative 3 are expected to be insignificant for small, medium, and large oil spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 3.4 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Economic Status

The overall economic status of communities, industries, and individuals that rely on coastal resources for sustenance, revenue, and quality of life can be affected by an oil spill. As noted above, coastal communities can suffer direct and indirect adverse economic effects due to an oil spill, as beach and fishery closures decrease revenue and eliminate jobs. More specifically, losses will be felt in commercial and recreational fisheries, by both the anglers themselves and by related industries as catch opportunities decrease or are eliminated entirely. Tourism and associated businesses will suffer economic setbacks as visits to affected coastal areas decline and purchase of area goods and services decrease because of perceived taint. Similarly, environmental justice issues may arise as low-income or minority communities are disproportionately affected by the spill (discussed below in more detail).

A small spill that is 3 or more statute mi offshore would have essentially no adverse effects on either the local or regional economies (Table 4.7-48). There is little to no risk of oiling economically important resources, and it is unlikely that any commercial or recreational fisheries would be affected.

While the risk increases as spill size increases, the effects remain localized. With chemical dispersion, medium and large spills will sweep 99 to 101 million m^2 and 282 to 332 million m^2 of marine waters, respectively, regardless of dispersant recovery efficiency (Table 4.7-48).

Despite chemical dispersion, a medium or large spill could be expected to have short-term adverse economic effects as a result of oiling recreational beaches, closures of commercial and recreational fishing grounds, and degradation of the appeal of coastal locations. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on economic status in the Oceania region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 3.4 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Vessel Transportation and Ports

Oil spills occurring 3 or more statute mi offshore are not likely to cause large adverse effects on vessel transportation and ports. Local resources would easily handle whatever response operations are implemented. However, an oil spill can disrupt marine commerce if it occurs in and around a shipping channel or port and results in limits on watercraft movement as a means of facilitating spill response. Vessel transportation is of paramount importance to the Oceania region's trade and tourism industries. Any interruption in the standard use of vessels or increase in travel times over water can result in hardship for the Oceania region's coastal communities, as fewer goods are exchanged, transportation costs rise, and the revenue streaming through the local economy falls. These adverse effects might be felt at a number of levels. For example, vessel operators may incur additional costs associated with delays and longer shipping distances; businesses that depend on timely receipt of feedstock or other goods may experience adverse effects such as production slowdowns; and individuals who work in adversely affected sectors may be displaced. To the extent that businesses in other locations depend on the affected industries, a longer-term disruption of vessel transportation could yield adverse effects beyond the immediate spill area. However, given alternative ports of call, substitute suppliers and shipping modes, and the expected short-term nature of any disruption in vessel traffic, such adverse effects are not likely to be high.

For a small spill, no great adverse effects on vessel transportation or ports are expected (Table 4.7-48). While the risk to the vessel transportation industry increases with spill size, the effects remain localized. With chemical dispersion medium and large spills will sweep 99 to 101 million m^2 and 282 to 332 million m^2 of marine waters, respectively, regardless of dispersant recovery efficiency (Table 4.7-48). However, a spill occurring under specific location, weather, and tidal conditions could adversely affect vessel transportation and ports and the industries and communities that depend on this traffic. Any adverse effects on vessel transportation and ports would likely be short lived—that is, even if shipping waters or ports are exposed to oil and are therefore closed, as soon as recovery efforts remove surface oil, these facilities would be expected to be reopened.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on vessel transportation and ports in the Oceania region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 3.4 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Fisheries

Commercial Fisheries

Commercial fisheries are vulnerable to oil spills because of closures and perceived taint. A moratorium on fishing operations in the wake of an oil spill can lead to high losses for the commercial fishing industry, as well as related industries, including those that supply equipment to and purchase products from commercial fleets. By contaminating key waters, an oil spill may also disrupt employment in the commercial fisheries and related sectors of the economy. In addition, oil spills can lead to a decreased demand for fish from affected waters because of actual or perceived taint, and can instigate alterations to fishing practices in a manner that increases operating costs and/or decreases revenues. Large spills can potentially injure fish nursery grounds and impose other risks that could reduce fish harvests in the longer term.

For a small spill in the Oceania region, the risk to commercial fisheries is negligible (Table 4.7-48). While the risk to the commercial fishing industry increases with spill size, the effects remain localized. With chemical dispersion medium and large spills will adversely affect 99 to 101 million m^2 and 282 to 332 million m^2, respectively, of marine waters used by the commercial fishing industry, regardless of dispersant recovery efficiency (Table 4.7-48).

A risk of economic loss to the marine fishery will occur when waters exceed relevant management and/or thresholds of concern. For example, fishing may not be permitted in waters swept by oil above the modeled threshold, thus reducing commercial fish landings for a period of time following a spill. The resulting adverse effects would be expected to reverberate through communities in the area of the spill, causing decreases in employment, income, and the viability of businesses associated with the commercial fishing industry. To the extent that substitute fishing grounds are available, spill effects on the commercial fishing economy may be less severe.

Recreational Fisheries

Similar to commercial fishing operations, recreational fisheries are at risk of closure or loss in value as a result of oil spills. These adverse effects will not generally be regional or national in nature, but could be high at the local level. For this modeling, the risks posed to recreational fishing activities are modeled in the same manner as risks to commercial fishing, in square meters of oiled surface water above the corresponding threshold of concern. The effects of an oil spill on recreational fishery-related activities will be felt more heavily by various populations, including recreational anglers, commercial tour boat operators, and firms that supply goods and services to recreational anglers. For example, recreational anglers fish for pleasure or sport, as opposed to monetary gain. In the wake of an oil spill, such anglers may choose to fish at a substitute location, may experience a reduced quality of experience, or may choose to forgo fishing entirely. The losses suffered will be related to these missed opportunities. In addition, while closing waters to recreational fishing will decrease the social welfare of recreationists, it would also be expected to affect the demand for boat rentals and other services consumed by fishing enthusiasts.

For a small spill, adverse effects on recreational fishing resources in the Oceania region would likely be negligible (Table 4.7-48). Medium and large spills may cause decreases in local recreational fishing activities and in the revenues generated from these activities.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on fisheries (commercial and recreational) in the Oceania region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 3.4 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Subsistence

Potential adverse effects on subsistence resources in the Oceania region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.7.5 and summarized in Table 4.5-79 (the results in Table 4.5-79 are included in Table 4.7-49 for comparison). Potential adverse effects on subsistence resources in the Oceania region are of particular concern because a significant percentage of an island's intertidal and nearshore habitats and resources may be adversely affected by a large spill, and there may not be suitable alternative areas for subsistence harvesting. The addition of *in situ* burning does not remove enough oil to reduce the severity of potential adverse effects from those with mechanical-only recovery alone.

Under Alternative 1, potential adverse effects on subsistence resources in the Oceania region are low for small and medium spills, and medium for large spills. Chemical dispersion may increase adverse effects on subsistence resources by increasing water column exposure to dissolved aromatics; however, effects on intertidal subsistence resources may be reduced because chemical dispersion is expected to reduce the amount of oil that strands in intertidal habitats (Section 4.3.2.4). The risk ranking using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) with the addition of chemical dispersion is presented in Table 4.7-49.

Table 4.7-49
Risk Ranking of Offshore Oil Spills[*] to Subsistence Using the Basic Response Scenario[†] with the Addition of Chemical Dispersion (Option A) in the Oceania Region[‡]

Spill Size	Response Option (% dispersant efficiency)	Resources Affected (estimated %)	Risk Score[§]
Small (200 bbl)	Basic	0–1	4E
	Chemical Dispersion (45 or 80)	0–1	4E
Medium (2,500 bbl)	Basic	1–5	4D
	Chemical Dispersion (45)	1–5	4D
	Chemical Dispersion (80)	5–10	4C
Large (40,000 bbl)	Basic	> 20	4A
	Chemical Dispersion (45 or 80)	> 20	4A

Source: Adapted from Parts B through F of the technical report (French McCay et al., 2004).

Note: Yellow represents a medium level of concern, and green, a low level of concern.

[*] Average spills.

[†] Current levels of mechanical recovery and *in situ* burning when circumstances permit.

[‡] Calculations are based on the appropriate portions of the five modeled locations (as discussed in the text) as representative of the Oceania region for modeling.

[§] The risk scoring process is explained in Section 4.4.3.

Effects on subsistence resources from a small spill were determined to be low by extrapolating from the results for a medium spill. With the addition of chemical dispersion at 45 percent efficiency for a medium spill, the modeling results showed water column exposure at low concentrations (1–100 ppb) in more widespread areas and at high concentrations (100–10,000 ppb) in localized areas. Sediment exposure was typically negligible or only occurred in small areas. The length of oiled shoreline was reduced by over 65 percent at 45 percent dispersant efficiency. Because of the increase in potential exposure to oil for water column resources, and the decrease in potential exposure for intertidal and shoreline resources, the risk scores did not change at 45 percent dispersant efficiency. With the addition of chemical dispersion at 80 percent efficiency for a medium spill, the Pacific region modeling results showed water column exposure at both low concentrations (1–100 ppb) and high concentrations (100–10,000 ppb) in more widespread areas in the than at 45 percent dispersant efficiency. Results at both dispersant efficiencies were similar in the Alaska region. Therefore, the levels of concern were the same. On average, reduced shoreline oiling at 80 percent dispersant efficiency were similar to those at 45 percent dispersant efficiency, and sediment oiling was negligible or minimal. The extent of oiling of intertidal habitats for a large spill using chemical dispersion would likely represent 1 to 5 percent of the intertidal habitat on an island. Because water column exposure at both low and high concentrations is more widespread at 80 percent dispersant efficiency than at 45 percent dispersant efficiency, the risk score increased (Table 4.7-49). A more conservative risk score was assigned for the Oceania region because subsistence resources make up a substantial portion of some Native Islanders' diets;

relocating to nonoiled areas may be impossible on a small island. The risk scores in Table 4.7-49 reflect the predicted recovery rates for subsistence resources of less than 1 year for all spill sizes (Section 4.3.5.6).

With the addition of chemical dispersion at 45 and 80 percent efficiency for a large spill, the modeling results showed water column exposure at both low concentrations (1–100 ppb) and high concentrations (100–10,000 ppb) in more widespread areas than under Alternative 1. Sediment exposure occurred in several areas in San Francisco Bay, but was negligible or minimal in other modeled areas so it is unlikely to occur in the Oceania region. On average, the length of oiled shoreline was reduced by 48 and 39 percent when 80 and 45 percent dispersant efficiency, respectively, was used in the modeled areas. While intertidal resources are less likely to be adversely affected by chemical dispersion, water column exposure was more widespread. On an overall regional level, effects on subsistence resources increase with spill volume. On a local level, a medium or large spill may cause high adverse effects on subsistence communities.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on subsistence in the Oceania region under Alternative 3 are expected to be insignificant, minor, and moderate for small, medium, and large spills, respectively, with or without dispersant use.

Archaeological/Historic Resources

Potential adverse effects on archaeological and historic resources in the Oceania region using the basic response scenario (current levels of mechanical recovery and *in situ* burning when circumstances permit) are presented in Section 4.5.7.5.

Under Alternative 3, adverse effects on archaeological and historic resources in the Oceania region would likely be negligible, regardless of spill size because known cultural resources in this region occur mostly onshore or in shallow coastal waters (Section 3.7.5.7). Chemical dispersion may help reduce the amount of oil that strands on the shoreline, which will also reduce the amount of shoreline cleanup and potential disturbance to sensitive cultural resources. There are limited data that identify long-term or chronic degradation to cultural resources due to chemical dispersion.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on archaeological and historic resources in the Oceania region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

Recreation and Tourism

Oil spills can adversely affect a coastal community's recreational and tourism assets. The tropical islands of the Oceania region provide visitors and residents with the opportunity to enjoy a number of outdoor recreational activities. Beaches, water sports, and the natural beauty of these areas make them popular with vacationers. An oil spill would be expected to affect recreationists' overall social welfare; in addition, the social and economic implications of a spill would reach beyond these direct effects on visitors and into the community. For example, visitors may be less likely to visit and spend money in an area perceived as affected by a spill, potentially leading to loss of business revenue and jobs (see Coastal Communities, Demography, and Employment above and in Section 4.5.7.5 for more details).

For a small spill in the Oceania region, the risk to recreation and tourism is negligible (Table 4.7-48). There is little to no risk of oiling economically important resources, and it is unlikely that any fisheries or recreational areas would be affected.

While the risk to recreation and tourism increases with spill size, the effects remain localized. With chemical dispersion medium and large spills will sweep 99 to 101 million m^2 and 282 to 332 million m^2, respectively, of marine waters, regardless of dispersant recovery efficiency (Table 4.7-48).

Despite chemical dispersion, a medium or large spill could be expected to have short-term adverse economic effects as a result of oiling of recreational beaches, closures of fishing grounds, and degradation of the appeal of coastal locations. While the physical effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on recreation and tourism in the Oceania region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 3.4 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Environmental Justice

As mentioned above, low-income, indigenous, and minority populations in some coastal areas may rely on regional fisheries and other marine resources for subsistence, as part of an artisanal economic system, or in the context of participating in commercial fishing or other marine resource-based employment. Many individuals from these groups rely on recreation- and tourism-related jobs, and the security of their employment depends on the ability of the coast to attract visitors. To the extent that an oil spill deters visits and reduces demand for hotel, restaurants, and other tourism- and recreation-related services, the economic status of low-income and minority groups may be affected. These groups may experience the effects of a spill more severely than the general population, which relies on a more diverse economic base for its livelihood and on the availability of a widespread, commercially available selection of foods. Additionally, subsistence use of natural resources and employment in marine resource-related industries might have value beyond the importance this resource holds as a food source or employment opportunity.

For a small spill that is 3 or more statute mi offshore in the Oceania region, the risk of adverse changes in any group's economic status is negligible, regardless of response options used (Table 4.7-48). Because of the small surface water area exposed to oil as a result of a small spill, marine-based economic factors such as local commercial or subsistence fisheries may experience little or no adverse effects. While the risk to coastal communities increases with spill size, the effects remain localized. With chemical dispersion medium and large spills sweep 99 to 101 million m^2 and 282 to 332 million m^2, respectively, of marine waters, regardless of dispersant recovery efficiency (Table 4.7-48).

As a result of this oiling, beaches in the immediate vicinity of a spill may be closed to visitors, and fishing may not be permitted in waters exposed to oil, causing revenue losses to both the tourism and commercial and recreational fishery sectors of the coastal economy. These effects would be expected to reverberate through communities in the spill area and disproportionately affect low-income and minority populations, causing decreases in employment opportunities. While the adverse effects of even a large spill would be relatively short lived, any reluctance on the part of users to return to the coastal resources, especially in areas dependent on tourism, could cause socioeconomic effects to be higher.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on environmental justice in the Oceania region under Alternative 3 are expected to be insignificant for small and medium spills, with or without dispersant use. For large spills sizes, impacts are expected to be moderate, but are reduced to insignificant with the addition of chemical dispersion. On average, only a small percentage of the total available resources in the modeled area is affected for even the largest modeled spills (regionally less than 3.4 percent of surface water would be affected); any adverse impacts are expected to be localized—that is, adverse regional or national impacts are unlikely to result from even the largest spill scenarios.

Public Safety and Worker Health

Potential adverse effects on public safety are defined as the risk to the public from direct exposure to oil or response activities as a result of the spill, or through consumption of contaminated water or organisms. There are many areas in the Oceania region with high population concentrations along the coast. However, adverse effects on public safety are unlikely from oil spills that occur 3 or more statute mi offshore for any of the spill sizes considered, regardless of the response options—mechanical recovery, *in situ* burning, and/or chemical dispersion—used. The USCG has protocols to protect the public from risk during shoreline response operations, as well as on-water protocols to prevent the public from entering the response area.

Potential adverse effects on worker health are related to direct exposure to oil during response operations. In addition, operating oil spill response equipment can be dangerous, which is well recognized and is the basis for the current worker certification and training requirements. There is also a health risk from inhalation of hydrocarbon fumes for first responders, which is recognized in current safety protocols. The risk is greater as the spill size and the corresponding intensity and duration of operations increase, but is minimized if safety standards are followed. There are also protocols in place for the proper application and handling of dispersants.

