U.S. Fish & Wildlife Service

Seabird Conservation Plan

Pacific Region

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Regional Seabird Conservation Plan

U.S. FISH AND WILDLIFE SERVICE
PACIFIC REGION

January 2005

List of Authors

Many Service personnel and partners participated in the preparation of this document. The Service solicited the help of experts to prepare specific sections of the plan in their area of expertise.

The primary authors of Part I included:

Maura Naughton	U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Portland, OR
Kyra Mills	PRBO Conservation Science, Stinson Beach, CA
Mark Rauzon	Marine Endeavours, Oakland, CA
William Sydeman	PRBO Conservation Science, Stinson Beach, CA
Tara Zimmerman	U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Portland, OR
Harry Carter	Carter Biological Consulting, Victoria, British Columbia, Canada
Michael Fry	University of California, Davis, CA
Theirry Work	U.S. Geological Survey, Honolulu, HI
Scott Newman	University of California, Davis, CA
David Hyrenbach	Duke University, Durham, NC
Roger Helm	U.S. Fish and Wildlife Service, Ecological Services, Portland, OR

The primary authors of Part II Species Profiles included (alphabetically):

Christine Abraham	PRBO Conservation Science, Stinson Beach, CA
Russ Bradley	PRBO Conservation Science, Stinson Beach, CA
Meredith Elliott	PRBO Conservation Science, Stinson Beach, CA
Derek Lee	PRBO Conservation Science, Stinson Beach, CA
Aileen Miller	PRBO Conservation Science, Stinson Beach, CA
Kyra Mills	PRBO Conservation Science, Stinson Beach, CA
Maura Naughton	U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Portland, OR
Mark Rauzon	Marine Endeavours, Oakland, CA
Leilani Takano	U.S. Fish and Wildlife Service, Pacific Islands Ecological Services, Honolulu, HI
Pete Warzybok	PRBO Conservation Science, Stinson Beach, CA

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Table of Contents

Part II

Tables, Figures and Appendices

List of Tables

List of Figures

List of Appendices

Executive Summary

The U.S. Fish and Wildlife Service (Service) Pacific Region, supports the most diverse group of seabirds in the United States and it is second only to Alaska in the total number of breeding seabirds. An estimated 14 million seabirds representing 60 species breed in this Region and millions more forage in the rich waters but do not breed. Two of the most diverse seabird assemblages in the U.S. are represented: the temperate species of the California Current System (California, Oregon, Washington) and the tropical/subtropical seabirds of Hawai`i and the other U.S. Pacific Islands.

Purpose

The purpose of this Plan is to identify the Service's priorities for seabird management, monitoring, research, outreach, planning and coordination. It will serve as a guide to coordinate Service activities for seabird conservation at the Regional scale. The Plan includes: a review of seabird resources and habitats, a description of issues and threats, and a summary of current management, monitoring and outreach efforts. All species are prioritized by conservation concern at the regional scale and recommendations for conservation actions are identified and prioritized. In Part II of this Plan, brief profiles for each breeding species provide a summary of current information on population size, status, ecology, distribution, habitats, threats, and recommended conservation actions.

Scope

The Pacific Region (Region), for the purposes of this plan, includes the coastal and offshore areas of California, Oregon, Washington, Hawai`i, and the U.S. Pacific Island commonwealths, territories, and possessions, including: Guam and the Commonwealth of the Northern Mariana Islands (CNMI); American Samoa; Johnston Atoll; Wake Atoll in the Marshall Archipelago; Palmyra Atoll, Kingman Reef and Jarvis Island in the Line Archipelago; Baker and Howland Islands in the Phoenix Archipelago; and Midway Atoll in the Hawaiian Archipelago.

Sixty species of seabirds representing three Orders and ten Families, nest in the Region including: three albatrosses, six petrels, four shearwaters, seven storm-petrels, three cormorants, one pelican, two frigatebirds, three boobies, two tropicbirds, five gulls, twelve terns, three noddies, one skimmer, one murre, one guillemot, three murrelets, two auklets and one puffin. Many of these populations are of global or national importance. In addition to the breeding seabirds, millions of non-breeding birds migrate to, or through, the area.

Threats

The most serious threats to seabirds in the Region involve invasive (non-native) species, interactions with fisheries, oil and other pollution, habitat loss and degradation, disturbance, and global climate change. Invasive species, especially introduced predators have had devastating effects on seabirds worldwide, especially at island colonies. Introduced plants, herbivores, and insects have caused drastic habitat changes, often to the detriment of breeding seabirds. Thousands of birds have been killed each year in interactions with fishing gear, especially longline and gillnet fisheries. Although regulatory actions have been taken in recent years that have reduced this mortality, much work still needs to be done to identify and further minimize or eliminate these impacts. The indirect effects of fishing activities, such as bright lights near seabird colonies or overfishing of fish stocks, have not been as well documented but are also of concern. The negative impacts of large oil spills have long been recognized but smaller spills occur regularly and potentially cause even greater mortality. Contaminants such as organochlorines and heavy metals caused major seabird declines historically and are still present in the environment, affecting seabirds both at sea and at the colonies. Plastics and other marine debris are ingested or entangle foraging seabirds, causing injury and death. Global climate change could significantly effect seabird prey resources, and rising sea levels associated with global warming could be disastrous for seabird nesting habitat, especially on low islands and atolls. Habitat loss

and degradation and human disturbance have resulted in population declines at the local and range-wide scales. The incidence of obstructions such as powerlines, communication towers, and wind generation facilities in areas used by seabirds is increasing. As the human population continues to grow and more people reside near the coasts, conflicts will continue to increase.

Current USFWS Program

Within the U.S., the Service is the principal federal agency responsible for the protection and management of migratory birds. Within the Service, different divisions have defined, but often overlapping responsibilities concerning the conservation of seabirds: Migratory Bird Management; Ecological Services (including Endangered Species, Environmental Contaminants, and Habitat Conservation branches); Law Enforcement; and the National Wildlife Refuge System.

