PACIFIC COAST GROUNDFISH FISHERY MANAGEMENT PLAN

FOR THE CALIFORNIA, OREGON, AND WASHINGTON GROUNDFISH FISHERY

APPENDIX D

NONFISHING EFFECTS ON WEST COAST GROUNDFISH ESSENTIAL FISH HABITAT AND RECOMMENDED CONSERVATION MEASURES

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NON-FISHING IMPACTS TO ESSENTIAL FISH HABITAT AND RECOMMENDED CONSERVATION MEASURES

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ACRONYMS AND ABBREVIATIONS

AAPA	American Association of Port Authorities
ACZA	ammoniacal copper zinc arsenate
AFS	American Fisheries Society
ATTF	Alaska Timber Task Force
BMPs	best management practices
BOD	biochemical oxygen demand
BTA	best technology available
CCA	chromated copper arsenate
CSREEs	Cooperative State Research, Education, and Extension
CWA	Clean Water Act
dB	decibel
DoN	Department of the Navy
Ecology	Washington State Department of Ecology
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FC	fecal coliform (bacteria)
FERC	Federal Energy Regulatory Commission
FIFRA	Federal Institute, Fungicides, and Rodenticide Act
FL	fork length
FMCs	Fishery Management Councils
FREP	Futilizer Research and Education Program
GIS	geographical information system
GOA	Gulf of Alaska
Hz	Hertz
IPM	integrated pest management
LTF	log transfer facilities
LWD	large woody debris
m/s^2	meters per second squared
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
NAWQA	National Water Quality Assessment
NEPA	National Environmental Policy Act
NMDMP	National Marine Debris Monitoring Program
NMFS	National Marine Fishery Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NPFMC	North Pacific Fishery Management Council
NPPC	Northwest Power Planning Council
NRC	National Research Council
OCS	outer coastal shelf
OWRRI	Oregon Water Resources Research Institute
PAH	polyaromatic hydrocarbon
PBDE	polybrominated diphenyl ether
PFMC	Pacific Fishery Management Council
PNPCC	Pacific Northwest Pollution Control Council
RPWAST	Rich Passage Wave Action Study Team
SCS	Soil Conservation Service
SPL	sound pressure levels
SSC	suspended sediment concentration

TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WCS	water control structure
WDFW	Washington State Department of Fish and Wildlife
ZOD	zone of deposit

1.0 INTRODUCTION

Background on Essential Fish Habitat

In 1996, the U. S. Congress added new habitat conservation provisions to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), the federal law that governs U.S. marine fisheries management. The renamed Magnuson-Stevens Act mandated the identification of Essential Fish Habitat[2] (EFH) for federally managed species and consideration of measures to conserve and enhance the habitat necessary for these species to carry out their life cycles.

The act also requires federal agencies to consult with National Oceanic and Atmospheric Administration (NOAA) Fisheries on all actions, or proposed actions, permitted, funded, or undertaken by the agency, that may adversely affect[3] EFH. Federal agencies do this by preparing and submitting an EFH Assessment to NOAA Fisheries. The EFH Assessment is a written assessment of the effects of the proposed federal action on EFH. Regardless of federal agency compliance to this directive, the act requires NOAA Fisheries to recommend conservation measures to federal as well as state agencies once it receives information or determines from other sources that EFH may be adversely affected. These EFH conservation recommendations are provided to conserve and enhance EFH by avoiding, minimizing, mitigating, or otherwise offsetting the adverse effects to EFH.

Activities proposed to occur in EFH areas do not automatically require consultation. Consultations are triggered only when the proposed action may adversely affect EFH, and then, only federal actions require consultation.

By providing EFH conservation recommendations before an activity begins, NOAA Fisheries may help prevent habitat damage before it occurs rather than restoring it after the fact, which is less efficient, unpredictable, and often more costly. This could ultimately save American taxpayers millions of dollars in habitat restoration funds and could save industries from having to remedy environmental problems down the road. Furthermore, EFH conservation will lead to more robust fisheries, providing benefits to coastal communities and commercial and recreational fishers alike (Benaka 1999).

This consultation process is usually integrated into existing environmental review procedures in accordance with the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), or the Fish and Wildlife Coordination Act, for instance, to provide the greatest level of efficiency.

Within 30 days of receiving NMFS' conservation recommendations, federal action agencies must provide a detailed response in writing to NMFS. The response must include measures proposed for avoiding, mitigating, or offsetting the impact of a proposed activity on EFH. State agencies are not required to respond to EFH conservation recommendations. If the federal action agency chooses not to adopt NMFS' conservation recommendations, it must provide an explanation. Examples of federal action agencies that

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[2] EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." *Waters* include aquatic areas and their associated physical, chemical, and biological properties. *Substrate* includes sediment underlying the waters. *Necessary* means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. *Spawning, breeding, feeding, or growth to maturity* covers all habitat types utilized by a species throughout its life cycle.

[3] Adverse effect is any impact which reduces the quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to benthic organisms, prey species, and their habitat, and other ecosystem components. Adverse effects may be site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions [50 CFR 600.910(a)]

permit or undertake activities that may trigger the EFH consultation process include, but are not limited to, the U.S. Army Corps of Engineers (USACE), the U.S. Environmental Protection Agency (EPA), the Federal Energy Regulatory Commission, and the Department of the Navy (DoN). NOAA's Fishery Management Councils (FMCs) may also choose to comment on proposed actions that may adversely impact EFH.

Significance of Essential Fish Habitat

The waters and substrate that comprise EFH designations under the jurisdiction of the FMCs are diverse and widely distributed. They are also closely interconnected with other aquatic and terrestrial environments.

From a broad perspective, EFH is the geographic area where the species occurs at any time during its life. This area can be described in terms of ecological characteristics, location, and time. Ecologically, EFH includes waters and substrate that focus distribution (e.g., migration corridors, spawning areas, rocky reefs, intertidal salt marshes, or submerged aquatic vegetation) and other characteristics that are less distinct (e.g., turbidity zones, salinity gradients). Spatially, habitats and their use may shift over time due to climate change, human activities, geologic events, and other circumstances. The type of habitat available, its attributes, and its functions are important to species productivity, diversity, health, and survival.

The following discussion addresses non-fishing activities that may adversely impact EFH. They are grouped into four different systems in which the activities usually occur: upland, river or riverine, estuary or estuarine, and coastal or marine. Riverine habitats provide important habitat that serves multiple purposes for anadromous species such as salmon. These purposes include migration, feeding, spawning, nursery, and rearing functions. Protecting these functions is key to providing for a productive system and a healthy fishery. An important component of a river system also includes the riparian corridor. The term "riparian" refers to the land directly adjacent to a stream, lake, or estuary. A healthy riparian area has vegetation harboring prey items (e.g., insects), contributes necessary nutrients, provides large woody debris (LWD) that creates channel structure and cover for fish, and provides shade, which controls stream temperatures (Bilby and Ward 1991) . When vegetation is removed from riparian areas, waters are heated, and LWD is less common. This results in less refuge for fish, fundamental changes in channel structure (e.g., loss of pool habitats), instability of streambanks, and alteration of nutrient and prey sources within the river system.

Estuaries are the bays and inlets influenced by both the ocean and rivers, and they serve as the transition zone between fresh and salt water (Botkin et al. 1995). Estuaries support a community of plants and animals that are adapted to the zone where fresh and salt waters mix (Zedler et al. 1992). Estuarine habitats fulfill fish and wildlife needs for reproduction, feeding, refuge, and other physiological necessities (Simenstad et al. 1991, Good 1987, Phillips 1984). Healthy estuaries include eelgrass beds which protect young fish from predators, provide habitat for fish and wildlife, improve water quality, and control sediments (Thayer et al. 1984, Hoss and Thayer 1993, Phillips 1984). In addition, mud flats, high salt marsh, and saltmarsh creeks also provide productive shallow water habitat for epibenthic fishes and decapods (Sogard and Able 1991).

Coastal or marine habitats comprise a variety of broad habitat types for EFH managed species including sand bottoms, rocky reefs, and submarine canyons. When rock reefs support kelp stands, they become exceptionally productive. Relative to other habitats, including wetlands, shallow and deep sand bottoms, and rock bottom artificial reefs, giant kelp habitats are substantially more productive in the fish communities they support (Bond et al. 1999). Foster and Schiel (1985) reported that the net primary productivity of kelp beds may be the highest of any marine community. Lush kelp forest communities (e.g., giant kelp, bull kelp, elk kelp, and feather boa kelp) are found relatively close to shore along the open coast. These subtidal communities provide vertically structured habitat through the water column on the rocky shelf, made up of a canopy of tangled stipes from the water line to a depth of 10 feet; a mid-kelp, water-column region; and the bottom, holdfast region. The stands provide nurseries, feeding grounds, and/or shelter to a variety of groundfish species and their prey (Feder et al. 1974; Ebeling et al.

1980).

Non-fishing Impacts

The diversity, widespread distribution, and ecological linkages with other aquatic and terrestrial environments make the waters and substrates that comprise EFH susceptible to a wide array of human activities unrelated to fishing.

Non-fishing activities have the potential to adversely affect the quantity or quality of EFH designated areas in riverine, estuarine, and marine systems. Broad categories of such activities include, but are not limited to, mining, dredging, fill, impoundment, discharge, water diversions, thermal additions, actions that contribute to nonpoint source pollution and sedimentation, introduction of potentially hazardous materials, introduction of exotic species, and the conversion of aquatic habitat that may eliminate, diminish, or disrupt the functions of EFH. For each activity, known and potential adverse impacts to EFH are described in this document. The descriptions explain the mechanisms or processes that may cause the adverse effects and how these may affect habitat function.

The report also provides proactive conservation measures designed to minimize or avoid the adverse effects of these non-fishing gear activities on Pacific coast EFH. These measures should be viewed as options to avoid, minimize, or compensate for adverse impacts and promote the conservation and enhancement of EFH. Generally, non-water-dependent actions should not be located in EFH if such actions may have adverse impacts on EFH. Activities that may result in significant adverse affects on EFH should be avoided where less environmentally harmful alternatives are available. If there are no alternatives, the impacts of these actions should be minimized. Environmentally sound engineering and management practices should be employed for all actions that may adversely affect EFH. If avoidance or minimization is not possible, or will not adequately protect EFH, compensatory mitigation to conserve and enhance EFH is recommended.

Purpose of Document

It is of paramount importance that NOAA Fisheries' biologists review proposed projects under the EFH provisions to ensure that they provide appropriate EFH conservation recommendations. It is equally challenging during the consultation phase to consider all potential non-fishing impacts to EFH so that the appropriate mix of recommendations can be made. Because impacts that may adversely affect EFH can be direct, indirect, and cumulative, the biologist must consider and analyze these interrelated impacts. Consequently, it is not unusual for particular impacts to be overlooked or the most recent science on impacts not to be considered during the consultation. This reference document was prepared to assist NOAA Fishery biologists in reviewing proposed projects and considering potential impacts that may adversely affect EFH and to provide consistent and substantiated EFH conservation recommendations. The document should also be useful for federal action agencies undertaking EFH consultations and especially in preparing EFH assessments.

The document is organized by activities that may potentially impact EFH occurring in four discreet ecosystems. The separation of these ecosystems is artificial, and many of the impacts and their related activities are not exclusive to one system. For instance, sand and gravel mining activities often occur in riverine systems but also take place in estuarine systems. Because activities are located in the ecosystem where they initially occur in a watershed progression, the reader is encouraged to rely on the index at the end of this document to verify other systems where such activities may also take place. In addition, many types of impacts occur beyond just the primary activity. For example, pile driving creates its own set of unique impacts to EFH. However, while installing piles, other construction activities such as dredging may occur, and this secondary activity brings its own set of potential adverse impacts. Again, the biologist should rely on the index to ensure that all project activities are considered in the consultation.

The EFH conservation recommendations included with each activity present a series of site-specific measures that can be undertaken by the action agency to avoid, offset, or mitigate impacts to EFH. Not all of these suggested measures are necessarily applicable to any one project or activity that may adversely affect EFH. More specific or different measures based on the best and most current scientific information may be developed prior to, or during, the EFH consultation process and communicated to the appropriate agency. The conservation recommendations provided represent a short menu of general types of conservation actions that can contribute to the conservation and enhancement of properly functioning EFH.

2.0 UPLAND ACTIVITIES

2.1 Nonpoint Source Pollution

The information in this section is adapted from the following reference: EPA. 1993. Guidance for specifying management measures for sources of nonpoint pollution in coastal waters. EPA Office of Water. 840-B-92-002. 500+ pp.

Nonpoint source pollution generally results from land runoff, precipitation, atmospheric deposition, seepage, or hydrologic modification. Technically, the term ‘nonpoint source’ means anything that does not meet the legal definition of ‘point source’ in section 502(14) of the Clean Water Act, which refers to “discernable, confined and discrete conveyance” from which pollutants are or may be discharged. The major categories of nonpoint pollution are agricultural runoff, urban runoff, including developed and developing areas (see Section 2.2), silvicultural (forestry) runoff (see Section 2.1.2), marinas and recreational boating, road construction, and channel and streambank modifications, including channelization, channel modifications (see Section 4.7), and streambank and shoreline erosion.

Nonpoint source pollution is usually lower in intensity than an acute point source event, but may be more damaging to fish habitat in the long term. Nonpoint source pollution is often difficult to detect. It may affect sensitive life stages and processes, and the impacts may go unnoticed for a long time. When severe population impacts are finally noticed, they may not be tied to any one event and hence may be difficult to correct, clean up, or mediate.

2.1.1 Agricultural/Nursery Runoff

Substantial portions of croplands and commercial nursery operations are connected to inland and coastal waters where nonpoint pollution can have a direct adverse effect on aquatic habitats. Tillage aerates the upper soil, but compacts fine textured soils just below the depth of tillage, thus altering infiltration. Use of farm machinery on cropland and adjacent roads causes further compaction, reducing infiltration and increasing surface runoff. Agricultural lands are also characterized by poorly maintained dirt roads and ditches that, along with drains, route sediments, nutrients, and pesticides directly into surface waters. Natural channels filter and process pollutants. In many instances, roads, ditches and drains have replaced headwater streams, and these constructed systems deliver pollutants directly to surface waters (Larimore and Smith 1963).

Rangeland soils can also become compacted by livestock (Platts 1991, Heady and Child 1994) with similar effects on runoff. Compaction of rangelands generally increases with grazing intensity, although site-specific soil and vegetative conditions are important (Kauffman and Krueger 1984, Heady and Child 1994). Johnson (1992) reviewed studies related to grazing and hydrologic processes and concluded that heavy grazing nearly always decreases infiltration, reduces vegetative biomass, and increases bare soil. Primary runoff pollutants are nutrients, pesticides, sediment, salts, and animal wastes. Because the primary routes of pesticide transport to EFH include not only surface runoff events, but also direct application, aerial drift, and groundwater systems, pesticide contamination is addressed separately in Section 2.1.3.

Potential Adverse Impacts

Adverse impacts to EFH from agricultural and nursery runoff can result from 1) nutrient loading, 2) introduction of animal wastes, 3) erosion, and 4) sedimentation.

Nutrients are applied to agricultural land in several different forms and come from various sources, including commercial fertilizers, manure from animal production facilities (with bedding and other wastes added to the manure), municipal and industrial treatment plant effluent and sludge, legume and crop residues, irrigation water, and atmospheric deposition of nutrients such as nitrogen and sulfur. Specifically, nitrogen and phosphorus are the two major nutrients from agricultural land that degrade water quality. Introduction of these nutrients into aquatic systems can dramatically increase aquatic plant productivity and decay (cultural eutrophication; Waldichuk 1993). This process can increase turbidity, temperature, and the accumulation of dead organic material, and it can decrease light penetration, oxygen, and the growth of submerged aquatic vegetation. These alterations can result in the destruction of habitat for small or juvenile fish and severely impair biological food chains.

Animal waste (manure) includes fecal and urinary wastes of livestock and poultry; process water (such as from a milking parlor); and the feed, bedding, litter, and soil with which they become intermixed. Because riparian areas are favored by cattle, nutrients consumed elsewhere are often excreted as waste in riparian zones (Heady and Child 1994). Pollutants contained in manure and associated bedding materials can be transported into marine environments by runoff and process wastewater from rangelands, pastures, or confined animal facilities. Theses pollutants may include oxygen-demanding substances such as nitrogen, phosphorus, and organic solids; salts; bacteria, viruses, and other microorganisms, as well as sediments that increase organic decomposition. Runoff of animal wastes can cause fish kills due to ammonia, and solids deposited into the marine environment can reduce productivity over extended periods of time due to the accelerated effects of cultural eutrophication. Runoff can be accelerated by grazing processes that remove or disturb riparian vegetation and soils.

Sediment is the result of erosion. Sheet, rill, and gully erosion all transport fine sediment, enriched with a wide variety of attached pollutants, from agricultural land into the aquatic environment. The presence of livestock in the riparian zone accelerates sediment transport rates by increasing both surface erosion and mass wasting (Platts 1991, Marcus et al. 1990, Heady and Child 1994). Likewise, grazing in uplands can result in increased sediment delivery through channelized flows. For example, the Soil Conservation Service (SCS) estimated that 92 percent of the total sediment yields in the Snake and Walla Walla River basins of southeastern Washington resulted from sheet and rill erosion from cropland accounting for only 43 percent of total land area (SCS et al. 1984). Increased sediment in aquatic systems can increase turbidity, reduce light penetration, smother fish spawning areas and food supplies, clog the filtering capacity of filter feeders, clog and harm the gills of fish, interfere with feeding behaviors, and significantly lower overall biological productivity.

Salts are a product of natural weathering of soil and geologic material. The movement and deposition of salts depend on the amount and distribution of rainfall and irrigation, the soil and underlying strata, evapotranspiration rates, and other environmental factors. Irrigation water, whether from ground or surface water sources, has a natural base load of dissolved mineral salts. As water is consumed by plants or lost to the atmosphere by evaporation, the remaining salts become concentrated in the soil (the “concentrating effect”). Thus, the total salt load carried by irrigation return flow is the sum of the salts remaining in the applied water plus any additional salt picked up from the irrigated land. Irrigation return flows convey the salt to the receiving streams or groundwater reservoirs. If the amount of salt in the return flow is low in comparison to the total stream flow, water quality may not be degraded to the extent that EFH functions are impaired. However, if the process of water diversion and the return flow of saline drainage water is repeated many times along a stream or river, downstream habitat quality can become progressively degraded.

Groundwater is also susceptible to nutrient contamination in agricultural lands composed of sandy or other coarse-textured soil (Franco et al. 1994, USGS 1999). Nitrate, a highly soluble form of nitrogen, can leach rapidly through the soil profile and accumulate in groundwater, especially in shallow zones (Jordan and Weller 1996, Brady and Weil 1996). This groundwater can be a significant source of nutrients in surface waters when discharged through seeps, drains, or by direct subsurface flow to water bodies (Lee and Taylor 2000).

Recommended Conservation Measures

1. Protect and restore soil quality with controls that affect soil’s ability to grow crops, partition and

regulate water flow, and act as an environmental filter (e.g., permeability, water holding capacity, nutrient availability, organic matter content, and biological activity). Relevant practices include cover cropping, crop sequence, conservation tillage, crop residue management, grazing management, and use of low-impact equipment (e.g., minimally sized, rubber tired).

2. Improve land use efficiencies for key agricultural inputs including nitrogen, phosphorus, pesticides, and irrigation water. Relevant practices are agronomic nutrient applications based upon nutrient testing, including manure, during clear weather, use of integrated pest management, and irrigation management.

3. Increase resistance to soil erosion and runoff. Sediment basins, contour farming, and grazing management are examples of key practices.

4. Protect and restore rangelands using practices such as rotational grazing systems or livestock distribution controls, exclusion from riparian and aquatic areas, livestock-specific erosion controls, reestablishment of vegetation, or extensive brush management correction.

5. Increase field and landscape buffers to provide cost-effective protection against the cumulative effects of many small, but unavoidable, pollutant discharges associated with an active agricultural enterprise and the kinds of catastrophic pollution that can be associated with the high energy flows and runoff associated with episodic storms. The full range of agricultural buffer practices (e.g., riparian forests, alley cropping, contour buffer strips, crosswind trap strips, field borders, filter strips, grassed waterways with vegetative filters, herbaceous wind barriers, vegetative barriers, and windbreak/shelterbelts) has to be systematically deployed, protected and managed across the agricultural landscape or overall aquatic habitat improvements will be minimal.

6. Optimize siting of new confined animal facilities or expansion of existing facilities by placing them away from riparian areas, surface water, and areas with high leaching potential to surface or groundwater. Ensure that adequate nutrient and wastewater collection facilities are in place. Ensure that sufficient cropland is available for agronomic application of animal wastes.