Based on the results from the modeling (see the technical report [French McCay et al., 2004]) and the scientific literature review (see Section 4.3), potential regional adverse impacts on public health and worker safety in the Oceania region under Alternative 3 are expected to be insignificant for small, medium, and large spills, with or without dispersant use.

4.8. ENVIRONMENTAL CONSEQUENCES: ALTERNATIVE 4–INCREASE ON-WATER MECHANICAL RECOVERY CAPABILITY, ESTABLISH ON-WATER DISPERSANT APPLICATION CAPABILITY (OPTION B), ESTABLISH *IN SITU* BURN CREDIT, AND ESTABLISH AND MAINTAIN AERIAL TRACKING CAPABILITY

This section describes the potential adverse and beneficial environmental impacts associated with Alternative 4 for the resources described in Chapter 3. Under this alternative, the USCG would revise the current regulations to increase the amount of mechanical recovery equipment that vessel planholders would be required to have available to respond to an oil spill at the levels required under Alternatives 2 and 3. The dispersant credit in the current regulations would be eliminated, with the USCG amending the current regulations to require planholders to establish dispersant application capability equipment (Option B) to respond to an oil spill. (Option B requires more delivery capacity under Tier 1 [0–12 hours] than Option A requires.) This requirement would apply only to planholders of tank vessels operating 3 or more nm from shore where chemical dispersion has been pre-authorized[59] in accordance with the National Contingency Plan (NCP). Planholders would also have the opportunity to apply for an *in situ* burn credit to offset the requirements for mechanical recovery and would be required to establish and maintain aerial tracking capabilities. In addition, this alternative only requires the availability of response capabilities but does not mandate the use of any particular response capability (see Section 2.6.5 for more details).

Based on the requirements established by this alternative, the material presented in the *Response Plan Equipment Caps Review* (USCG, 1999), and the results of the regulatory analysis (USCG, 2008), mechanical recovery and *in situ* burn equipment is already maintained in all six geographic regions considered in this PEIS (Table 4.5-1). As explained under Alternative 1, any increase in mechanical response equipment would be minimal in many (if not most) regions and the new requirement would not result in increased efficiency or additional oil being removed from the water. Thus the impacts associated with increasing the level of mechanical recovery equipment would be equivalent to those under Alternative 3. For Alternative 4, dispersant Option B (Table 2.6-1) requires slightly more delivery capacity under Tier 1 (0–12 hours) than dispersant Option A under Alternative 3. For the purpose of this analysis, however, the USCG estimated the amount of oil that could be treated during response operations based only on Option B (Appendix B). This was done to simplify the analysis and to ensure that exposure to dispersants and dispersed oil in the water column was considered at the highest potential levels. Therefore, potential adverse and beneficial impacts on the environment under Alternative 4 would be equivalent to those under Alternative 3, which will not be repeated here (see Section 4.7 for complete discussion).

4.9. ENVIRONMENTAL CONSEQUENCES: ALTERNATIVE 5–NO INCREASE IN MECHANICAL RECOVERY CAPABILITY, ESTABLISH ON-WATER DISPERSANT APPLICATION CAPABILITY (OPTION B), ESTABLISH *IN SITU* BURN CREDIT, AND ESTABLISH AND MAINTAIN AERIAL TRACKING CAPABILITY

This section describes the potential adverse and beneficial environmental impacts associated with Alternative 5 for the resources described in Chapter 3. Under this alternative, the USCG would revise the current regulations to maintain at current levels the amount of mechanical recovery equipment that vessel planholders would be required to have available to respond to an oil spill. The dispersant credit in the current regulations would be eliminated, with the USCG amending the current regulations to require planholders to establish dispersant application capability equipment (Option B) available to respond to an oil spill. (Option B requires more delivery capacity under Tier 1 [0–12 hours] than Option A does.) This requirement would apply only to planholders of tank vessels operating 3 or more nm from shore where chemical dispersion has been pre-authorized[60] in accordance with the NCP. Planholders would also have the opportunity to apply for an *in situ* burn credit to offset the requirements for mechanical recovery and would be required to establish and maintain aerial tracking capabilities. In addition, this alternative only requires the availability of response capabilities but does not mandate the use of any particular response capability (see Section 2.6.5 for more details).

Based on the requirements established by this alternative, the material presented in the Response Plan Equipment Caps Review (USCG, 1999), and the results of the regulatory analysis (USCG, 2008), mechanical recovery and *in situ* burn equipment is already maintained in all six geographic regions considered in this PEIS (Table 4.5-1). The impacts associated with maintaining the level of mechanical recovery equipment would be equivalent to those under Alternative 1 (and Alternative 3) since any increase in mechanical recovery equipment will not increase the amount of oil treated because adding more mechanical recovery equipment would not increase the number of opportunities to use that equipment.

Under Alternative 5 dispersant Option B (Table 2.6-1) requires slightly more delivery capacity under Tier 1 (0–12 hours) than dispersant Option A under Alternative 3. For the purpose of this analysis, however, the USCG estimated the amount of oil that could be treated during response operations based only on Option B (Appendix B). This was done to simplify the analysis and to ensure that exposure to dispersants and dispersed oil in the water column was considered at the highest potential levels. Therefore, adverse and beneficial environmental impacts under Alternative 5 would be equivalent to those under Alternative 3 (see Section 4.7 for complete discussion).

4.10 ENVIRONMENTAL CONSEQUENCES: ALTERNATIVE 6–NO INCREASE IN MECHANICAL RECOVERY CAPABILITY, ESTABLISH ON-WATER DISPERSANT APPLICATION CAPABILITY (OPTION B), AND ESTABLISH AND MAINTAIN AERIAL TRACKING CAPABILITY [PREFERRED ALTERNATIVE]

This section describes the potential adverse and beneficial environmental impacts associated with Alternative 6 for the resources described in Chapter 3. Under this alternative, the USCG would revise the current regulations to maintain at current levels the amount of mechanical recovery equipment that vessel planholders would be required to have available to respond to an oil spill. The dispersant credit in the current regulations would be eliminated, with the USCG amending the current regulations to require planholders to establish dispersant application capability equipment (Option B) available to respond to an oil spill. (Option B requires more delivery capacity under Tier 1 [0–12 hours] than Option A does.) This requirement would apply only to planholders of tank vessels operating 3 or more nm from shore where chemical dispersion has been pre-authorized[61] in accordance with the NCP. Planholders would also be required to establish and maintain aerial tracking capabilities. In addition, this alternative only requires the availability of response capabilities but does not mandate the use of any particular response capability (see Section 2.6.5 for more details).

Based on the requirements established by this alternative, the material presented in the Response Plan Equipment Caps Review (USCG, 1999), and the results of the regulatory analysis (USCG, 2008), mechanical recovery equipment is already maintained in all six geographic regions considered in this PEIS (Table 4.5-1). The impacts associated with maintaining the level of mechanical recovery equipment would be equivalent to those under Alternative 1 (and Alternative 3) since any increase in mechanical recovery equipment will not increase the amount of oil treated because adding more mechanical recovery equipment would not increase the number of opportunities to use that equipment.

Under Alternative 6, dispersant Option B (Table 2.6-1) requires slightly more delivery capacity under Tier 1 (0–12 hours) than dispersant Option A under Alternative 3. For the purpose of this analysis, however, the USCG estimated the amount of oil that could be treated during response operations based only on Option B (Appendix B). This was done to simplify the analysis and to ensure that exposure to dispersants and dispersed oil in the water column was considered at the highest potential levels. Therefore, adverse and beneficial environmental impacts under Alternative 6 would be equivalent to those under Alternative 3 (see Section 4.7 for complete discussion).

4.11. COMPARING THE ALTERNATIVES

This section compares the regional- and national-level conclusions regarding the significance of potential adverse and beneficial impacts associated with the alternatives considered in this PEIS. As explained throughout Chapter 4, the analysis performed to determine the significance of potential adverse and beneficial impacts of each alternative is based on the assumption that an oil spill has occurred. Thus, the impacts presented in Sections 4.5 through 4.10 represent the adverse and beneficial impacts of an oil spill with the alternatives. The impacts of the alternatives cannot be considered independently from the oil spill, since the alternatives are implemented in response to an oil spill. However, it is important to clarify that the each alternative results in the removal of different quantities of floating or stranded oil after an oil spill. This section compares the regional-level impacts of an oil spill on physical, biological, and socioeconomic resources under the six alternatives, assesses the potential net environmental impacts of the alternatives as well as the overall national-level potential impacts from the alternatives.

As described in Chapter 2, the alternatives relate to the availability of oil spill response options. The alternatives do not mandate the use of any particular oil spill response option. Thus, the actual use of any particular response option remains at the discretion of the Federal On-Scene Coordinator (FOSC). The alternatives are not expected to change the actual use of mechanical recovery and *in situ* burning in any region or of chemical dispersion in the Gulf of Mexico or Alaska regions. In addition, the alternatives are not expected to affect oil spill response operations in areas closer to shore than those covered under existing pre-authorization agreements (Figures 2.2-1 and 2.2-2). Alternatives 3, 4, 5, and 6 would ensure the uniform availability of dispersant capability in the four regions—Atlantic, Caribbean, Pacific, and Oceania—where appropriate response times cannot currently be met. The modeling developed in support of this PEIS is presented in detail in the technical report (French McCay et al., 2004) and is summarized in Sections 4.5 through 4.10.

The modeling (see the technical report [French McCay et al., 2004]) and literature review (Section 4.3) show that, on the regional level, potential adverse impacts on physical, biological, and socioeconomic resources are insignificant to minor for small (200-bbl) spills that occur 3 or more statute mi[62],[63] offshore. The analysis also shows that, as expected, the level of potential adverse impacts increases with spill size. Potential adverse impacts from medium (2,500-bbl) and large (40,000-bbl) spills are highly related to the spill location, as potential adverse impacts on sensitive resources largely depend on the resources' presence and distribution. Thus, potential adverse impacts depend on the spill size and location relative to sensitive or important resources.

As discussed above, the actual use of mechanical recovery and *in situ* burning is not expected to change under the different alternatives. In general, it was estimated that these two oil spill response options would offer limited protection to physical, biological, and socioeconomic resources when compared with a hypothetical natural removal response option (no cleanup action). Because of the difficulties inherent in collecting oil at sea, these two response options frequently do not result in the recovery of large amounts of oil, and only a limited amount (generally considered to be less than 15 percent) of the oil is likely to be recovered on water using mechanical recovery or *in situ* burning, regardless of how much equipment is employed.

While the analysis shows that mechanical recovery can provide some environmental benefits, there is still the potential for oil spills to cause moderate to significant adverse impacts on the physical, biological and socioeconomic resources. As explained in Section 4.4, *in situ* burning is not expected to change the amount of oil removed from the marine environment. This is because the physical limitations for skimming and collecting oil floating on the water are essentially the same for both mechanical recovery and *in situ* burning. Thus, the potential adverse and beneficial impacts on the physical, biological and socioeconomic resources would not change since it is assumed that *in situ* burning would simply replace mechanical recovery. Finally, as discussed in Sections 4.5 and 4.7, even though air quality impacts would be different under *in situ* burning, they would be localized and insignificant.

The analysis considered two dispersant efficiencies (45 and 80 percent) and compared the results to a scenario with no dispersant application. As expected, based on scientific knowledge and experience, the modeling showed that chemical dispersion at 45 and 80 percent efficiency would be expected to significantly increase the amount of dispersed oil, removing correspondingly more oil from the water surface and thereby reducing the length of shoreline oiled and surface water areas swept by floating oil above thresholds of concern. However, since the distribution of organisms in the marine environment is not random and varies seasonally, it is difficult to quantify the magnitude of potential benefits.

Overall, the analysis shows that the uniform availability of dispersant capability has the potential to provide additional protection to certain biological and socioeconomic resources, including sensitive resources that recover relatively slowly such as intertidal habitats, sea turtles, and marine and coastal birds. Chemical dispersion capability, which is required under Alternatives 3, 4, 5, and 6, would be expected to reduce the level of potential adverse impacts proportional to the estimated reduction in shoreline length and surface water area oiled. However, chemical dispersion would not eliminate the potential adverse impacts posed by oil spills in the marine environment. Additionally, dispersed oil in the water column has the potential to adversely affect a different set of sensitive resources. As expected, the analysis shows that when chemical dispersion is used, there is a large increase in the volume of water contaminated above the assumed threshold of concern. However, for both medium and large spills, the volumes estimated represent only a small fraction of the total dilution volume available. Given dispersant application offshore and in deep water, the results of the analysis presented in Sections 4.5 and 4.7 indicate that the potential adverse impacts on water quality and water column communities are not expected to be significant. The results of the analysis are consistent with the expected results described in Section 4.3 based on a review of the scientific literature and observations from actual spills. The results of the analysis are also consistent with the logic that supports the establishment of the pre-authorization agreement areas—chemical dispersion is acceptable when reasonable dilution can be anticipated. In addition, the FOSCs can, on the advice of their scientific support team, adjust the dispersant application to avoid sensitive resources (see Section 2.3). Finally, the results of the analysis show that the potential benefits associated with chemical dispersion are higher for medium oil spills than for large oil spills.

Spill response already includes aircraft for tracking and vessels for response operations, so there is no anticipated change in emissions from these sources. Even so, relative to the evaporation from the oil slick, emissions from aircraft or vessels that are applying dispersants are a minor concern.

4.11.1. Comparison of Potential Adverse Impacts of Oil Spills under the Alternatives

This section compares the potential adverse environmental consequences of an oil spill under the alternatives analyzed in this PEIS for the physical, biological, and socioeconomic resources. Table 4.10-1 (at the end of Section 4.10) displays the range of potential adverse environmental impacts of an oil spill under the alternatives. As shown in the table and discussed below, the potential adverse and beneficial impacts of an oil spill under Alternative 2 are expected to be equivalent to those under Alternative 1, while the potential adverse and beneficial impacts of an oil spill under Alternatives 4 and 5 are expected to be equivalent to those under Alternative 3.

4.11.1.1. Alternative 1—No Action, Whereby No Change in Response Plan Regulations Would Be Implemented

Under Alternative 1, there would be no change to existing regulations. Aerial tracking capability would not be required, but it is usually provided by the oil spill response community. The cost-benefit analysis performed for the regulatory analysis determined that there is no net present value (NPV) cost or benefit of Alternative 1 (USCG, 2008).

Current availability of oil spill response options would remain unchanged. On-water mechanical recovery and *in situ* burn capabilities would be available in all regions. On-water dispersant capability would not meet required response times except in the Gulf of Mexico and Alaska regions.

Consequences to the Physical Environment

Insignificant to moderate adverse impacts on **coastal water quality** could occur if large amounts of oil become stranded in confined, shallow areas. Adverse impacts could be mitigated through offshore chemical dispersion; however, dispersant capability would only be available in the Gulf of Mexico and Alaska regions under Alternative 1 because appropriate response times cannot currently be met in other regions. Insignificant impacts on **marine water quality** are expected. Local adverse impacts of short duration could occur under extreme events where storms may drive oil into the water column, but no significant impacts are expected on the regional or national levels. Chemical dispersion would increase the levels of hydrocarbons in the water column offshore but not to levels of concern and only in local areas and for short periods of time. Insignificant adverse impacts are expected for **air quality** for all spill sizes, regardless of the response option used. Local adverse impacts of short duration on air quality (with or without the *in situ* burning) could occur, but no significant impacts are expected on the regional or national levels. Spill response already includes aircraft for tracking and vessels for response operations, so there is no anticipated change in emissions from these sources. Even so, relative to the evaporation from the oil slick, emissions from vessels or aircraft that are applying dispersant are a minor concern. Relative to the evaporation from the oil slick, emissions from response vessels are a minor concern.

In the Gulf of Mexico and Alaska regions, chemical dispersion could reduce the potential adverse impacts on resources of concern without significantly increasing potential risks because of the rapid dilution that occurs offshore.