To date, Service activities have focused primarily on the protection and restoration of seabird nesting habitats. The largest seabird colonies in the Region are located on National Wildlife Refuge System lands, and numerically over 80% of the seabirds nest on these lands. Conservation activities include the control and eradication of introduced predators and other invasive species, broad scale monitoring and inventory of breeding populations, threat abatement, and specific responsibilities associated with endangered species management, oil spills and contaminant issues.

Recommended Service Priorities, Pacific Region

Based on the review of seabird and habitat resources and threats the following priorities for seabird conservation have been identified.

Habitat Management

- Maintain, protect and enhance habitats (breeding, roosting, foraging, migrating and wintering) to meet seabird needs. Identify important habitats and provide protection (*e.g.*, through acquisition, easement, regulation, or special designations) for areas not adequately protected.
- Restore lost or degraded seabird habitats through activities such as eradicating invasive plant species, restoring native vegetation, removing hazards, and restoring or simulating natural ecological function.

Threat Management

The goals of Service activities with respect to threat management include identification and prioritization of threats, actions to remove or minimize the impacts, investigations to document the effects of threats on seabirds, and research to minimize impacts. Monitoring is an important component of threat management. Coordination with a wide range of federal, state, industry, and conservation partners is key to effectively addressing threats.

- ***Invasive Species.*** Eradicate or control introduced predators and other invasive species that have negative impacts on seabird populations. Support national and international efforts to prevent the introduction of invasive species to important seabird areas and to eradicate/control these species. Support research to develop new technologies to control invasive plants and animals.
- ***Fisheries Interactions.*** Identify problems and minimize the negative impacts of fisheries interactions. Work with partners to identify problematic fisheries and develop observer programs. Provide technical assistance and support in the development of new gear, fishing techniques, or mitigative measures to reduce and eventually eliminate seabird bycatch.
- ***Oil Spills.*** Respond to oil spills and work with other response agencies to minimize the impacts of spills to seabirds and other wildlife. Provide technical information on seabird distribution and abundance to increase the effectiveness of spill response efforts and increase Service participation in spill prevention and pre-spill planning activities.
- ***Contaminants.*** Identify contaminant problems and work with partners to ameliorate the effects and clean-up contaminated sites. Design and implement a seabird monitoring program to provide early warning of potential issues and support research into the source and effects of contaminants on seabirds.

Inventory and Monitoring

- Design and implement a comprehensive seabird inventory and monitoring program. Work with USGS, seabird scientists, and other partners to develop a standardized system for data collection and analysis that is science based and statistically rigorous.

- Annually review and report the results of seabird monitoring and develop an interactive web interface with GIS mapping capabilities to disseminate the information to stakeholders and partners.

- Identify species with declining population trends, investigate causal relationships, and develop and implement actions to reverse the trend.

Research

The Service will focus on research necessary to make informed conservation and management decisions. Priority will be given to seabirds listed as Birds of Conservation Concern and those listed under the Endangered Species Act.

- Support research directed at evaluating, ameliorating, or eliminating the effects of threats. For example, research to minimize the negative impacts of fisheries interactions or to devise methods to eradicate/control invasive species.

- Develop methods to monitor seabird population trends for those species where current methods are inadequate.

- Work with partners to investigate the interrelationships of seabirds and their environment: seabird foraging ecology; ecology of prey; response of seabirds and prey to large and small scale oceanographic and climatological cycles; etc.

Outreach and Education

Educate the public about seabird ecology, threats, and conservation issues.

- Develop curriculums for schools; a seabird website with links to current monitoring and investigations; presentations for field offices and general distribution; interpretive displays, brochures, posters, and other outreach materials.

- Provide increased opportunities for the public to view and experience seabirds in the wild through viewing stations and remote cameras feeds.

- Provide technical assistance, outreach, and education to industry and other stakeholders and partners to resolve conflicts involving seabirds.

Planning and Coordination

Seabirds are a shared resource that cross international, state, Tribal, and agency responsibility boundaries. Coordination with a wide variety of partners is essential to effective seabird conservation.

- Coordinate with other countries, U.S. Territorial and Commonwealth governments, Tribes, federal and state agencies, conservation and industry groups, and the public on the conservation and management of seabirds, at all scales.

- In partnership with others, develop and implement seabird components of regional waterbird plans under the North American Waterbird Conservation Plan and foster the development of international waterbird working groups to implement these plans.

- Participate in working groups, interagency teams, and other venues designed to further seabird conservation in the Region.

- Improve coordination with USGS and support increased involvement by USGS in seabird conservation through research and technical assistance on key issues. Improve coordination with NOAA-Fisheries on shared monitoring, management, and seabird conservation issues.

- Biannually update a seabird conservation strategic plan to focus Service efforts on priority management, monitoring, and research needs.

Part I. Introduction

VISION:

Restore and sustain healthy seabird populations and the natural systems on which they depend, through sound management, diverse partnerships, and science.

U.S. Fish and Wildlife Service (Service or USFWS) is the federal agency with the primary responsibility for the management of migratory birds.[1] The Service's Pacific Region (Region) is vast, stretching across the north Pacific from the coasts of California, Oregon, and Washington in the east, to the Mariana Islands in the far western Pacific, and south of the equator to the islands of American Samoa (Figure 1). The Region supports the most diverse group of seabirds in the United States and it is second only to Alaska (Region 7) in the total number of breeding seabirds. An estimated 14 million seabirds representing 60 species breed in the Region and millions more winter or migrate through the area.

Two of the most diverse seabird assemblages in the U.S. are represented: the temperate species of the California Current System (California, Oregon, Washington) and the tropical/subtropical seabirds of Hawai`i and the other U.S. Pacific Islands (USPI). For four species, essentially the entire world population breeds in the Region. For 23 more species, the Region supports the entire U.S. population. Seven species/subspecies have small or declining populations and face significant threats that result in their inclusion on the national list of Birds of Conservation Concern (BCC).[2] Six more are listed under the Endangered Species Act (ESA) (see Appendix 3).