7. Consider using restored wetlands to reduce contamination from a variety of sources including nitrogen, phosphorus, suspended solids, biochemical oxygen demand (BOD), trace metals, trace organics, and pathogens. Larger wetland systems relative to the amount of land that is drained with longer retention times (at least 1 to 2 weeks) are most beneficial at improving water quality. Wetlands located within riparian buffer strips provide the most effective pollution removal by combining different treatment methods.

2.1.2 Silviculture/Timber Harvest

The harvest and cultivation of timber and other forestry products are major activities that can have both short- and long-term impacts throughout many coastal watersheds and estuaries. Timber harvest removes the dominant vegetation, converts mature and old-growth upland and riparian forests to tree stands or forests of early seral stage, reduces permeability of soils and increases the area of impervious surfaces, increases sedimentation from surface runoff and mass wasting processes, results in altered hydrologic regimes, and impairs fish passage through inadequate design, construction, and/or maintenance of stream crossings.

Deforestation associated with timber harvest can alter or impair instream habitat structure and watershed function. Timber harvest may result in inadequate or excessive surface and stream flows, increased stream bank and stream bed erosion, loss of complex instream habitats, sedimentation of riparian habitat, and increased surface runoff with associated contaminants (e.g., herbicides, fertilizers, fine sediments). Hydrologic characteristics, (e.g., water temperature, annual hydrograph) change, and greater variation in stream discharge is associated with timber harvest. Alterations in the supply of LWD and sediment can have negative effects on the formation and persistence of instream habitat features. Excess debris in the form of small wood and silt can smother benthic habitat and reduce dissolved oxygen levels.

Potential Adverse Impacts

Four major categories of activities can adversely affect EFH: 1) construction of logging roads, 2) creation of barriers, 3) removal of streamside vegetation, and 4) disturbance associated with log transfer facilities (LTFs) (see Section 4.9).

Logging road construction can destabilize slopes and increase erosion and sedimentation (see Road Building and Maintenance, Section 2.3). Two major types of erosion occur: mass wasting and surface erosion. Mass movement of soils, commonly referred to as landslides or debris slides, is associated with timber harvest and road building on high hazard soils and unstable slopes. Both frequency and size of debris slides are increased when logging roads are built on, or timber is harvested from, these unstable land forms. The result is increased erosion and sediment deposition in downslope waterways. Erosion from roadways is most severe when poor construction practices are employed that do not include properly located, sized, and installed culverts; proper ditching; and ditch blocker water bars (Furniss et al. 1991).

Stream crossings (bridges and culverts) on forest roads are often inadequately designed, installed, and maintained, and they frequently result in full or partial barriers to both the upstream and downsteam migration of adult and juvenile fish. Perched and undersized culverts can accelerate stream flows to the point that these structures become velocity barriers for migrating fish. Blocked culverts result from installation of undersized culverts or inadequate maintenance to remove debris. Blocked culverts can result in displacement of the stream from the downstream channel to the roadway or roadside ditch, resulting in dewatering of the downstream channel and increased erosion of the roadway. Culverts and bridges deteriorate structurally over time. Failure to replace or remove them at the end of their useful life may cause partial or total blockage of fish passage. Caution should be used, however, when removing culverts. Channel incision can often occur downstream of a culvert and generally moves upstream. An existing culvert can act as a grade control, halting the upstream progression of a headcut and causing further channel regrade (Castro 2003). The unchecked upstream progression of a headcut can cause further damage to EFH.

Removing streamside vegetation increases the amount of solar radiation reaching the stream and can result in warmer water temperatures, especially in small, shallow streams of low velocity. In southeast Alaska, Meehan et al. (1969) found that maximum temperature in logged streams without riparian buffers exceeded that of unlogged streams by up to 5ºC, but did not reach lethal temperatures. However, the increased water temperatures often exceeded optimum temperatures for pink and chum salmon (Reiser and Bjornn 1979). Logged streams have been associated with higher water temperatures, lower base flows and higher peak flows, and low oxygen levels that have resulted in significant mortalities of pink and chum salmon (Flanders and Cariello 2000). In cold climates, the removal of riparian vegetation can result in lower water temperatures during winter, increasing the formation of ice and damaging and delaying the development of incubating fish eggs and alevins.

By removing vegetation, timber harvest reduces transpiration losses from the landscape and decreases the absorptive capability of the groundcover. These changes result in increased surface runoff during periods of high precipitation and decreased base flows during dry periods. Reduced soil strength results in destabilized slopes and increased sediment and debris input to streams (Swanston 1974). Sediment deposition in streams can reduce benthic community production (Culp and Davies 1983), cause mortality of incubating salmon eggs and alevins, and reduce the amount of habitat available for juvenile salmon (Heifetz et al. 1996). Cumulative sedimentation from logging activities can significantly reduce the egg-to-fry survival of coho and chum salmon (Cederholm and Reid 1987, Myren and Ellis 1984.) Reductions in the supply of LWD also result when old-growth forests are removed, with resulting loss of habitat complexity that is critically important for successful salmonid spawning and rearing. (Bisson et al. 1988).

Recommended Conservation Measures

1. Set best management practices (BMPs) for impacts affecting particular habitats and resulting from specific types of silviculture-related activities provided in the “Additional Resources” section.

2. Avoid timber operations to the extent practicable near streams with EFH. For the Alaska region, see the following link: Fish: Forest-Wide Standards and Guides:
http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF;
http://www.or.blm.gov/ForestPlan/newsandga.pdf

3. Avoid timber operations to the extent practicable in wetlands contiguous with anadromous fish streams. See the following link: Wetlands: Forest-Wide Standards and Guides:
http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF

4. Avoid timber operations to the extent practicable near estuary and beach habitats. See the following link: Beach and Estuary Fringe: Forest-Wide Standards and Guides:
http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF

5. Maintain riparian buffers along all streams. In the Alaska region, buffer width is site-specific and dependent on stream process type. Stream process groups are described in the following link: http://www.fs.fed.us/r10/TLMP/F_PLAN/APPEND_D.PDF. Standards and guidelines for riparian buffers for the Alaska region are described in the following link: Riparian: Forest-Wide Standards and Guides: http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF .

6. Incorporate watershed analysis into timber and silviculture projects. Particular attention should be given to the cumulative effects of past, present, and future timber sales within the watershed. See the following link on watershed analysis: http://www.fs.fed.us/r10/TLMP/F_PLAN/APPEND_J.PDF

7. Follow BMPs. See the following link on BMPs:
http://www.fs.fed.us/r10/TLMP/F_PLAN/APPEND_C.PDF

8. For forest roads, see Section 2.3, Road Building and Maintenance. For the Alaska region, also see the following links: 1) transportation: forest-wide standards and guides http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF and 2) soils and water: forest-wide standards and guides: http://www.fs.fed.us/r10/TLMP/F_PLAN/FPCHAP4.PDF

2.1.3 Pesticide Application

More than 800 different pesticides are currently registered for use in the United States. Legal mandates covering pesticides are the Clean Water Act (CWA) and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Water quality criteria for the protection of aquatic life have only been developed for a few of the currently used chemicals (EPA, Office of Pesticide Programs). Collectively, these substances are designed to repel, kill, or regulate the growth of undesirable biological organisms. This diverse group includes fungicides, herbicides, insecticides, nematicides, molluscicides, rodenticides, fumigants, disinfectants, repellents, wood preservatives, and antifoulants. The most common pesticides are insecticides, herbicides, and fungicides. These are used for pest control on forested lands, agricultural crops, tree farms and nurseries, highways and utility rights of way, parks and golf courses, and residences. Pesticides can enter the aquatic environment as single chemicals or complex mixtures. Direct applications, surface runoff, spray drift, agricultural return flows, and groundwater intrusions are all examples of transport processes that deliver pesticides to aquatic ecosystems.

Pesticides are frequently detected in freshwater and estuarine systems that provide EFH. Nationwide, the most comprehensive environmental monitoring efforts have been conducted by the USGS as part of the National Water Quality Assessment (NAWQA) Program. A variety of human activities such as fire suppression on forested lands, forest site preparation, noxious weed control, right-of-way maintenance (roads, railroads, power lines, etc.), algae control in lakes and irrigation canals, various agricultural practices, riparian habitat restoration, and urban and residential pest control results in contamination from these substances. It is important to note that the term “pesticide” is a collective description of hundreds of chemicals with different sources, different fates in the aquatic environment, and different toxic effects on fish and other aquatic organisms. Despite these variations, all current use pesticides are 1) specifically designed to kill, repel, or regulate the growth of biological organisms and 2) intentionally released into the environment. Habitat alteration from pesticides is different from more conventional water quality parameters such as temperature, suspended solids, or dissolved oxygen because, unlike temperature or dissolved oxygen, the presence of pesticides can be difficult to detect due to limitation in proven methodologies. This monitoring may also be expensive. However, as analytical methodologies have improved in recent years, the number of pesticides documented in fish and their habitats has increased.

Potential Adverse Impacts

There are three basic ways that pesticides can adversely affect EFH. These are 1) a direct toxicological impact on the health or performance of exposed fish, 2) an indirect impairment of the productivity of aquatic ecosystems, and 3) a loss of aquatic vegetation that provides physical shelter for fish.

Fish kills are rare when pesticides are used according to their labels. For fish, the vast majority of effects from pesticide exposures are sublethal. Sublethal effects are a concern if they impair the physiological or behavioral performance of individual animals in ways that will decrease their growth or survival, alter migratory behavior, or reduce reproductive success. In addition to early development and growth, key physiological systems affected include the endocrine, immune, nervous, and reproductive systems. Many pesticides have been shown to impair one or more of these physiological processes in fish (Moore and Waring 2001). In general, however, the sublethal impacts of pesticides on fish health are poorly understood. Accordingly, this is a focus of recent and ongoing NOAA research (Scholz et al. 2000, Van Dolah et al. 1997).

The effects of pesticides on ecosystem structure and function can be a key factor in determining the cascading impacts of that chemical on fish and other aquatic organisms at higher trophic levels (Preston 2002). This includes impacts on primary producers (Hoagland et al. 1996) and aquatic microorganisms (DeLorenzo et al. 2001), as well as macroinvertebrates that are prey species for fish. For example, many pesticides are specifically designed to kill insects. Not surprisingly, these chemicals are relatively toxic to insects and crustaceans that inhabit river systems and estuaries. Overall, pesticides will have an adverse impact on fish habitat if they reduce the productivity of aquatic ecosystems. Finally, some herbicides are toxic to aquatic plants that provide shelter for various fish species. A loss of aquatic vegetation could damage nursery habitat or other sensitive habitats such as eelgrass beds and emergent marshes.

Recommended Conservation Measures

1. Incorporate integrated pest management (IPM) and BMPs as part of the authorization or permitting process to ensure the reduction of pesticide contamination in EFH (Scott et al. 1999).
2. Carefully review labels and ensure that application is consistent. Follow local, supplemental instructions such as county use bulletins where they are available.
3. Avoid the use of pesticides in and near EFH designated waters.
4. Refrain from areal spraying of pesticides on windy days.

2.2 Urban/Suburban Development

The information in this section is adapted from the following reference: NOAA Fisheries. 1998. Draft Document - Non-fishing threats and water quality: A reference for EFH consultation.

Urban growth and development in the United States continues to expand in coastal areas at a rate approximately four times greater than in other areas. The construction of urban, suburban, commercial, and industrial centers and corresponding infrastructure results in land use conversions typically resulting in vegetation removal and the creation of additional impervious surfaces. This runoff from impervious surfaces and storm sewers is the most widespread source of pollution into the Nation’s waterways (EPA 1995).

Potential Adverse Impacts

Development activities within watersheds and in coastal marine areas often impact the EFH of managed species on both long-term and short-term scales. Many of the impacts listed here are discussed in greater detail in other sections of this documents. However, primary impacts include 1) the loss of riparian and shoreline habitat and vegetation and 2) runoff. The removal of upland and shoreline vegetation removal can increase stream water temperatures, reduce supplies of LWD, and reduce sources of prey and nutrients to the water system. An increase in impervious surfaces, such as the addition of new roads (see also Section 2.3), roofs, bridges, and parking facilities, results in a decreased infiltration to groundwater and increased runoff volumes. This also has the potential to adversely affect water quality and water quantity/timing in downstream water bodies (i.e. estuaries and coastal waters).

The loss of riparian and shoreline habitat and vegetation can increase water temperatures and remove sources of cover. Such impacts can alter the structure of benthic and fish communities, resulting in an expected reduction in diversity and abundance of EFH species. Shoreline stabilization projects (see Section 4.7) that affect reflective wave energy can impede or accelerate natural movements of shoreline substrates, thereby impacting intertidal and sub-tidal habitats. Channelization of rivers cause loss of floodplain connectivity and simplification of habitat. The resulting sediment runoff can also restrict tidal flows and tidal elevations, resulting in losses of important fauna and flora (e.g., submerged aquatic vegetation).

Due to the intermittent nature of rainfall and runoff, the large variety of pollutant source types, and the variable nature of source loadings, urban runoff is difficult to control (Safavi 1996). The National Water Quality Inventory (EPA 2002) reports that runoff from urban areas is the leading source of impairment to surveyed estuaries and the third largest source of impairment to surveyed lakes. These include construction sediments, oil from autos, bacteria from failing septic systems, road salts, and heavy metals. Urban areas have an insidious pollution potential that one-time events such as oil spills do not. Pollutant increases gradually result in gradual declines in habitat quality.

Storm drains are often built to move water quickly away from roads, resulting in increased water input to streams. This greater volume and velocity erodes streambanks, increasing sediment loads and often temperatures. In a simulation model comparing an urban watershed with a forested watershed, Corbett et al. (1997) demonstrated that urban runoff volume and sediment yield were 5.5 times greater than forest runoff.

Also waterborne polyaromatic hydrocarbon (PAH) levels have been found to be significantly higher in an urbanized watershed when compared to a non-urbanized watershed (Fulton et al. 1993). Petroleum-based contaminants (such as fuel, oil, and some hydraulic fluids) contain PAHs which can cause acute toxicity to EFH species and their prey at high levels of exposure and can also cause chronic lethal as well as acute and chronic sublethal toxicity (Neff 1985).

Failing septic systems are an outgrowth of urban development. EPA estimates that 10 to 25 percent of all individual septic systems are failing at any one time, introducing excrement, detergents, endocrine disruptors, and chlorine into the environment. Even treated wastewater from urban areas can alter the physiology of intertidal organisms (Moles, A. and N. Hale. in press). Sewage discharge is a major source of coastal pollution, contributing 41 percent, 16 percent, 41 percent, and 6 percent of the total pollutant load for nutrients, bacteria, oils and toxic metals, respectively (Kennish 1998). Nutrients such as phosphorus concentrations, in particular, are indicative of urban stormwater runoff (Holler 1990). Sewage wastes may also contain significant amounts of organic matter that exert a biochemical oxygen demand (Kennish 1998). Organic contamination contained within urban runoff can also cause immuno suppression (Arkoosh et al. 2000) (NOAA Fisheries Draft 1998).

Recommended Conservation Measures

See also Section 2.3, Recommended Conservation Measures for Roads.

1. Implement BMPs (EPA 1993) for sediment control during construction and maintenance operations. These can include avoiding ground disturbing activities during the wet season; minimizing exposure time of disturbed lands; using erosion prevention and sediment control methods; minimizing the spatial extent of vegetation disturbance; maintaining buffers of vegetation around wetlands, streams, and drainage ways; and avoiding building activities in areas of steep slopes and areas prone to mass wasting events with highly erodible soils. Use methods such as sediment ponds, sediment traps, bioswales, or other facilities designed to slow water runoff and trap sediment and nutrients.
2. Avoid using hard engineering structures for shoreline stabilization and channelization when possible. Use bioengineering approaches (i.e., using vegetation approaches with principles of geomorphology, ecology, and hydrology) to protect shorelines and river banks. Naturally stable shorelines and river banks should not be altered (see Section 4.7).
3. Encourage comprehensive planning for watershed protection so as to avoid filling and building in floodplain areas affecting EFH. Development sites should be planned to minimize clearing and grading, cut-and-fill, and new impervious surfaces.
4. Where feasible, remove impervious surfaces such as abandoned parking lots and buildings from riparian and shoreline areas, and reestablish wetlands and native vegetation.
5. Protect and restore vegetated buffer zones of appropriate width along all streams, lakes, and wetlands that include or influence EFH.
6. Manage stormwater to duplicate the natural hydrologic cycle, maintaining natural infiltration and runoff rates to the maximum extent practicable.
7. Where in-stream flows are insufficient to maintain water quality and quantity needed for EFH, establish conservation guidelines for water use permits and encourage the purchase or lease of water rights and the use of water to conserve or augment instream flows in accordance with state and federal water law.
8. Encourage municipalities to use the best available technologies in upgrading their wastewater systems to avoid combined sewer overflow problems and chlorinated sewage discharges into rivers, estuaries, and the ocean.
9. On-site disposal systems should be properly designed and installed. They should be located away from open waters, wetlands, and floodplains.

2.3 Road Building and Maintenance

The building and maintenance of roads can affect aquatic habitats by increasing rates of natural processes such as debris slides or landslides and sedimentation, introducing exotic species, and degrading water quality and chemical contamination (e.g., petroleum-based contaminants; see Section 2.2). Paved and dirt roads introduce an impervious or semi-pervious surface into the landscape. This surface intercepts rain and creates runoff carrying soil, sand and other sediments, and oil-based materials quickly downslope. If roads are built near streams, wetlands, or other sensitive areas, these may be affected by the increased sedimentation that occurs both from maintenance and use and during storm and snowmelt events. Even carefully designed and constructed roads can become sources of sediment and pollutants if they are not properly maintained.

Potential Adverse Impacts

The effects of roads on aquatic habitat can be profound and include 1) increased deposition of fine sediments, 2) changes in water temperature, 3) elimination or introduction of migration barriers such as culverts, 4) changes in streamflow, 5) introduction of non-native plant species, and 6) changes in channel configuration.

Poorly surfaced roads can substantially increase surface erosion, and the rate of erosion is primarily a function of storm intensity, surfacing material, road slope, and traffic levels. This surface erosion results in an increase in fine sediment deposition (Bilby et al. 1989, MacDonald et al. 2001, Ziegler et al. 2001). An increase of fine-sediment deposition in stream gravels has been linked to decreased fry emergence, decreased juvenile densities, loss of winter carrying capacity, and increased predation of fishes (Koski 1981). Increased sediment fines can reduce benthic production or alter the composition of the benthic community. For example, embryo-to-emergent fry survival of incubating salmonids is negatively affected by increases in fine sediments in spawning gravels (Chapman 1988, Everest et al. 1987, Scrivener and Brownlee 1989, Weaver and Fraley 1993, Young et al. 1991).

Roads built adjacent to streams result in changes in water temperature and increased sunlight reaching the stream as riparian vegetation is removed and/or altered in composition. Beschta et al. (1987) and Hicks et al. (1991) document some of the negative effects of road construction on fish habitat, including elevation of stream temperatures beyond the range of preferred rearing, inhibition of upstream migrations, increased disease susceptibility, reduced metabolic efficiency, and shifts in species assemblages.

Roads can also degrade aquatic habitat through improperly placed culverts at road-stream crossings that reduce or eliminate fish passage (Belford and Gould 1989, Clancy and Reichmuth 1990, Evans and Johnston 1980, Furniss et al. 1991). In a large river basin in Washington, 13 percent of the historical coho habitat was lost due to improper culvert design and placement. (Beechie et al. 1994). Road crossings also affect benthic communities of stream invertebrates. Roads have a negative effect on the biotic integrity of both terrestrial and aquatic ecosystems (Trombulak and Frissell 2000). Studies indicate that populations of non-insect invertebrates tend to increase the farther from a road they are measured (Luce and Crowe 2001).

Roads may be the first point of entry into a virgin landscape for non-native grass species that are seeded along road cuts or introduced from seeds transported by tires and shoes. Roads can serve as corridors for such species allowing plants to move further into the landscape (Greenberg et al. 1997, Lonsdale and Lane 1994). Some non-native plants may be able to move away from the roadside and into aquatic sites of suitable habitat, where they may out-compete native species and have significant biological and ecological effects on the structure and function of the ecosystem.

Roads have three primary effects on hydrologic processes. First, they intercept rainfall directly on the road surface, in road cutbanks, and as subsurface water moving down the hillslope. Second, they concentrate flow, either on the road surfaces or in adjacent ditches or channels. Last, they divert or reroute water from flowpaths that would otherwise be taken if the road were not present (Furniss et al. 1991).