Consequences to the Biological Environment

Insignificant to significant adverse impacts could occur for **marine and coastal birds**, **intertidal habitats**, and **areas of special concern**. The level of concern largely depends on the presence and distribution of the particular resource/species. Insignificant to moderate adverse impacts are expected for **marine mammals**, **plankton and fish**, **subtidal habitats**, **sea turtles**, and **Essential Fish Habitat** for all spill sizes, regardless of response option used. On-water mechanical recovery or *in situ* burning reduces, but does not eliminate, potential adverse impacts on sensitive resources from floating oil and oil stranded on the shoreline.

In the Gulf of Mexico and Alaska regions, chemical dispersion could reduce the potential adverse impacts on resources of concern without significantly increasing the potential risk to **plankton and fish** because of the rapid dilution that occurs offshore.

Consequences to the Socioeconomic Environment

Insignificant to minor adverse impacts are expected for most socioeconomic resources for all spill sizes, but could increase to significant levels of concern for **commercial and recreational fisheries** and **environmental justice**, regardless of response option used. In all regions, insignificant to moderate adverse impacts are expected for **subsistence** resources. The primary cause of potential adverse impacts is the presence of floating or stranded oil. The pattern of adverse impacts was similar in all six geographic regions considered in this PEIS, with potential adverse impacts being characterized by their local nature and short duration. However, it is important to note that the perception of damage by the local or regional populations is often as significant as the actual potential impacts. Areas heavily dependent on coastal resources such as **fisheries** could be affected the most. On-water mechanical recovery or *in situ* burning reduces, but does not eliminate, adverse impacts on sensitive resources.

In the Gulf of Mexico and Alaska regions, chemical dispersion could significantly reduce the adverse impacts on socioeconomic resources.

4.11.1.2. Alternative 2–Increase On-Water Mechanical Recovery Capability and Establish and Maintain Aerial Tracking Capability

Under Alternative 2, on-water mechanical recovery capability would increase by 25 percent. In addition, aerial tracking capability would be established and maintained. The cost-benefit analysis performed for the regulatory analysis determined that for Alternative 2, the NPV at 7% of total national cost is $82.96 million (USCG, 2008).

Since current levels of mechanical recovery capability would exceed the new requirement levels, the increased level of mechanical recovery capability under Alternative 2 would produce no change from Alternative 1 (Sections 2.6.2 and 2.6.6). Thus, current availability of oil spill response options would remain unchanged. On-water mechanical recovery and *in situ* burn capabilities would be available in all regions. On-water dispersant capability would not meet required response times except in the Gulf of Mexico and Alaska regions.

Consequences to the Physical Environment

Potential adverse impacts are the same as those identified under Alternative 1 (Section 4.10.1.1).

Consequences to the Biological Environment

Potential adverse impacts are the same as those identified under Alternative 1 (Section 4.10.1.1).

Consequences to the Socioeconomic Environment

Potential adverse impacts are the same as those identified under Alternative 1 (Section 4.10.1.1).

4.11.1.3. Alternative 3–Increase On-Water Mechanical Recovery Capability, Establish On-Water Dispersant Application Capability (Option A), Establish In Situ Burn Credit, and Establish and Maintain Aerial Tracking Capability

Under Alternative 3, on-water mechanical recovery capability would increase by 25 percent. On-water dispersant capability (Option A) and an *in situ* burn credit would be established. In addition, aerial tracking capability would be established and maintained. The cost-benefit analysis performed for the regulatory analysis determined that for Alternative 3, the NPV at 7% of total national cost is $127.92 million (USCG, 2008).

Current availability of on-water mechanical recovery and *in situ* burn capabilities would remain unchanged since current levels of mechanical recovery capability would exceed the new requirement levels. On-water dispersant capability would be uniformly available in all geographic regions considered in this PEIS.

Consequences to the Physical Environment

Potential adverse impacts are the same as those identified under Alternative 1, with the only difference being that under this alternative, dispersant capability would be uniformly available in all geographic regions considered in this PEIS, increasing the potential hydrocarbon levels in the water column offshore in the Atlantic, Caribbean, Pacific, and Oceania regions. However, rapid dilution would prevent any significant adverse impacts on **marine water quality** since hydrocarbon levels in the water column offshore would increase only in local areas for short periods of time and not to levels of concern. Insignificant to moderate adverse impacts are expected for all spill sizes, regardless of response option used.

Offshore chemical dispersion could provide protection for **coastal water quality** by preventing movement of the surface slick into coastal waters and allowing for dilution of dispersed oil in deeper water.

Consequences to the Biological Environment

Potential adverse impacts on biological resources are the same as those identified under Alternative 1, with the only difference being that under this alternative, dispersant capability would be uniformly available in all six geographic regions considered in this PEIS, possibly increasing the potential hydrocarbon levels in the water column offshore in the Atlantic, Caribbean, Pacific, and Oceania regions. However, rapid dilution would prevent any significant adverse impacts on **plankton and fish** since hydrocarbon levels in the water column would increase only in local areas for short periods of time and not to levels of concern. Insignificant to significant adverse impacts could occur for **marine and coastal birds**, **intertidal habitats**, and **areas of special concern**. Insignificant to moderate adverse impacts are expected for **subtidal habitats**, **sea turtles**, and **Essential Fish Habitat** and minor to moderate adverse impacts are expected for **marine** mammals and **plankton and fish** for all spill sizes, regardless of response option used.

Offshore chemical dispersion could provide protection for resources by reducing floating or stranded oil.

Consequences to the Socioeconomic Environment

Potential adverse impacts are the same as those identified under Alternative 1, with the only difference being that under this alternative, dispersant capability would be uniformly available in all six geographic regions considered in this PEIS. Insignificant to minor adverse impacts are expected for most resources for all spill sizes, but could increase to significant levels of concern for **commercial and recreational fisheries** and **environmental justice**, regardless of response option used. In all regions, insignificant to moderate adverse impacts are expected for **subsistence** resources.

Offshore chemical dispersion could reduce the amount of floating or stranded oil, thereby potentially reducing adverse impacts on socioeconomic resources of concern.

4.11.1.4. Alternative 4–Increase On-Water Mechanical Recovery Capability, Establish On-Water Dispersant Application Capability (Option B), Establish In Situ Burn Credit, and Establish and Maintain Aerial Tracking Capability

Under Alternative 4, on-water mechanical recovery capability would increase by 25 percent. On-water dispersant capability (Option B) and an *in situ* burn credit would be established. In addition, aerial tracking capability would be established and maintained. The cost and benefit analysis performed for the regulatory analysis determined that for Alternative 4, the NPV at 7% of total national cost is $111.37 million (USCG, 2008).

Current availability of on-water mechanical recovery and *in situ* burn capabilities would remain unchanged since current levels of mechanical recovery capability would exceed the new requirement levels. On-water dispersant capability would be uniformly available in all six geographic regions considered in this PEIS. The amount of dispersant required in Tier 1 is slightly reduced, but the difference was considered to be inconsequential for this analysis. Thus, there would be no change in the implications from those under Alternative 3.

Consequences to the Physical Environment

Potential adverse impacts are the same as those identified under Alternative 3 (Section 4.11.1.3).

Consequences to the Biological Environment

Potential adverse impacts are the same as those identified under Alternative 3 (Section 4.11.1.3).

Consequences to the Socioeconomic Environment

Potential adverse impacts are the same as those identified under Alternative 3 (Section 4.11.1.3).

4.11.1.5. Alternative 5–No Increase in Mechanical Recovery Capability, Establish On-Water Dispersant Application Capability (Option B), Establish In Situ Burn Credit, and Establish and Maintain Aerial Tracking Capability

Under Alternative 5, there would be no increase in on-water mechanical recovery capability. On-water dispersant capability (Option B) and an *in situ* burn credit would be established. In addition, aerial tracking capability would be established and maintained. The cost and benefit analysis performed for the regulatory analysis determined that for Alternative 5, the NPV at 7% of total national cost is $91.32 million (USCG, 2008).

Current availability of on-water mechanical recovery and *in situ* burn capabilities would remain unchanged since current levels of mechanical recovery capability would exceed the new requirement levels. On-water dispersant capability would be available in all six geographic regions considered in this PEIS. The amount of dispersant required in Tier 1 is slightly reduced, but the difference was considered to be inconsequential for this analysis. Thus, there would be no change in the implications from those under Alternative 3.

Consequences to the Physical Environment

Potential adverse impacts are the same as those identified under Alternative 3 (Section 4.11.1.3).

Consequences to the Biological Environment

Potential adverse impacts are the same as those identified under Alternative 3 (Section 4.11.1.3).

Consequences to the Socioeconomic Environment

Potential adverse impacts are the same as those identified under Alternative 3 (Section 4.11.1.3).

4.11.1.6. Alternative 6–No Increase in Mechanical Recovery Capability, Establish On-Water Dispersant Application Capability (Option B), and Establish and Maintain Aerial Tracking Capability [Preferred Alternative]

Under Alternative 6, there would be no increase in on-water mechanical recovery capability. On-water dispersant capability (Option B) would be established. In addition, aerial tracking capability would be established and maintained. The total national cost is expected to be similar to that for Alternative 5.

Current availability of on-water mechanical recovery capabilities would remain unchanged since current levels of mechanical recovery capability would exceed the new requirement levels. On-water dispersant capability would be available in all six geographic regions considered in this PEIS. The amount of dispersant required in Tier 1 is slightly reduced, but the difference was considered to be inconsequential for this analysis. Thus, there would be no change in the implications from those under Alternative 3.

Consequences to the Physical Environment

Potential adverse impacts are the same as those identified under Alternative 3 (Section 4.11.1.3).

Consequences to the Biological Environment

Potential adverse impacts are the same as those identified under Alternative 3 (Section 4.11.1.3).

Consequences to the Socioeconomic Environment

Potential adverse impacts are the same as those identified under Alternative 3 (Section 4.11.1.3).

4.11.2. Preferred Alternative

Alternative 6 is the USCG preferred alternative. This alternative would produce the same increase in oil treated as Alternatives 3 - 5 because it requires the same quantity of dispersant application equipment. The historical oil spill data in Section 2.8 indicates a considerable increase in the percentage of oil spills that could be responded to under Alternatives 3 - 6 when compared with that under Alternatives 1 and 2. In addition, as stated in Chapter 2, since the increase in mechanical recovery equipment (under Alternatives 2, 3, and 4) and the credit for *in situ* burn equipment (under Alternatives 3, 4, and 5) would not increase the quantity of oil removed or treated, requiring those additional capabilities does not offset the costs incurred in establishing and maintaining them. Alternative 6 provides the largest potential net environmental benefit and meets the objectives of the USCG to increase the response plan equipment capability requirements for tank vessels and MTR facilities, protect the marine environment, and promote maritime safety at reasonable cost and with substantial benefit.

4.11.3. Regional Net Beneficial and Adverse Impacts of the Alternatives

As described above, the net adverse and beneficial environmental impacts depend on the size and location of the oil spill, and the effectiveness of the response option used. The net adverse or beneficial impacts of the response alternatives are determined by comparing the potential adverse regional impacts for each of the alternatives. Since Alternative 1 represents the basic response scenario or the currently available oil spill response capability in each region, Alternatives 2 through 6 are compared to Alternative 1 to ascertain the net adverse or beneficial impacts of each alternative. For example, an improvement in the level of concern from a significant adverse impact to a minor adverse impact indicates that the response option employed had a net beneficial impact on reducing the adverse impact of the oil spill. As explained above, the potential regional adverse impacts associated with Alternatives 1 and 2 are equivalent, as are the potential impacts associated with Alternatives 3, 4, 5, and 6. Thus, the net adverse or beneficial impacts were determined by comparing the potential regional adverse impacts of these two sets of alternatives.

4.11.3.1. Net Beneficial Impacts

A net beneficial impact occurs under Alternatives 3, 4, 5, or 6 (which would ensure the uniform availability of dispersant capability in each region) in certain regions and certain spill sizes for several biological resources and one socioeconomic resource listed below:

- **Marine and coastal birds:** Atlantic region (medium spill sizes), Pacific region (small spill sizes), and Oceania region (small spill sizes)
- **Intertidal habitats:** Atlantic region (medium spill sizes and large [45 percent dispersant efficiency] spill sizes), Caribbean region (medium spill sizes), Gulf of Mexico region (medium spill sizes), Pacific (small and medium spill sizes), Alaska region (medium and large spill sizes), and Oceania region (small and medium spill sizes)
- **Sea turtles:** Caribbean region (large spill sizes), Gulf of Mexico (medium spill sizes), and Oceania region (medium spill sizes)
- **Areas of special concern:** Atlantic region (medium spill sizes and large [45 percent dispersant efficiency] spill sizes), Caribbean region (medium spill sizes), Gulf of Mexico region (medium spill sizes), Pacific region (small and medium spill sizes), Alaska region (medium spill sizes), and Oceania region (small and medium spill sizes)
- **Environmental justice:** Caribbean (large spill sizes) and Oceania region (large spill sizes)

4.11.3.2. Net Adverse Impacts

A net adverse impact occurs under Alternatives 3, 4, 5, or 6 (which would ensure the uniform availability of dispersant capability in each region) in certain regions and certain spill sizes for one physical, two biological, and one socioeconomic resource listed below:

- **Coastal water quality:** Caribbean region (large spill sizes), Pacific region (medium and large spill sizes), and Alaska region (medium and large spill sizes)
- **Plankton and fish:** Pacific region (large spill sizes)
- **Essential Fish Habitat:** Pacific region (large spill sizes)
- **Subsistence:** Atlantic region (large spill sizes), Caribbean region (small, medium, and large spill sizes), Gulf of Mexico (large [80 percent dispersant efficiency] spill sizes), and Pacific region (medium [80 percent dispersant efficiency] spill sizes and large spill sizes)

For the remainder of the resources, we analyzed a comparison of the alternatives and found that the potential adverse impacts would remain at the same impact level as under the currently available response option.

4.11.4. National Net Beneficial and Adverse Impacts of the Alternatives

Oil spill impacts on U.S. waters are mostly localized and generally short lived; therefore, the potential benefits associated with a reduction in oil spill impacts would also be localized and short lived. The potential benefits associated with the reduction in floating or stranded oil resulting from the alternatives are thus localized and short lived, and insignificant from a national standpoint. For the resources analyzed, the impacts were assessed on a regional level. The national-level impacts are extrapolated from the regional-level findings. Any change in the net beneficial or adverse impact levels can be attributed to a particular region and are expected to be localized; therefore, national impacts are unlikely to result from even the largest spill scenarios.

Table 4.11-1
Summary of Potential Adverse Regional Impacts of Offshore Oil Spills* under All Alternatives in the Six Geographic Regions Considered in This PEIS

		Resources of Concern																			
		Physical Environment			**Biological Environment**								**Socioeconomic Environment**								
Response Alternative	**Spill Size**	**Coastal Water Quality**	**Marine Water Quality**	**Air Quality**	**Marine Mammals†**	**Marine and Coastal Birds†**	**Plankton and Fish†**	**Intertidal Habitats**	**Subtidal Habitats**	**Sea Turtles†**	**Areas of Special Concern**	**Essential Fish Habitat**	**Coastal Communities, Demography, and Employment**	**Economic Status**	**Vessel Transportation and Ports**	**Fisheries**	**Subsistence**	**Archaeological/Historic Resources**	**Recreation and Tourism**	**Environmental Justice**	**Public Safety and Worker Health**
Alternative 1, 2	Small	Ins	Ins	Ins	Min	Mod	Ins	Ins–Mod	Ins	Min	Ins–Mod	Ins	Ins–Min	Ins–Min	Ins	Ins–Min	Ins	Ins	Ins	Ins–Min	Ins
	Medium	Ins–Min	Ins	Ins	Min–Mod	Mod	Ins–Min	Ins–Sig	Ins–Mod	Min–Mod	Ins–Sig	Ins–Mod	Ins–Min	Ins–Min	Ins	Ins–Mod	Ins–Min	Ins	Ins	Ins–Mod	Ins
	Large	Min–Mod	Ins	Ins	Min–Mod	Mod–Sig	Ins–Min	Mod–Sig	Ins–Mod	Min–Mod	Mod–Sig	Ins–Mod	Ins–Min	Ins–Min	Ins	Ins–Sig	Ins–Mod	Ins	Ins	Ins–Sig	Ins
Alternative 3, 4, 5, 6‡	Small	Ins	Ins	Ins	Min	Ins–Mod	Ins	Ins–Mod	Ins	Min	Ins–Mod	Ins	Ins–Min	Ins–Min	Ins	Ins–Min	Ins–Min	Ins	Ins	Ins–Min	Ins
	Medium	Ins–Min	Ins	Ins	Min–Mod	Min–Mod	Ins–Min	Ins–Mod	Ins–Mod	Min	Ins–Mod	Ins–Mod	Ins–Min	Ins–Min	Ins	Ins–Mod	Ins–Min	Ins	Ins	Ins–Mod	Ins
	Large	Min–Mod	Ins	Ins	Min–Mod	Mod–Sig	Ins–Mod	Min–Sig	Ins–Mod	Min–Mod	Min–Sig	Ins–Mod	Ins–Min	Ins–Min	Ins	Ins–Sig	Min–Mod	Ins	Ins	Ins–Sig	Ins

Note: Based on the risk ranking tables for each region in Sections 4.5 and 4.7. Small, 200 bbl; medium, 2,500 bbl; and large, 40,000 bbl. Sig, significant; Mod, moderate; Min, minor; and Ins, insignificant.