Within this vast expanse, significant numbers of breeding seabirds nest on 30 National Wildlife Refuges (NWR), owned and managed by the Service. This Regional Seabird Conservation Plan (Plan) will serve to guide and coordinate Service activities to conserve seabird populations and habitats in the Pacific Region and to foster conservation of seabirds at the ecoregion scale in coordination with our partners.

Goals of USFWS Seabird Conservation Program in the Region

I. Maintain the current abundance, diversity, and distribution of healthy populations of breeding seabirds in the Pacific Region. Enhance the abundance and distribution of declining, depleted, or extirpated seabird species.

II. Maintain, protect, and enhance seabird habitats (breeding, roosting, foraging, migrating, and wintering) in sufficient quantity and quality to meet seabird needs.

III. Alleviate or eliminate threats and resolve management conflicts that negatively affect seabirds.

IV. Improve coordination and communication directed towards the conservation of seabirds at all scales: international, national, regional, and local.

V. Increase and improve opportunities for people to view, enjoy, and learn about seabirds of the Pacific Region.

[1] See Appendix 1: Treaties, Legislation, Policies, National and International Initiatives and Jurisdiction.

[2] USFWS 2002

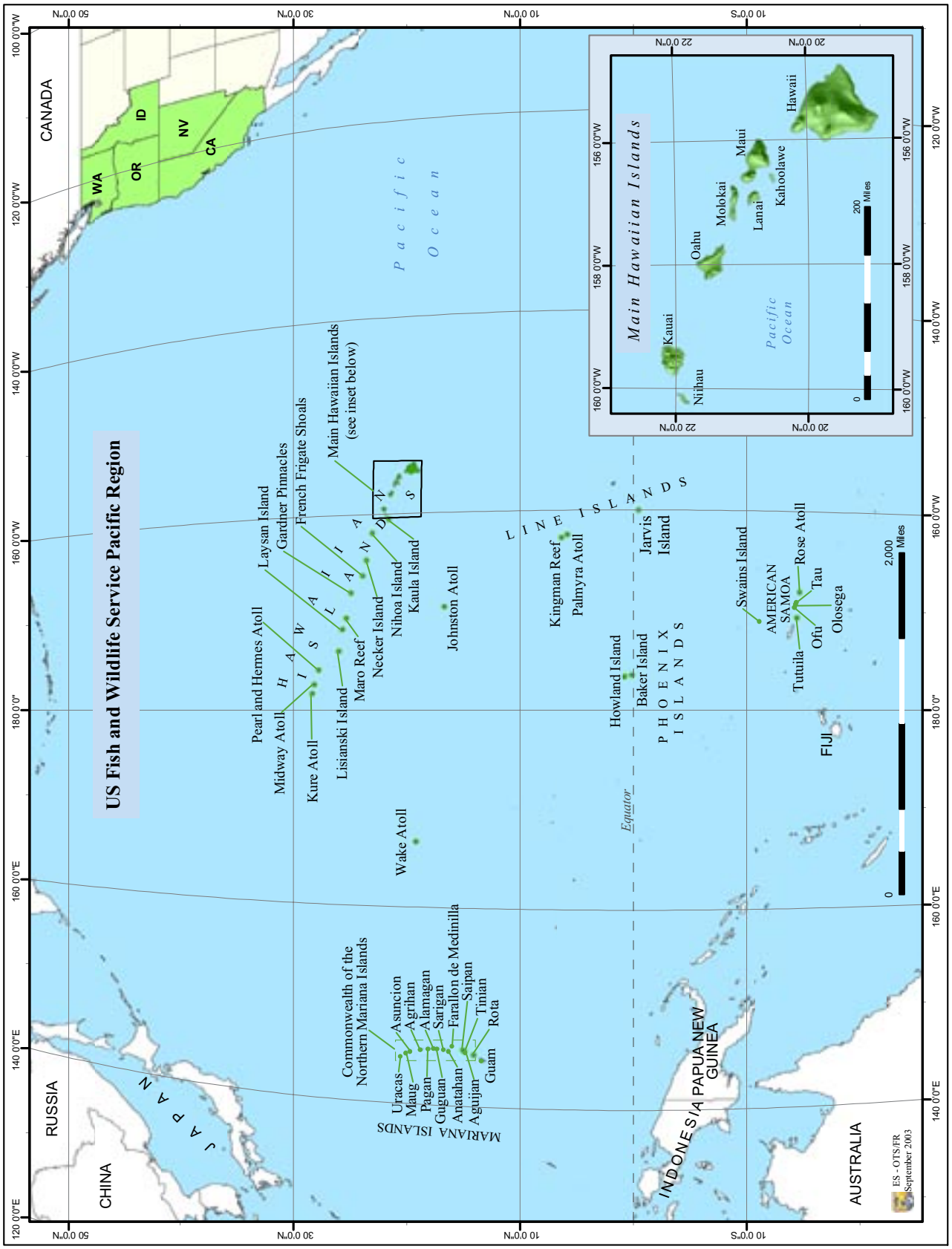

Figure 1. Map of U.S. Fish and Wildlife Service, Pacific Region.

Purpose and Objectives

The purpose of this Plan is to identify the Service's priorities for seabird management, monitoring, research, and outreach within the Region and to develop a comprehensive and coordinated regional strategy for seabird conservation. The seabirds covered in this Plan are a significant national and international resource. This Plan will serve as the foundation for developing cooperative seabird conservation efforts with agencies, academia, non-governmental organizations, and others at all scales from local to international. The objectives of this Plan are:

1. Present an overview of the seabird and habitat resources in the Region and a review of current Service seabird conservation activities.

2. Identify threats, issues and conservation concerns that jeopardize healthy seabird populations.

3. Establish Service priorities for seabird management, monitoring, research, outreach, and coordination to provide a foundation for program planning, budgeting, and implementation.

4. Promote internal, interagency, national and international coordination in seabird management and monitoring, and forge new and stronger ties with agency personnel, researchers and non-government organizations (NGOs) active in seabird conservation.