Road drainage and transport of water and debris, especially during heavy rains and snow melt periods, are primary reasons why roads fail, often with major structural, ecological, economic, or other social consequences. The effects of roads on peak streamflow depend strongly on the size of the watershed and the density of roads. Some of the effects are 1) changes in flood flows (Wemple et al. 1996) but mainly in smaller basins and for smaller floods (Beschta et al. 2000), and 2) increased channel erosion and mass wasting (Montgomery 1994, Madej 2001, Wemple et al. 2001). For example, capture and rerouting of water can dewater one small stream and cause major channel adjustments in the stream receiving the additional water. In large watersheds with low road density, properly located and maintained roads may constitute a small proportion of the land surface and have relatively insignificant effects on peak flow.

Roads can lead to increased rates of natural processes such as debris or landslides and sedimentation when slopes are destabilized and surface erosion and soil mass movement increases. Erosion is most severe when poor construction practices are allowed, combined with inadequate attention to proper road drainage and maintenance practices. Mass movement risks increase when roads are constructed on high-hazard soils and overly steep slopes. In steep areas prone to landslides, rates of mass soil movements affected by roads include shallow debris slides, deep-seated slumps and earthflows, and debris flows. Accelerated erosion rates from roads because of debris slides range from 30 to 300 times the natural rate in forested areas, but vary with terrain in the Pacific Northwest (Sidle et al. 1985). The magnitude of road-related mass erosion varies by climate, geology, road age, construction practices, and storm history. Road-related mass failures result from various causes, including improper placement and construction of road fills and stream crossings; inadequate culvert sizes to pass water, sediment, and wood during floods; poor road siting; modification of surface or subsurface drainage by the road surface or prism; and diversion of water into unstable parts of the landscape (Burroughs et al. 1976, Clayton 1983, Hammond et al. 1988, Furniss et al. 1991, Larsen and Parks 1997).

Recommended Conservation Measures

1. Avoid locating roads near fish-bearing streams. Roads should be sited to avoid sensitive areas such as streams, wetlands, and steep slopes.
2. Incorporate erosion control and stabilization measures into road construction plans to reduce erosion potential.
3. Build bridges when possible. If culverts are to be used, they should be sized, constructed, and maintained to match the gradient and width of the stream, so as to accommodate 100-year flood flows, but equally to provide for migratory passage of adult and juvenile fishes. Utilize guidelines provided in the document: "Guidelines for Salmonid Passage at Stream Crossing," NOAA Fisheries, Southwest Region, October 2001 (http://swr.nmfs.noaa.gov/hcd/NMFSSCG.PDF).
4. Locate stream crossings in stable stream reaches.
5. Design bridge abutments to minimize disturbances to streambanks and place abutments outside of the floodplain whenever possible.
6. Avoid road construction across alluvial floodplains, mass wastage areas, or braided stream bottom lands unless site-specific protection can be implemented to ensure protection of soils, water, and associated resources.
7. Avoid side-casting of road materials into streams year-round.
8. Use only native vegetation in stabilization plantings.
9. Maintenance practices should not cause existing problems to worsen.

3.0 RIVERINE ACTIVITIES

3.1 Mining (see Section 5.6 - Marine Mining)

Mining and mineral extraction activities take many forms such as commercial dredging and recreational suction dredging, placer, area surface removal, and contour operations. Activities include exploration, site preparation, mining, milling, waste management, decommissioning or reclamation, and even mine abandonment (American Fisheries Society [AFS] 2000). Mining and its associated activities have the potential to cause environmental impacts from exploration through post-closure. These impacts may include adverse effects to EFH. The operation of metal, coal, rock quarries, and gravel pit mining has caused varying degrees of environmental damage in urban, suburban, and rural areas. Some of the most severe damage, however, occurs in remote areas, where some of the most productive fish habitat is often located (Sengupta 1993). Regulations have been designed to control and manage these changes to the landscape to avoid and minimize impacts. These regulations are updated as new technologies are developed to improve mineral extraction, reclaim mined lands, and limit environmental impacts. However, while environmental regulations may avoid, limit, control, or offset many of these potential impacts, mining will, to some degree, always alter landscapes and environmental resources (National Research Council [NRC] 1999).

3.1.1 Mineral Mining

Potential Adverse Impacts

Potential impacts from mining include 1) adverse modification of hydrologic conditions so as to cause erosion of desirable habitats, 2) removal of substrates that serve as habitat for fish and invertebrates, 3) conversion of habitats, 4) release of harmful or toxic materials, and 5) creation of harmful turbidity levels.

The effects of mineral mining on EFH depend on the type, extent, and location of the activities. Minerals are extracted using several methods. Surface mining involves suction dredging, hydraulic mining, panning, sluicing, strip mining, and open-pit mining (including heap leach mining). Underground mining uses tunnels or shafts to extract minerals by physical or chemical means. Surface mining probably has a greater potential to affect aquatic ecosystems, though specific effects will depend on the extraction and processing methods and the degree of disturbance (Spence et al. 1996). Surface mining has the potential to eliminate vegetation, permanently alter topography, permanently and drastically alter soil and subsurface geological structure, and disrupt surface and subsurface hydrologic regimes (AFS 2000). While mining may not be as geographically pervasive as other sediment-producing activities, surface mining typically increases sediment delivery much more per unit of disturbed area than other activities because of the level of disruption of soils, topography, and vegetation. Erosion from surface mining and spoils may be one of the greatest threats to salmonid habitats in the western United States (Nelson et al. 1991).

Mining and placement of spoils in riparian areas can cause the loss of riparian vegetation and changes in heat exchange, leading to higher summer temperatures and lower winter stream temperatures (Spence et al. 1996). Bank instability can also lead to altered width-to-depth ratios, which further influence temperature (Spence et al. 1996). Mining efforts can also bury productive habitats near mine sites.

Mining operations can release harmful or toxic materials and their byproducts, either in association with actual mining, or in connection with machinery and materials used for mining. Mining can also introduce levels of heavy metals and arsenic that are naturally found within the stream bed sediments. Tailings and discharge waters from settling ponds can result in loss of EFH and life stages of managed species. The impact degrades water quality and levels can become high enough to prove lethal (North Pacific Fishery

Management Council [NPFMC] 1999).

Commercial operations may also involve road building (see Section 2.3), tailings disposal (Section 4.2), and leaching of extraction chemicals, all of which may create serious impacts to EFH. Cyanide, sulfuric acid, arsenic, mercury, heavy metals, and reagents associated with such development are a threat to EFH. Improper or in-water disposal of tailings may be toxic to managed species or their prey downstream. Upland disposal of tailings in unstable or landslide prone areas can cause large quantities of toxic compounds to be released into streams or to contaminate groundwater (NPFMC 1999). Indirectly, the sodium cyanide solution used in heap leach mining is contained in settling ponds from which groundwater and surface waters may become contaminated (Nelson et al. 1991).

Water pollution by heavy metals and acid is also often associated with mineral mining operations, as ores rich in sulfides are commonly mined for gold, silver, copper, iron, zinc, and lead. When stormwater comes in contact with sulfide ores, sulfuric acid is commonly produced (West et al. 1995). Abandoned pit mines can also cause severe water pollution problems.

Recreational gold mining with such equipment as pans, motorized or nonmotorized sluice boxes, concentrators, rockerboxes, and dredges can adversely affect EFH on a local level. Commercial mining is likely to involve activities at a larger scale with much disturbance and movement of the channel involved (OWRRI 1995).

Recommended Conservation Measures

The following suggested measures are adapted from recommendations in Spence et al. (1996), NMFS (1996), and Washington Department of Fish and Wildlife (WDFW) (1998).

1. Avoid mineral mining in waters and streams containing EFH.
2. Schedule necessary in-water activities when the fewest species/least vulnerable life stages of federally managed species will be present.
3. Use an integrated environmental assessment, management, and monitoring package in accordance with state and federal law. Allow for adaptive operations to minimize adverse effects on EFH.
4. Avoid spills of dirt, fuel, oil, toxic materials, and other contaminants into EFH. Prepare a spill prevention plan and maintain appropriate spill containment and water repellent/oil absorbent cleanup materials on hand.
5. Treat wastewater (acid neutralization, sulfide precipitation, reverse osmosis, electrochemical, or biological treatments) and recycle on site to minimize discharge to streams. Test wastewater before discharge for compliance with federal and state clean water standards.
6. Minimize opportunities for sediments to enter or affect EFH. Use methods such as contouring, mulching, and construction of settling ponds to control sediment transport. Monitor turbidity during operations, and cease operations if turbidity exceeds predetermined threshold levels. Use turbidity/sediment curtains to limit the spread of suspended sediments and minimize the area affected.
7. Reclaim, rather than bury, mine waste that contains heavy metals, acid materials, or other toxic compounds if leachate can enter EFH through groundwater.
8. Restore natural contours and plant native vegetation on site after use to restore habitat function to the extent practicable. Monitor the site for an appropriate period of time to evaluate performance and implement corrective measures if necessary.
9. Minimize the aerial extent of ground disturbance (e.g., through phasing of operations), and stabilize disturbed lands to reduce erosion.

3.1.2 Sand and Gravel Mining

Potential Adverse Impacts

Mining of sand and gravel is extensive and occurs by several methods. These include wet-pit mining (i.e., remove material from below the water table), dry-pit mining on beaches, exposed bars and ephemeral streambeds, and subtidal mining. Sand and gravel mining in riverine, estuarine, and coastal environments can create EFH impacts including 1) turbidity plumes and resuspension effects, 2) removal of spawning habitat, and 3) alteration of channel morphology.

Mechanical disturbance of EFH spawning habitat by mining equipment can also lead to high mortality rates in early life stages. One result is the creation of turbidity plumes (Section 4.1) which can move several kilometers downstream. Sand and gravel mining in riverine, estuarine, and coastal environments can also suspend materials at the sites (Section 5).

Sedimentation may be a delayed effect, because gravel removal typically occurs at low flow when the stream has the least capacity to transport fine sediments out of the system. Another delayed sedimentation effect results when freshets inundate extraction areas that are less stable than before. In addition, for species such as salmon, gravel operations can also interfere with migration past the site if they create physical or thermal changes at the work site or downstream from the site (OWRRI 1995).

Additionally, extraction of sand and gravel in riverine ecosystems can directly eliminate the amount of gravel available for spawning if the extraction rate exceeds the deposition rate of new gravel in the system. Gravel excavation also locally reduces the supply of gravel to downstream habitats. The extent of suitable spawning habitat may be reduced where degradation reduces gravel depth or exposes bedrock (Spence et al. 1996).

Mining can also alter channel morphology by making the stream channel wider and shallower. Consequently, the suitability of stream reaches as rearing EFH may be decreased, especially during summer low-flow periods when deeper waters are important for survival. Similarly, a reduction in pool frequency may adversely affect migrating adults that require holding pools (Spence et al. 1996). Changes in the frequency and extent of bedload movement and increased erosion and turbidity can also remove spawning substrates, scour redds (resulting in a direct loss of eggs and young), or reduce their quality by deposition of increased amounts of fine sediments. Other effects that may result from sand and gravel mining include increased temperatures (from reduction in summer base flows and decreases in riparian vegetation), decreased nutrients (from loss of floodplain connection and riparian vegetation), and decreased food production (loss of invertebrates) (Spence et al. 1996).

Examples of using gravel removal to improve habitat and water quality are limited and isolated (OWRRI 1995). Deep pools created by material removal in streams appear to attract migrating adult salmon for holding. These concentrations of fish may result in high losses as a result of increase in predation or recreational fishing pressure.

Recommended Conservation Measures

The following suggested measures are adapted from NMFS (1996) and OWRRI (1995).

1. Avoid sand/gravel mining in waters containing EFH. Many factors influence site selection for a gravel or sand mining site. Because of the need to incorporate technical, economic and environmental factors, siting decisions should be considered on a case-by-case basis (USFWS 1980).
2. Identify upland or off-channel (where channel will not be captured) gravel extraction sites as alternatives to gravel mining in or adjacent to EFH, if possible.
3. Design, manage, and monitor sand and gravel mining operations to minimize potential direct and indirect impacts to EFH if operations in EFH cannot be avoided. This includes, but is not limited to, migratory corridors, foraging and spawning areas, stream/river banks, intertidal areas, etc.
4. Minimize the areal extent and depth of extraction.
5. Include restoration, mitigation, and monitoring plans in sand/gravel extraction plans.

3.2 Debris Removal

3.2.1 Organic Debris

Natural occurring flotsam such as LWD and macrophyte wrack (i.e., kelp) is often removed from streams, estuaries, and coastal shores. This debris is removed for a variety of reasons including dam operations, aesthetic concerns, and commercial and recreational uses. Because the debris affects habitat function and provides habitat for aquatic and terrestrial organisms, removing it may change the ecological balance among riverine, estuarine, and coastal ecosystems.

Potential Adverse Impacts

LWD and macrophyte wrack promote habitat complexity and structure to various aquatic and shoreline habitats. The structure provides cover for managed species, creates habitats and microhabitats (e.g., pools, riffles, undercut banks, side channels), and retains gravels and can maintain the underlying channel structure (Abbe and Montgomery 1996, Montgomery et al. 1995, Ralph et al. 1994, Spence et al. 1996) in riverine systems. Its removal reduces these habitat functions. Reductions in LWD input to estuaries have reduced the spatially complex and diverse channel systems that provide for productive salmon habitat (NRC 1996). Woody debris also plays a significant role in salt marsh ecology (Maser and Sedell 1994). Reductions in woody debris input to the estuaries may affect the ecological balance of the estuary. LWD also plays a significant role in benthic ocean ecology, where deep-sea wood borers convert the wood to fecal matter, providing terrestrial based carbon to the ocean food chain (Maser and Sedell 1994). Dams and commercial in-river harvest of large woody debris have dwindled the supply of wood, jeopardizing the ecological link between the forest and the sea (Collins et al. 2002, Collins et al. 2003, Maser and Sedell 1994).

Species richness, abundance, and biomass of macrofauna (e.g., sand crabs, isopods, amphipods and polychaetes) associated with beach wrack are higher compared to beach areas with lower amounts of wrack or that are groomed(Dugan et al. 2000). The input and maintenance of wrack can strongly influence the structure of macrofauna communities including the abundance of sand crabs (*Emerita analoga)* (Dugan et al. 2000), an important prey species to some EFH managed species. Beach grooming can substantially alter the macrofaunal community structure of exposed sand beaches (Dugan et al. 2000). In addition, there are concerns that beach grooming efforts to remove wrack may also harm the eggs of the grunion (*Leuresthes tenuis*), an important prey item of EFH managed species.

Recommended Conservation Measures

1. Remove woody debris only when it presents a threat to life or property. Leave LWD wherever possible. Reposition, rather than remove woody debris that must be moved.
2. Encourage appropriate federal, state, and local agencies to prohibit or minimize commercial removal of woody debris from rivers, estuaries, and beaches.
3. Encourage appropriate federal, state, and local agencies to aid in the downstream movement of LWD around dams, rather than removing it from the system.
4. Educate landowners and recreationalists about the benefits of maintaining LWD.
5. Localize beach grooming practices and minimize it whenever possible.
6. Conduct beach grooming only above the semilunar high tide as soon as the grunion spawning period begins in the spring, and continue 2 weeks after the last grunion spawning runs are observed in the summer.
7. Familiarize beach maintenance staff with the importance of such practices.

3.2.2 Inorganic Debris

Marine debris is a problem along much of U.S. coastal waters, littering shorelines, fouling estuaries, and creating hazards in the open ocean. Marine debris consists of a huge variety of man-made materials such as general litter, dredged materials, hazardous wastes, and discarded or lost fishing gear. It enters waterways either indirectly through rivers and storm drains or by direct ocean dumping. Marine debris can have serious negative effects on EFH. Although several legislative laws and regulatory programs exist to prevent or control the problem, marine debris continues to severely impact our waters.

Congress has passed numerous legislative acts intended to prevent the disposal of marine debris in U.S. ocean waters. These include the Marine Protection, Research, and Sanctuaries Act, Titles I and II (also known as the Ocean Dumping Act), The Federal Water Pollution Control Act (Clean Water Act), and the Comprehensive Environmental Response, Compensation, and Liability Act. The International Convention for the Prevention of Pollution from Ships, commonly known as MARPOL Annex V (33 CFR 151), is intended to protect the marine environment from various types of garbage by preventing ocean dumping if the ship is less than 25 nautical miles from shore. Dumping of unground food waste and other garbage is prohibited within 12 nautical miles from shore, and ground non-plastic or food waste may not be dumped within 3 nautical miles of shore. The Ocean Dumping Act implements the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention) for the United States. Section 311 of the Federal Water Pollution Control Act makes it unlawful for any person to discharge any pollutant into the waters of the United States except as authorized by law. The Comprehensive Environmental Response, Compensation, and Liability Act stipulates that releases of hazardous substances in reportable quantities must be reported, and the release must be removed by the responsible party. Regulations implementing these acts are intended to control marine debris from ocean sources, including galley waste and other trash from ships, recreational boaters and fishermen, and offshore oil and gas exploration and facilities.

Land-based sources of marine debris account for about 80 percent of the marine debris on beaches and in our waters. Debris from these sources can originate from combined sewer overflows and storm drains, storm-water runoff, landfills, solid waste disposal, poorly maintained garbage bins, floating structures, and general littering of beaches, rivers and open waters. Typical debris from these land-based sources includes raw or partially treated sewage, litter, hazardous materials, and discarded trash. Legislation and programs that address these land-based sources of pollution include the BEACH Act, the National Marine Debris Monitoring Program (NMDMP), the Shore Protection Act of 1989, and the Clean Water Act. The BEACH Act authorizes the EPA to fund state, territorial, Tribal, and local government programs that test and monitor coastal recreational waters near public access sites for microbial contaminants and to assess and monitor floatable debris. The NMDMP is a 5-year study designed to provide statistically valid estimates of marine debris affecting the entire U.S. coastline and to determine the main sources of the debris. The Shore Protection Act contains provisions to ensure that municipal and commercial solid wastes are not deposited in coastal waters during vessel transport from source to the waste receiving station. The Clean Water Act requires the EPA to develop and enforce regulations that treat storm water and combined sewer overflows as point source discharges requiring National Pollution Discharge Elimination System (NPDES) permits that prohibit non-storm water discharges into storm sewers.

Potential Adverse Impacts

Land- and ocean-based marine debris is a very diverse problem and adverse effects to EFH are likewise diverse. Floating or suspended trash can directly affect fish who consume or are entangled in the debris. Toxic substances in plastics can kill or impair fish and invertebrates that use habitat polluted by these materials which persist in the environment and can bioaccumulate through the food web. Once floatable debris settles to the bottom of estuaries, coastal, and open ocean areas, it may continue to cause environmental problems. Plastics and other materials with a large surface area can cover and suffocate immobile animals and plants, creating large spaces devoid of life. Currents can carry suspended debris to underwater reef habitats where the debris can become snagged, damaging these sensitive habitats. The typical floatable debris from combined sewer overflows includes street litter, sewage containing viral and bacterial pathogens, pharmaceutical by-products from human excretion, and pet wastes. It may contain condoms, tampons, and contaminated hypodermic syringes, all of which can pose physical and biological threats to EFH. Suspended organic matter has a high biological oxygen demand, and its reduction can cause algal blooms and anoxia that are detrimental to productive marine habitats. Pathogens can also contaminate shellfish beds.

Recommended Conservation Measures

1. Encourage proper trash disposal in coastal and ocean settings.
2. Advocate and participate in coastal cleanup activities.
3. Encourage enforcement of regulations addressing marine debris pollution and proper disposal.
4. Provide resources and technical guidance for development of studies and solutions addressing the

problem of marine debris.
5. Provide resources to the public on the impact of marine debris and guidance on how to reduce or eliminate the problem.

3.3 Dam Operation

The construction and operation of dams provide a source of hydropower, a reservoir for water storage, and a means to control flood control. Their operation, however, can affect water quality and quantity in riverine systems.

Potential Adverse Impacts

The effects of dam construction and operation on EFH can include 1) migratory impediments, 2) water flow and current pattern shifts, 3) thermal impacts, and 4) limits on sediment and woody debris transport.

One of the major impacts from dam construction and operation is that it impedes or completely creates impassable barriers to anadromous fish migrations in streams and rivers. Unless proper fish passage devices are in place, dams can either prevent access to productive upstream spawning habitat upstream or can alter downstream juvenile movements. The passage of salmon through turbines, sluiceways, bypass systems, and fish ladders also affects the quality of EFH (Pacific Fishery Management Council [PFMC] 1999).

In addition, dam operations also reduce downstream water velocities and change current patterns (PFMC 1999). These modifications can increase migration times (Raymond 1979). Water-level fluctuations, altered seasonal and daily flow regimes, reduced water velocities, and discharge volumes can affect the migratory behavior of juvenile salmonids and reduce the availability of shelter and foraging habitat (PFMC 1999).