* Average spills.

† Risk to threatened, endangered, or candidate species are derived from the scores for marine mammals, marine and coastal birds, fish, and sea turtles (sea turtles are not considered in the Alaska region).

‡ Range for Alternatives 3, 4, 5, and 6. Alternative 3 dispersant Option A requires slightly less delivery capacity under Tier 1 (0–12 hours) than Alternatives 4 and 5 dispersant Option B. For the purpose of this analysis, however, the USCG estimated the amount of oil that could be treated during response operations based only on Option B. This was done to simplify the analysis and ensure that the highest potential levels of exposure to dispersants and dispersed oil in the water column were considered.

4.12. UNAVOIDABLE ADVERSE IMPACTS OF THE PROPOSED ACTION

The analysis of the alternatives, including Alternative 1, shows that no significant adverse environmental impacts are expected to occur. Minor to moderate adverse impacts could occur for some resources; however, these unavoidable impacts are expected to be localized and short lived. The six alternatives would result in oil spill response storage and maintenance activities. However, the oil spill response community has resources available to satisfy the requirements of all alternatives[64]. The negligible adverse impacts associated with the facilities used for storage and maintenance would be equivalent in significance to those associated with low-intensity industrial development. In the event of an oil spill, the alternatives would influence what response options are immediately available for consideration by the oil spill response community. Based on the analysis of the alternatives, it is expected that all available response options have the potential to reduce the unavoidable adverse impacts associated with an oil spill, relative to the natural recovery of the spill area. The final decision concerning the use of the response options is the FOSC's responsibility. The FOSC would select those response options that have the higher potential to minimize adverse environmental impacts.

4.13. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Based on the relatively infrequent occurrence of oil spills and the nature of the alternatives, implementing the alternatives would not result in a significant commitment of resources beyond those already in place, and in no case would the commitment amount to important irreversible or irretrievable losses. Currently, the oil spill response community has resources available to satisfy all alternatives[65]. However, implementing a response operation would require a commitment of these resources, as well as energy resources required for deployment. Any alternative, including Alternative 1, would require the maintenance and uniform availability of a relatively limited supply of oil spill response equipment and associated infrastructure. This would result in the utilization of nonrenewable resources; however, the demand that this would place on environmental resources is expected to be minimal when compared with national demand from all economic sectors.

4.14. RELATIONSHIP BETWEEN THE SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The objective of the alternatives is to improve the nation's ability to respond to oil spills, thereby minimizing the extent of potential adverse environmental impacts. The results of the analysis of the alternatives, including Alternative 1, show that no significant adverse short-term impacts are expected to occur beyond those adverse impacts that already occur during and after an oil spill. Alternatives 3 through 6 are the only alternatives that modify the current conditions. Before an oil spill occurs, the implications of these alternatives are restricted to making response aircraft for dispersant application and response vessels for mechanical or *in situ* burn equipment uniformly available. When an oil spill occurs, the six alternatives have the potential, when used appropriately, to mitigate the potential long-term loss of productivity that might result from the adverse environmental impacts of the spilled oil. The results of the analysis for the alternatives indicate that there would be an environmental benefit from any of the response options that are available. This potential environmental benefit would be more evident when chemical dispersion is used in the current pre-authorization agreement areas (Figure 2.2-1), thus potentially reducing the adverse impacts on the shoreline and on sensitive organisms that congregate on the water's surface. Both of these habitats are highly vulnerable to spilled oil and can lead to adverse impacts that can last, in some cases, for decades. Ultimately, however, even severe oil spills are recoverable events, and the actions available under any alternative have the potential to enhance the rate of recovery.

4.15. CUMULATIVE IMPACTS

Council on Environmental Quality (CEQ) regulations that implement the procedural provisions of NEPA define a cumulative impact as "the impact on the environment, which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR § 1508.7). Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. The combination of different stresses on the environment, coupled with individually minor effects of multiple actions over time, can result in significant adverse environmental impacts on physical, biological, and socioeconomic resources. Thus, the analysis of cumulative impacts is a critical component of the NEPA process.

The significance of an action's cumulative impacts depends on how they compare with the environmental baseline and relevant resource thresholds (e.g., regulatory standards) (CEQ, 1997). The determination of the environmental baseline requires the identification of the current level of impacts on specific resources of concern, which are selected based on the potential for significant cumulative impacts. This includes the identification of relevant past, present, and reasonably foreseeable actions, and the consideration of past, present and future impacts associated with those actions (e.g., fishing, habitat degradation, coastal development, coastal pollution, and nonindigenous aquatic species). The analysis of cumulative impacts of an action requires delineating the relationships between multiple actions and the environmental and socioeconomic resources of concern, and the determination of the magnitude and significance of cumulative effects on those resources. To determine the cumulative impacts of the action on the resources of concern, potential impacts from the action should be placed in the context of the impacts associated with other actions, to determine which cumulative environmental changes result from the proposed action and other actions. This allows the development of overall conclusions regarding potential cumulative impacts from the action to those specific resources (CEQ, 1997).

4.15.1. Cumulative Impacts on Coastal and Marine Resources

This section defines the environmental baseline for determining cumulative impacts by presenting a summary of national status and trends of marine and coastal resources in the United States, and the main national issues and threats that affect specific resources. Firstly, a brief summary of the value of U.S. coastal and marine resources is presented. Secondly, an overview is provided of the status and main environmental issues surrounding U.S. coastal and marine resources. Lastly, an overview of the status, trends, and main threats to those resources identified as having the largest potential for cumulative effects is presented. These resources were selected based on their value, sensitivity, and current and projected impacts from other actions. The selected resources are water quality, coastal and estuarine resources, coral reef ecosystems, fish resources and commercial and recreational fisheries, and marine and coastal wildlife.

4.15.1.1. Value of Coastal and Marine Resources

U.S. waters cover a broad range of physical and biological conditions, from warm tropical to cold Arctic waters and coastal to oceanic environments that support a wide variety of marine resources and wildlife. The living organisms that compose marine and coastal resources, and the ecological processes that sustain them, form a foundation for the quality of human life. They provide food, medicines, and industrial products, with great scope for developing new or improved products. In addition, marine and coastal resources are subjects for research and education, and provide spiritual and recreational benefits that are highly valued by an increasing number of people.

Marine and coastal resources provide a wide variety of ecological services, including pollutant absorption, climate regulation, prevention of coastal and seabed erosion, maintenance of water quality, and storage and recycling of nutrients, and are indicators of global, regional and local environmental change. For example, coastal areas provide critical habitats that serve as spawning grounds, nurseries, shelter, and food for finfish, shellfish, birds, and other wildlife. Coastal resources also provide nesting, resting, feeding, and breeding habitat for 85 percent of waterfowl and other migratory birds (USEPA, 2004). Healthy estuaries are a rich source of nutrients and food that support the estuary and adjacent coastal waters, and often support valuable fisheries as a result. Marshes trap sediments and filter nutrients and chemicals from the water. Coral reefs provide physical structure, food, and protection for a great diversity of marine species, and the coral itself is composed of calcium carbonate that has been produced by animals and plants in a process that sequesters large quantities of carbon dioxide from the environment. In summary, marine and coastal resources provide essential economic, environmental, aesthetic, recreational, and cultural benefits to society.

Coastal and marine resources provide tremendous value to the U.S. economy. In 2000, ocean-related activities directly contributed more than $117 billion to the economy and supported more than 2 million jobs. By including coastal activities, more than $1 trillion, or one-tenth of the nation's annual GDP, is generated within the nearshore zone. Annually, U.S. ports handle more than $700 billion in merchandise, while the cruise industry and its passengers account for another $12 billion in spending. It is estimated that more than 13 million jobs are connected to maritime trade. Offshore oil and gas operations continue to expand, and annual production is valued at between $25 and $40 billion. In addition, ocean exploration has led to a growing industry in marine-based products and pharmaceuticals. Fisheries are an important source of economic revenue and employment and constitute an important cultural heritage for fishing communities nationwide. The commercial use of U.S. waters provides about 5 percent of the world's fisheries production, making the United States the fifth largest producer of seafood in the world (USGS, 1999). The commercial fishing industry's total annual value exceeds $28 billion, and the saltwater recreational fishing industry is valued at approximately $20 billion. Finally, tourism and recreation is one of the nation's fastest growing business sectors, providing economic revenue and employment in virtually all coastal areas across the United States (USCOP, 2004).

4.15.1.2. National Status and Environmental Issues

General Overview

The structure and function of marine and coastal ecosystems—and their overall health—are adversely affected by increased stress from human activities, which have altered these systems for a long period of time. However, the scale, intensity and rate of human activities and associated impacts has significantly increased in the past century, as a consequence of, among other things, growing populations, higher levels of consumption, and technological advances. For example, human population concentration in coastal areas is expected to continue to increase with time, increasing the potential for human impacts. Human impacts on marine and coastal resources have resulted in declines in natural systems and populations as a result of habitat destruction and resource exploitation, increases in harmful events such as disease epidemics and algal blooms, and issues associated with coastal and marine pollution.

Human impacts on marine and coastal resources are significant and are expected to continue to increase as the scale of human activity increases. Examples of human influences on marine and coastal resources include the release of toxic effluents, habitat degradation, eutrophication of coastal ecosystems as a result of excessive nutrient loading in coastal ecosystems (particularly along the Atlantic and Gulf coasts), harmful algal blooms, emergent diseases, fallout from aerosol contaminants, coral reef bleaching, nonindigenous aquatic species, and losses of living marine resources from pollution effects and overexploitation (USGS, 1999). The cumulative effect of these impacts has resulted in changes in marine and coastal biodiversity and resource sustainability.

Examples of documented impacts include the fluctuations in fisheries yields across the United States; the crash of the Northeast groundfish fisheries; the extinction of a once overabundant U.S. native Atlantic salmon commercial fishery (Montgomery, 2003); the poor welfare of some Pacific coast salmon stocks; declines in some marine mammal populations; reduced oxygen levels caused by excessive nutrient loadings within the northern Gulf of Mexico from the Mississippi River drainage basin that have been linked to extensive die-offs of coastal fishes; excessive nutrient loadings from river basin drainages within the Northeast shelf ecosystem that may be the cause of the growing frequency and extent of harmful algal blooms and the emergence of marine mammal and human pathogens; and changes in the gene pool of wild stocks from inadvertent releases of cultured stocks (USGS, 1999).

A range of human activities affects living marine resources, including fish, marine mammals, sea turtles, and marine and coastal birds. Increasingly intensive fishing efforts, in conjunction with the use of more sophisticated fishing gear and electronics, have resulted in gross overfishing of some marine populations. An impact associated with fishing is by-catch, or the taking of nontarget organisms during fishing operations. Another major concern is the impact on threatened and endangered species. A recent example is the impacts on salmon runs in Pacific coast streams where the use of river waters for irrigation, power generation, and domestic consumption by large urban areas has compromised these streams and the survival of the salmon runs (USGS, 1999).

Habitat alterations have taken place in rivers and estuaries, as well as in coastal zones, as a result of urbanization. Urbanization results in alteration of freshwater flows, erosion, introduction of toxic chemicals and other contaminants into the waters, introduction of nonindigenous species, and degradation of the marine habitats essential to the survival of living marine resources. Approximately 50 percent of the U.S. population lives close to major freshwater systems such as the Great Lakes or to coastal waters. There are numerous demographic trends that suggest these conditions and threats are not likely to change in the immediate future. Thus, as the nation grows, further growth in coastal zones is expected. Coastal development often alters coastal and marine ecosystems and affects living marine resources (USEPA, 2004).

Water Quality

Coastal and marine water quality is threatened by multiple sources of pollution, including point, nonpoint, and atmospheric sources; vessels; nonindigenous species; and waste being washed onto coastal areas and into the ocean (USCOP, 2004). Over the last few decades, important steps have been made in reducing water pollution from point sources; however, some point sources of pollution like wastewater treatment plants, sewer system overflows, industrial facilities, and animal feeding operations continue to contribute to coastal and marine water-quality problems across the United States. In addition, nonpoint sources like agricultural runoff have not been successfully addressed. It is estimated that nonpoint sources are a factor in 90 percent of all incidents nationwide where water quality is determined to be below the standard set for specific activities, such as recreation, water supply, aquatic life, or agriculture (USCOP, 2004).

Coastal and Estuarine Resources

Overall, the nation's estuaries are in fair condition, with poor conditions in the Northeast coast and Puerto Rico, and fair conditions in the Southeast, Gulf, and West coasts (USEPA, 2004). This rating is based on five indicators of ecological condition: water-quality index (including dissolved oxygen, chlorophyll a, nitrogen, phosphorus, and water clarity), sediment quality index (including sediment toxicity, sediment contaminants, and sediment total organic carbon [TOC]), benthic index, coastal habitat index, and fish tissue contaminants index. Twenty-one percent of resources are unimpaired (good condition); 35 percent are impaired (poor condition); and 44 percent are threatened (fair condition) for aquatic life use or human use. The indicators that show the poorest conditions throughout the United States are coastal habitat condition, sediment quality, and benthic condition. The indicators that generally show the best condition are the individual components of water quality—dissolved oxygen and dissolved inorganic nitrogen [DIN] (USEPA, 2004).

Estuaries are bodies of water that provide transition zones between the fresh water of rivers and the saline environment of the ocean. This interaction produces a unique environment that supports wildlife and fisheries and contributes substantially to the economy of the United States.

Humans place a high value on estuarine areas for living, working, and recreation. Estuaries provide cooling waters for industry and energy production and sites for aquaculture; accommodate the needs of large ships and tanker traffic; buffer coastal areas against storm and wave damage; provide wetlands and bottom habitat; supply space for coastal development; and accumulate pollutants from the rivers and streams entering coastal waters. Estuarine areas are among the most densely populated and heavily used areas in the United States and are home to an estimated 45 percent of the country's human population (USGS, 1999). As human populations grow, demands for increased use of estuarine resources are expected to continue.

Habitat degradation and loss affect mostly coastal and estuarine ecosystems. The primary threats are wetland destruction, alteration of freshwater flows, toxic chemicals, and nutrient overenrichment. Alterations to the freshwater input through damming and diversions of major rivers have affected coastal ecosystems adapted to seasonal discharges of freshwater. Loss of aquatic plant-based habitats (wetlands, eelgrass, and kelp beds) resulting from development, such as for marinas and docking facilities, adversely affects a variety of food webs that are important to adults and juveniles of several marine and anadromous species. Dredging and dredge disposal in estuaries and bays also cause significant habitat destruction. Marine ecosystems are damaged by habitat loss or alterations in rivers, such as effects due to forestry, industrial, and agricultural practices (e.g., excess sedimentation, hydroelectric dams). Estuaries and coastal systems near urban areas are degraded by runoff from farmlands and by urban development. Much of the contaminant input to waters consists of organic substances having nutritional value for phytoplankton, which form the base of the food chain. Nitrogenous substances—a range of carbohydrates and fats, phosphates, and other nutrients from atmospheric contamination or discharges to rivers in the coastal zone—result in nutrient enrichment and then phytoplankton blooms. For example, some of the greatest stocks of phytoplankton and highest rates of primary production occur in coastal waters off the New York Bight, enriched by ocean dumping and nonpoint sources (USGS, 1999).