Scope of the Plan

The Service's Pacific Region encompasses the six western states: Washington (WA), Oregon (OR), California (CA), Idaho, Nevada and Hawai`i (HI); and the U.S. island possessions, territories, and commonwealths in the central Pacific, including: Midway Atoll in the Hawaiian Archipelago; Johnston Atoll; Wake Atoll in the Marshall Archipelago; Guam and the Commonwealth of the Northern Mariana Islands (CNMI); Palmyra Atoll, Kingman Reef and Jarvis Island in the Line Archipelago; Baker and Howland Islands in the Phoenix Archipelago; and the islands of American Samoa (Appendix 2). Thus this plan encompasses migratory birds over a huge area, stretching across the north Pacific Ocean from California to the Mariana Islands and south of the equator to American Samoa - a distance of approximately 5,000 miles from east to west and 4,000 miles from north to south (Figure 1). Included are exposed coastlines, coastal bays, estuaries, coastal marshes, coral reefs, and offshore islands, rocks, and sea stacks of the three west coast states and the U.S. Pacific Islands (USPI).

The Plan includes species of the Orders Procellariiformes, Pelecaniformes and Charadriiformes (suborders Lari and Alcae) that breed on oceanic islands or along continental coastlines and exploit the marine and estuarine environments. Loons, grebes, sea ducks, and shorebirds are not included. The Plan also does not cover inland nesting "seabirds" such as White Pelicans[3] or Black Terns, nor does it include the inland breeding segments of wide-spread species such as Double-crested Cormorants.

Six species/subspecies are listed under ESA: Short-tailed Albatross, Hawaiian Petrel, Newell's Shearwater, California Brown Pelican, California Least Tern and Marbled Murrelet. The Service's Division of Endangered Species has primary responsibility for these species. ESA listed species are covered in this plan but readers are directed to the respective Recovery Plans[4] for a more in-depth discussion of the ecology, conservation, recovery goals, and priorities for these species. Short-tailed Albatross were listed in the U.S. in 2000 and a recovery plan is in development.

[3] Scientific names used in this plan are listed in Appendix 5

[4] USFWS 1980, USFWS 1983a, USFWS 1983b, USFWS 1997

Seabird Overview

Sixty species of seabirds representing three Orders and ten Families, nest in the Region: three albatross,[5] six petrels, four shearwaters, seven storm-petrels, three cormorants, one pelican, two frigatebirds, three boobies, two tropicbirds, five gulls, twelve terns, three noddies, one skimmer, one murre, one guillemot, three murrelets, two auklets and one puffin (Table 1). Many of these populations are of global or national importance (Appendix 3). For example, the entire world populations of Hawaiian Petrels and Newell's Shearwaters, and over 95% of the world's Laysan and Black-footed Albatross nest in the Hawaiian archipelago. Most of the world's Ashy Storm-Petrels, Western Gulls, and Brandt's Cormorants nest along the U.S. west coast. For 27 species, this Region supports the entire U.S. population; this includes many of the central Pacific albatrosses, petrels, storm-petrels, shearwaters, frigatebirds and noddies. This group also includes Black Storm-Petrels, Elegant Terns and Xantus's Murrelets that nest in Mexico and California.

In addition to the breeding seabirds, millions of seabirds representing more than 100 different species migrate to or through the waters of this Region. The exact number of birds that utilize this area is unknown, even in the relatively well studied waters off California, Oregon and Washington. Estimates of 5.5 - 6 million birds off California and 1.8 million birds off Oregon and Washington, representing more than 100 species, were generated from at-sea surveys conducted during 1975-1990.[6] Surveys around the Hawaiian Islands during the summer and fall of 2002, documented 40 different species; 20 local breeders and 20 migrant species.[7] These visiting birds have wide biogeographic affinities including species that nest inland and move to the coast during the winter and birds that breed elsewhere in the north and south Pacific. Numerically the most abundant seabird off the California coast is the Sooty Shearwater, a southern hemisphere breeder that migrates to the north Pacific during the austral winter.[8] Several other southern hemisphere seabirds (*e.g.,* Short-tailed and Pink-footed Shearwaters) also migrate to or through this area. Northern nesting species such as Northern Fulmars and Black-legged Kittiwakes migrate south into the Region during the winter.

Seabirds are often grouped in relation to their basic foraging ecology: coastal, neritic or pelagic. Coastal seabirds rarely range far from land, foraging in marine, estuarine, freshwater, and sometimes even terrestrial habitats, and most return to land to roost at night. Pelicans, cormorants, and most temperate terns and gulls are considered coastal birds. Several of these species (*e.g.,* Double-crested Cormorants and California Gulls) have broad distributions that range far inland and segments of their populations may never encounter the ocean. Neritic species such as the alcids, usually occur over the continental shelf and typically remain at sea at night when not breeding. Pelagic species include the albatrosses, petrels, and many tropical terns that are strictly marine, ranging far out to sea and returning to land only to breed.

About 98% of all seabird species typically nest in colonies.[9] While individuals from many species might occasionally nest solitarily, the Marbled Murrelet is the only species in the Region that does so consistently. Small predator-free islands in the Region (*e.g.,* Laysan Is.) can support millions of breeding birds, representing 15 or more species.

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[5] Short-tailed, Black-footed, and Laysan Albatross all nest at Midway Atoll. Short-tailed Albatross have laid eggs but there is no documentation that these eggs hatched. Accounts of chicks fledging in the 1950s/60s have not been substantiated.