Dams can also affect the thermal regimes of streams by raising water temperatures. Changes in water temperature can affect the development and smoltification of salmonids (PFMC 1999) and adult migration (Spence et al. 1996).

Dams also limit or alter natural sediment and LWD transport processes by impeding the high flows needed to scour fine sediments and move woody debris downstream (PFMC 1999). Curtailing these resources will affect the availability of spawning gravels and change channel morphology (Spence et al. 1996).

Recommended Conservation Measures (Adapted from PFMC 1999)

1. Operate facilities to create flow conditions that provide for passage, water quality, proper timing of life history stages, and properly functioning channel conditions, and to avoid strandings and redd dewatering.
2. Develop water and energy conservation guidelines for integration into dam operation plans and into regional and watershed-based water resource plans.
3. Provide mitigation (including monitoring and evaluation) for nonavoidable adverse effects on EFH.

3.4 Commercial and Domestic Water Use

Commercial and domestic water use demands to support the needs of homes, farms, and industries require a constant supply of water. Freshwater is diverted directly from lakes, streams, and rivers by means of pumping facilities or is stored in impoundments. Because human populations are expected to continue increasing along most of the West Coast, it is reasonable to assume that water uses, including water impoundments and diversion, will similarly increase (Gregory and Bisson 1997).

Potential Adverse Impacts

The information in this section is adapted from the following reference: NOAA Fisheries. 1998. Draft

Document - Non-fishing threats and water quality: A reference for EFH consultation.

The withdrawal of water can affect EFH by 1) altering natural flows and the process associated with flow rates, 2) affecting shoreline riparian habitats, 3) affecting prey bases, 4) affecting water quality, and 5) entraping fishes. Water diversions can involve either withdrawals, thus reducing flow, or discharges, thus increasing flow. Water withdrawal will alter natural flow and stream velocity and channel depth and width. It can also change sediment and nutrient transport characteristics (Christie et al. 1993, Fajen and Layzer 1993), increase deposition of sediments, reduce depth, and accentuate diel temperature patterns (Zale et al. 1993). Loss of vegetation along stream banks and coastlines due to fluctuating water levels can decrease the availability of fish cover and reduce stability (Christie et al. 1993). Changes in the quantity and timing of stream flow alters the velocity of streams, which, in turn, affects the composition and abundance of both insect and fish populations (Spence et al. 1996). Returning irrigation water to a stream, lake, or estuary can substantially alter and degrade habitat (NRC 1989). Problems associated with return flows include increased water temperature, increased salinity, introduction of pathogens, decreased dissolved oxygen, increased toxic contaminants from pesticides and fertilizers, and increased sedimentation (NPPC 1986). Diversions can also physically divert or entrap EFH managed species (see Section 5.3).

Recommended Conservation Measures

1. Design projects to create flow conditions adequate to provide for passage, water quality, proper timing of life history stages, and avoidance of juvenile stranding and redd dewatering, as well as to maintain and restore properly functioning channel, floodplain, riparian, and estuarine conditions.
2. Establish adequate instream flow conditions for anadromous fish.
3. Screen water diversions on fish-bearing streams, as needed.
4. Incorporate juvenile and adult fish passage facilities on all water diversion projects (e.g., fish bypass systems).
5. Ensure that mitigation is provided for non-avoidable impacts.

4.0 ESTUARINE ACTIVITIES

4.1 Dredging

Dredging navigable waters is a continuous impact primarily affecting benthic and water-column habitats in the course of constructing and operating marinas, harbors, and ports. Routine dredging, that is, the excavation of soft bottom substrates, is used to create deepwater navigable channels or to maintain existing channels that periodically fill with sediments. In addition, port expansion has become an almost continuous process due to economic growth, competition between ports, and significant increases in vessel size (see Section 4.3). Elimination or degradation of aquatic and upland habitats is commonplace since port expansion almost always affects open water, submerged bottoms, and, possibly, riparian zones.

Potential Adverse Impacts

The environmental effects of dredging on EFH can include 1) direct removal/burial of organisms; 2) turbidity/siltation effects, including light attenuation from turbidity; 3) contaminant release and uptake, including nutrients, metals, and organics; 4) release of oxygen consuming substances; 5) entrainment; 6) noise disturbances; and 6) alteration to hydrodynamic regimes and physical habitat.

Many EFH species forage on infaunal and bottom-dwelling organisms. Dredging may adversely affect these prey species at the site by directly removing or burying immobile invertebrates such as polychaete worms, crustacean, and other EFH prey types (Newell et al. 1998, Van der Veer et al. 1985). Similarly, the dredging activity may also force mobile animals such as fish to migrate out of the project area. Recolonization studies suggest that recovery may not be quite as straightforward. Physical factors including particle size distribution, currents, and compaction/stabilization processes following deposition reportedly can regulate recovery after dredging events. Rates of recovery listed in the literature range from several months for estuarine muds to up to 2 to 3 years for sands and gravels. Recolonization can also take up to 1 to 3 years in areas of strong current but up to 5 to 10 years in areas of low current. Thus, forage resources for benthic feeders may be substantially reduced.

The use of certain types of dredging equipment can result in greatly elevated levels of fine-grained mineral particles or suspended sediment concentration (SSC), usually smaller than silt, and organic particles in the water column. The associated turbidity plumes of suspended particulates may reduce light penetration and lower the rate of photosynthesis for subaquatic vegetation (Dennison 1987) and the primary productivity of an aquatic area if suspended for extended periods of times (Cloern 1987). If suspended sediments loads remain high, fish may suffer reduced feeding ability (Benfield and Minello 1996) and be prone to fish gill injury (Nightingale and Simenstad 2001a).

Sensitive habitats such as submerged aquatic vegetation beds, which provide food and shelter also may be damaged. Eelgrass beds are critical to nearshore food web dynamics (Wyllie-Echeverria and Phillips 1994, Murphy et al. 2000). Studies have shown seagrass beds to be among the areas of highest primary productivity in the world (Herke and Rogers 1993, Hoss and Thayer 1993). This primary production, combined with other nutrients, provide high rates of secondary production in the form of fish (Herke and Rogers 1993, Good 1987, Sogard and Able 1991).

The contents of the suspended material may react with the dissolved oxygen in the water and result in short-term oxygen depletion to aquatic resources (Nightingale and Simenstad 2001a). Dredging can also disturb aquatic habitats by resuspending bottom sediments and, thereby, recirculate toxic metals (e.g., lead, zinc, mercury, cadmium, copper etc.), hydrocarbons (e.g., polyaromatics) hydrophobic organics (e.g., dioxins), pesticides, pathogens, and nutrients into the water column (EPA 2000). Toxic metals and organics, pathogens, and viruses, absorbed or adsorbed to fine-grained particulates in the material, may become biologically available to organisms either in the water column or through food chain processes.

Direct uptake of fish species by hydraulic dredging at the proposed borrow site is also an issue. Definitive information in the literature shows that elicit avoidance responses to the suction dredge entrainment occurs for both benthic and water column oriented species (Larson and Moehl 1990, McGraw and Armstrong 1990).

Dredging, as well as the equipment used in the process such as pipelines (see Section 4.10), may damage or destroy spawning, nursery, and other sensitive habitats such as emergent marshes and subaquatic vegetation, including eelgrass beds and kelp beds. Dredging may also modify current patterns and water circulation of the habitat by changing the direction or velocity of water flow, water circulation, or dimensions of the water body traditionally used by fish for food, shelter, or reproductive purposes.

Recommended Conservation Measures

1. Avoid new dredging to the maximum extent practicable. Activities that would likely require dredging (such as placement of piers, docks, marinas, etc.) should, instead, be sited in deep water areas or designed to alleviate the need for maintenance dredging. Projects should be permitted only for water dependent purposes and only when no feasible alternatives are available.
2. Incorporate adequate control measures to minimize turbidity where the dredging equipment used is expected to create significant turbidity.
3. Undertake multi-season, pre-, and post-dredging biological surveys to assess impacts to animal and submerged aquatic vegetation communities.
4. Provide appropriate compensation for significant impacts (short-term, long-term and cumulative) to benthic environments resulting from dredging.
5. Perform dredging during the time frame when impacts due to entrainment of EFH managed species or their prey are least likely to be entrained. Dredging should be avoided in areas with submerged aquatic vegetation.
6. Reference all dredging latitude-longitude coordinates at the site so that information can be incorporated into a geographical information system (GIS) format. Inclusion of aerial photos may be useful to identify precise locations for long-term evaluation.
7. Test sediments for contaminants as per EPA and USACE requirements.
8. Address cumulative impacts of past and current dredging operations on EFH by considering them as part of the permitting process.
9. Identify excess sedimentation in the watershed that prompts excessive maintenance dredging activities and implement appropriate management techniques to ensure that actions are taken to curtail those causes.
10. Ensure that bankward slopes of the dredged area are slanted to acceptable side slopes (e.g., 3:1) to ensure that sloughing does not occur.
11. Avoid placing pipelines and accessory equipment used in conjunction with dredging operations to the maximum extent possible close to kelp beds, eelgrass beds, estuarine/salt marshes, and other high value habitat areas.

4.2 Disposal/Landfills

The discharge of dredged materials subsequent to dredging operations or the use of fill material in the construction/development of harbors results in sediments (e.g., dirt, sand, mud) covering or smothering existing submerged substrates. Usually these covered sediments are of a soft-bottom nature as opposed to rock or hard-bottom substrates.

4.2.1 Disposal of Dredged Material

Potential Adverse Impacts

The disposal of dredged material can adversely affect EFH by 1) impacting or destroying benthic communities, 2) affecting adjacent habitats; 3) creating turbidity plumes and introducing contaminants and/or nutrients.

Disposing dredged materials result in varying degrees of change in the physical, chemical, and biological characteristics of the substrate. Discharges may adversely affect infaunal and bottom-dwelling organisms at the site by smothering immobile organisms (e.g., prey invertebrate species) or forcing mobile animals (e.g., benthic-oriented fish species) to migrate from the area. Infaunal invertebrate plants and animals present prior to a discharge are unlikely to recolonize if the composition of the discharged material is drastically different.

Erosion, slumping, or lateral displacement of surrounding bottom of such deposits can also adversely affect substrate outside the perimeter of the disposal site by changing or destroying benthic habitat. The bulk and composition of the discharged material and the location, method, and timing of discharges may all influence the degree of impact on the substrate.

The discharge of material can result in greatly elevated levels of fine-grained mineral particles, usually smaller than silt, and organic particles in the water column (i.e., turbidity plumes). These suspended particulates may reduce light penetration and lower the rate of photosynthesis and the primary productivity of an aquatic area if suspended for lengthy intervals. Aquatic vegetation such as eelgrass beds and kelp beds may also be affected. Managed fish species may suffer reduced feeding ability, leading to limited growth and lowered resistance to disease if high levels of suspended particulates persist. The contents of the suspended material may react with the dissolved oxygen in the water and result in oxygen depletion. Toxic metals and organics, pathogens, and viruses absorbed or adsorbed to fine-grained particulates in the material may become biologically available to organisms either in the water column or through food chain processes.

The discharge of dredged or fill material can change the chemistry and the physical characteristics of the receiving water at the disposal site by introducing chemical constituents in suspended or dissolved form. Reduced clarity and excessive contaminants can reduce, change or eliminate the suitability of water bodies for populations of groundfish, other fish species and their prey. The introduction of nutrients or organic material to the water column as a result of the discharge can lead to a high biochemical oxygen demand (BOD), which in turn can lead to reduced dissolved oxygen, thereby potentially affecting the survival of many aquatic organisms. Increases in nutrients can favor one group of organisms such as polychaetes or algae to the detriment of other types.

4.2.2 Fill Material

Potential Adverse Impacts

Adverse impacts to EFH from the introduction of fill material included 1) loss of habitat function and 2) changes in hydrologic patterns.

Aquatic habitats sustain remarkably high levels of productivity and support various life stages of fish species and their prey. Many times these habitats are used for multiple purposes including habitat necessary for spawning, breeding, feeding, or growth to maturity. The introduction of fill material eliminates those functions and permanently removes the habitat from production.

The discharge of dredged or fill material can modify current patterns and water circulation by obstructing flow, changing the direction or velocity of water flow and circulation, or otherwise changing the dimensions of a water body. As a result, adverse changes can occur in the location, structure, and dynamics of aquatic communities; shoreline and substrate erosion and deposition rates; the deposition of suspended particulates; the rate and extent of mixing of dissolved and suspended components of the water body; and water stratification (NMFS 1998).

Recommended Conservation Measures

1. Study all options for disposal of dredged materials, including disposal sites and methods used. Upland dredge disposal sites should be considered as an alternative to offshore disposal sites.
2. The cumulative impacts of past and current fill operations on EFH should be addressed by federal, state, and local resource management and permitting agencies and considered in the permitting process.

3. Disposal of dredge material in EFH should meet or exceed applicable state and/or federal quality standards for such disposal.
4. State and federal agencies should identify the direct and indirect impacts open-water disposal permits for dredged material may have on EFH during proposed project reviews. Benthic productivity should be determined by sampling prior to any discharge of fill material. Sampling design should be developed with input from state and federal natural resource agencies.
5. The areal extent of any disposal site in EFH should be avoided or minimized. However, in some cases, thin layer disposal may be less deleterious. All non-avoidable adverse impacts should be mitigated.
6. All spoil disposal permits should reference latitude-longitude coordinates of the site so information can be incorporated into GIS systems. Inclusion of aerial photos or benthic photos may also be required to identify precise locations and determine long-term effects.
7. Fills in estuaries and bays for development of commercial enterprises should be avoided.
8. Identify and characterize EFH habitat functions/services in the project areas.
9. Adequate compensatory mitigation should be provided for unavoidable impacts.

4.3 Vessel Operations/Transportation/Navigation

The demand by port districts to increase infrastructure capacity to accommodate additional vessel operations for cargo handling activities and marine transportation is predicted to continue. Population growth and demands for international business trade along the Pacific Rim exert pressure to expand coastal towns and port facilities, resulting in net estuary losses (Kagan 1991, Fawcett and Marcus 1991). Port expansion has become an almost continuous process due to economic growth, competition between ports, and significant increases in vessel size (NPFMC 1999). In addition, with increased population growth comes the steady demand for providing new and expanded water transit services. Finally, providing additional recreational opportunities by constructing and enlarging recreational marinas is also foreseen.

Potential Adverse Impacts

The expansion of port facilities, vessel/ferry operations, and recreational marinas can bring additional impacts to EFH. Additional land needed to improve shipping efficiency can only be accommodated by changing land-use operations or adding new land by filling aquatic habitats. New wharves and piers decrease photic penetration in the water and decreases primary production (see Section 4.6). More hard surface increases nonpoint surface discharges (see Section 2.2), adds debris sources, and reduces buffers between land use and the aquatic ecosystem. These will include direct, indirect, and cumulative impacts on shallow subtidal, deep subtidal, eelgrass beds, mudflats, sand shoals, rock reefs, and salt marsh habitats. Such impacts would be site-specific. Some activities impacting these habitats, including new channel deepening and maintenance dredging (see Section 4.1), disposal of dredged material (see Section 4.2), reduced water quality from resuspension of contaminated sediments, ballast water discharge (see Section 4.4), and shading from overwater structures (see Section 4.6), have been addressed in other sections. Additional impacts include vessel groundings, modification of water circulation (breakwaters, channels, and fill), vessel wake generation, pier lighting, anchor scour and prop scour, and the discharge of contaminants and debris.

Potential adverse impacts to EFH can occur during both the construction and operation phases. Direct impacts include permanent or temporary loss of productive forage habitat resulting from new channel deepening and maintenance dredging (see Section 4.1), turbidity-related impacts due to both dredging and disposal of dredged material (see Section 4.2), and reduced water quality from resuspension of contaminated sediments (see Section 4.1). In addition, dredging in tidal wetland areas could result in the spread of nonnative invasive plant species (see Section 4.4).

An increase in the number and size of vessels can generate more wave and surge effects on shorelines. These vessel-wake, wash events can affect shorelines depending on the wake wave energy, the water depth, and the type of shoreline. Vessel wakes can cause a significant increase in shoreline erosion, impact wetland habitat, and increase water turbidity. Vessel prop wash can also damage aquatic vegetation and disturb sediments which may increase turbidity and suspend contaminants (Klein 1997, Warrington 1999). Changes in prey communities under ferry terminals have been attributed, in part, to prop wash from ferries (Blanton et al. 2001, Haas et al. 2002).

Impacts can also occur from anchor scour. Mooring buoys, when anchored in shallow nearshore waters, can drag the anchor chain across the bottom, destroying submerged vegetation and creating a circular scour hole (Walker et al. 1989, cited in Shafer 2002). A study by Hastings et al. (1995) (cited in Shafer 2002) in Australia found that up to 18 percent of total seagrass cover was lost to mooring buoy scour.

Vessel discharges, engine operations, bottom paint sloughing, boat washdowns, painting and other vessel maintenance activities can deliver debris, nutrients and contaminants to waterways and may degrade water quality and contaminate sediments.

Inadequate flushing of marinas also results in water quality problems (U.S. Army Corps of Engineers 1993, Klein 1997). Poor flushing in marinas in Puget Sound resulted in increases in temperature, increased phytoplankton populations with nocturnal dissolved oxygen level declines resulting in organism hypoxia, and pollutant inputs (Cardwell et al. 1980). An exchange of at least 30 percent of the water in the marina during a tidal change should minimize temperature increases and dissolved oxygen problems (Cardwell et al. 1980).

Recommended Conservation Measures

1. Locate marinas in areas of low biological abundance and diversity, for example, avoiding dense beds of eelgrass or other submerged aquatic vegetation including macroalgae.
2. Excavate uplands to create marina basins rather than converting intertidal or shallow subtidal to deeper subtidal for basin creation.
3. Avoid the disturbance of beds, mudflats and wetlands as part of the project design. In situations where such impacts are unavoidable, appropriate compensatory mitigation should be incorporated into the project with the approval of appropriate regulatory agencies. Specific habitat types such as eelgrass beds need to be mitigated in-kind. For other habitat types where in-kind mitigation is unavailable, the habitat values or functions of these threatened habitats should be calculated and appropriate mitigation be provided to ensure no net loss of habitat functions. This also includes the habitat value of traditional shoreline protection materials (e.g., revetments and breakwaters). Other dredging-related conservation measures are provided in Section 4.1.
4. Leave marine riparian buffers in place to enhance intertidal microclimate and nutrient input.
5. Adequate monitoring on the success of mitigation efforts should be included as part of the project and incorporated into a mitigation and monitoring plan.
6. Conduct preconstruction surveys by qualified biologists/botanists to identify and map areas of invasive plant species existing within potential project construction areas. Eradication of non-native species should be conducted well in advance of construction.
7. Include low-wake vessel technology, appropriate routes, and best management practices for wave attenuation structures as part of the design and permit process. Vessels should be operated at sufficiently low speeds to reduce wake energy, and no-wake zones should be designated near sensitive habitats.
8. Incorporate best management practices to prevent or minimize contamination from ship bilge waters, antifouling paints, shipboard accidents, shipyard work, maintenance dredging and disposal, and nonpoint source contaminants from upland facilities related to vessel operations and navigation.
9. Locate mooring buoys in water deep to avoid grounding and minimize affects of prop wash. Use subsurface floats or other methods to prevent contact of the anchor line with the substrate.
10. Collect and treat runoff from parking lots and other impervious surfaces to remove contaminants prior to delivery to any receiving waters
11. Locate facilities in areas with sufficient water velocities to dissipate fuels and pollutants from vessels and maintain temperature and dissolved oxygen levels within acceptable ranges.
12. Locate marinas where they do not interfere with drift sectors determining the structure and function of adjacent habitats.

4.4 Introduction of Exotic Species

The introductions of exotic species into estuarine and marine habitats has been well documented (Rosecchi et al. 1993, Kohler and Courtenay 1986, Spence et al. 1996) and can be intentional (e.g., for the purpose of stock or pest control) or unintentional (e.g., fouling organisms). Exotic fish, shellfish, pathogens, and plants can enter the environment from industrial shipping (e.g., as ballast), recreational boating, aquaculture (see Section 4.11), biotechnology, and aquariums. The transportation of nonindigenous organisms to new environments can have many severe impacts on habitat (Omori et al. 1994).