Marine organisms have been transported from their original ranges to new localities since the beginning of maritime transportation. Many of these introductions have been beneficial to humans as food sources, but introduced organisms can also affect indigenous species, threaten human health, and create financial burdens on human societies (OTA, 1993). The increasing alteration of ecosystem structure and function in estuaries and other coastal habitats by nonindigenous species has become an issue of great concern. For example, Asian clams introduced to San Francisco Bay filter plankton from water so efficiently that they capture much of the region's productivity, thus reducing the ability of the ecosystem to sustain its original biological diversity, as well as valuable fisheries production. Unintentional aquatic introductions continue to increase and include the release of ornamental organisms from the aquarium trade, the accidental release of cultured species, and the release of species into new areas by transport via ballast water. Nonindigenous organisms are difficult or impossible to eradicate once they become established (OTA, 1993). Thus, reducing the spread of nonindigenous aquatic species and controlling the effects of introduced species already established are conservation problems of growing importance.

Coral Reef Ecosystems

Coral reef ecosystems can be classified in two broad categories: pristine coral reefs and coral reefs at risk (USGS, 1999). Pristine coral reef ecosystems are those in remote locations with little or no human threat to ecosystem health. By definition (and with minor localized exceptions) the status of these ecosystems is good and the trend in health is steady. Areas under U.S. jurisdiction with pristine coral reef ecosystems include the Flower Garden Banks in the Gulf of Mexico and the uninhabited Northwest Hawaiian Islands, Wake Island, the Commonwealth of Northern Mariana Islands (CNMI) (except Saipan), Palmyra Atoll and Kingman Reef, Howland Island, Baker Island, and Jarvis Island in the Pacific Ocean (USGS, 1999).

Coral reef ecosystems at risk are located near human population centers, with some or all of the reefs experiencing local anthropogenic stress. Some important sources of stress include nutrient enrichment from sewage and agriculture; overfishing; coral reef bleaching; and high sedimentation caused by deforestation, agriculture, vessel traffic, and coastal runoff. The status of many coral reefs within these areas is poor, and the trends in their health are declining. Coral reef ecosystems at risk within U.S. jurisdiction include the Florida reef tract (Puerto Rico and the U.S. Virgin Islands in the western Atlantic and Caribbean) and the inhabited parts of the main Hawaiian Islands, Johnston Atoll, Guam, Saipan, and American Samoa in the Pacific Ocean (USGS, 1999).

Fish Resources and Commercial and Recreational Fisheries

Fishery resources are those taken for their commercial and recreational value. The Food and Agriculture Organization (FAO) of the United Nations ranked the United States fifth in the world for fisheries landings (NMFS, 1999). The U.S. catch was 4.5 percent of the world's total catch (121 million metric tons [t]) of marine and freshwater fisheries products. The FAO also ranked the U.S. second in value for world imports (12.5% of the $56.9 billion world total) and third in value for world exports of fish and fishery products including aquaculture (5.6% of the $52.9 billion international trade) in 1996 (NMFS, 1999). By region, the percentage distribution of recent average catches for that year was 12 percent for the Northeast, 19 percent for the Southeast, 11 percent for the Pacific coast, 55 percent for the Alaska, and 3 percent for the Western Pacific.

Overfishing is recognized as a potential threat to living marine resources. Examples of many overfished stocks can be found throughout the country. Many are disproportionately affected by fishing because of their low populations in relation to more abundant target species. Despite more stringent federal and state regulations to control overfishing and protect fishing resources throughout the United States, fishing resources continue to decline—some naturally, some through habitat change, and some through excessive fishing efforts. Destructive fishing methods damage habitat in coastal and marine areas. In the past, extremely damaging fishing practices (with explosives or poisons) were prevalent in the Pacific Islands. Less extreme habitat-destructive harvest methods such as trawling are also of concern. In contrast, habitat alterations—for example, artificial reefs—can be purposefully beneficial to living marine resources.

Since nearshore species around the entire U.S. coast fall under varied jurisdiction and data collection regimes, it is difficult to assess their status. Management authority is typically a regional, state, or local responsibility because most fisheries occur within the 3-nm interior boundary to the federally controlled EEZ. Generally, Atlantic oysters, hard clams, softshell clams, bay scallops, and abalones are overutilized, at least in part of their ranges. Fully utilized resources include Pacific shrimps and clams, Dungeness crab, blue crab, and calico scallop (USGS, 1999). Three historically important groundfish species—cod, haddock, and yellowtail flounder—on Georges Bank off New England are currently among the most overfished stocks in U.S. waters. Haddock and yellowtail flounder are classified as collapsed by virtue of their current low abundance due to prolonged excessive fishing pressure. The cod stock was in imminent danger of collapse in 1994, but drastic management measures reduced the fishing mortality rate by 83 percent and improved spawning stock biomass by 48 percent from 1994 to 1996. The cod stock, however, is still considered overexploited and at low population levels (USGS, 1999). In addition, the Atlantic salmon, a highly prized game and food fish native to New England rivers, had a historic North American range that extended from the rivers of Ungava Bay, Canada, to Long Island Sound. As a result of industrial and agricultural development, most populations native to New England have been extirpated. Remnant native populations of Atlantic salmon in the United States now persist only in eastern Maine. Restoration and rehabilitation efforts, in the form of stocking and fish passage construction, are underway in the Connecticut, Pawcatuck, Merrimack, Penobscot, and eastern Maine Rivers of New England (NOAA, 2001b).

All five species of Pacific salmon—chinook, coho, sockeye, pink, and chum, which begin their lives in the rivers and streams of Washington, Oregon, and California—are considered overfished. However, the main cause for their decline appears to be related to freshwater habitat alterations, such as water diversion and river-stream blockage by hydroelectric dams, which cause severe restrictions on upstream (adult spawning) and downstream (juvenile migration to the ocean) movements (USGS, 1999). In the Gulf of Mexico, king mackerel was severely depleted because of excessively high catches in the late 1970s and early 1980s. Red snapper, traditionally the most important reef fish in the Gulf, is taken mainly as incidental catch in the shrimp fishery and its stock is highly depleted (USGS, 1999).

The incidental take of nontarget species in fishing operations reflects the fact that aquatic species do not live in pure, discrete, exploitable patches but as members of interconnected communities. For example, groundfish fisheries have notoriously visible by-catch problems. These fisheries, whether using trawl gear, longlines, or pot gear, catch and discard large volumes of animals that are of the wrong size, species, maturity stage, or other distinguishing factor. By-catch in these fisheries may be a serious threat to species already low in abundance (NMFS, 1999).

Additionally, estuaries are critical for many of the nation's commercial and recreational fisheries. For example, the species making up the top four fisheries in the Gulf of Mexico—shrimp, menhaden, oyster, and blue crab—use estuaries extensively, and the quantity, quality, and timing of freshwater inflow to these areas can be particularly important to the within-year and between-year success of these fisheries. In addition, several of the most valuable south Atlantic fisheries—shrimp, blue crab, hard clam, and summer flounder—are also estuarine dependent. In the north Atlantic region, softshell clam, Atlantic salmon, Atlantic herring, winter flounder, and other fishery species require or prefer estuarine areas at some time of the year. Although the relative area of estuarine habitat in the Pacific region is small, three of the top five most valuable fisheries—salmon, Dungeness crab, and oyster—are all estuarine dependent (USGS, 1999).

Mollusks are of special concern in estuaries because they are sessile. In 1990, more than 69,000 km^2 of estuarine waters nationwide were classified as shellfish harvest areas (USGS, 1999). However, many areas were occasionally restricted for harvest because of public health threats from bacterial or viral contamination. Urban stormwater runoff, sewage treatment plant effluent, agricultural runoff, and increased boating activity are the primary causes of harvest restrictions.

Marine and Coastal Wildlife

Approximately 163 stocks of at least 62 species of marine mammals are found within U.S. waters (USGS, 1999). The U.S. Fish and Wildlife Service (USFWS) manages stocks of North Pacific walrus, Alaska polar bear, West Indian manatee, and Alaska and California sea otters, and the National Marine Fisheries Service (NMFS) is responsible for the remaining cetaceans and pinnipeds (155 stocks, including 10 eastern tropical Pacific dolphins). The 1994 amendments to the Marine Mammal Protection Act (MMPA) identified strategic stocks as those that are listed as threatened or endangered under the ESA or that are declining and likely to be listed in the foreseeable future, those designated as depleted under the MMPA (that is, below the optimal sustainable population level), and those for which human-caused mortality exceeds the estimated replacement yield. Of the 153 marine mammal stocks managed under Section 117 of the MMPA (using 1995 totals), 54 are classified as strategic. These include two stocks that are depleted under the MMPA, four that are listed as threatened and 24 listed as endangered under the ESA. In addition, two of ten stocks of eastern tropical Pacific dolphins managed under Section 104(h) of the MMPA are listed as depleted. Of the total 163 marine mammal stocks in U.S. waters, there is sufficient long-term population information to describe trends for only 55 stocks (33%); the status of the remaining 108 stocks (66%) is unknown. Of those for which information is available, 24 (15%) are known to be increasing, 8 (5%) are declining, and 23 (14%) are believed to be stable (USGS, 1999).

ESA status for all species of sea turtles remains unchanged from their initial listings in the 1970s, but trend data and population estimates have been developed to aid in the identification and monitoring of sea turtle populations in U.S. waters. Population increases have been observed for green turtles throughout their range in U.S. waters, the loggerhead in central-southwest Florida, and the olive ridley in the Pacific. Conservation efforts have reversed the annual rate of decline for the Atlantic Kemp's ridley to a sustained increase in the number of nests. The leatherback has gone from unknown status to stable in the Atlantic Ocean but declining in the Pacific Ocean. In the Pacific Ocean, the loggerhead and hawksbill have gone from unknown status in 1992 to stable. However, other species such as loggerhead stocks from Florida to North Carolina in the Atlantic Ocean and the Florida Panhandle in the Gulf of Mexico, and the hawksbill in the Atlantic Ocean are now in declining or unknown status (NMFS, 1999).

The ecological effects of commercial fisheries on marine birds and mammals are still largely unknown. Estimates of marine mammal kills by direct interactions with fishing gear are generally low for most U.S. fisheries; however, there are significant fisheries-related mortalities of some marine mammals. The magnitude of direct kills of marine birds due to interactions with fishing activities is not well known (USGS, 1999). However, there are other indirect threats to marine and coastal birds and marine mammals from fisheries, including competition for food. Marine birds and mammals consume a wide variety of fish species, some of which are commercially important. For example, many marine mammals in Alaska, particularly seals and sea lions, consume juvenile groundfish, whereas fisheries tend to target adult-sized groundfish. Thus, although direct competition for prey is reduced, commercial fisheries may disrupt prey availability through by-catch of small fish, removal of spawning fish, or general disruption of the food web (USGS, 1999).

In addition, fish-processing waste can alter the feeding habits of some marine and coastal birds and marine mammals. For example, gulls, sea lions, bottlenose dolphins, and killer whales feed on fish wastes discharged by processing vessels and plants. Disposal of this waste at sea may create an artificial dependency that is not beneficial for the long-term well-being of the species. Finally, increases in predator populations such as gulls resulting from this supplemental feeding may be detrimental to populations of their prey, such as other marine and coastal birds, and the increase in their population may also result in displacement of other bird species by increased competition for nesting areas (USGS, 1999).

Marine debris—mostly generated inshore—pollutes U.S. coastal and marine areas, with potential impacts on marine and coastal birds and marine mammals through entanglement and ingestion. At least 135 species of marine vertebrates and 8 invertebrates have been reported entangled in marine debris. The list includes most of the world's sea turtle species, more than 25 percent of marine mammal species, and more than 15 percent of marine and coastal bird species (USGS, 1999). Ingestion of marine debris can also be a serious threat to wildlife. Sea turtles mistake clear plastic bags for jellyfish, one of their favorite meals. Marine and coastal birds mistake plastic pellets for fish eggs. In other instances, animals can accidentally ingest plastic in association with natural food. Ingested debris damages the digestive tract, causes starvation by blocking food, may be toxic, and often kills marine animals (USGS, 1999).

4.15.2. Cumulative Impacts Associated with the Alternatives

This section summarizes the cumulative impacts of the alternatives analyzed in this PEIS. As stated in the introduction to Section 4.14, to determine the cumulative impacts of the alternatives on the resources of concern, potential impacts from the alternatives should be placed in the context of the impacts associated with other actions, to determine the total cumulative environmental changes, as well as which changes result from the alternatives and which result from other actions. Firstly, a historical background on oil spills and oil spill response is presented. Secondly, a summary of the national-level impacts of the alternatives is provided. Lastly, overall conclusions regarding the potential cumulative impacts from the alternatives and all other actions to the resources presented in Section 4.15.1 are summarized.

Petroleum input into North American waters comes from four main sources: (1) natural seeps, a natural phenomena that occurs when crude oil seeps from the geological strata beneath the seafloor to the overlying water column; (2) petroleum extraction activities, which can result in the release of crude oil and refined products as a result of human activities associated with efforts to explore for and produce petroleum; (3) petroleum transportation, which can result in oil spills associated with tanker accidents and operational releases; and (4) petroleum consumption (NRC, 2003). The focus of this PEIS is on the analysis of the environmental consequences of oil spill response regulations for vessel response plans and marine transportation-related (MTR) facility response plans.

Large oil spills associated with petroleum transportation are rare events; the *Response Plan Equipment Caps Review* (USCG, 1999) identified only 231 spills (over 1,000 gal) from 1993 to 1998 that occurred in the marine coastal environment in the United States. Tank vessel spills represent approximately 2 percent of the petroleum input into North American marine waters (NRC, 2003). While tending to be concentrated around shipping lanes and near ports, oil spills are widely distributed in space and time and represent a very small proportion of the total input. The remaining 98 percent of the petroleum input into North American waters is associated mostly with natural seeps and petroleum consumption activities, and to a lesser degree from petroleum extraction activities. Thus, on the national level, oil spills are not the driving factor in determining the potential impacts associated with hydrocarbon pollution in North American waters. In addition, hydrocarbon pollution impacts have been noted usually in areas beyond the scope of this PEIS, such as harbors or enclosed water bodies with multiple sources of hydrocarbons.

Section 2.8 examines the influence of the alternatives on oil spill response. Under Alternatives 1 and 2, there would be a potential response in 71 percent of all spills (over 1,000 gal) that occur beyond 3 nm from shore. Alternatives 3, 4, 5, and 6 would change the potential response percentage, increasing effective response capability by ensuring that dispersant capability is uniformly available in the all geographic regions, including the four regions—Atlantic, Caribbean, Pacific, and Oceania—where appropriate response times cannot currently be met. Since the use of chemical dispersion is rare, as reflected in its being the only viable alternative for 16 percent of the spills occurring beyond 3 nm from shore, an additional 16 percent of the spills that occur beyond 3 nm from shore could be responded to using chemical dispersion under Alternatives 3, 4, 5, and 6, bringing the total to 87 percent of all spills. The detailed regional-level analysis (see Sections 4.5 and 4.7) shows that chemical dispersion under Alternatives 3, 4, 5, and 6 generally reduces the potential adverse impacts on physical, biological, and socioeconomic resources, leading to a potential environmental benefit from this dispersant use. Overall, no removal action is recommended for approximately 13 percent of spills beyond 3 nm from shore, so natural removal is the preferred strategy.

Historically, chemical dispersion has been used a total of only thirteen times in different locations around the United States since 1969, with eight of these events occurring since 1990. Under alternatives 3, 4, 5, and 6 there would be uniform availability of dispersant capability in all six geographic regions considered in this PEIS. The proposed regulations apply only to waters where pre-authorization agreement areas exist, which are generally demarcated as waters in the United States greater than 3 nm from shore[66]. Finally, since oil spill events are widely distributed in space and time, the use of chemical dispersants will continue to occur at very infrequent intervals (e.g., approximately once every 2 years) and in geographically diverse areas, avoiding potential impacts on water column communities from repeated use in particular regions. Thus, uniform availability of dispersant capability under Alternatives 3, 4, 5, and 6 generally results in a net benefit in existing pre-authorization agreement areas by decreasing the potential adverse impacts on both shoreline and surface water resources without increasing adverse impacts on water column communities to a significant level.