[6] Briggs *et al*. 1987a, Briggs *et al*. 1992

[7] Ballance *et al*. 2004

[8] Tyler *et al.* 1993

[9] Furness and Monaghan 1987

Table 1. Breeding Seabirds of the Coastal USFWS Pacific Region and Distribution by State.[1]

Scientific Name	Common Name	WA	OR	CA	HI	USPI
Order PROCELLARIIFORMES						
Family DIOMEDEIDAE						
Phoebastria albatrus	Short-tailed Albatross				b	
Phoebastria nigripes	Black-footed Albatross				B	B
Phoebastria immutabilis	Laysan Albatross				B	B
Family PROCELLARIIDAE						
Pterodroma sandwichensis	Hawaiian Petrel				B	
Pterodroma arminjoniana	Herald Petrel					B
Pterodroma rostrata	Tahiti Petrel					B
Pterodroma hypoleuca	Bonin Petrel				B	B
Pterodroma alba	Phoenix Petrel					Ex
Bulweria bulwerii	Bulwer's Petrel				B	B
Puffinus pacificus	Wedge-tailed Shearwater				B	B
Puffinus nativitatis	Christmas Shearwater				B	B
Puffinus auricularis newelli	Newell's Shearwater				B	
Puffinus lherminieri	Audubon's Shearwater					B
Family HYDROBATIDAE						
Oceanodroma furcata	Fork-tailed Storm-Petrel	B	B	B		
Oceanodroma leucorhoa	Leach's Storm-Petrel	B	B	B		
Oceanodroma homochroa	Ashy Storm-Petrel			B		
Oceanodroma castro	Band-rumped Storm-Petrel				B	
Oceanodroma melania	Black Storm-Petrel			B		
Oceanodroma tristrami	Tristram's Storm-Petrel				B	
Nesofregetta fuliginosa	Polynesian Storm-Petrel					B
Order PELECANIFORMES						
Suborder PHAETHONTES						
Family PHAETHONTIDAE						
Phaethon lepturus	White-tailed Tropicbird				B	B
Phaethon rubricauda	Red-tailed Tropicbird				B	B
Suborder PELECANI						
Family SULIDAE						
Sula dactylatra	Masked Booby				B	B
Sula leucogaster	Brown Booby				B	B
Sula sula	Red-footed Booby				B	B
Family PELECANIDAE						
Pelecanus occidentalis	Brown Pelican			B		

Table 1. Breeding Seabirds of the USFWS Pacific Region and Distribution by State (continued).

Scientific Name	Common Name	WA	OR	CA	HI	USPI
Family PHALACROCORACIDAE						
Phalacrocorax auritus	Double-crested Cormorant	B	B	B		
Phalacrocorax penicillatus	Brandt's Cormorant	B	B	B		
Phalacrocorax pelagicus	Pelagic Cormorant	B	B	B		
Family FREGATIDAE						
Fregata minor	Great Frigatebird				B	B
Fregata ariel	Lesser Frigatebird					B
Order CHARADRIIFORMES						
Suborder LARI						
Family LARIDAE						
Larus delawarensis	Ring-billed Gull	B	B			
Larus californicus	California Gull			B		
Larus occidentalis	Western Gull	B	B	B		
Larus glaucescens	Glaucous-winged Gull	B	B			
Larus heermanni	Heermann's Gull			B		
Sterna nilotica	Gull-billed Tern			B		
Sterna caspia	Caspian Tern	B	B	B		
Sterna maxima	Royal Tern			B		
Sterna elegans	Elegant Tern			B		
Sterna paradisaea	Arctic Tern	B				
Sterna forsteri	Forster's Tern			B		
Sterna albifrons	Little Tern				B	B
Sterna antillarum	Least Tern			B		
Sterna lunata	Gray-backed Tern				B	B
Sterna anaethetus	Bridled Tern					B?
Sterna fuscata	Sooty Tern				B	B
Anous stolidus	Brown Noddy				B	B
Anous minutus	Black Noddy				B	B
Procelsterna cerulea	Blue-gray Noddy				B	B
Gygis alba	White Tern				B	B
Rynchops niger	Black Skimmer			B		
Suborder ALCAE						
Family ALCIDAE						
Uria aalge	Common Murre	B	B	B		
Cepphus columba	Pigeon Guillemot	B	B	B		
Brachyramphus marmoratus	Marbled Murrelet	B	B	B		
Synthliboramphus hypoleucus	Xantus's Murrelet			B		
Synthliboramphus antiquus	Ancient Murrelet	B				
Ptychoramphus aleuticus	Cassin's Auklet	B	B	B		
Cerorhinca monocerata	Rhinoceros Auklet	B	B	B		
Fratercula cirrhata	Tufted Puffin	B	B	B		

B = Breeding; b = unsuccessful breeding attempts; B? = breeding suspected; Ex = extirpated breeders

[1] Only the coastal portions of seabird breeding populations are represented.

Seabirds are long-lived, with delayed maturity, low fecundity and high adult survival.[10] They are almost invariably monogamous with relatively high rates of mate retention.[11] Clutch sizes typically are small, with most neritic and pelagic species laying only one large egg. Coastal seabirds tend to have larger clutch sizes, with temperate gulls and terns laying 2-3 eggs and cormorants averaging 3-4 eggs.[12] Both adults participate in incubation and the period of chick rearing can be quite extended compared to other birds (six weeks for Caspian Terns and six months for Laysan and Black-footed Albatross). Frigatebirds have the longest post-fledging parental care period of any species of bird with adults continuing to feed young up to a year after fledging.[13]

Seabirds spend most of their lives in the marine environment. Laysan Albatross young remain at sea for 3-4 years before returning to land to find a mate.[14] Sooty Tern chicks go to sea for 2-5 years before they return to the nesting islands, and they spend most of this time "on the wing", because they quickly become waterlogged if they sit on the water. In contrast, cormorants and Brown Pelicans have wettable feathers, and they return to land daily to roost and dry their plumage. Coastal species will often return to land several times a day during the breeding season to feed a chick or relieve a mate incubating an egg. More pelagic species can be gone for days or weeks. At the Farallon Islands, Brandt's Cormorants have a mean incubation shift of approximately 5 hours[15] while at Midway Atoll, male Laysan Albatrosses incubate the egg for an average of 22-23 days during their first shift.[16]

Seabirds obtain their food from the ocean and they forage on a variety of marine organisms. They employ a variety of methods to obtain food including diving (propelled by wings or feet), plunging, plunge-diving (plunging coupled with active underwater pursuit), aerial capture (*e.g.,* flyingfish), dipping, pattering, skimming, surface-seizing, scavenging, and piracy. Plunge diving, aerial pursuit, and surface feeding are more common in the clear waters of the tropics while diving is more common in the turbid and productive waters farther north. Most seabirds feed on small fish, squid and the larger zooplankton such as euphausiids, copepods, and amphipods.