Potential Adverse Impacts

Long-term impacts of the introduction of nonindigenous and reared species can change the natural community structure and dynamics, lower the overall fitness and genetic diversity of natural stocks, and pass and/or introduce exotic lethal disease. Overall, exotic species introductions create five types of negative impacts: 1) habitat alteration, 2) trophic alteration, 3) gene pool alteration, 4) spatial alteration, and 5) introduction of diseases. Habitat alteration includes the excessive colonization of exotic species (e.g., *Spartina* grasses) which preclude the growth of endemic organisms (e.g., eelgrass). The introduction of exotic species may alter community structure by predation on native species or by population explosions of the introduced species. Spatial alteration occurs when territorial introduced species compete with and displace native species. Although hybridization is rare, it may occur between native and introduced species and can result in gene pool deterioration.

Non-native plants and algae can degrade coastal and marine habitats by changing natural habitat qualities. Introduced organisms increase competition with indigenous species or forage on indigenous species, which can reduce fish and shellfish populations. Long-term impacts from the introduction of nonindigenous and reared species can change the natural community structure and dynamics, lower the overall fitness and genetic diversity of natural stocks, and pass and/or introduce exotic lethal diseases. The introduction of exotic organisms also threatens native biodiversity and could lead to changes in relative abundances of species and individuals that are of ecological and economic importance.

The introduction of bacteria, viruses, and parasites is another severe threat to EFH as it may reduce habitat quality. New pathogens or higher concentrations of disease can be spread throughout the environment resulting in deleterious habitat conditions.

Recommended Conservation Measures

1. Encourage vessels to perform a ballast water exchange in marine waters (in accordance with the U.S. Coast Guard’s voluntary regulations) to minimize the possibility of introducing exotic estuarine species into similar habitats. Ballast water taken on in marine waters will contain fewer organisms and these will be less likely to become invasive in estuarine conditions than species transported from other estuaries.
2. Discourage vessels that have not performed a ballast water exchange from discharging their ballast water into estuarine receiving waters.
3. Require vessels brought from other areas over land via trailer to clean any surfaces that may harbor non-native plant or animal species (propellers, hulls, anchors, fenders, etc.). Bilges should be emptied and cleaned thoroughly using hot water or a mild bleach solution. These activities should be performed in an upland area to prevent introduction of non-native species during the cleaning process.
4. Exclude exotic species from aquaculture operations until a thorough scientific evaluation and risk assessment is performed (see Section 4.11).
5. Aquaculture facilities rearing non-native species should be located upland and use closed-water circulation systems whenever possible.
6. Treat effluent from public aquaria displays, and laboratories, and educational institutes using exotic species prior to discharge to prevent the introduction of viable animals, plants, reproductive material, pathogens, or parasites into the environment.

4.5 Pile Installation and Removal

Pilings are an integral component of many overwater and in-water structures. They provide support for the decking of piers and docks, function as fenders and dolphins to protect structures, support navigation markers, and are used to construct breakwaters and bulkheads. Materials used in pilings include steel, concrete, wood (both treated and untreated), plastic or a combination thereof. Piles are usually driven into the substrate using one of two types of hammer: impact hammers and vibratory hammers. Impact hammers consist of a heavy weight that is repeatedly dropped onto the top of the pile, driving it into the substrate. Vibratory hammers utilize a combination of a stationary, heavy weight and vibration, in the plane perpendicular to the long axis of the pile, to force the pile into the substrate. The type of hammer used depends on a variety of factors, including pile material and substrate type. Impact hammers can be used to drive all types of piles, while vibratory hammers are generally most efficient at driving piles with a cutting edge (e.g., hollow steel pipe) and are less efficient at driving “displacement” piles (those without a cutting edge that must displace the substrate). Displacement piles include solid concrete, wood, and closed-end steel pipe. While impact hammers are able to drive piles into most substrates (including hardpan, glacial till, etc.), vibratory hammers are limited to softer, unconsolidated substrates (e.g., sand, mud, gravel). Since vibratory hammers do not use force to drive the piles, the bearing capacity is not known and the piles must often be “proofed” with an impact hammer. This involves striking the pile a number of times with the impact hammer to ensure that it meets the designed bearing capacity. Under certain circumstances, piles may be driven using a combination of vibratory and impact hammers. The vibratory hammer makes positioning and plumbing of the pile easier; therefore, it is often used to drive the pile through the soft, overlying material. Once the pile stops penetrating the sediment, the impact hammer is used to finish driving the pile to final depth. An additional advantage of this method is that the vibratory hammer can be used to extract and reposition the pile, while the impact hammer cannot.

Overwater structures must often meet seismic stability criteria, requiring that the supporting piles are attached to, or driven into, the underlying hard material. This requirement often means that at least some impact driving is necessary. Piles that do not need to be seismically stable, including temporary piles, fender piles, and some dolphin piles, may be driven with a vibratory hammer, providing the type of pile and sediments are appropriate.

Piles can be removed using a variety of methods, including vibratory hammer, direct pull, clam shell grab, or cutting/breaking the pile below the mudline. Vibratory hammers can be used to remove all types of pile, including wood, concrete, and steel. However, old, brittle piles may break under the vibrations and necessitate another method. The direct pull method involves placing a choker around the pile and pulling upward with a crane or other equipment. Broken stubs are often removed with a clam shell and crane. In this method, the clam shell grips the pile near the mudline and pulls it out. In other instances, piles may be cut or broken below the mudline, leaving the buried section in place.

4.5.1 Pile Driving

Potential Adverse Impacts

Pile driving can generate intense underwater sound pressure waves that may adversely affect the ecological functioning of EFH. These pressure waves have been shown to injure and kill fish (e.g., CalTrans 2001, Longmuir and Lively 2001, Stotz and Colby 2001, Stadler, pers. obs. 2002). Injuries associated directly with pile driving are poorly studied, but include rupture of the swimbladder and internal hemorrhaging (CalTrans 2001; Abbott and Bing-Sawyer 2002; Stadler, pers. obs. 2002). Sound pressure levels (SPL) 100 decibels (dB) above the threshold for hearing is thought to be sufficient to damage the auditory system in many fishes (Hastings 2002).

The type and intensity of the sounds produced during pile driving depend on a variety of factors, including, but not limited to, the type and size of the pile, the firmness of the substrate into which the pile is being driven, the depth of water, and the type and size of the pile-driving hammer. SPLs are positively correlated with the size of the pile, as more energy is required to drive larger piles. Wood and concrete piles appear to produce lower sound pressures than hollow steel piles of a similar size, although it is not yet clear if the sounds produced by wood or concrete piles are harmful to fishes. Hollow steel piles as small as 14-inch diameter have been shown to produce SPLs that can injure fish (Reyff 2003). Firmer substrates require more energy to drive piles, and produce more intense sound pressures. Sound attenuates more rapidly with distance from the source in shallow than in deep water (Rogers and Cox 1988).

Driving hollow steel piles with impact hammers produce intense, sharp spikes of sound which can easily reach levels that injure fish. Vibratory hammers, on the other hand, produce sounds of lower intensity, with a rapid repetition rate. A key difference between the sounds produced by impact hammers and those produced by vibratory hammers is the responses they evoke in fish. When exposed to sounds which are similar to those of a vibratory hammer, fish consistently displayed an avoidance response (Enger et al. 1993, Dolat 1997, Knudsen et al. 1997, Sand et al. 2000), and did not habituate to the sound, even after repeated exposure (Dolat 1997, Knudsen et al. 1997). Fishes may respond to the first few strikes of an impact hammer with a "startle" response. After these initial strikes, the startle response wanes and the fishes may remain within the field of a potentially harmful sound (Dolat 1997, NOAA Fisheries 2001). The differential responses to these sounds are due to the differences in the duration and frequency of the sounds. When compared to impact hammers, the sounds produced by vibratory hammers are of longer duration (minutes vs. msec) and have more energy in the lower frequencies (15-26 Hz vs 100-800 Hz) (Würsig, et al. 2000, Carlson et al. 2001). Studies have shown that fish respond to particle acceleration of 0.01 m/s^2 at infrasound frequencies, that the response to infrasound is limited to the nearfield (< 1 wavelength), and the fish must be exposed to the sound for several seconds (Enger et al. 1993, Knudsen et al. 1994, Sand et al. 2000). Impact hammers, however, produce such short spikes of sound with little energy in the infrasound range, that fish fail to respond to the particle motion (Carlson et al. 2001). Thus, impact hammers may be more harmful than vibratory hammers because they produce more intense pressure waves and because the sounds produced do not elicit an avoidance response in fishes, which exposes them for longer periods to those harmful pressures.

The degree to which an individual fish exposed to sound will be affected is dependent upon a number of variables, including 1) species of fish, 2) fish size, 3) presence of a swimbladder, 4) physical condition of the fish, 5) peak sound pressure and frequency, 6) shape of the sound wave (rise time), 7) depth of the water around the pile, 8) depth of the fish in the water column, 9) amount of air in the water, 10) size and number of waves on the water surface, 11) bottom substrate composition and texture, 12) effectiveness of bubble curtain sound/pressure attenuation technology, 13) tidal currents, and 14) presence of predators.

Depending on these factors, effects on fish can range from changes in behavior to immediate mortality. There is little data on the SPL required to injure fish. Short-term exposure to peak SPL above 190 dB (re:1 µPa) are thought to injure physical harm on fish (Hastings 2002). However, 155 dB (re: 1 µPa) may be sufficient to temporarily stun small fish (J. Miner, pers. comm. 2002). Stunned fish, while perhaps not physically injured, are more susceptible to predation. Small fish are more prone to injury by intense sound than are larger fish of the same species (Yelverton et al. 1975). For example, a number of surfperches (*Cymatogaster aggregata* and *Embiotoca lateralis*) were killed during impact pile driving (Stadler, pers. obs. 2002). Most of the dead fish were the smaller *C. aggregata* and similar sized specimens of *E. lateralis*, even though many larger *E. lateralis* were in the same area. Dissections revealed that the swimbladder of the smallest fish (80 mm forklength [FL]) were completely destroyed, while those of the largest individual (170 mm FL) was nearly intact, indicating a size-dependent effect. The SPLs that killed these fish are not yet known. Of the reported fish kills associated with pile driving, all have occurred during use of an impact hammer on hollow steel piles (Longmuir and Lively 2001, NOAA Fisheries 2001, Stotz and Colby 2001, NOAA Fisheries 2003).

Systems successfully designed to reduce the adverse effects of underwater SPLs on fish have included the use of air bubbles. Both confined (i.e., metal or fabric sleeve) and unconfined air bubble systems have been shown to attenuate underwater sound pressures up to 28 dB (Wursig et al. 2000, Longmuir and Lively 2001, Christopherson and Wilson 2002, Reyff and Donovan 2003). When using an unconfined air bubble system in areas of strong currents, it is critical that the pile is fully contained within the bubble curtain. To accomplish this, adequate air flow and ring spacing both vertically and distance from the pile are factors that should be considered when designing the system.

Recommended Conservation Measures

1. Install hollow steel piles with an impact hammer at a time of year when larval and juvenile stages of fish species with designated EFH are not present. If this is not possible, then the following measures should be incorporated to minimize adverse effects.
2. Drive piles during low tide periods when located in intertidal and shallow subtidal areas.
3. Use a vibratory hammer when driving hollow steel piles. Under those conditions where impact hammers are required for reasons of seismic stability or substrate type, it is recommended that the pile be driven as deep as possible with a vibratory hammer prior to the use of the impact hammer.
4. Monitor peak SPLs during pile driving to ensure that they do not exceed the 190 dB re:1 µPa threshold for injury to fish.
5. Implement measures to attenuate the sound should SPLs exceed the 180 dB re: 1 µPa threshold. If sound pressure levels exceed acceptable limits, implement mitigative measures. Methods to reduce the sound pressure levels include, but are not limited to, the following:
    a) Surround the pile with an air bubble curtain system or air-filled coffer dam.
    b) Since the sound produced has a direct relationship to the force used to drive the pile, use of a smaller hammer should be used to reduce the sound pressures.
    c) Use a hydraulic hammer if impact driving cannot be avoided. The force of the hammer blow can be controlled with hydraulic hammers; reducing the impact force will reduce the intensity of the resulting sound.
6. Drive piles when the current is reduced (i.e., centered around slack current) in areas of strong current to minimize the number of fish exposed to adverse levels of underwater sound.

4.5.2 Pile Removal

Potential Adverse Impacts

The primary adverse effect of removing piles is the suspension of sediments, which may result in harmful levels of turbidity and release of contaminants contained in those sediments (see Section 4.1). Vibratory pile removal tends to cause the sediments to slough off at the mudline, resulting in relatively low levels of suspended sediments and contaminants. Vibratory removal of piles is gaining popularity because it can be used on all types of piles, providing that they are structurally sound. Breaking or cutting the pile below the mudline may suspend only small amounts of sediment, providing the stub is left in place and little digging is required to access the pile. Direct pull or use of a clamshell to remove broken piles, however, may suspend large amounts of sediment and contaminants. When the piling is pulled from the substrate using these two methods, sediments clinging to the piling will slough off as it is raised through the water column, producing a potentially harmful plume of turbidity and/or contaminants. The use of a clamshell may suspend additional sediment if it penetrates the substrate while grabbing the piling.

While there is a potential to adversely affect EFH during the removal of piles, many of those removed are old creosote-treated timber piles. In some cases, the long-term benefits to EFH obtained by removing a consistent source of contamination may outweigh the temporary adverse effects of turbidity.

Recommended Conservation Recommendations

1. Remove piles completely rather than cutting or breaking off if the pile is structurally sound.
2. Minimize the suspension of sediments and disturbance of the substrate when removing piles. Measures to help accomplish this include, but are not limited to, the following:
    a) When practicable, remove piles with a vibratory hammer, rather than the direct pull or clamshell method.
    b) Remove the pile slowly to allow sediment to slough off at, or near, the mudline.
    c) The operator should first hit or vibrate the pile to break the bond between the sediment and pile to minimize the potential for the pile to break, as well as reduce the amount of sediment sloughing off the pile during removal.
    d) Place a ring of clean sand around the base of the pile. This ring will contain some of the sediment

   that would normally be suspended.
   e) Encircle the pile, or piles, with a silt curtain that extends from the surface of the water to the substrate.
3. Complete each pass of the clamshell to minimize suspension of sediment if pile stubs are removed with a clamshell.
4. Fill all holes left by the piles with clean, native sediments if possible.
5. Place piles on a barge equipped with a basin to contain all attached sediment and runoff water after removal. Creosote-treated timber piles should be cut into short lengths to prevent reuse, and all debris, including attached, contaminated sediments, should be disposed of in an approved upland facility.
6. Drive broken/cut stubs using a pile driver, sufficiently below the mudline to prevent release of contaminants into the water column as an alternative to their removal.

4.6 Overwater Structures

Overwater structures include commercial and residential piers and docks, floating breakwaters, barges, rafts, booms, and mooring buoys. These structures are typically located in intertidal areas out to about 15 meters below the area exposed by the mean lower low tide (i.e., the shallow subtidal zone). Light, wave energy, substrate type, depth and water quality are the primary factors controlling the plant and animal assemblages found at a particular site. Overwater structures and associated activities can alter these factors and interfere with key ecological functions such as spawning, rearing, and refugia. Site-specific factors (e.g., water clarity, current, depth, etc.) and the type and use of a given overwater structure determine the occurrence and magnitude of these impacts.

Potential Adverse Impacts

Overwater structures and associated developments may adversely affect EFH in a variety of ways, primarily by changes in ambient light conditions, alteration of the wave and current energy regime, and through activities associated with the use and operation of the facilities (Nightingale and Simenstad 2001b).

Overwater structures create shade which reduces the light levels below the structure. The size, shape and intensity of the shadow cast by a particular structure depends upon its height, width, construction materials, and orientation. High and narrow piers and docks produce narrower, more diffuse shadows than do low and wide structures. Increasing the numbers of pilings used to support a given pier increases the shade cast by pilings on the under-pier environment. In addition, less light is reflected underneath structures built with light-absorbing materials (e.g., wood) than from structures built with light-reflecting materials (e.g., concrete or steel). Structures that are oriented north-south produce a shadow that moves across the bottom throughout the day, resulting in a smaller area of permanent shade than those that are oriented east-west.

The shadow cast by an overwater structure affects both the plant and animal communities below the structure. Distributions of plants, invertebrates, and fishes have been found to be severely limited in under-dock environments when compared to adjacent, unshaded vegetated habitats. Light is the single most important factor affecting aquatic plants. Under-pier light levels have been found to fall below threshold amounts for the photosynthesis of diatoms, benthic algae, eelgrass, and associated epiphytes and other autotrophs. These photosynthesizers are an essential part of nearshore habitat and the estuarine and nearshore foodwebs that support many species of marine and estuarine fishes. Eelgrass and other macrophytes can be reduced or eliminated, even through partial shading of the substrate, and have little chance to recover.

Fishes rely on visual cues for spatial orientation, prey capture, schooling, predator avoidance, and migration. The reduced-light conditions found under an overwater structure limit the ability of fishes, especially juveniles and larvae, to perform these essential activities. Shading from overwater structures may also reduce prey organism abundance and the complexity of the habitat by reducing aquatic vegetation and phytoplankton abundance (Kahler et al. 2000, Haas et al. 2002). Glasby (1999) found that epibiotic assemblages on pier pilings at marinas subject to shading were markedly different than in surrounding areas. Other studies have shown shaded epibenthos to be reduced relative to that in open areas. These factors are thought to be responsible for the observed reductions in juvenile fish populations found under piers and the reduced growth and survival of fishes held in cages under piers, when compared to open habitats (Able et al. 1998, Duffy-Anderson and Able 1999).

The shadow cast by an overwater structure may increase predation on EFH managed species by creating a light/dark interface that allows ambush predators to remain in a darkened area (barely visible to prey) and watch for prey to swim by against a bright background (high visibility) (Helfman 1981). Prey species moving around the structure are unable to see predators in the dark area under the structure and are more susceptible to predation. Furthermore, the reduced vegetation (i.e., eelgrass) densities associated with overwater structures decrease the available refugia from predators.

In addition to piscivorous predation, in-water structures (e.g., pilings) also provide perching platforms for avian predators such as double-crested cormorants (*Phalacrocorax auritis*), from which they can launch feeding forays or dry their plumage.

Wave energy and water transport alterations from overwater structures can impact the nearshore detrital foodweb by altering the size, distribution, and abundance of substrate and detrital materials. Disruption of longshore transport can alter substrate composition and can present potential barriers to the natural processes that build spits and beaches and provide substrates required for plant propagation, fish and shellfish settlement and rearing, and forage fish spawning.

Pilings can alter adjacent substrates with increased shell deposition from piling communities and changes to substrate bathymetry (see Section 4.5). Changes in substrate type can alter the nature of the flora and fauna native to a given site. In the case of pilings, native dominant communities typically associated with sand, gravel, mud, and eelgrass substrates are replaced by communities associated with shell hash substrates.

Treated wood used for pilings and docks releases contaminants into saltwater environs. Poly-aromatic hydrocarbons (PAHs) are commonly released from creosote-treated wood. PAHs can cause a variety of deleterious effects (cancer, reproductive anomalies, immune dysfunction, and growth and development impairment) to exposed fish (Johnson et al. 1999, Johnson 2000, Stehr et al. 2000). Wood also is commonly treated with other chemicals such as ammoniacal copper zinc arsenate (ACZA) and chromated copper arsenate (CCA) (Poston 2001). These preservatives are known to leach into marine waters for a relatively short period of time after installation, but the rate of leaching is highly variable and dependent on many factors. Concrete or steel, on the other hand, are relatively inert and do not leach contaminants into the water.

Construction and maintenance of overwater structures often involves driving of pilings (see Section 4.5) and dredging of navigation channels (see Section 4.1). Both activities may also adversely affect EFH.

While the effect of some individual overwater structures on EFH may be minimal, the overall impact may be substantial when considered cumulatively. The additive effects of these structures increases the overall magnitude of impact and reduces the ability of the EFH to support native plant and animal communities.