As summarized in Section 4.11, with the exception of commercial and recreational fisheries and environmental justice in the Alaska region, no significant adverse impacts from an oil spill are expected to affect physical and socioeconomic resources under any of the alternatives. Under any of the alternatives, potential adverse impacts from an oil spill are expected to be insignificant to moderate for subtidal habitats, plankton and fish, and Essential Fish Habitat; minor to moderate for marine mammals, and sea turtles; and insignificant to significant for marine and coastal birds, intertidal habitats, and areas of special concern. Alternatives 3, 4, 5, and 6 would ensure the uniform availability of dispersant capability and result in potential net beneficial and adverse impacts. Net beneficial impacts would occur in certain regions for marine and coastal birds, intertidal habitats, sea turtles, areas of special concern, and environmental justice. The net environmental impacts would remain the same for the remainder of the resources with the exception of net adverse impacts in certain regions for coastal water quality, plankton and fish, Essential Fish Habitat, and subsistence resources.

The analysis was performed to determine the significance of potential adverse impacts of each alternative and is based on the assumption that an oil spill has occurred. The impacts summarized above represent the adverse impacts of an oil spill when the alternatives are implemented and the response options defined under each alternative are available for use in the event of an oil spill. The relative reduction of adverse impacts depends on the effectiveness of the response options—mechanical recovery, *in situ* burning, and chemical dispersion—available under each alternative to reduce floating or stranded oil after an oil spill. As discussed in Section 4.15.1.2, any alternative would result in benefits to water quality, coastal and estuarine resources, coral reef ecosystems, fish resources and commercial and recreational fisheries, and marine and coastal wildlife[67].

As discussed previously, large oil spills are rare events, are widely distributed in space and time, and represent a very small proportion of the total oil input into U.S. waters. In addition, hydrocarbon pollution impacts have been noted usually in areas beyond the scope of the alternatives, such as harbors or enclosed water bodies with multiple sources of hydrocarbons. As a result, on the national level, oil spills are not the main source of hydrocarbon pollution. Oil spill impacts on U.S. waters are mostly localized and generally short lived; therefore, the potential benefits associated with a reduction in oil spill impacts would also be localized and short lived. The minor potential benefits associated with the reduction in floating or stranded oil resulting from the alternatives are thus localized and short lived, and insignificant from a national standpoint.

Marine and coastal resources are under continuously increasing pressure from human activities, including coastal development, fishing, industrial processes, agriculture, and resource exploitation. The cumulative effects of these activities have resulted in significant impacts on marine and coastal habitats, biodiversity losses, and a reduction in resource sustainability. The potential changes to these cumulative effects, resulting from the alternatives, are negligible when compared to the contributions from all other relevant actions identified and summarized in Section 4.15.1 (e.g., overfishing, release of toxic effluents, habitat degradation, eutrophication of coastal ecosystems, aerosol contaminants, coral reef bleaching from ocean warming, introduction of nonindigenous aquatic species, and losses of living marine resources from overexploitation and pollution effects). Therefore, on a national level, the alternatives would result in insignificant cumulative benefits to marine and coastal resources in the United States. However, at a local level, the alternatives could more significantly reduce the potential cumulative adverse impacts of oil spills in U.S. waters.

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CHAPTER 5
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CHAPTER 4

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CHAPTER 7
GLOSSARY

305(b) Report	The National Water Quality Inventory, commonly referred to as the 305(b) report, is a biennial report to Congress and the public prepared under Section 305(b) of the Clean Water Act (CWA). It contains information from each state on the quality of the nation's rivers, lakes, wetlands, estuaries, coastal waters, and ground water, along with information on public health and aquatic life concerns, and various programs implemented to restore and protect U.S. waters.
Advection	The movement of oil in the ocean due to the influence of overlying winds and underlying currents.
Aerial tracking	Following the movement of an oil spill in the ocean environment and collecting information on several important characteristics of the spill using trained oil spill monitoring personnel operating fixed-wing or rotary aircraft capable of sustained operations over water. This allows response managers to more effectively and efficiently deploy the appropriate response resources for removal.
Alaska region	One of six geographic regions with reasonably unique environmental conditions in which oil spill response operations could occur, this region includes the coast of Alaska.
Anadromous	Fish that hatch in fresh water, migrate to sea, spend most of their life in the ocean, and then return to freshwater natal streams to spawn and die.
Anthropogenic	Of, relating to, or resulting from the influence of human beings on nature.
Apex predators	Predators at the top of a local food web (the interconnected feeding relationships in an ecosystem). Typically, they suffer little predation from other carnivores, and they limit the population densities of their prey.

API° gravity	The universally accepted scale adopted by the American Petroleum Institute (API) for expressing the relative density of liquid petroleum products. API° gravity is measured by a hydrometer instrument having a scale graduated in degrees API. The higher the API° gravity, the lighter the oil.
Area Committee	The entity appointed by the president consisting of members from qualified personnel of federal, state, and local agencies with responsibilities that include preparing an Area Contingency Plan (ACP) for an area designated by the president, as stated in the CWA sections 311(a)(18) and (j)(4). The Area Committee determines the potential oil spill risks and devises strategies to mitigate oil spills in the most environmentally protective manner practicable, including adopting dispersant and *in situ* burn pre-authorization agreements in a given area.
Area Contingency Plan (ACP)	Prepared by an Area Committee that is developed to be implemented in conjunction with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and Regional Contingency Plan (RCP), in part to address removal of a worst case discharge (WCD) and to mitigate or prevent a substantial threat of such a discharge from a vessel, offshore facility, or onshore facility operating in or near an area designated by the president, as provided by the CWA sections 311(a)(19) and (j)(4).
Atlantic region	One of six geographic regions with reasonably unique environmental conditions in which oil spill response operations could occur, this region extends from Maine to the east coast of Florida.
Atmospheric rainout	Gases and aerosols in clouds are incorporated in cloud particles and later form rain or snow.
Atoll	A coral island consisting of a reef surrounding a lagoon.
Attainment	Any area that meets the primary or secondary National Ambient Air Quality Standards (NAAQS) for a pollutant.
Average most probable discharge (AMPD)	Defined as 50 bbl, but to make a conservative estimate of the potential impacts from such spills, a volume four times larger, or 200 bbl, is used.
Barrel (bbl)	A volumetric unit of measure for crude oil and petroleum products (1 bbl = 42 U.S. gal).
Barrier islands	Long sandbars offshore that form a barricade between open ocean waves and the main shoreline. Common along low-lying coasts where sediment is abundant.
Basic response scenario	In each region, this scenario consists of current levels of mechanical recovery and *in situ* burning when circumstances permit.
Benthic	A collection of organisms living on or in sea or lake bottoms.
Bilge	The lowest part of the interior of a vessel's hull along the sides of the keel where any internal water collects.

Bioassay	A laboratory test or other assessment utilizing a living organism to determine the effect of a condition to which the organism is exposed. Such tests are performed under controlled environmental conditions and duration. The dosage of interest is typically the lethal concentration, known as LC50, that kills 50 percent of the population of organisms in a given period of time. Chronic bioassay tests indicate sublethal effects, such as changes in growth or reproduction of the organism over a longer period of time.
Bioavailability	The rate and extent to which a chemical is absorbed and is available for use by the body or the tendency of a contaminant such as oil to partition in a form conducive to uptake by organisms.
Biodegradation	The process by which naturally occurring bacteria and fungi consume hydrocarbons found in oil as a food source, and excrete carbon dioxide and water as waste products.
Biota	The flora and fauna of a region.
Boom	A temporary floating barrier used to contain and divert an oil spill.
Booming	The practice of containing and diverting oil within a temporary floating barrier.
Bunker washings	Discharges when bunker holding tanks or compartments are cleaned out with water. (Bunker is heavy oil used as fuel for ocean vessels.)
Burn boom (burning boom)	A floating barrier used to corral oil constructed of fireproof materials and designed to withstand prolonged periods of exposure to heat and flames during *in situ* burn operations. (*See* also Fireproof boom and Fire-resistant boom.)
Burn residue	Unburned oil following an *in situ* burn event. The physical properties of burn residue depend on burn efficiency and oil type. Efficient burns of heavy crude oils generate brittle, solid residues (like peanut brittle); residues from efficient burns of other crude oils are described as semisolid (like cold roofing tar). Inefficient burns generate mixtures of unburned oil, burned residues, and soot that are sticky, taffy-like, or semiliquid. Depending on water density, initial density of the spilled oil, oil slick thickness, and efficiency of the *in situ* burning, burn residues may either sink or float. Burn residues have less volatile hydrocarbons with low boiling points, are denser and more viscous than unburned oil, and show relative enrichment in metals and the higher molecular weight polynuclear aromatic hydrocarbons (PAHs).
By-catch	A species caught in a fishery intended to target another species, as well as reproductively immature juveniles of the target species. By-catch is a serious issue that can contribute to species endangerment.
Candidate species	Species or population for which reliable information is available that listing under the Endangered Species Act of 1973 (ESA) may be warranted.
Carbon monoxide (CO)	A colorless, odorless, poisonous gas produced by incomplete burning of carbon in fuels.

Caribbean region	One of six geographic regions with reasonably unique environmental conditions in which oil spill response operations could occur, this region includes Puerto Rico and the U.S. Virgin Islands.
Cays	A low island or reef of sand or coral.
Central California Shelf	Selected for the modeling analysis as representative of the marine waters in the Pacific region, the area encompasses two biogeographical provinces: the Central California Coast and San Francisco Bay.
Cetacean	An order (Cetacea) of aquatic, mostly marine, mammals that includes whales, dolphins, porpoises, and related forms with a torpedo-shaped, nearly hairless body and paddle-shaped forelimbs, but no hind limbs; one or two nares opening externally at the top of the head; and a horizontally flattened tail used for locomotion.
Chemical dispersion	Applying liquid chemical in large quantities to an oil spill to break down oil into small droplets for oil spill response.
CHEMMAP (Chemical Spill Model Application Package)	A computer model developed by Applied Science Associates (ASA) that predicts the three-dimensional trajectory, fate, and biological effects for chemical products in the water and atmosphere.
Coastal counties	Defined by the Office of Ocean Resources, Conservation and Assessment (ORCA), National Ocean Service (NOS), National Oceanic and Atmospheric Administration (NOAA) as a county fulfilling one of two criteria: (1) at least 15 percent of their total land area is located within the nation's coastal watersheds (as defined by ORCA's Coastal Assessment Framework), or (2) the county accounts for at least 15 percent of the land area of a coastal cataloging unit (a U.S. Geological Survey-defined drainage basin). The U.S. Census Bureau also uses ORCA's coastal counties list.
Conjunctivitis	Commonly known as "pink eye," it is an inflammation of the conjunctiva, a membrane that lines the inside of the eyelid and touches the white part of the eye, resulting in secretion of a mucous that lubricates the eyeballs.
Convergence zone	Strong ocean currents in opposition, usually with sharp demarcations in temperature and water mass characteristics, and outbreaks of high biological productivity.
Council on Environmental Quality (CEQ)	Congress established the CEQ within the Executive Office of the President as part of the National Environmental Policy Act of 1969 (NEPA). The CEQ coordinates federal environmental efforts and works closely with agencies and other White House offices in the development of environmental policies and initiatives.
Criterion Continuous Concentration (CCC)	An estimate of the highest concentration in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.
Criterion Maximum Concentration (CMC)	An estimate of the highest concentration in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect.

Critical habitat	Specific areas in which physical or biological features essential to species conservation exist. May be inside or outside species range at time of listing; but usually should not include entire range. This area is a required determination under the ESA.
Crude oil	A general term for unrefined petroleum or liquid petroleum as found in the earth, before it is refined into oil products. It is a mixture of hydrocarbons that existed in liquid phase in underground reservoirs and remains liquid at atmospheric pressure after passing through surface separating facilities. Crude oil varies greatly in its properties, namely specific gravity and viscosity.
Demersal	Living near, deposited on, or sinking to the bottom of the sea.
Detrital	Refers to dead organic matter; however, some researchers define detritus as both the dead organic matter and the associated microbial community.
Dispersant	Liquid chemical is applied in large quantities to an oil spill to break down the oil into small droplets that will spread throughout the water column. This helps to increase the surface area of the oil spill, which increases the rate at which the oil can be degraded or weathered into less toxic substances. (*See* Surfactant.)
Dispersant recovery efficiency	The operating effectiveness of the dispersant or the percentage of released oil that is removed or recovered from the water. The greater the efficiency, the more effective the dispersant.
Dissolution	The transfer of oil components from a slick on the surface into solution in the water column.
Diurnal	Actions or processes that have a period or a cycle of approximately 1 tidal-day or are completed within a 24-hour period and recur every 24 hours. Thus, the tide is said to be diurnal when only one high water and one low water occur during a tidal day.
Ecopark	Area that is managed for the conservation of natural biological diversity representative of the ecological region in which the site is located. Includes extensive use of educational practices and technology, including interpretive signs, brochures, and programs designed to promote public understanding of, and participation in, the benefits of an ecosystem approach to fish and wildlife conservation.
Ecotourism	Excursions to seminatural areas, to understand the natural and cultural history of the place visited, taking care of the integrity of the ecosystem.
Emulsification	The mixing of seawater droplets into oil spilled on the water's surface.
Endangered species	Any species in danger of extinction throughout all or a significant part of its range (excludes insect pests).
Endemic	Characteristic of or prevalent in a particular field, area, or environment; native to or confined to a certain region.

Environmental Sensitivity Index (ESI)	The ESI was produced by NOAA to define and rank shoreline habitats in terms of oil vulnerability. Sensitivity is determined by the species that use the habitat. Habitats are ranked from least (1) to most (10) sensitive as follows: 1. Exposed rocky headlands 2. Exposed wave-cut rocky platforms 3. Gently sloping fine-grained sandy beaches 4. Moderately sloping shores of medium to coarse-grained sand 5. Shores of mixed sand and coarser sediments (gravel, pebbles, and boulders) 6. Gravel, pebble, and boulder shores with high permeability. 7. Exposed tidal flats of compacted sediments with high biological productivity 8. Sheltered rocky shores with high biological productivity 9. Sheltered tidal flats with high biological productivity 10. Salt marshes
Epifauna	Benthic animals living on the substrate (such as a hard sea floor) or on other organisms.
Epipelagic	The part of the oceanic zone into which enough light penetrates for photosynthesis.
Epithelium	A layer or layers of cells that line the surface of organs or cavities in animals. Epithelial tissue also often contains cells that secrete or absorb various substances. The skin, the coverings of most organs, and the linings of the body's passageways are made up of epithelial tissue.
Essential fish habitat (EFH)	The waters and substrate necessary for fish to spawn, breed, feed, and grow to maturity as defined by Congress (16 U.S.C. 1802(10)).
Estimated daily burn capacity (EDBC)	The estimated amount of oil that can be effectively removed from the surface of the water by burning in 1 day.
Estuary	A partially enclosed body of water formed where freshwater from rivers and streams flows into the ocean, mixing with the salty seawater. Estuaries and the lands surrounding them are places of transition from land to sea, and from freshwater to saltwater. Although influenced by the tides, estuaries are protected from the full force of ocean waves, winds, and storms by the reefs, barrier islands, or fingers of land, mud, or sand that define an estuary's seaward boundary.
Euphotic zone	The upper, illuminated zone of aquatic ecosystems. It is above the compensation level and therefore the zone of effective photosynthesis. In marine ecosystems it is much thinner than the deeper aphotic zone (below the level of effective light penetration), typically reaching 30 m in coastal waters, but extending to 100–200 m in open ocean waters.