Pacific seabirds are a shared international resource. Foraging seabirds can spend considerable time in international waters or the territorial waters of other Pacific Rim nations. Birds breeding on islands in the California Current System (CCS) (Figure 2) may migrate or disperse after the breeding season, north to Canadian waters or south to Mexico, Central or South America. Many USPI birds forage far beyond the 200 mile U.S. Exclusive Economic Zone (EEZ). The most numerous seabird off the west coast of North America is the Sooty Shearwater; a southern hemisphere breeder.

Pacific Region seabirds face a range of threats at sea and on the colonies. Invasive (non-native) species, fishery bycatch, disturbance, pollution, and loss of habitat are the most serious issues.

The 60 species of seabirds breeding in this Region were classified according to regional conservation concern using the ranking system of the North American Waterbird Conservation Plan. The ranking process considers population size and trends, extent of the breeding and non-breeding distribution, and threats during the breeding and non-breeding seasons. In the *Waterbird Conservation for the Amercias: North American Waterbird Conservation Plan*, seabirds were classified at the larger scale of North and Central America, Caribbean, and USPI, however, regional population trends and threats can vary greatly, especially for seabirds that breed in both the Pacific and the Carribean. In this plan, conservation scores were assessed at the regional scales of the CCS and USPI (Tables 2 and 3). A more detailed description of the scoring and ranking process is presented in Kushlan *et al.* (2002).

Almost half (47%) of the seabird species breeding in the Region fall into the two highest categories of conservation concern: "Highly Imperiled" and

[10] Weimerskirch 2002

[11] Furness and Monaghan 1987

[12] Johnsgard 1993

[13] Nelson 1976

[14] Rice and Kenyon 1962b

[15] Boekelheide *et al.* 1990

[16] Fisher 1971

Figure 2, The West Coast of California, Oregon, and Washington with Key Features of Significance to Seabirds.

Table 2. Conservation Classification for Breeding Seabirds of the California Current System.

English Name	ESA/BCC Status [a]	Regional Conservation Category [b]
Ashy Storm-Petrel	BCC	Highly Imperiled
Marbled Murrelet	T	Highly Imperiled
Black Storm-Petrel		High Concern
California Brown Pelican	E	High Concern [c]
Pelagic Cormorant		High Concern
Elegant Tern	BCC	High Concern [d]
Western Gull-billed Tern	BCC	High Concern
California Least Tern	E	High Concern
Black Skimmer	BCC	High Concern
Xantus's Murrelet	P/BCC	High Concern
Cassin's Auklet	BCC-32	High Concern
Rhinoceros Auklet		High Concern
Brandt's Cormorant		Moderate
Heermann's Gull		Moderate
Caspian Tern	BCC-5	Moderate [d]
Forster's Tern		Moderate
Common Murre		Moderate
Pigeon Guillemot		Moderate
Ancient Murrelet		Moderate [e]
Tufted Puffin		Moderate
Leach's Storm-Petrel		Low
California Gull		Low
Western Gull		Low
Royal Tern		Low [e]
Arctic Tern		Low [e]
Fork-tailed Storm-Petrel		Currently Not at Risk
Double-crested Cormorant		Currently Not at Risk
Ring-billed Gull		Currently Not at Risk
Glaucous-winged Gull		Currently Not at Risk

[a] Federal Endangered Species Act or Birds of Conservation Concern Status: E=Endangered, T=Threatened, C=Candidate, P=Petitioned, BCC= Bird of Conservation Concern at the National or Regional scale (USFWS 2002), BCC-# = Bird of Conservation Concern in the Bird Conservation Region (BCR) indicated.

[b] Seabirds were ranked according to the process outlined in the North American Waterbird Conservation Plan (Kushlan *et al.* 2002).

[c] Brown Pelicans rank as Moderate but are upgraded to High Concern because of endangered status in the Region.

[d] Species rank as Low or Moderate Concern but are Birds of Conservation Concern in the Region or BCR and their category is upgraded due to extreme concentration of the population at a few colonies.

[e] Species rank as High or Moderate Concern but are downgraded because of limited occurrence in the Region.

Table 3. Conservation Classification for Breeding Seabirds of Hawai`i and U.S. Pacific Islands.

English Name	ESA/BCC Status [a]	Regional Conservation Category [b]
Hawaiian Petrel	E	Highly Imperiled
Tahiti Petrel	BCC	Highly Imperiled
Phoenix Petrel	BCC	Highly Imperiled
Newell's Shearwater	T	Highly Imperiled
Band-rumped Storm-Petrel	C/BCC	Highly Imperiled
Polynesian Storm-Petrel	BCC	Highly Imperiled
Short-tailed Albatross	E	High Concern
Laysan Albatross	BCC-5,67,68	High Concern
Black-Footed Albatross	BCC	High Concern
Herald Petrel	BCC-68	High Concern
Christmas Shearwater	BCC-67,68	High Concern
Audubon's Shearwater		High Concern
Tristram's Storm-Petrel	BCC	High Concern [c]
Lesser Frigatebird	BCC-68	High Concern
Blue-gray Noddy	BCC	High Concern
Bonin Petrel		Moderate
Bulwer's Petrel		Moderate
Red-tailed Tropicbird		Moderate
Masked Booby		Moderate
Brown Booby		Moderate
Great Frigatebird		Moderate
Little Tern		Moderate [d]
Gray-backed Tern		Moderate
Sooty Tern		Moderate
Black Noddy		Moderate
White Tern		Moderate
Wedge-tailed Shearwater		Low
White-tailed Tropicbird		Low
Bridled Tern		Low
Red-Footed Booby		Currently not at Risk
Brown Noddy		Currently not at Risk

[a] Federal Endangered Species Act or Birds of Conservation Concern Status: E=Endangered, T=Threatened, C=Candidate, P=Petitioned, BCC= Birds of Conservation Concern at the National or Regional scale (USFWS 2002), BCC-# = Birds of Conservation Concern in the Bird Conservation Region (BCR) indicated.

[b] Seabirds were ranked according to the process outlined in the North American Waterbird Conservation Plan (Kushlan *et al.* 2002).