Recommended Conservation Measures

1. Use upland boat storage whenever possible to minimize need for overwater structures.
2. Locate overwater structures in sufficiently deep waters to avoid intertidal and shade impacts, to minimize or preclude dredging, to minimize groundings, and to avoid displacement of submerged aquatic vegetation, as determined by a pre-construction survey.
3. Design piers, docks, and floats to be multi-use facilities in order to reduce the overall number of such

structures and the nearshore habitat that is impacted.
4. Incorporate measures that increase the ambient light transmission under piers and docks. These measures include, but are not limited to, maximizing the height of the structure and minimizing the width of the structure to decrease shade footprint; grated decking material; using solar tubes to direct light under the structure and glass blocks to direct sunlight under the structure; illuminating the under-structure area with metal halide lamps and use of reflective paint or materials (e.g., concrete or steel instead of materials that absorb light such as wood) on the underside of the dock to reflect ambient light; using the fewest number of pilings necessary to support the structures to allow light into under-pier areas and minimize impacts to the substrate; and aligning piers, docks and floats in north-south orientation to allow arc of sun to cross perpendicular to structure and reduce duration of light limitation.
5. Use floating breakwaters whenever possible and remove them during periods of low dock use. Encourage seasonal use of docks and off-season haul-out.
6. Use waveboards to minimize effects on littoral drift and benthic habitats.
7. Locate floats in deep water to avoid light limitation and grounding impacts to the intertidal zone, and maintain at least one foot of water between the substrate and the bottom of the float.
8. Conduct in-water work during the time of year when EFH-managed species and prey species are least likely to be impacted.
9. Avoid use of treated wood timbers or pilings to the extent practicable. Use of alternative materials such as untreated wood, concrete, or steel is recommended.
10. Fit all pilings and navigational aids, such as moorings and channel markers, with devices to prevent perching by piscivorous bird species.
11. Orient night lighting such that illumination of the surrounding waters is avoided.
12. Mitigate for unavoidable impacts to benthic habitats that is adequately provided, properly monitoried, and adaptively managed.

4.7 Flood Control/Shoreline Protection

The protection of riverine and estuarine communities from flooding events can result in varying degrees of change in the physical, chemical, and biological characteristics of existing shoreline and riparian habitat. The use of dikes and berms can also have long-term adverse effects in tidal marsh and estuarine habitats. Tidal marshes are highly variable, but typically have freshwater vegetation at the landward side, saltwater vegetation at the seaward side, and a gradient of species in between that are in equilibrium with the prevailing climatic, hydrographic, geological, and biological features of the coast. These systems normally drain through highly dendritic tidal creeks that empty into the bay or estuary. Freshwater entering along the upper edges of the marsh drain across the surface and enter the tidal creeks. Structures placed for coastal shoreline protection include, but are not limited to, concrete or wood seawalls; rip-rap revetments (sloping piles of rock placed against the toe of the dune or bluff in danger of erosion from wave action); dynamic cobble revetments (natural cobble placed on an eroding beach to dissipate wave energy and prevent sand loss); vegetative plantings; and sandbags.

<u>Potential Adverse Impacts</u>

Dikes, levees, ditches, or other water controls at the upper end of a tidal marsh can cut off all tributaries feeding the marsh, preventing freshwater flushing and annual flushing, annual renewal of sediments and nutrients, and the formation of new marshes. Water controls within the marsh proper intercept and carry away freshwater drainage, block freshwater from flowing across seaward portions of the marsh, increase the speed of runoff of freshwater to the bay or estuary, lower the water table, permit saltwater intrusion into the marsh proper, and create migration barriers for aquatic species. In deeper channels where reducing conditions prevail, large quantities of hydrogen sulfide are produced that are toxic to marsh grasses and other aquatic life. Acid conditions of these channels can also result in release of heavy metals from the sediments

Long-term effects on the tidal marsh include land subsidence (sometimes even submergence), soil compaction, conversion to terrestrial vegetation, greatly reduced invertebrate populations, and general loss of productive wetland characteristics. Loss of these low-salinity environments reduces estuarine fertility, restricts suitable habitat for aquatic species, and creates abnormally high salinity during drought years. Low-salinity environments form a barrier that prevents the entrance of many marine species, including competitors, predators, parasites and pathogens.

Armoring of shorelines to prevent erosion and maintain or create shoreline real estate simplifies habitats, reduces the amount of intertidal habitat, and affects nearshore processes and the ecology of a myriad of species (Williams and Thom 2001). Hydraulic effects to the shoreline include increased energy seaward of the armoring, reflected wave energy, dry beach narrowing, substrate coarsening, beach steepening, changes in sediment storage capacity, loss of organic debris, and downdrift sediment starvation (Williams and Thom 2001). Installation of breakwaters and jetties can result in community changes from burial or removal of resident biota; changes in cover and preferred prey species; and predator attraction (Williams and Thom 2001). As with armoring, breakwaters and jetties modify hydrology and nearshore sediment transport as well as movement of larval forms of many species (Williams and Thom 2001).

Recommended Conservation Measures

1. Minimize the loss of riparian habitats as much as possible.
2. The diking and draining of tidal marshlands and estuaries should not be undertaken unless a satisfactory compensatory mitigation plan is in effect and monitored.
3. Wherever possible, “soft” approaches (such as beach nourishment, vegetative plantings, and placement of large woody debris) to shoreline modifications should be utilized.
4. Include efforts to preserve and enhance EFH by providing new gravel for spawning areas; removing barriers to natural fish passage; and using weirs, grade control structures, and low flow channels to provide the proper depth and velocity for fish.
5. Construct a low-flow channel to facilitate fish passage and help maintain water temperature in reaches where water velocities require armoring of the riverbed.
6. Replace in-stream fish habitat by providing rootwads, deflector logs, boulders, rock weirs and by planting shaded riverine aquatic cover vegetation.
7. Use an adaptive management plan with ecological indicators to oversee monitoring and ensure mitigation objectives are met. Take corrective action as needed.

4.8 Water Control Structures

Many coastal areas of the Pacific Northwest utilize Water Control Structures (WCSs), such as pumping stations and tidegates, to regulate water levels in nearshore and estuary settings. WCSs enable certain agricultural crops to survive through floods, maintain high water tables, and manage the threat of saltwater intrusion. In some cases, infrastructures such as roads, industrial and residential developments, and sewer treatment plants have been built because of the enhanced drainage. These structures have been installed within streams, blind and distributary sloughs, and marsh/wetlands within estuarine and nearshore areas.

Tide gates have typically been installed on culverts passing through levees, dikes, and berms to prevent tidal inundation in areas landward of the berms. As the tide backs up and closes the tide gate, fish passage upstream is blocked. As the tide turns and begins to flow out or the river level drops, a conventional tide gate opens a little but often not enough to allow upstream passage or with such velocity as to constitute a complete or partial blockage (Charland 1998). Pump stations are used to maintain more consistent control of water levels in nearshore and estuary settings. Some pumps are also used in conjunction with tide gates; many act as dams by stopping tidal or river stage levels, thus extending the capacity of the drainage system. While there is variability in the design and operation of these structures, they generally pump surface water from the drainage system to the respective receiving body.

Potential Adverse Impacts

Adverse effects to EFH from the installation and operation of WCSs can occur through 1) partially or completely blocked habitat, 2) altered water chemistry composition through suppressed mixing of fresh and saltwater, 3) decreased sediment and nutrient delivery, and 4) degraded water quality through thermal loading.

Various life stages of some EFH-managed species utilize nearshore and estuarine habitats, and food produced from these areas in the form of small fish and other aquatic organisms are important for overall food web function (PFMC 1998, PFMC 2003). WCSs can limit or eliminate habitat access to areas that may be important for food sources and refuge from predators of these species.

Depending on their location, WCSs alter the normal circulation and mixing of fresh and saltwater. Estuaries are biologically rich and productive areas, partly because of the complex gradient of fresh and salt water mixing process. Estuaries accumulate nutrients such as potassium and nitrogen, which are concentrated and recycled in a repeating interactive process by which the incoming tidal water resuspends nutrients at the fresh-saltwater interface while moving them back up the estuary to meet the seaward moving land-based nutrients (Day 1989). Estuarine food chains are extremely complex and sensitive to alterations in the physical and chemical range of stresses (Day 1989). Loss or disruption of one element can have a cascading effect on species presence and productivity. The inhibition of the gradual mixing of salt and fresh water and nutrients over the original volume of habitat can decrease the overall productivity of the estuary and may cause prey community changes.

Often WCSs impound water for various amounts of time, which can lead to premature sediment and nutrient deposition and cause a subsequent need to dredge behind the structure. Sediment deposition within estuarine and nearshore areas is important for beach nourishment, and sediments often serve as absorptive surfaces for nutrients.

Impounded water can result in increased thermal loading which, in turn, can interfere with physiological processes, behavioral changes, and disease enhancement (Bell 1986). Increased thermal loading can also cause increased microbial activity and vegetative growth, which in turn can deplete levels of dissolved oxygen (Waldichuk 1993, Spence et al. 1996). These impacts may combine to affect entire aquatic systems by changing primary and secondary productivity, community respiration, species composition, biomass, and nutrient dynamics (Hall et al. 1978). These effects, while perhaps more acute in the regulated watercourse, can nonetheless be manifested in the receiving body as well, particularly in areas where much of the historic estuary habitat is regulated by WCSs.

Recommended Conservation Measures

1. Avoid installing new WCSs. In some cases, tidegates that replace dams or pump stations (those which completely block habitat) can improve habitat conditions by enhancing fish passage and water circulation.
2. Design WCSs to enhance habitat access and water circulation.
3. Assess habitat potential or value behind the WCS by investigating current and potential aquatic vegetation, the volume and depth of the water body, the amount and timing of freshwater inflow, the presence of upland rearing and spawning habitat, and the relative salinity of the water body.
4. Assess the hydrology of the regulated land's tolerance for increased water exchange. The assessment should account for active management of the WCS to allow increased water exchange during critical periods. Existing programs that compensate landowners for lost production of land can be investigated (such as the Conservation Reserve Enhancement Program administered by the United States Department of Agriculture) if appropriate.
5. Design WCSs to mimic natural water exchange velocities. This can be done by maximizing the conveyance of water through increased width, thus reducing flow velocities during periods the gates are open.
6. Utilize WCS materials that are nontoxic and noncorrosive. Treated wood should not be used.
7. Stabilize associated banks through bio-engineered means, minimizing the use of riprap and incorporating native materials as appropriate.
8. Install WCS during low flow periods and tidal stage; incorporate appropriate erosion and sediment control BMPs, and have an equipment spill and containment plan and appropriate materials onsite.
9. Monitor WCS operations to assess impacts on water temperatures, dissolved oxygen, and other

applicable parameters. Adaptive management should be designed to minimize impacts.

4.9 Log Transfer Facilities/In-water Log Storage

Using rivers, estuaries, and bays to transport logs was the primary means of transportation and storage historically in the Pacific Northwest. Log storage within the bays and estuaries remains an issue in several Pacific Northwest bays. Using estuaries and bays and nearby uplands for storage of logs is common in Alaska, with most of Alaska's LTFs existing in Southeast Alaska and a few in Prince William Sound.

Potential Adverse Impacts

Log handling and storage in the estuary and intertidal zones of rivers can result in water quality degradation and modifications to habitat. An LTF is a facility which is constructed in whole or part in waters of the United States and which is utilized for the purpose transferring commercially harvested logs to or from a vessel or log raft, including the formation of a log raft. (EPA 2000). LTFs may include a crane, an A-frame structure, conveyor, slide or ramp, and are used move logs into the water. Logs can also be placed in the water at the site by helicopters and barges. The physical adverse impacts from these structures are similar in many ways to those of floating docks and other "over-water" structures (see Section 4.6).

EFH may also be physically impacted from activities associated with LTFs. Bark and wood debris may impact EFH as a result of the abrasion of log surfaces from transfer equipment. After the logs have entered the water, they are usually bundled into rafts and hooked to a tug for shipment. In the process, bark and other wood debris can pile up on the ocean floor. The piles can "smother" clams, mussels, some seaweed, kelp and grasses, with the bark sometimes remaining for decades. Accumulation of bark debris in shallow and deep water environments has resulted in locally decreased epifaunal macrobenthos richness and abundance (Kirkpatrick et al. 1998, Jackson 1986), which can ultimately impact various life-stages of groundfish.

Storage of logs may also result in significant release soluble, organic compounds. Log bark may affect groundfish by significantly increasing oxygen demand within the area of accumulation (PNPCC 1971). High oxygen demand can lead to an anaerobic zone where toxic sulfide compounds are generated, particularly in brackish and marine waters. Leaching of soluble organic compounds also leads to cumulative oxygen demand and reduced visibility. Reduced oxygen levels, anaerobic conditions, and the presence of toxic sulfide compounds are presumed to lead to reduced production of groundfish species and their forage base. Anaerobic areas reduce available habitat. In addition, soils at onshore facilities where logs are decked are often contaminated with gasoline, diesel fuel, solvents, etc., from trucks and heavy equipment. These contaminants can leach into nearshore EFH.

The physical, chemical, and biological impacts of LTF operations can be substantially reduced by adherence to appropriate siting and operational constraints. In 1985, the Alaska Timber Task Force (ATTF) developed guidelines to "delineate the physical requirements necessary to construct a log transfer and associated facilities, and in context with requirements of applicable law and regulations, methods to avoid or control potential impacts from these facilities on water quality, aquatic and other resources." Since 1985, the ATTF Guidelines have been applied to new LTFs through the requirements of National Pollutant Discharge Elimination System (NPDES) permits and other state and federal programs (EPA 1996). Adherence to guidelines such as the ATTF operational and siting guidelines and BMPs in the NPDES General Permit will reduce the 1) amount of bark and wood debris which enters the marine and coastal environment, 2) the potential for displacement or harm to aquatic species, and 3) accumulation of bark and wood debris on the ocean floor. The following conservation measures reflect those guidelines.

Recommended Conservation Measures

1. Storage and handling of logs should be restricted or eliminated from waters where state and federal

water quality standards cannot be met at all times.
2. Minimize potential impacts of log storage by employing effective bark and wood debris controls, collection, and disposal methods at log dumps, raft building areas, and mill-side handling zones; avoiding the free-fall dumping of logs; using easy let-down devices for placing logs in the water; and bundling logs prior to water storage (bundles should not be broken except on land and at millside).
3. Storage of logs should not take place where they will ground at any time or shade aquatic vegetation.
4. Avoid siting log storage areas and LTFs in sensitive habitat and areas important for specified species.
5. Site log storage areas and LTFs in areas with good currents and tidal exchanges.
6. Recommend land-based storage sites with the goal of eliminating in-water storage of logs.
7. For the Alaska region, also see the following link: Log Transfer Facility (LTF) Guidelines: http://www.fs.fed.us/r10/TLMP/F_PLAN/APPEND_G.PDF.

4.10 Utility Line/Cables/Pipeline Installation

With the continued development of coastal regions comes greater demand for the installation of cables, utility lines for power and other services, and pipelines for water, sewage, etc. The installation of pipelines, utility lines, and cables can have direct and indirect impacts on the offshore, nearshore, estuarine, wetland, beach, and rocky shore coastal zone habitats. The coastal zone can be as narrow as a few feet in some areas to hundreds of miles inland in others, and it is not just development in the nearshore coastal regions that can cause impacts. Many of the primary and direct impacts occur during the construction phase of installation, such as with the ground disturbance in the clearing of the right-of-way, access roads, and equipment staging areas. Indirect impacts can include increased turbidity, saltwater intrusion, accelerated erosion, and the introduction of urban and industrial pollutants.

Potential Adverse Impacts

Adverse effects to EFH from the installation of pipelines, utility lines, and cables can occur through 1) destruction of organisms and habitat, 2) turbidity impacts, 3) resuspension of contaminants, and 4) changes in hydrology.

Destruction of organisms and habitats can occur in the right-of-way of pipeline or cable. This destruction can lead to long-term or permanent damage depending on the degree and type of habitat disturbance and the mitigation measures employed. Shallow water environments, rocky reefs, nearshore and offshore rises, salt, and freshwater marshes (wetlands), and estuaries are more likely to be adversely impacted than open-water habitats. This is due to their higher sustained biomass and lower water volumes, which decrease their ability to dilute and disperse suspended sediments (Gowen 1978).

Because vegetated coastal wetlands provide forage and protection to commercially important invertebrates and fish, marsh degradation due to plant mortality, soil erosion, or submergence will eventually decrease productivity. Vegetation loss and reduced soil elevation within pipeline construction corridors should be expected with the continued use of current double-ditching techniques (Polasek 1997).

Increased water turbidity from higher than normal sediment loading can result in decreased primary production. Depending on the time of year of the construction, adverse impacts can occur, such as during highly productive spring phytoplankton blooms or times when organisms are already under stressed conditions. Changes in turbidity can temporarily alter phytoplankton communities. Depending upon the severity of the turbidity, these changes in water clarity can affect the EFH habitat functions of species higher in the food chain.

Another impact is resuspension of contaminants such as heavy metals and pesticides from the sediment, which can have lethal effects (Gowen 1978). Spills of petroleum products, solvents, and other construction-related material can also adversely affect habitat.

Pipeline canals have the potential to change the hydrology of coastal areas by 1) facilitating rapid drainage of interior marshes during low tides or low precipitation, 2) reducing or interrupting freshwater inflow and associated littoral sediments, and 3) allowing saltwater to move father inland during periods of high tides (Chabreck 1972). Saltwater intrusion into freshwater marsh often causes loss of salt-intolerant emergent and submerged aquatic plants (Chabreck 1972, Pezeshki 1987), erosion, and net loss of soil organic matter (Craig et al. 1979).

Recommended Conservation Measures

1. Align crossings along the least environmentally damaging route. Sensitive habitats such as hard-bottom (e.g., rocky reefs), submerged aquatic vegetation, oyster reefs, emergent marsh, sand and mud flats, should be avoided. If unavoidable, compensatory mitigation should be implemented.
2. Use horizontal directional drilling where cables or pipelines would cross salt marsh, vegetated inter-tidal zones, or steep erodible bluff areas adjacent to the inter-tidal zone, to avoid surface disturbances.
3. Avoid construction of permanent access channels since they disrupt natural drainage patterns and destroy wetlands through excavation, filling, and bank erosion.
4. Store and contain excavated material on uplands. If storage in wetlands or waters cannot be avoided, alternate stockpiles should be used to allow continuation of sheet flow. Stockpiled materials should be stored on construction cloth rather than bare marsh surfaces, sea grasses, or reefs.
5. Backfill excavated wetlands with either the same or comparable material capable of supporting similar wetland vegetation. Original marsh elevations should be restored. Topsoil and organic surface material such as root mats should be stockpiled separately and returned to the surface of the restored site. Adequate material should be used so that following settling and compaction of the material, the proper preproject elevation is attained. If excavated materials are insufficient to accomplish this, similar grain size material should be used to restore the trench to the required elevation. After backfilling, erosion protection measures should be implemented where needed.
6. Use existing rights-of-way whenever possible to lessen overall encroachment and disturbance of wetlands.
7. Bury pipelines and submerged cables where possible. Unburied pipelines or pipelines buried in areas where scouring or wave activity eventually exposes them run a much greater risk of damage leading to leaks or spills.
8. Remove inactive pipelines and submerged cables unless they are located in sensitive areas (e.g., marsh, reefs, sea grass, etc.) or located in areas that present no safety hazard. If allowed to remain in place, pipelines should be properly pigged, purged, filled with seawater, and capped prior to abandonment in place.
9. Use silt curtains or other type barriers to reduce turbidity and sedimentation if sea grass or oyster reefs occur at or near the project site. These silt barriers should extend at least 100 feet beyond the limits of the sea grass beds or oyster reefs. If sea grasses and oyster reefs cannot be avoided, pre- and post-construction surveys should be completed to determine project impacts and mitigation needs.
10. Access for equipment should be limited to the immediate project area. Tracked vehicles are preferred over wheeled vehicles. Consideration should be given to the use of mats and boards to avoid sensitive areas. Equipment operators should be informed to avoid sensitive areas. Sensitive areas should be clearly marked to ensure that equipment operators do not traverse them.
11. Limit construction equipment to the minimum size necessary to complete the work. Shallow-draft equipment should be employed so as to minimize impacts and eliminate the necessity of temporary access channels. The size of the pipeline trench proper should also be minimized. The push-ditch method, in which the trench is immediately backfilled, reduces the impact duration, and should therefore be employed when possible.
12. Conduct construction during the time of year that will have the least impact on sensitive habitats and species.
13. Suspend transmission lines beneath existing bridges or directional boring under streams to reduce the environmental impact. If transmission lines span streams, site towers a minimum of 200 feet from streams.

Activities on the continental shelf

14. Shunt drill cuttings through a conduit and discharge near the sea floor, or transport ashore.
15. Locate drilling and production structures, including pipelines, at least one mile from the base of a hard-bottom habitat.
16.a) Bury pipelines to a minimum of three feet beneath the sea floor, whenever possible. Particular considerations (i.e., currents, ice scour) may require deeper burial or weighting to maintain adequate cover. Buried pipeline and cables should be examined periodically for maintenance of adequate earthen cover. b) Where burial is not possible, such as in hard-bottomed areas, pipelines and cables should be attached to substrate to avoid unnecessary conflicts with fishing gear. Wherever possible the route should be marked by lighted buoys and/or lighted ranges on platforms to reduce the risk of damage to fishing gear and the pipelines. c) Alignments should be located along routes that minimize damage to marine and estuarine habitat. Avoid laying cable over high relief bottom habitat and across “live” bottom habitats such as coral and sponge. If coral or sponge habitats are encountered, NMFS would be interested in position and description information. d) Where user conflicts are likely, consult and coordinate with fishing stakeholder groups through the appropriate Fishery Management Council during the route-planning process in order to minimize conflict.
17. Avoid all natural reefs and banks, as well as artificial reef areas. Hard-bottom areas should be avoided to permit cable or pipeline burial. If unavoidable, compensatory mitigation should be mitigated.