Evaporation	The preferential transfer of light- and medium-weight components of oil from the liquid phase to the vapor phase and into the atmosphere.
Facility response plan (FRP)	Per agreement signed by 27 federal departments and agencies in April 1987 and developed under the authorities of the Earthquake Hazards Reduction Act of 1977 (42 U.S.C. 7701 *et seq.*) and the Disaster Relief Act of 1974 (42 U.S.C. 3231 *et seq.*), as amended by the Stafford Disaster Relief Act of 1988, this detailed plan must be prepared in accordance with the oil pollution prevention regulation (40 CFR 112.20) by facilities that may cause "substantial harm" to the environment or exclusive economic zone. The plan must contain an Emergency Response Action Plan (ERAP) and demonstrate that a facility has the resources to respond to a WCD oil spill.
Fate and effects model	The fate or changes in the chemical composition of oil released into the environment is due to weathering. Weathering occurs by evaporation, microbial degradation, chemical oxidation, and photochemical reactions. In offshore environments fate processes also include the impact of water currents and wind, spreading, evaporation, dispersion, dissolution, and emulsification. The predicted impact of these fate processes is used in computer models to predict the concentration of a compound in the environment (i.e., surface water). Information on the concentration and chemical composition, including the toxicity data, of the oil is needed to determine the effects of a spill. The physical and chemical properties of a compound provide valuable information about the likely partitioning behavior of the oil in the environment. The effects of an oil spill on marine organisms, for example, would depend on the organisms exposed, the conditions of the exposure, the volume of oil spilled, and other variables at the time of the spill. Response activities may also affect the impact of a spill on organisms, benthos, sandy intertidal and rocky intertidal habitat, and human uses such as tourism and recreational.
Fathom	A unit of length equal to 6 ft (1.83 m) used especially for measuring the depth of water.
Federal On-Scene Coordinator (FOSC)	The person responsible for overseeing the cleanup efforts at a spill site; the FOSC represents either the U.S. Environmental Protection Agency (USEPA) or the U.S. Coast Guard (USCG).
Fireproof boom	A floating barrier used to corral oil constructed of fireproof materials and designed to withstand prolonged periods of exposure to heat and flames during *in situ* burn operations. This boom has a demonstrated service life that extends through multiple days of burning operations. (*See* also Burn boom.)
Fire-resistant boom	An oil containment boom constructed out of fire-retardant fabrics and reinforced internal strength members and designed to withstand exposure to heat and flame during *in situ* burn operations. Fire-resistant boom typically undergoes material degradation when subjected to intense heat and flame for extended periods, as is associated with *in situ* burning. Fire-resistant booms have a planning service life of 1 operational-day. (*See* also Burn boom.)

First responder	The first personnel to arrive on the scene of a hazardous materials incident or oil spill scene.
Fishery Management Plan (FMP)	A plan developed by a regional Fishery Management Council (FMC), or the Secretary of Commerce under certain circumstances, to manage a fishery resource in the U.S. Exclusive Economic Zone (EEZ), pursuant to the Magnuson-Stevens Fishery Conservation and Management Act.
Florida Straits	Selected for the modeling analysis as an area of interest representative of similar areas of marine waters around islands in the Caribbean and Oceania regions, with respect to geographical size, bottom topography (steeply dropping off away from shore), and environmental conditions (warm, trade winds, intermittent severe storms), the area encompasses two biogeographical provinces: Florida Straits and Florida Bay.
Fringing reefs	Emergent reefs extending directly from shore. Often extensions of headlands or points, separated from the shore by an open lagoon.
Geographical region	Marine waters of the EEZ off the coasts of the continental United States, Alaska, Hawaii, Guam, Puerto Rico, and other U.S. territories in which oil spill response operations could occur. This area is categorized into six separate regions, each with reasonably unique environmental conditions including the Atlantic region, Caribbean region, Gulf of Mexico region, Pacific region, Alaska region, and Oceania region.
Glaciated	An area that has been subjected to glacial action; or to produce glacial effects in or to cover with a glacier.
Groundfish	As defined by the National Marine Fisheries Service (NMFS) with a few exceptions, live on or near the bottom of the ocean. These include a wide variety of bottom fishes, rockfishes, and flatfishes.
Groups I–IV petroleum	Petroleum oil means petroleum in any form, including, but not limited to, crude oil, fuel oil, sludge, oil residue, and refined products. Groups I, II, and III are mineral oils classified by the amount of saturates and sulfur they contain and by their viscosity indices. Group I contains the least saturates and the most sulfur, and has the lowest viscosity. Progressing to Groups II and III, the oil contains more saturates and less sulfur, and has a higher viscosity. Group IV is made up of polyalphaolefins (PAOs) that contain no sulfur. The performance of the oil in terms of thermal stability, oxidative stability, and pour point characteristics improves as the group number increases from I to IV.
Gulf of Mexico region	One of six geographic regions with reasonably unique environmental conditions in which oil spill response operations could occur. Extends from the west coast of Florida to Texas.
Gyre	A circular/elliptical oceanic surface current.
Haulout area	An area on land that marine animals, such as seals, sea lions, and walruses, use for various activities, such as rutting, mating, whelping, nursing their young, and resting. Groups of marine mammals often rest closely packed together at favored haulout areas.

Heinz-body hemolytic anemia (4.1)	This is a form of anemia that indicates there is a decrease in red blood cell mass. Hemolytic refers to something that destroys red blood cells in the blood stream. A Heinz-body forms when hemoglobin molecules are adversely changed and the hemoglobin coalesces in the red blood cells. This makes the red blood cells more rigid and more likely to rupture or be filtered out of the bloodstream.
Helitorch	A specialized drip torch hung from or mounted on a helicopter that dispenses globs of ignited gelled gasoline.
Herbaceous	A material having the texture, color, or appearance of a leaf or plant.
Herding agents	Designed to contract a spill and keep it from spreading, herding agents push or compress oil on the water surface and can be used to direct the movement of oil to produce a thick oil film and enhance recovery.
Hermatypic corals	Invertebrates (i.e., animals with no backbone) that produce hard limestone skeletons and need sunlight to live. These are the reef-building corals that become encrusted together and pile up over thousands of years to form a coral reef.
Holoplankton	Organisms that spend their entire existence as pelagic organisms floating in the water column, not attached to any substrate, and unable to move against the currents and tides.
Hydrocarbon	A naturally occurring organic compound containing only hydrogen and carbon. Petroleum is a complex mixture of hydrocarbons. The most common hydrocarbons are natural gas, oil, and coal.
Hydrocarbon emissions	The product of partial fuel combustion, fuel evaporation, and refueling losses caused by spillage and vapor leakage. Hydrocarbons react with nitrogen oxides and sunlight to form ozone. Some hydrocarbons are toxic and may be carcinogenic.
Hypoglycemia	Low blood sugar or a reduced level of sugar glucose in the blood that can cause loss of consciousness, seizures, coma, or death.
Hypoxia	Low levels of dissolved oxygen in the water; an oxygen-depleted condition that is extremely stressful to most aquatic life.
Ichthyoplankton	Eggs and larvae of fish drifting in the water column.
Immunosuppression	A condition in which the immune system is functioning at a lower than normal level.
Infauna	Benthic animals living in the substrate and especially in a soft sea bottom.
Inland	The area inland of the coastal zone excluding the Great Lakes and specified ports and harbors on inland rivers. This operating area is shoreward of the nearshore boundary lines. The term inland operating environment delineates an area of federal responsibility for response action. Precise boundaries are determined by USEPA–USCG agreements and identified in federal RCPs.

***In situ* burn credit**	Planholders that carry Groups II, III, and IV cargoes and operate in inland, nearshore, offshore, and open ocean operating environments where an *in situ* burn pre-authorization agreement exists can add and maintain *in situ* burn capability that allows for an offset to mechanical recovery requirements as follows: • 5,000 barrels per day (bpd) at Tier 1 • 10,000 bpd at Tier 2 • 10,000 bpd at Tier 3 (The credit is held at 10,000 bpd for Tier 3 because of the limited window of opportunity for use after 72 hours.)
***In situ* burning**	Setting boomed oil on fire for oil spill response.
Insular shelf	A zone around an island that extends from the low water line to a depth at which there is usually a marked increase of a slope toward the ocean.
Interfacial tension	The free energy tension that exists between two immiscible (cannot mix to form a homogenous mixture) liquids, such as oil and water. Interfacial tension is caused by the difference in fluid pressures of the liquids. (Surface tension is the term for the energy barrier between a liquid and air.)
Intertidal	The shore zone between the highest and lowest tides that is regularly exposed to the air by the tidal movement of the sea. Marine organisms that inhabit the intertidal zones have to adapt to periods of exposure to air and to waves, which makes it the most physically demanding of the marine habitats.
Kelp forest	Large masses of large, floating seaweed. Kelp is a plant that is restricted to cold and temperate marine ecosystems that is held to the sea floor by a holdfast and is usually brown.
Landings	Quantities of fish, shellfish, and other aquatic plants and animals brought ashore and sold. Data for all mollusks are published on a meat-weight basis.
LC50	Lethal concentration in water of any chemical that kills 50 percent of the organisms in a population per unit time.
Life history	An organism's lifetime pattern of growth, differentiation, storage, and reproduction.
Log-normal relationship	The log-normal distribution is an asymmetric distribution, which starts from zero, rises to a maximum and then tails off more slowly to infinity. It is related to the normal distribution: X has a lognormal distribution if ln (X) has a normal distribution.
Mangroves	Tropical maritime trees or shrubs that send out many prop roots and form dense masses important in coastal land building
Marine mammal	Any mammal morphologically adapted to the marine environment. Also includes parts of marine mammals.
Marine transportation-related (MTR) facilities	An onshore facility, including piping and any structure used to transfer oil to or from a vessel, subject to regulation under 33 CFR part 154 and any deepwater port subject to regulation under 33 CFR part 150.

Maximum most probable discharge (MMPD)	Defined as 2,500 bbl and represents a “medium” spill.
Mechanical recovery	Using booms (barriers) to contain and divert oil, and skimmers to recover or remove the contained oil from the water surface.
Meroplankton	Organisms that spend part of their lives as pelagic organisms floating through the water column, not attached to any substrate, and unable to move against the currents and tides.
Micronektonic marine organisms	Relatively small but actively swimming organisms ranging in size between plankton, which drift with the currents, and the larger nekton, which have the ability to swim against the current.
Mid-Atlantic Bight	An area in the Atlantic region extending roughly from Cape Cod, MA, to Cape Hatteras, NC.
Mid-Atlantic Shelf	Selected for the modeling analysis as representative of the marine waters in the Atlantic region, this area encompasses three biogeographical provinces: New York-New Jersey Shelf, Delaware Bay, and Delmarva Shelf.
Midden deposits	A mound or deposit containing shells, animal bones, and other refuse that indicates the site of a human settlement.
Monoaromatic hydrocarbon (MAH)	Chemical compounds composed only of carbon and hydrogen containing a single benzene ring (six carbons in a hexagonal arrangement and bonded to hydrogen atoms) such as toluene, benzene, and ethylbenzene.
National Ambient Air Quality Standards (NAAQS)	Standards set by the USEPA to protect public health, including sensitive populations, such as children and the elderly, and public welfare, such as the effects of air pollution on vegetation, materials, and visibility. There are six criteria pollutants with primary standards: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter with an aerodynamic size less than or equal to 10 micrometers (PM10), and sulfur dioxide (SO_2).
National Environmental Policy Act of 1969 (NEPA)	Declares a national policy that encourages productive and enjoyable harmony between humans and their environment; promotes efforts that will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of humans; enriches the understanding of the ecological systems and natural resources important to the nation; and establishes the CEQ.
National Oil and Hazardous Substances Pollution Contingency Plan (NCP)	Plan designed to ensure that resources and expertise of the federal government will be available in the event of a very serious oil spill.
NCP Product Schedule	Section 311(d)(2) of the CWA and Section 4201(a) of the Oil Pollution Act of 1990 (OPA 90) require the preparation of a “schedule of dispersants, other chemicals, and other spill mitigating devices and substances, if any, that may be authorized for use on oil discharges.” The USEPA prepares and maintains this list.

National Response Center	An organization staffed by officers and marine science technicians from the USCG that serves as the national communications center responsible for notifying On-Scene Coordinators.
National Response System (NRS)	A mechanism for coordinating response actions by all levels of government in support of the On-Scene Coordinator. The NRS is composed of the National Response Team (NRT), Regional Response Team (RRT), On-Scene Coordinator, Area Committees, Special Teams, and related support entities. The NRS is capable of expanding or contracting to accommodate the response effort required by the size or complexity of the discharge or release to ensure that oil spill control and cleanup activities are timely and efficient and minimize threats to human health and the environment.
National Response Team (NRT)	An organization composed of 16 federal agencies, each of which has responsibilities and expertise in responding to oil spill and hazardous materials emergencies.
Natural dispersion	The process of forming small oil droplets that become incorporated into the water column in the form of a dilute oil-in-water suspension. This process occurs when breaking waves mix the oil into the water column. Large droplets (more than 0.1 mm in diameter) are formed when mixing occurs and tend to concentrate near the water surface, while small droplets (less than 0.1 mm in diameter) break away from the main mass and become dispersed in the water column.
Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDA/CME)	An air dispersion model, which is part of the chemical fate and transport model CHEMMAP, that simulates the wind transport, turbulent dispersion, and degradation rate of hydrocarbons evaporated from a spill, with an output of concentration in the lower atmosphere over time.
Natural resource trustee	An official of a federal natural resources management agency designated in subpart G of the NCP or a designated state official or Indian tribe or in the case of discharges covered by OPA 90, a foreign government official, who may pursue claims for damages under section 107(f) of CERCLA or section 1006 of OPA 90. These representatives act on behalf of the public as trustees for natural resources, including their supporting ecosystems, within the boundary or belonging to, managed by, controlled by, or appertaining to or otherwise controlled by the United States (including the resources of the EEZ). Natural resources include land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources. The trustees serve as decisionmakers with the Area or Regional Committees.
Nautical mile (nm)	Used by all nations to measure sea and air travel (1 nm = 6,076.115 ft or 1.1508 statute mi). It is based on the circumference of earth. If the earth were cut in half at the equator, one half could be picked up one and looked at the equator as a circle. That circle could then be divided into 360°. Then a degree could be divided into 60 minutes. A minute of arc on earth is 1 nm.

Nearshore	The operating area extending seaward 12 nm from the boundary lines defined in 46 CFR Part 7, except in the Gulf of Mexico. In the Gulf of Mexico, it means the area extending seaward 12 nm from the line of demarcation (COLREG lines) defined in §§ 80.740–80.850.
Neoplastic conditions	An abnormal new growth of tissue in animals or plants; a tumor.
Neritic	The shallow pelagic zone over the continental shelf; nearshore ocean ecosystems; those associated with the coasts because the waters are overlying continental shelves and/or the waters are less than 200 m deep in areas of coastal submarine slopes.
Nitrogen dioxide (NO_2)	A brownish, highly reactive gas that is present in all urban atmospheres.
No. 2 fuel oil	A light fuel oil that is distilled during the refining process—a distillate fuel oil. These products are used primarily for space heating.
Non-attainment	Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the primary or secondary NAAQS for a pollutant.
North Texas Shelf	Selected for the modeling analysis as representative of the marine waters in the Gulf of Mexico region, the area encompasses the Galveston Bay and the Texas portion of the Louisiana-North Texas Shelf.
Oceania region	One of six geographic regions with reasonably unique environmental conditions in which oil spill response operations could occur; includes Hawaii, American Samoa, Guam, and Commonwealth of Northern Mariana Islands (CNMI).
Oceanic	Pertaining to the open ocean beyond the continental shelf. Living in the open ocean.
Offshore	The operating area up to 38 nm seaward of the outer boundary of the nearshore area (12–50 mi).
Oil Pollution Act of 1990 (OPA 90)	Makes owners and operators of vessels or facilities that discharge oil strictly liable for cleanup costs and damages caused by such discharges. Liability was not extended to cargo owners. A double hull requirement was imposed on virtually all oil tankers operating in U.S. waters. The full name of OPA 90 is the Oil Pollution, Prevention, Response, Liability, and Compensation Act of 1990.
Oligotrophic	Characterized by a low supply of dissolved inorganic or mineral nutrient materials and a consequent minimized ability to support organic production. High levels of dissolved oxygen are typically present and turbidity is usually low.
Open ocean	The operating area seaward of the outer boundary of the offshore operating environment to the seaward boundary of the EEZ (50–200 mi).
Operating environment	Includes rivers and canals, inland, Great Lakes, nearshore, offshore, or open ocean. These terms are used to define the geographic location(s) in which a facility or tank vessel is handling, storing, or transporting oil.
Osmoregulation	The control of the levels of water and mineral salts in the blood.