[c] Species rank as Low or Moderate but are Birds of Conservation Concern in the Region or BCR and their category is upgraded due to extreme concentration of the population at a few colonies.

[d] Species rank as High or Moderate but are downgraded because of limited occurrence in the Region.

"High Concern" (Table 4). Procellariiformes have the highest representation (75% of 20 species), including all of the albatrosses. Alcids are also heavily represented (62% of 8 species). There are more high priority seabirds in the USPI (15 species) than in the CCS (12 species). This reflects the concentration of breeding birds on a smaller number of islands, the devastating impacts of invasive species, habitat degradation associated with human habitation of islands, and the impacts of commercial fisheries. In the CCS, oil and other contaminants, habitat loss, and interactions with fisheries are the primary factors that resulted in high conservation rankings.

For most seabirds, population recovery is slow because of life history traits such as delayed maturity and low fecundity. Annual declines in populations are often difficult to detect, but can have long-term consequences if left unchecked. Careful and precise monitoring to detect trends, resources to investigate the causes of population changes, and active management to stay or reverse declining trends are fundamental to seabird conservation.

Table 4. Summary by Family of Seabirds Breeding in USFWS Pacific Region that are Ranked High Concern or Highly Imperiled at the Regional Scale.

Family	Common Name	Number Breeding Species [a]	Number of Species Ranked High Conservation Concern [b]	% Ranked High Conservation Concern
Diomedeidae	albatrosses	3	3	100%
Procellariidae	petrels and shearwaters	10	7	70%
Hydrobatidae	storm-petrels	7	5	71%
subtotal	*Procellariiformes*	*20*	*15*	*75%*
Phaethontidae	tropicbirds	2	0	-
Sulidae	boobies	3	0	-
Pelecanidae	pelicans	1	1	100%
Phalacrocoracidae	cormorants	3	1	33%
Fregatidae	frigatebirds	2	1	50%
subtotal	*Pelecaniformes*	*11*	*3*	*27%*
Laridae	gulls, terns, skimmers	21	5	24%
Alcidae	murres, murrelets, auklets, puffins	8	5	62%
subtotal	*Charadriiformes*	*29*	*10*	*34%*
TOTAL		**60**	**28**	**47%**

[a] Includes extirpated breeders and unsuccessful breeders (*e.g.,* Short-tailed Albatross).

[b] Includes species regionally ranked 4: High Concern or 5: Highly Imperiled according to Colonial Waterbird scoring system (Kushlan *et al.* 2002).

Seabird Habitats

Seabirds spend most of their life at sea feeding on fish, squid and other invertebrates, but return to land to breed. Terrestrial and ocean habitats in this Region are described in the following sections. Nesting and roosting habitats along the Washington, Oregon, and California coasts are quite distinct from those found on the tropical and subtropical Pacific Islands, so each of these broad geographic areas is summarized separately, after the general discussion below.

Nesting and Roosting Habitat

Most seabirds nest directly on the ground, or underground in burrows and crevices, or on vegetation. Disturbance - and predator-free habitats are important determinants of successful breeding. More than 99% of the seabirds in the Region nest on islands. The intrinsic isolation of islands afford greater protection from disturbance and terrestrial predators. Historically, as human populations expanded, large islands were settled, often accompanied by the introduction of exotic plants and animals. Increased disturbance, habitat degradation, and predation associated with human habitation resulted in declines of seabird populations, range contractions, and colony extirpations. Today, relatively small islands[19] support the largest colonies and the majority of the breeding birds. Small islands are often uninhabited and free of mammalian predators such as rats, cats, dogs, foxes, racoons, and mongooses. The large, inhabited islands of the Region typically do not support correspondingly large seabird populations. However, these large islands do provide habitat for several species that nest nowhere else in the U.S., or in some cases the world (*e.g.,* Newell's Shearwaters and Hawaiian Petrels). Many of the seabird species restricted to these larger islands are listed or are candidates for listing under the ESA or BCC.[20]

Suitable nesting habitat is limited, but generally not a regulating mechanism for today's seabird populations. Seabirds nest in three strata: on the surface, underground, and above ground (Table 5). Each of these broad categories can be further divided. For example, storm-petrels nest under cover, but Black and Ashy Storm-Petrels typically nest in rocky crevices or among boulders, while Leach's and Tristram's Storm-Petrels typically excavate burrows in the soil. Surface nesters may prefer: 1) narrow ledges on steep cliffs (*e.g.,* Pelagic Cormorant), 2) broad ledges and flat tops of offshore islands (*e.g.,* Brandt's Cormorant and Common Murre), 3) the level surface of low, flat islands, either associated with vegetation (Laysan Albatross), or 4) barren areas generally devoid of vegetation (Black-footed Albatross and Caspian Tern). Many of the surface nesting species select nest sites associated with cover, such as under vegetation or man-made objects (*e.g.,* Christmas Shearwater and Xantus's Murrelet). Red-footed Boobies and frigatebirds prefer to nest on trees and shrubs, but will nest on the ground if vegetation is unavailable. Marbled Murrelets are the most specialized of the above-ground nesters, laying eggs on the branches of trees in old growth forests.

In the tropical Pacific, birds nest year-round and there is temporal segregation in the use of some breeding habitats. For example, Bonin Petrels and Wedge-tailed Shearwaters both nest in burrows, but the petrels breed in the winter/spring and the shearwaters in summer/fall. Late-fledging petrels are often forcibly ejected or killed by shearwaters returning to the burrows.

Roost sites are another essential habitat for many seabirds. Roosting allows birds to rest, preen and dry their plumage. Communal roosting may benefit social functions such as mate selection and facilitate finding prey. Many pelagic and neritic seabirds such

[19] Small islands are generally defined as <40ha (100ac) in the CCS area and <400ha (1,000ac) in the USPI.

[20] USFWS 2002

Table 5. Spatial Segregation of Seabird Nesting Habitat.