4.11 Commercial Utilization of Habitat

Productive embayments are often used for commercial culturing and harvesting operations. These locations provide a source of warmer water temperatures and protected waters, thereby providing excellent growout sites for oyster and mussel culturing. These operations may occur in areas of productive eelgrass beds. The commercial harvest of nearshore giant kelp is another habitat type that is used. Giant kelp forest canopies serve as nursery, feeding grounds, and/or shelter to a variety of groundfish species and their prey (Cross and Allen 1993, Feder et al. 1974, Foster and Schiel 1985). In addition, when kelp plants are naturally broken free of their holdfasts, drift kelp is produced. Kelp detritus supports high secondary production and prey for many fishes (Vetter 1995).

Potential Adverse Impacts

Adverse impacts to EFH by operations that directly or indirectly utilize habitat include 1) discharge of organic waste/contaminants, 2) impacts to the seafloor bed, 3) risk if introducing undesirable species, 4) impacts on estuarine food webs, and 5) impacts on kelp forest communities.

The culture of estuarine and marine species in estuarine areas can reduce or degrade habitats used by native species, depending on the location and operation of these facilities. A major concern of culture operations is the discharge of organic waste. The introduction of antibiotics and other drugs in medicated feeds is also a concern. Wastes are composed primarily of feces and excess feed. The buildup of waste products into the receiving waters will depend upon water depths and circulation patterns. The release of these wastes can introduce nutrients or organic materials into the surrounding water body and lead to a high BOD leading to lower dissolved oxygen levels, thereby potentially affecting the survival of many aquatic organisms in the area. Nutrient overloads at the discharge site can also induce changes in community composition and structure, potentially favoring one group of organisms to the detriment of other.

In the case of cage mariculture operations for grow-out operations, impacts to the seafloor below the cages or pens can occur. The build-up of organic materials on the sea floor can impact the composition and diversity of the bottom-dwelling community (e.g., prey organisms for EFH species). Growth of submerged aquatic vegetation, which can provide shelter and nursery habitat for a number of fish species and their prey, can be inhibited by shading effects. Disruption of eelgrass habitat by management activities (e.g., the dumping of shell with spawn on eelgrass beds, damage to eelgrass due to subsequent water or wind shear against the sharp oyster shells, repeated mechanical raking or trampling) associated with this category are also of concern, though few studies have documented impacts. It is known that hydraulic dredges used to harvest oysters in coastal bays with eelgrass habitat can cause long-term adverse impacts to eelgrass beds, reducing or eliminating the beds (Phillips 1984).

The rearing of non-native, ecologically undesirable species may pose a risk of escape or accidental release into areas adversely affecting the ecological balance. Escape or other release into the environment can result in competition with native, wild fish for food, mates, spawning sites, which, if followed by successful interbreeding with wild stocks, can result in genetic dilution. Escapees can also pose a risk of transmission of disease to wild stocks.

Concern has also been expressed about extensive shellfish culture in estuaries and their impacts on estuarine food webs. Oysters are efficient filter feeders and can change the trophic structure by removal of the microalgae and zooplankton that are also the food source for salmon prey species. However, the extent of this effect, if any, is unknown, especially in light of the fact that native oysters were once present in large quantities co-existing with other species. Some effects might also be offset by the structure that oyster shells create, which creates shelter for a diverse biota.

Kelp is harvested for several reasons, including directly obtaining its by-products as well as indirectly for use as a food source in abalone culturing and as a substrate in the Pacific herring fishery. Harvesting can have a variety of possible impacts on the habitat functions provided by kelp canopies. For example, giant kelp provides refuge to prey resources utilized by some EFH species. The kelp canopy also serves as habitat for canopy-dwelling invertebrates and can have an enhancing effect on fish recruitment and abundance. Removal of the canopy may affect some species by potentially displacing species such as young-of-the-year or juvenile rockfishes (Miller and Geibel 1973).

Recommended Conservation Measures

1. Site mariculture operations away from subaquatic vegetation areas. Facilities should be close-circuited and located in upland areas as often as possible. Tidally influenced wetlands should not be enclosed or impounded for mariculture purposes, including hatchery and grow-out operations. Siting of facilities should also take into account the size of the facility, proximity of wild fish stocks, migratory patterns, competing uses, hydrographic conditions, and upstream uses.
2. Determine benthic productivity by sampling prior to any operations. Areas of high productivity should be avoided to the maximum extent possible. Sampling design should be developed with input from local, state, Tribal and federal resource agencies.
3. Investigate water depths and circulation patterns where cage mariculture operations are undertaken to insure conditions are adequate to preclude the buildup of waste products, excess feed, and chemical agents.
4. Undertake a thorough scientific review and risk assessment before any non-native species are allowed to be introduced. Any net pen structure should have small enough webbing to prevent entanglement by prey species. Mitigation should be provided for the areas impacted by the facility.
5. Encourage research into the timing of fish recruitment to kelp canopies and the response of canopy dwelling juvenile groundfish to kelp harvesting operations in order to minimize potential adverse impacts to canopy habitat function.
6. Encourage development of harvesting methods to minimize impacts on plant communities such as the destruction of canopy-dwelling invertebrates and the loss of food and/or habitat to fish populations during harvesting operations.
7. Mitigation for unavoidable, extensive, or permanent loss of plant communities should be provided.

5.0 COASTAL/MARINE ACTIVITIES

5.1 Point Source Discharge

Point-source discharges from municipal sewage treatment facilities or storm water discharges are controlled through the EPA's mandated regulations under the Clean Water Act and by state water regulations. The primary concerns associated with municipal point-source discharges involve treatment levels needed to attain acceptable nutrient inputs and overloading of treatment systems due to rapid development of the coastal zone. Storm drains are contaminated from communities with settling and storage ponds, street runoff, and harbor activities. Annually, wastewater facilities through sewage outfall lines introduce large volumes of untreated excrement and chlorine as well as treated freshwater into the nation's waters. This can significantly alter pH levels of marine waters (NPFMC 1999).

Potential Adverse Impacts

There are many potential impacts from point-source discharge, but it is important to note that point-source discharges and resulting altered water quality in aquatic environments does not necessarily result in adverse impacts to either marine resources or EFH. Because most point-source discharges are regulated by the state or EPA, effects to receiving waters are generally considered in those cases. Point-source discharges can adversely affect EFH by 1) reducing habitat functions necessary for growth to maturity, 2) modifying community structure, 3) bioaccumulation, and 4) modifying habitat.

At certain concentrations, point-source discharges can alter the following properties of ecosystems and associated communities: diversity, nutrient and energy transfer, productivity, biomass, density, stability, connectivity, and species richness and evenness. Pollution effects may be related to changes in water flow, pH, hardness, dissolved oxygen, and other parameters that affect individuals, populations, and communities. Sewage, fertilizers, and de-icing chemicals (e.g., glycols, urea) are examples of common urban pollutants that decompose with high biological or chemical oxygen demand (NPFMC 1999).

Point-source discharges, at certain concentrations, can modify by altering the following characteristics of finfish, shellfish, and related organisms: growth, visual acuity, swimming speed, equilibrium, feeding rate, response time to stimuli, predation rate, photosynthetic rate, spawning seasons, migration routes, and resistance to disease and parasites. Additionally, zones of low dissolved oxygen from their decomposition can retard growth of salmon eggs, larvae, and juveniles and may delay or block smolt and adult migration. Sewage and fertilizers also introduce nutrients into urban drainages that drive algal and bacterial blooms which may smother incubating salmon or produce toxins as they grow and die. Thermal effluents from industrial sites and removal of riparian vegetation from streambanks allowing solar warming of water can degrade salmon habitat. Heavy metals, petroleum hydrocarbons, chlorinated hydrocarbons, and other chemical wastes can be toxic to salmonids and their food, and they can inhibit salmon movement and habitat use in streams (NPFMC 1999).

Elevated salinity levels from desalination plants also need to be considered. While these studies have shown that they may not produce toxic effects (Bay and Greenstein 1994), peripheral effects of pollution may include forcing rearing fish into areas of high predation. Conversely, influx of treated freshwater from municipal wastewater plants may force rearing fish into habitat with less than optimal salinity for growth (NPFMC 1999).

Point-discharges may affect the growth, survival and condition of EFH-managed species and prey species if high levels of contaminants (e.g., chlorinated hydrocarbons; trace metals, PAHs, pesticides, and herbicides) are discharged. If contaminants are present, they may be absorbed across the gills or concentrated through bioaccumulation as contaminated prey is consumed (Raco-Rands 1996). Many heavy metals and persistent organic compounds such as pesticides and polychlorinated biphenyls tend to adhere to solid particles discharged from outfalls. As the particles are deposited, these compounds or their degradation products (which may be equally or more toxic than the parent compounds) can enter the EFH foodchain by bioaccumulating in benthic organisms at much higher concentrations than in the surrounding waters (Stein et al. 1995). Due to burrowing, diffusion, and other upward transport mechanisms that move buried contaminants to the surface layers and eventually to the water column, pelagic and nektonic biota may also be exposed to contaminated sediments through mobilization into the water column.

Discharge sites may also modify habitat by creating adverse impacts to sensitive areas such as freshwater shorelines and wetlands, emergent marshes, sea grasses, and kelp beds if located improperly. Extreme discharge velocities of effluent may also cause scouring at the discharge point as well as entrain particulates and thereby create turbidity plumes. These turbidity plumes of suspended particulates can reduce light penetration and lower the rate of photosynthesis and the primary productivity of an aquatic area while elevated turbidity persists. The contents of the suspended material can react with the dissolved oxygen in the water and result in oxygen depletion, or smother submerged aquatic vegetation sites including eelgrass beds and kelp beds. Accumulation of outfall sediments may also alter the composition and abundance of infaunal or epibenthic invertebrate communities (Ferraro 1991). Pollutants, either suspended in the water column (e.g., nitrogen, contaminants, fine sediments) or settled on the bottom, can affect habitat. Many benthic organisms are quite sensitive to grain size, and accumulation of sediments can also submerge food organisms (see Section 4.2.2).

Recommended Conservation Measures

1. Locate discharge points in coastal waters well away from shellfish beds, sea grass beds, coral reefs, and other similar fragile and productive habitats.
2. Reduce potentially high velocities by diffusing effluent to acceptable velocities.
3. Determine benthic productivity by sampling prior to any construction activity related to installation of new or modified facilities. Outfall design (e.g., modeling concentrations within the predicted plume or likely extent of deposition along a productive nearshore), should be developed with input from appropriate resource and Tribal agencies.
4. Provide for mitigation when the degradation or loss of habitat from placement and operation of the outfall structure and pipeline.
5. Institute source-control programs that effectively reduce noxious materials to avoid introducing these materials into the waste stream.
6. Ensure compliance with pollutant discharges regulated through discharge permits which set effluent discharge limitations and/or specify operation procedures, performance standards, or best management practices. These efforts rely on the implementation of best management practices to control polluted runoff (EPA 1993).
8. Discharges should be treated to the maximum extent practicable, including implementation of up-to-date methodologies for reducing discharges of biocides (e.g., chlorine) and other toxic substances.
9. Use land-treatment and upland disposal/storage techniques where possible. Use of vegetated wetlands as natural filters and pollutant assimilators for large-scale discharges should be limited to those instances where other less damaging alternatives are not available and the overall environmental and ecological suitability of such an action has been demonstrated.
10. Avoid siting pipelines and treatment facilities in wetlands and streams. Since pipelines and treatment facilities are not water dependent with regard to positioning, it is not essential that they be placed in wetlands or other fragile coastal habitats. Avoiding placement of pipelines within streambeds and wetlands will also reduce inadvertent infiltration into conveyance systems and retain natural hydrology of local streams and wetlands.

5.2 Fish Processing Waste - Shoreside and Vessel Operation

Seafood processing facilities are either shore-based facilities discharging through stationary outfalls or mobile vessels engaged in the processing of fresh or frozen seafood (SAIC 2001). Discharge of fish waste from shoreside and vessel processing has occurred in marine waters since the 1800s (NPFMC

1999). With the exception of fresh market fish, some form of processing involving butchering, evisceration, pre-cooking or cooking is necessary to bring the catch to market. Precooking or blanching facilitates the removal of skin, bone, shell, gills, and other materials. Depending on the species, the cleaning operation may be manual, mechanical, or a combination of both (EPA 1974). Seafood processing facilities generally consist of mechanisms to offload the harvest from fishing boats; tanks to hold the seafood until the processing lines are ready to accept them; processing lines, process water and waste collection systems; treatment and discharge facilities; processed seafood storage areas; and necessary support facilities such as electrical generators, boilers, retorts, water desalinators, offices, and living quarters. In addition, marinas that cater to patrons who fish a large amount can produce a large amount of fish waste at the marina from fish cleaning.

Potential Adverse Impacts

Generally, seafood processing wastes consist of biodegradable materials that contain high concentrations of soluble organic material. Seafood processing operations have the potential for adversely affecting EFH through 1) direct and/or nonpoint source discharge, 2) particle suspension, and 3) increased turbidity and surface plumes.

Seafood processing operations have the potential for adversely affecting EFH through the direct and/or nonpoint source discharge of nutrients, chemicals, fish by-products, and "stickwater" (water and entrained organics originating from the draining or pressing of steam-cooked fish products). Investigations by the EPA show that impacts affecting water quality are a direct function of the receiving waters. In areas with strong currents and high tidal ranges, waste materials disperse rapidly. In areas of quieter waters, waste materials can accumulate and result in shell banks, sludge piles, dissolved oxygen depressions, and associated aesthetic problems (Stewart and Tangarone 1977). If adequate disposal facilities are not available at marinas that generate a large amount of fish waste, there is a potential for disposal of fish waste in areas without enough flushing to prevent decomposition and the resulting dissolved oxygen depression (EPA 1993).

Processors discharging fish waste are required to have NPDES permits from the EPA. Various water quality standards including those for BOD, total suspended solids (TSS), fecal coliform bacteria (FC), oil and grease, pH, and temperature are all considerations in the issuance of such permits. Although fish waste, including heads, viscera, and bones, is biodegradable, fish parts that are ground to fine particles may remain suspended for some time, thereby overburdening habitats from particle suspension (NPFMC 1999). Such pollutants have the potential to adversely impact EFH. The wide differences in habitats, types of processors, and seafood processing methods define those impacts and can also prevent the effective use of technology-based effluent limits.

In certain areas such as Alaska, seafood processors are allowed to deposit fish parts in a Zone of Deposit (ZOD) (EPA 2001). This can remove benthic habitat from the environment, reduce locally associated invertebrate populations, and lower dissolved oxygen levels in overlying waters. Impacts from accumulated processing wastes are not limited to the area covered by the ZOD. Severe anoxic and reducing conditions occur adjacent to effluent piles (EPA 1979). Examples of localized damage to benthic environment include several acres of bottom-driven anoxic by piles of decomposing waste up to 26 fee (7.9 m) deep. Juvenile and adult stages of flatfish are drawn to these areas for food sources. One effect of this attraction may lead to increased predation on juvenile fish species by other flatfishes, diving seabirds, and marine mammals drawn to the food source (NPFMC 1999). However, due to the difficulty in monitoring these areas, impacts to species can go undetected.

Scum and foam from seafood waste deposits can also occur on the water surface and/or increase turbidity. Increased turbidity decreases light penetration into the water column, reducing primary production. Reduced primary production decreases the amount of food available for consumption by higher trophic level organisms. In addition, stickwater takes the form of a fine gel or slime that can concentrate on surface waters and move onshore to cover intertidal areas.

Recommended Conservation Measures

1. Base effluent limitations on site-specific water quality EFH concerns to the maximum extent practicable.
2. Avoid the practice of discharging untreated solid and liquid waste directly into the environment. Use of secondary or wastewater treatment systems should be encouraged where possible.
3. Designation of new ZODs should not be allowed. Options to eliminate or reduce ZODs at existing facilities should be explored.
4. Control stickwater by physical or chemical methods.
5. Promote sound fish waste management through a combination of fish-cleaning restrictions, public education, and proper disposal of fish waste.
6. Encourage the alternative use of fish processing wastes (e.g., fertilizer for agriculture, and animal feed).
7. Options for additional research should be explored. There is not much current research on which to base management decisions about habitat. Some improvements in waste processing have occurred, but the technology-based effluent guidelines have not changed in 20 years.
8. Locate new plants outside rearing and nursery habitat. Monitor both biological and chemical changes to the site.

5.3 Water Intake Structures/Discharge Plumes

The withdrawal of riverine, estuarine and marine waters by water intake structures is a common aquatic activity. Water may be withdrawn to cool coastal power generating stations, used as a source of water for agricultural purposes, and more recently, as a source of potable water for desalinization plant operations. In the case of power plants and desalinization plants, the subsequent discharge of heated and/or chemically-treated discharge water can also occur.

Potential Adverse Impacts

Adverse impacts to EFH from water intake structures and effluent discharges can interfere or disrupt EFH functions in the source or receiving waters by 1) entrainment, 2) impingement, 3) discharge, 4) operation and maintenance, and 5) construction-related impacts.

Entrainment is the withdrawal of aquatic organisms along with the cooling water into the cooling system. These organisms are usually the egg and larval stages of managed species and their prey. Entrainment can subject these life stages to adverse conditions resulting from the effects of increased heat, antifouling chemicals, physical abrasion, rapid pressure changes, and other detrimental effects. Consequently, diverting water without adequate screening prevents that portion of the EFH from providing important habitat functions necessary for the early life stages of managed living marine resources and their prey. Long-term water withdrawal may adversely affect fish and shellfish populations by adding another source of mortality to the early life stage which often determines recruitment and year-class strength (Travnichek et al. 1993).

Impingement occurs to organisms that are too large to pass through in-plant screening devices and instead become stuck or impinged against the screening device or remain in the forebay sections of the system until they are removed by other means (Grimes 1975, Hanson et al. 1977, Helvey and Dorn 1987, Helvey 1985, Langford et al. 1978, Moazzam and Rizvi 1980). The organisms cannot escape due to the water flow that either pushes them against the screen or prevents them from exiting the intake tunnel. Similar to entrainment, the withdrawal of water can entrapped particular species especially when visual acuity is reduced (Helvey 1985). This condition reduces the suitability of the source waters to provide normal EFH functions necessary for subadult and adult life stages of managed living marine resources and their prey.

Thermal effluents in inshore habitat can cause severe problems by directly altering the benthic community or killing marine organisms, especially larval fish. Temperature influences biochemical processes of the environment and the behavior (e.g., migration) and physiology (e.g., metabolism) of marine organisms (Blaxter 1969). Further, the proper functioning of sensitive areas may be affected by the action of intakes as selective predators, resulting in cascading negative consequences as observed by the overexploitation of local fish populations in coral-reef fish communities (Carr et al. 2002).

Other impacts to aquatic habitats can result from construction related activities (e.g., dewatering, dredging, etc.) (see Section 4.1) as well as routine operation and maintenance activities. There is a broad range of impacts associated with these activities depending on the specific design and needs of the system. For example, dredging activities can cause turbidity, degraded water quality, noise, and substrate alterations. Many of these impacts can be reduced or eliminated through the use of various techniques, procedures, or technologies, but some may not be fully eliminated except by eliminating the activity itself.

In the case of power plants using once-through cooling, biocides such as sodium hypochlorite and sodium bisulfate may used periodically to clean the intake and discharge structures. Chlorine is extremely toxic to aquatic life.