Overwintering	To spend winter in a particular place; certain bird species migrate to warmer locations during the winter months to increase chances of survival.
Ozone (O_3)	A photochemical oxidant and the major component of smog.
Pacific region	One of six geographic regions with reasonably unique environmental conditions in which oil spill response operations could occur; includes the waters along the coasts of California, Oregon, and Washington.
Particulate matter (PM)	A mixture of solid particles and liquid droplets found in the air including dust, dirt, soot, and smoke. Some particles are emitted directly from their sources, such as factories, power plants, cars, construction activity, fires, and cars. In other cases, gases such as sulfur oxide and SO_2, NO_2, and VOCs (volatile organic compounds) interact with other compounds in the air to form fine particles. Since July 1, 1987, USEPA has used the indicator PM10 in place of total suspended particulate (TSP), which includes only those particles with an aerodynamic diameter smaller than 10 micrometers. In 1997, USEPA added two new PM-2.5 standards for particles smaller than 2.5 micrometers in diameter. The regulations focus on these size classes because they are likely to be responsible for adverse health effects due to their ability to reach the lower regions of the respiratory tract.
Patch reefs	Small, irregular-shaped reefs that rise from the bottom and are separated from other reef sections. Diverse coral communities typified by the presence of hermatypic (reef-building) species.
Pelagic	Of, relating to, or living in open oceans or seas rather than waters adjacent to land or inland waters.
Petroglyphs	A carving or inscription on a rock, especially one made by prehistoric people.
Photic zone	Region of the ocean through which light penetrates; and the place where photosynthetic marine organisms live.
Photo-oxidation	The process by which sunlight, in the presence of oxygen, transforms oil into new by-products.
Photosynthesis	A process in which organisms, with the aid of chlorophyll (green plant enzyme), convert carbon dioxide and inorganic substances into oxygen and additional plant material, using sunlight for energy. All green plants grow by this process.
Phytoplankton	Free-floating, often microscopic, photosynthetic organisms such as algae that inhabit aquatic environments. It is the basic food source in many aquatic ecosystems.
Pinnacle trends	Mountain-like, discontinuous carbonate reef structures.
Pinniped	Any of a suborder (Pinnipedia) of aquatic carnivorous mammals (such as a seal or walrus) with all four limbs modified into flippers.

Planholder	Owners and operators of tank vessels and MTR facilities that are required under USCG regulations (that implement OPA 90) to develop plans describing how they will respond to an oil pollution incident, including a WCD.
Plankton	Organisms that float at or near the surface of the water and are unable to swim against tides, winds, or currents.
Platform	A vessel or aircraft outfitted with equipment capable of accomplishing the oil response requirements.
Pollutants (pollution)	Unwanted chemicals or other materials found in the air, in water, or on land that can harm health, the environment, and property. For example, many air pollutants occur as gases or vapors, but some are very tiny solid particles, such as dust, smoke, or soot.
Polynuclear aromatic hydrocarbon (PAH)	A family of chemical compounds that contain more than one benzene ring. They are commonly found in oil, coal products, and tar. Burning fossil fuels particularly on a small scale when combustion is often incomplete, PAH compounds form and escape to the atmosphere or to water. PAHs occur both in gaseous form and bound to particles (soot). PAH vapors can cause harm to humans and animals.
Pour point	The lowest temperature at which an oil or distillate fuel is observed to flow.
Pre-authorization agreement	An agreement adopted by a RRT and an Area Committee that authorizes the use of chemical dispersion or *in situ* burning at the discretion of the FOSC (in some cases in the context of the Unified Command) without further approval of other federal or state authorities. Pre-authorization agreement areas are generally limited to particular geographic areas within each region.
Precious coral	Precious corals are slow growing, long-lived, marine colonial organisms that live on solid substrates in deepwater benthic habitats 35–1,500 m deep. Precious coral polyps form colonies resembling small trees, and these colonies form aggregations called beds, which provide important habitat for other deepwater species. Precious corals include black and the deepwater pink, gold, and bamboo corals.
Prince William Sound	Selected for modeling analysis as representative of the marine waters in the Alaska region.
Produced water	Water that is brought up via a well along with oil and gas during extraction operations. This water is then usually discharged to the open sea.
Programmatic Environmental Impact Statement (PEIS)	An EIS is a detailed and concise public document required for major federal actions that are likely to have an effect on the human environment. It provides information regarding potential significant environmental effects of the proposed action. A programmatic-level EIS or PEIS is prepared prior to a federal agency's decision regarding a major program, plan, or policy, which usually is broad in scope.

Pulmonary emphysema	A chronic lung condition in which alveoli, or air sacs, may be destroyed, narrowed, collapsed, stretched, or overinflated. Overinflation of the air sacs is a result of a breakdown of the walls of the alveoli, and causes a decrease in respiratory function and breathlessness. Damage to the air sacs is irreversible and results in permanent "holes" in the tissues of the lower lungs.
Pyrogenic polynuclear aromatic hydrocarbon	A PAH (see definition above) resulting from high temperatures such as the combustion of gasoline or wood-burning fires. This contrasts with petrogenic PAHs which are found in crude oil or oil products.
Radiocarbon dating	Method for determining the age of an organic substance by measuring the amount of the carbon isotope, carbon-14, remaining in the substance; useful for determining ages in the range of 500 to 70,000 years.
Red tide	A proliferation of marine plankton toxic and often fatal to fish, perhaps stimulated by the addition of nutrients. A tide can be red, green, or brown, depending on the coloration of the plankton.
Regional Response Team (RRT)	Thirteen teams (each representing a particular geographic region) that provide assistance to On-Scene Coordinators. RRTs are composed of representatives from field offices of the federal agencies that make up the NRT, as well as state representatives.
Removal	The term "remove" or "removal" is used throughout this Programmatic Environmental Impact Statement (PEIS) as it is defined by section 311(a)(8) of the CWA, and refers to containment and removal of oil from the water and shorelines or the taking of such other actions as may be necessary to minimize or mitigate damage to the public health or welfare of the United States (including, but not limited to, fish, shellfish, wildlife, public and private property, and shorelines and beaches) or to the environment. While the use of dispersants, which break an oil slick into small droplets that then disperse into the water column, renders further manual removal attempts infeasible, the use of dispersants increases the opportunity for the oil to undergo natural bioremediation. The terms "removal" and "treatment" are used interchangeably throughout this PEIS.
Removal capacity	The capacity of a response technology to alter the movement and environmental impact of oil spilled on the water. None of the response options being considered in this proposed action fully removes spilled oil from the environment. Rather each alters the physical environment the oil ultimately reaches and therefore it impacts the environment. Mechanical recovery results in removal of the oil from the water surface for temporary storage and transport back to land, where it must ultimately be disposed of. *In situ* burning removes oil from the water surface into the atmosphere and into the water column. Chemical dispersion removes oil from the water surface into the water column.
Response community	Federal, state, and local government agencies; oil-transportation and -handling industries; the oil spill response industry; environmental and other public interest groups; and the general public.

Rhizome	A rootlike stem that grows horizontally under or along the ground that sends out roots from its lower surface and leafy shoots from its upper surface.
Risk ranking	Determined using the risk matrix developed for this PEIS, which is based on an evaluation of two factors—the proportion of the resource affected by the action and the time for the resource to recover—for each ecological resource included in this model. The two factors are then defined through the risk rankings, which comprise a number (1–4) score and a letter (A–E) score. These scores correspond to high, medium, and low levels of concern that can be used in combination with the literature review to determine the NEPA level impact as significant, moderate, and minor or insignificant, respectively.
Riverine	An area or deposit relating to, formed by, or resembling a river.
Salinity	Amount of salt found in 1 kg of water. Salinity, or salt content, is expressed in parts per thousand (ppt) because there are 1,000 g in 1 kg.
Salmonids	Any soft-finned fishes of cold and temperate waters which belong to the superorder *Malacopterygii*.
Sedimentation	The incorporation of oil within suspended and bottom sediments. This usually occurs with the heavier components of oil that do not dissolve in water. Sedimentation can occur when oil is stranded onshore, becomes incorporated with sediments, and is subsequently transported to subtidal environments. Sedimentation also occurs when marine organisms ingest naturally dispersed oil droplets and eliminate them as part of the fecal matter after passing undigested oil through their systems.
Sensory panelist	A professional that is trained to evaluate the taste or odor of a samples in an unbiased, objective manor.
Sessile invertebrates	Invertebrates (i.e., animals with no backbone) that live attached to something, perhaps a rock or another animal and are nonmoving.
Shoreline stranding	The visible accumulation of petroleum along the shoreline following an oil spill.
Short tons	A unit of weight equaling 2,000 lb or 0.907 metric tons.
SIMAP (Oil Spill Impact System Model)	A computer model developed by ASA that provides detailed predictions of the three-dimensional trajectory, fate, and biological effects of spilled oil.
Sirenian	Any of an order of aquatic herbivorous mammals, including the manatee, dugong, and Steller's sea cow.
Skimmer	A device used to remove oil from the water's surface.
Slope water	Water formed from a complex process of interaction between fresh water from the Labrador Current mixing with higher salinity water from the Gulf Stream. It extends over the upper 1,000 m along the north American continental rise north of Cape Hatteras.

Sorbent materials	Inert and insoluble materials that are used to remove oil and hazardous substances from water through adsorption, in which the oil or hazardous substance is attracted to the sorbent surface and then adheres to it; absorption, in which the oil or hazardous substance penetrates the pores of the sorbent material; or a combination of the two. Sorbents are generally manufactured in particulate form for spreading over an oil slick or as sheets, rolls, pillows, or booms.
Sortie	All operational activities for a single aircraft from the time the engines are started at the home base parking area until the aircraft returns to the parking area and turns off the engines. An aircraft sortie can contain any number of different flight events between the initial takeoff and the final landing.
Special Monitoring of Applied Response Technologies (SMART)	A program comprising criteria and guidelines for monitoring both chemical dispersion and *in situ* burning during spill response operations that was developed by the USCG, USEPA, NOAA, and U.S. Centers for Disease Control and Prevention (CDC) as members of the NRT. SMART relies on small, highly mobile teams to deploy to the scene of chemical dispersion or *in situ* burning. The monitoring teams collect real-time data using portable, rugged, and easy-to-use instruments, and channel the data to the Unified Command, a group made up of representatives from the USCG, the state, and the responsible party. The data are used to monitor the ongoing effectiveness of individual response strategies in mitigating spill impacts and possibly redirect response efforts.
Species	A category of biological classification ranking immediately below the genus or subgenus, comprising related organisms or populations potentially capable of interbreeding, and being designated by a binomial that consists of the name of a genus followed by a Latin or latinized uncapitalized noun or adjective agreeing grammatically with the genus name.
Specific gravity	The ratio of the density of a substance to the density of water; substances with a specific gravity greater than 1 are more dense than water and sink; substances that have a specific gravity less than 1 are less dense than water and float.
Spray booms	Dispersant application tools fitted to fixed-wing aircraft or waterborne vessels.
Spreading	The movement of an entire oil slick horizontally on the surface of the water because of the effects of gravity, inertia, friction, viscosity, and surface tension.
Star mounds	A type of ceremonial burial ground found in certain areas of the Oceania region.
Statute mile (statute mi)	A mile as measured on land (1 mi = 5,280 ft or 1.6 km). Distances at sea are measured in nm (1 nm = 1.1508 statute mi).
Stochastic	Involving chance or probability, probabilistic.

Subsistence	A source or means of obtaining the necessities of life (i.e., food, water, shelter, clothing) for basic existence. Refers to a lifestyle in which a person or community produce what they need and do not enter their products into the market but consume them locally to meet nutritional and cultural requirements.
Subtidal	Located below the level of the mean low-water spring tide, this area remains submerged, but is influenced by the tide and is often considered a subaqueous but shallow marine environment.
Sulfur dioxide (SO_2)	Results largely from stationary sources, such as coal and oil combustion, steel mills, refineries, and pulp and paper mills and from nonferrous smelters. Also a primary contributor to acid deposition, or acid rain, which causes acidification of lakes and streams and can damage trees, crops, historic buildings, and statues.
Surfactant	The term derived from surface active agent describes a compound containing both hydrophilic (affinity for water) and hydrophobic (repelling water) groups. When a surfactant is dissolved in a liquid, even in very small quantities, it greatly reduces surface or interfacial tension and renders oils and greases soluble in water. Surfactants serve to break oil into small droplets. This helps to increase the surface area of an oil spill, which increases the rate at which the oil can be degraded or weathered into less toxic substances. (*See* Dispersant.)
Tainted	To contaminate or affect. Following an oil spill, tainting of fish and invertebrates becomes a concern when the concentration of oil constituents in the water exceeds approximately 100 ppb.
Thermocline	The region in a thermally stratified body of water which separates warmer oxygen-rich surface water from cold oxygen-poor deep water and in which temperature decreases rapidly with depth.
Thermoregulation	The maintenance or regulation of temperature, specifically the maintenance of a particular temperature of the living body.
Threatened species	Any species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
Tier 1, 2, 3	A tier designates both the required response resources and the time periods within which the resources must arrive on scene. Each tier requires the planholder to maintain a certain level of locally available mechanical recovery, *in situ* burn, or dispersant application equipment and supplemental equipment from other regions over time. For each operational period of response, the response times depend on the proximity of major port areas.
Toxicity	The extent, quality, or degree of being poisonous or harmful to humans or other living organisms.
Transboundary species	Species that by virtue of their migration or distribution cross boundaries that separate states or nations, including tribes.
Transitory species	Species that spend brief periods of time in a particular area, but are not permanent or resident to that particular area.

Treatment	*See* Removal.
U.S. Exclusive Economic Zone (EEZ)	Established by Presidential Proclamation Numbered 5030, dated March 10, 1983, including the ocean waters of the areas referred to as "eastern special areas" in Article 3(1) of the Agreement between the United States of America and the Union of Soviet Socialist Republics on the Maritime Boundary, signed June 1, 1990 as defined by OPA 90 section 1001. It is an area beyond and adjacent to the territorial sea, not to exceed 200 nm from the territorial sea baseline, under which the rights and jurisdiction of the coastal state and the rights and freedoms of other states are governed by the relevant provisions of the United Nations Convention on the Law of the Sea. The coastal state may, in the exercise of its sovereign rights to explore, exploit, conserve, and manage the living resources in the EEZ, take such measures, including boarding, inspection, arrest, and judicial proceedings, as may be necessary to ensure compliance with the laws and regulations adopted in conformity with this convention.
Upwelling	Caused by prevailing northwesterly winds and results in lower dissolved oxygen and higher nutrients and CO_2 concentrations as deeper, cooler water is pushed into the shallower water.
Vessel response plan (VRP)	Vessels carrying oil as cargo in U.S. waters must have a VRP. This detailed plan must include notifications to be made in the event of an oil spill and list resources under contract or other approved means to respond to an oil spill.
Viscosity	Having a resistance to flow; substances that are extremely viscous do not flow easily.
Volatile organic compounds (VOCs)	A family of chemical compounds found in oils; VOCs evaporate readily into the air and have low water solubility. VOCs are often hazardous chemicals (many contain cancer causing agents) that may cause nerve damage and behavioral abnormalities in mammals when inhaled.
Water column	An imaginary cylinder of water from the surface to the bottom a water body.
Weathering	A wide variety of physical, chemical, and biological processes that transform oil discharged into the environment, changing its composition, behavior, routes of exposure, and toxicity. The processes include spreading, advection, evaporation, dissolution, natural dispersion, emulsification, photo-oxidation, sedimentation, shoreline stranding, and biodegradation.
Worst case discharge (WCD)	Considered the loss of all cargo from a tank vessel or the largest foreseeable discharge from an offshore facility. To quantify such an extreme event for this analysis, a "large" spill volume is equal to the loss of cargo from two storage tanks, which is approximately 40,000 bbl.
Zooplankton	Free-floating, often microscopic, heterotrophic organisms that inhabit aquatic environments.