Recommended Conservation Measures

1. Locate facilities that rely on surface waters for cooling in areas other than estuaries, inlets, heads of submarine canyons, rock reefs or small coastal embayments where EFH species or their prey concentrate. Discharge points should be located in areas that have low concentrations of living marine resources. They should incorporate cooling towers to control temperature and employ sufficient safeguards to ensure against release of blow-down pollutants into the aquatic environment in concentrations that reduce the quality of EFH.
2. Design intake structures to minimize entrainment or impingement. Velocity caps that produce horizontal intake/discharge currents should be employed and intake velocities across the intake screen should not exceed 0.5 foot per second.
3. Design power plant cooling structures to meet the “best technology available” requirements (BTAs) as developed pursuant to Section 316(b) of the Clean Water Act. Use of alternative cooling strategies, such as closed cooling systems (e.g., dry cooling) should be used to completely avoid entrainment/impingement impacts in all industries which require cooling water. When alternative cooling strategies prove infeasible, other BTAs may include but are not limited to fish diversion or avoidance systems, fish return systems that convey organisms away from the intake and mechanical screen systems that prevent organisms from entering the intake system, and habitat restoration measures.
4. Regulate discharge temperatures (both heated and cooled effluent) such that they do not appreciably alter the temperature that could cause a change in species assemblages and ecosystem function in the receiving waters. Strategies should be implemented to diffuse the heated effluent.
5. Avoid the use of biocides (e.g., chlorine) to prevent fouling where possible. The least damaging antifouling alternatives should be implemented.
6. Mitigate for impacts related to power plants and other industries requiring cooling water. Mitigation should compensate for the net loss of EFH habitat functions from placement and operation of the intake and discharge structures. Mitigation should be provided for the loss of habitat from placement of the intake structure and delivery pipeline, the loss of fish larvae and eggs that may be entrained by large intake systems, and the degradation or loss of habitat from placement of the outfall structure and pipeline as well as the treated water plume.
7. Treat all discharge water from outfall structures to meet state water quality water standards at the terminus of the pipe. Pipes should extend a substantial distance offshore and be buried deep enough to not affect shoreline processes. Buildings and associated structures should be set well back from the shoreline to preclude the need for bank armoring.

5.4 Oil/Gas Exploration/Development/Production

Offshore exploration, development, and production of natural gas and oil reserves have been, and continues to be, an important aspect of the U.S. economy. As demand for energy resources grows, the debate over trying to balance the development of oil and gas resources and the protection of the environment will also continue. Projections indicate that U.S. demand for oil will increase by 1.3 percent per year between 1995 and 2020. Gas consumption is projected to increase by an average of 1.6 percent during the same time frame (Waisley 1998). Much of the 1.9 billion acres within the offshore jurisdiction of the U.S. remain unexplored (OGTAD 1985). It is also expected that some of the older oil and gas platforms in operation will reach the end of their productive life in the near future. The question of decommissioning is also an issue.

Potential Adverse Impacts

Offshore oil and gas operations can be classified into exploration, development, and production activities. Petroleum exploration/development/production occurs in varying water depths and usually over soft-bottom substrates, although hard-bottom habitats may be present in the general vicinity. These areas are subject to an assortment of physical, chemical, and biological disturbances. These disturbances include 1) noise from seismic surveys, vessel traffic, and construction of drilling platforms or islands, traffic from vessels, 2) physical alterations to habitat from the construction, presence and eventual decommissioning and removal of facilities such as islands or platforms, storage and production facilities, and pipelines to onshore common carrier pipelines, storage facilities, or refineries, 3) waste discharges including well drilling fluids, produced waters, surface runoff and deck drainage, domestic waste waters generated from the offshore facility, solid-waste from wells (drilling muds and cuttings) and other trash and debris from human activities associated with the facility, 4) oil spills, and 5) platform storage, and pipeline decommissioning (NPFMC 1999, Helvey 2002).

Noise sources may generate sound pressure that can disrupt or damage marine life. Oil and gas activities may generate noise from drilling activities, construction, production facility operations, seismic exploration and supply vessel and barge movements (see Section 4.5). The impacts of oil exploration-related seismic energy releases may interrupt and cause fish to disperse from the acoustic pulse with possible disruption to their feeding patterns. It is known that noise in the marine environment may adversely affect marine mammals by causing them to change behavior (movement, feeding), interfere with echolocation and communication, or may result in injury to hearing organs (Richardson et al. 1995). Activities such as vessel anchoring, platform or artificial island construction, pipeline laying (see Section 4.10), dredging, and pipeline burial can alter bottom habitat by altering substrates used for feeding or shelter. Disturbances to the associated epifaunal communities, which may provide feeding or predator escape habitat, can also result. Benthic organisms, especially prey species, may recolonize disturbed areas, but this may not occur if the composition of the substrate is drastically changed or if facilities are left in place after production ends. Dredging, trenching and pipelaying generate spoils that may be disposed of on land or the marine environment where sedimentation may smother benthic habitat and organisms. Most of these activities associated with oil and gas operations, however, are conducted under permits and regulations that require companies to minimize impacts or to avoid construction or other disturbances in sensitive marine habitats (see Section 4.2.2).

The discharge of drilling muds and cuttings can result in varying degrees of change on the sea floor and affect feeding, nursery, and shelter habitat for various life stages of managed species. Drilling muds and cuttings may adversely affect bottom-dwelling organisms at the site by burial of immobile forms or forcing mobile forms to migrate. Exploratory and construction activities may also result in resuspension of fine-grained mineral particles, usually smaller than silt, in the water column. These suspended particulates can reduce light penetration and lower the rate of photosynthesis and the primary productivity of the aquatic area especially if suspended for lengthy intervals. Groundfish and other fish species can suffer reduced feeding ability leading to limited growth if high levels of suspended particulates persist. The contents of the suspended material can react with the dissolved oxygen in the water and result in oxygen depletion. In addition, the discharge of oil drilling muds can change the chemical and physical characteristics of benthic sediments at the disposal site by introducing toxic chemical constituents. Changes in the clarity and the addition of contaminants can reduce or eliminate the suitability of water bodies as habitat for fish species and their prey (NMFS 1998).

Oil spills are a serious potential source of contamination to the marine environment from oil and gas development. Offshore oil and gas development will inevitably result in some oil entering the environment. Most spills are expected to be of small size, although there is a potential for large spills to occur. Many factors determine the degree of damage from a spill, including the type of oil, size and duration of the spill, geographic location of the spill, and the season. Although oil is toxic to all marine organisms at high concentrations, certain species are more sensitive than others. In general, the early life stages (eggs and larvae) are most sensitive, juveniles are less sensitive, and adults least so (Rice et al. 2000).

In whatever quantities, lost oil can affect habitats and living marine resources. Accidental discharge of oil can occur during almost any stage of exploration, development, or production on the outer continental shelf (OCS) or in nearshore coastal areas. Oil spills can occur from many possible sources including equipment malfunction, ship collisions, pipeline breaks, other human error, or severe storms. Oil spills can also be attributed to support activities associated with product recovery and transportation. In addition to crude oil spills, chemical, diesel, and other contaminant spills can occur with OCS activities (NPFMC 1999).

Chronic small oil spills are a potential problem because residual oil can build up in sediments and affect living marine resources. Low levels of petroleum components (polycyclic aromatic hydrocarbons- PAH) from such chronic pollution can accumulate in salmon tissues and cause lethal and sublethal effects, particularly at the embryo stage. Effects on fish from low-level chronic exposure may increase embryo mortality, reduce marine growth (Heintz et al. 2000), or increase straying away from natal streams by returning adults (Wertheimer et al. 2000).

It is possible for a major oil spill (i.e., 50,000 barrels) to produce a surface slick covering up to several hundred square kilometers of surface area. If the oil spill moves toward land, habitats and species could be affected by the loading of oil into the near shore environment. In the initial hours after a large spill, aromatic hydrocarbons would generally be at toxic levels to some organisms. Beneath and surrounding the surface slick, there would be some oil-contaminated waters. Physical and biological forces act to reduce oil concentrations with depth and distance (NPFMC 1999); generally the lighter fraction aromatic hydrocarbons evaporate rapidly, particularly during periods of high wind and wave activity. Heavier oil fractions may settle through the water column. Suspended sediment can adsorb and carry oil to the seabed. Hydrocarbons may be solubilized by wave action which may enhance adsorption to sediments, which then sink to the seabed, contaminating benthic sediments. Carls et al. (2003) demonstrated that tides and the resultant hydraulic gradients provide a mechanism for groundwater transport of soluble and slightly soluble contaminants (such as oil) from beaches surrounding streams into the hyporheic zone where pink salmon eggs incubate. Oil may reach nearshore areas and affect productive nursery grounds or areas containing high densities of fish eggs and larvae. An oil spill near an especially important habitat (e.g., a gyre where fish or invertebrate larvae are concentrated) could also result in a disproportionately high loss of a population of marine organisms. Other aquatic biota at risk would be eggs, larvae and other planktonic organisms in the upper seawater column. Because they cannot actively avoid exposure, their small size means they absorb contaminants quickly, and their proximity to the seasurface means they may be vulnerable to photo-enhanced toxicity effects, which can increase the toxicity of hydrocarbons several fold (Barron et al. 2003). In addition, oil spills may interrupt commercial or subsistence fishing activities.

Habitats that are susceptible to damage from spill oil include not just the low energy coastal bays and estuaries where oil may accumulate but also high energy cobble environments where oil is driven into sediments through wave action. Many of the beaches in Prince William Sound with the highest persistence of oil following the *Exxon Valdez* oil spill were high-energy environments containing large cobbles overlain with boulders. These beaches were pounded by storm waves which drove the oil into and well below the surface (Michel and Hayes 1999). Oil that mixes into bottom sediments can persist for years. Subsurface oil was still detected in beach sediments of Prince William Sound 12 years after the *Exxon Valdez* oil spill, much of it unweathered and more prevalent in the lower intertidal biotic zone than at higher tidal elevations (Short et al. 2002). Additional concern is the unknown impact of an oil-related event near and/or within ice. The water column adjacent to the ice edge is stable. This stabilization (or stratification) would allow relatively quick transport of oil to the sea floor. Additionally, oil trapped in ice could impact habitat significantly after the initial event, months or years later, and even into a different region (NPFMC 1999).

Residual oil from a spill can remain toxic for long periods. Petroleum is a complex mixture of alkanes and aromatic hydrocarbons, of which the alkyl-substituted and multi-ring PAHs are the most toxic and persistent. Following weathering, the aromatic fraction of oil is dominated by PAHs as the lighter aromatic components evaporate or are degraded. Because of low solubility in water, the large PAH concentrations probably contribute little to acute toxicity of oil-water solutions. Lipophilic PAH, however, may cause physiological injury if it accumulates in tissues after exposure (Carls et al. 1999, Heintz et al. 2000). Also, even when concentrations of oil are sufficiently diluted not to be physically damaging to marine organisms, it still may be detected by them, and may alter certain behavior patterns.

Oil and gas platforms may be comprised of a lattice-work of pilings, beams and pipes that support diverse fish and invertebrate populations and are considered de facto artificial reefs (Love and Westphal 1990, Love et al. 1994, Love et al. 1999, Helvey 2002). Because decommissioning includes plugging and abandoning all wells and removing the platforms and associated structures from the ocean, impacts to EFH can result during removal. Impacts during the demolition phase may include underwater sound pressure waves (see Section 4.5.1) and impacts on marine organisms; removal of structures may remove habitat for invertebrates and fish that associate with midwater structures. In some areas of the U.S., offshore oil and gas platforms are allowed to remain after decommissioning, thereby providing permanent habitat for some organisms.

The potential disturbances and associated adverse impacts on the marine environment has been reduced through the operating procedures required by regulatory agencies and in many cases self imposed by facilities operators. Most of the activities associated with oil and gas operations are conducted under permits and regulations that require companies to minimize impacts or avoid construction in sensitive marine habitats. New technological advancements result in improved operating practices reducing the potential for impacts. For example the discharge of muds and cuttings is being phased out of modern oil and gas production programs; generally such byproducts of exploration or development are ground into finer materials and injected into wells that penetrate subsea reservoir strata and do not enter the marine environment.

Recommended Conservation Measures

Oil and gas exploration, development, and production can be conducted in a manner that minimizes adverse impacts on the marine environment. Over the past several decades, government agencies and petroleum production companies have developed operating procedures that reduce potential adverse effects; these procedures are generally required through permits. The following are recommended measures that should be considered in permitting future oil and gas operations.

1. Conduct pre-project biological surveys in consultation with NMFS to determine the extent and composition of biological populations or habitat in the proposed production area. On the basis of the site-specific surveys a determination will be made whether or not the operations are likely to have an adverse effect upon EFH, or that a special biological population/habitat does not exist. Based on the information in the surveys, the following may be recommended:
   a. Redesign facilities to accommodate habitat concerns.
   b. Operate during those periods of time, as established in consultation with NMFS, that do not adversely affect biological resources.
   c. Modify operations to ensure that significant biological populations or habitats deserving protection are not affected.
2. Limit the discharge of produced waters into marine and estuarine environments. Re-inject produced waters into the oil formation whenever possible.
3. Avoid discharge of muds and cuttings into the marine and estuarine environment. Use methods to

grind and re-inject such wastes down an approved injection well or use onshore disposal wherever possible. When not possible, provide for a monitoring plan to quantitatively assess whether effluent discharges are meeting the needs of EFH.
4. Limit placement of causeways or structures in the nearshore marine environment.
5. Encourage the use of geographic response strategies that identify EFH and environmentally sensitive areas and identify appropriate cleanup methods to include the prestaging of response equipment.
6. Use methods to transport oil and gas that limit the need for handling in environmentally sensitive areas, including EFH.
7. Prohibit drilling of the first development well into the targeted hydrocarbon formations during hazardous or sensitive environmental conditions, such as broken ice.
8. Prohibit drilling of exploration wells into untested formations during hazardous or sensitive environmental conditions.
9. Provide for monitoring and leak detection systems that preclude oil and gas from entering the environment.
   a. Utilize systems that detect spills and leaks as rapidly as technologically possible so that action can be taken to avoid or reduce the effect to EFH, and
   b. Utilize maximum precautions to eliminate pipeline failure caused by external forces.
10. Evaluate impacts to habitat during the decommissioning phase, including impacts during the demolition phase and impacts resulting from permanent habitat losses.

5.5 Habitat Restoration/Enhancement

Habitat loss and degradation are major, long-term threats to the sustainability of fishery resources (NOAA Fisheries 2002). Viable coastal and estuarine habitats are important to maintaining healthy fish stocks. Good water quality and quantity, appropriate substrate, ample food sources and substantial hiding places are needed to sustain fisheries. Restoration and/or enhancement of coastal and riverine habitat that supports managed fisheries and their prey will assist in sustaining and rebuilding fisheries stocks and recovering certain threatened or endangered species by increasing or improving ecological structure and functions. Habitat restoration/enhancement may include, but is not limited, to improvement of coastal wetland tidal exchange or reestablishment of historic hydrology; dam or berm removal; fish passage barrier removal/modification; road related sediment source reduction; natural or artificial reef/substrate/habitat creation; establishment or repair of riparian buffer zones and improvement of freshwater habitats that support anadromous fishes; planting of native coastal wetland and submerged aquatic vegetation; creation of oyster reefs; and improvements to feeding, shade or refuge, spawning and rearing areas that are essential to fisheries.

<u>Potential Adverse Impacts</u>

The implementation of restoration/enhancement activities may have localized and temporary adverse impacts on EFH. Possible impacts can include 1) localized nonpoint source pollution such as influx of sediment or nutrients, 2) interference with spawning and migration periods, 3) temporary or permanent removal feeding opportunities; and 4) indirect effects from actual construction portions of the activity.

Unless proper precautions are taken, upland related restoration projects can contribute to nonpoint source pollution. Such concerns should be addressed as part of the planning process (see Section 2.1). Particular in-water projects may interfere with spawning periods or impede migratory corridors and should be addressed accordingly. Projects may also have an effect on the feeding behavior of managed species. For instance, if dredging is involved, benthic food resources may be impacted. (See also Section 4.1). Impacts can occur from individuals conducting the restoration, especially at staging areas, as part of accessing the restoration site, or the actual restoration techniques employed. Particular impacts can result from water quality impacts from individuals conducting the restoration, excessive foot traffic, diving techniques, equipment handling, boat anchoring, and planting techniques.

The use of artificial reefs is a popular form of habitat enhancement, but it can also impact the aquatic environment through the loss of habitat upon which the reef material is placed or the use of inappropriate materials in construction. Usually, reef materials are set upon flat sand bottoms or "biological deserts" which end up burying or smothering bottom-dwelling organisms at the site or even preventing mobile forms (e.g., benthic-oriented fish species) from utilizing the area as habitat. Some materials may be inappropriate for the marine environment (e.g., automobile tires; compressed incinerator ash) and can serve as sources of toxic releases or physical damage to existing habitat when breaking free of their anchoring systems (Collins et al. 1994).

Recommended Conservation Measures

1. Use BMPs to minimize and avoid all potential impacts to EFH during restoration activities. This conservation measure requires the use of BMPs during restoration activities to reduce impacts from project implementation. BMPs should include, but are not limited to, the following:
    a. Measures to protect the water column—Turbidity curtains, haybales, and erosion mats should be used.
    b. Staging areas—Areas used for staging will be planned in advance and kept to a minimum size.
    c. Buffer areas around sensitive resources—Rare plants, archeological sites, etc., will be flagged and avoided.
    d. Invasive species—Invasive plant and animal species should be removed from the proposed action area prior to commencement of work. Only native plant species should be planted. Measures to ensure native vegetation or revegetation success will be identified and implemented (see also Section 4.4).
    e. Ingress/egress areas—Temporary access pathways will be established prior to restoration activities to minimize adverse impacts from project implementation.
2. Avoid restoration work during critical fish windows to reduce direct impacts to important ecological functions such as spawning, nursery, and migration. This conservation measure requires scheduling projects when managed species are not expected in the area. These periods should be determined prior to project implementation to reduce or avoid any potential impacts.
3. Provide adequate training and education to volunteers and project contractors to ensure minimal impact to the restoration site. Volunteers should be trained in the use of low-impact techniques for planting, equipment handling, and any other activities associated with the restoration. Proper diving techniques need to be used by volunteer divers.
4. Conduct monitoring before, during, and after project implementation to ensure compliance with project design and restoration criteria. If immediate post-construction monitoring reveals that unavoidable impacts to EFH have occurred, appropriate coordination with NOAA Fisheries should occur to determine appropriate response measures, possibly including mitigation.
5. Mitigate fully any unavoidable damage to EFH during project implementation and accomplish within reasonable period of time after the impacts occurred.
6. Remove and restore, if necessary, any temporary access pathways and staging areas used in the restoration effort.
7. Determine benthic productivity by sampling prior to any construction activity in the case of subtidal enhancement (e.g., artificial reefs). Areas of high productivity should be avoided to the maximum extent possible. Sampling design should be developed with input from state and federal resource agencies. Prior to construction, an evaluation of the impact resulting from the change in habitat (sand bottom to rocky reef, etc.) should be performed. Post-construction monitoring should examine the effectiveness of the structures for increasing habitat productivity.

5.6 Marine Mining

Mining activity, as also described in Section 3.1.1 and Section 3.1.2, can lead to the direct loss of EFH for certain species. Offshore mining as well the mining of gravel from beaches, can increase turbidity of water and, thus, the resuspension of organic materials could affect less motile organisms (i.e., eggs and recently hatched larvae) in the area. Benthic habitats could be damaged or destroyed by these actions. Mining of large quantities of beach gravel can significantly affect the removal, transport, and deposition of sand and gravel along the shore, both at the mining site and down current (NPFMC 1999). Neither the future extent of this activity nor the effects of such mortality on the abundance of marine species is known.

Potential Adverse Impacts

Mining practices that can impact EFH include physical impacts from intertidal dredging and chemical impacts from the use of additives such as flocculates (NPFMC 1999). Impacts include the removal of substrates that serve as habitat for fish and invertebrates; creation (or conversion) of areas to less productive or uninhabitable sites such as anoxic holes or silt bottom; burial of productive habitats, such as in near shore disposal sites (as in beach nourishment); release of harmful or toxic materials either in association with actual mining, or in connection with machinery and materials used for mining; creation of harmful turbidity levels; and adverse modification of hydrologic conditions so as to cause erosion of desirable habitats. Submarine disposal of mine tailings can also alter the behavior of marine organisms. Submarine mine tailings may not provide suitable habitat for some benthic organisms. In laboratory experiments, benthic dwelling flatfishes (Johnson et al. 1998b) and crabs (Johnson et al. 1998a) strongly avoided mine tailings.

During beach gravel mining, water turbidity increases and the resuspension of organic materials can affect less motile organisms (i.e., eggs and recently hatched larvae) in the area. Benthic habitats can be damaged or destroyed by these actions. Changes in bathymetry and bottom type may also cause alteration in population and migrations patterns (Hurme and Pullen 1988).

Recommended Conservation Measures

1. Avoid mining in waters containing EFH.
2. Minimize the areal extent and depth of extraction to minimize recolonization times.
3. Limit sand mining and beach nourishment in areas with EFH.
4. Monitor turbidity during operations and cease operations if turbidity exceeds predetermined threshold levels. Use sediment or turbidity curtains to limit the spread of suspended sediments and minimize the area affected.
5. Monitor the number of individual mining operations to avoid and minimize cumulative impacts. For instance, three mining operations in an intertidal area could impact EFH, whereas one may not. Also, disturbance of previously contaminated mining areas threaten an additional loss of EFH.

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8.0 INDEX