	Above Ground	On Surface			Below Surface	
	On Vegetation	**Under Vegetation**	**With Vegetation**	**Without Vegetation**	**Burrows**	**Cavities/Crevices**
Pacific Islands	Red-footed Booby Great Frigatebird Lesser Frigatebird Brown Noddy Black Noddy White Tern	Christmas Shearwater Phoenix Petrel Polynesian Storm-Petrel Newell's Shearwater Red-tailed Tropicbird	Laysan Albatross Brown Booby Red-footed Booby* Sooty Tern Blue-gray Noddy Brown Noddy	Black-footed Albatross Masked Booby Gray-backed Tern Little Tern Black Noddy* Brown Noddy* White Tern	Hawaiian Petrel Tahiti Petrel Herald Petrel Bonin Petrel Wedge-tailed Shearwater Polynesian Storm-Petrel Tristram's Storm-Petrel	Hawaiian Petrel Bulwer's Petrel Christmas Shearwater* Newell's Shearwater* Tristram's Storm-Petrel* Red-tailed Tropicbird*
California Current System	Brown Pelican Double-crested Cormorant Marbled Murrelet	Xantus's Murrelet	Brown Pelican Double-crested Cormorant Ring-billed Gull California Gull Western Gull Glaucous-winged Gull Gull-billed Tern Forster's Tern	Double-crested Cormorant Brandt's Cormorant Pelagic Cormorant Gull-billed Tern Caspian Tern Royal Tern Elegant Tern Arctic Tern Forster's Tern* Least Tern Black Skimmer Common Murre	Fork-tailed Storm-Petrel Leach's Storm-Petrel Ancient Murrelet Cassin's Auklet Rhinoceros Auklet Tufted Puffin	Fork-tailed Storm-Petrel Leach's Storm-Petrel* Ashy Storm-Petrel Band-rumped Storm-Petrel Black Storm-Petrel Pigeon Guillemot Xantus's Murrelet Ancient Murrelet Cassin's Auklet Rhinoceros Auklet* Tufted Puffin*

as albatrosses, petrels, Sooty Terns, and several alcids, return to land only during the breeding season and they roost at the colonies. Seabirds that feed closer to shore, return to land regularly to roost, both during the breeding and non-breeding seasons. Gulls, terns, and cormorants return to land frequently and roost sites are located both at and away from colonies. The plumage of some seabirds, such as pelicans and cormorants, is not waterproof; therefore, roosting on dry land is necessary for drying feathers.[21]

California Current System Terrestrial Habitats

The coastal and offshore areas of California, Oregon, and Washington provide a variety of roosting and nesting habitats, including islands, rocks, cliffs, headlands, beaches, estuaries, and man-made structures such as bridges, dikes, dredge spoil islands, jetties, navigation structures, and breakwaters. Loss and degradation of coastal habitat has been significant, especially of beaches and associated sand dunes, coastal marshes, and estuarine islands. The larger islands (*e.g.*, Channel Islands and San Juan Islands) have been significantly altered. Smaller offshore rocks and islands have also been affected, but due to their relative inaccessibility, they typically have not been degraded to the same degree as large islands or mainland and inshore habitats.

The mainland coast from Canada to Mexico stretches approximately 2,500 km,[22] or 11,600 km following coastal contours. If the thousands of offshore rocks and islands are included, the total tidal coastline is approximately 14,000 km. Estuaries provide important nesting and foraging habitat for cormorants, terns, and gulls. The largest estuaries are Puget Sound, WA; Columbia River Estuary, OR and WA; and San Francisco Bay, CA.

The largest colonies and the vast majority of breeding seabirds are found on small islands (<40 ha; <100ac). There are more than 15,000 small offshore rocks and islands strewn along this coast. Almost half of the seabirds in the CSS nest in Oregon, most within the Oregon Coast NWR Complex where the largest offshore island is <8ha (<20ac). The two largest colonies in California are at Farallon NWR (a complex of seven islands; the largest individual island is 26ha/65ac) and Castle Rock NWR in northern California (6ha/14ac). Small islands also support an impressive diversity of breeding species: the most species-rich seabird nesting island in the Region is Prince Island (16 ha/ 39 ac), off San Miguel Island in southern California.

Many of the larger islands (*e.g.,* Channel Islands, CA; San Juan Islands, WA; and other islands in Puget Sound, WA) support human habitation, some for thousands of years. Mammalian predators often occurred naturally and non-native predators and other invasive species were introduced. Habitats and ecology of larger islands were significantly altered by human activities: agricultural, residential, commercial, and military. Consequently, few of the large islands support large numbers of breeding seabirds and colonies are usually restricted to steep cliffs, sea caves, and other remote and relatively inaccessible areas. Smaller islets just off main islands often support larger numbers of breeding seabirds and greater species diversity.

Most of the islands utilized by seabirds are composed of rock, the result of tectonic or volcanic activity. Habitat features such as size, shape, height, composition, micro-habitat characteristics, distance from shore, distance to feeding areas, soil characteristics, and plant and animal communities determine seabird community structure and size. These rocky, offshore islands are the primary breeding habitat for the more pelagic seabirds (storm-petrels and alcids) and also Brown Pelicans, cormorants, and Western Gulls.

Included in the island category, but unique, are the low inshore islands and exposed sand bars of bays and estuaries. These islands form naturally when sediments fall out of suspension in the slower moving waters of an estuary. Much more dynamic in size and shape than the rocky, marine islands, these islands appear, disappear, and continually change shape in a naturally functioning ecosystem. Scoured by winter floods, they often have little or no vegetation and provide important nesting and roosting habitat for coastal species, especially

[21] Rijke 1970, Johnsgard 1993

[22] Values for coastline length differ considerably between sources. For the purposes of this report (unless otherwise noted) we used the values provided by NOAA Medium Resolution Digital Vector Shoreline, created by the Strategic Environmental Assessments (SEA) Division of NOAA's Office of Ocean Resources Conservation and Assessment.

gulls, terns, and Double-crested Cormorants. Human activities that alter natural hydrology (*e.g.*, channelization, hydro-electric dams, and dredging) have significantly degraded estuarine nesting and roosting habitat. On the other hand, islands created or enhanced by deposition of dredge spoils now provide important habitat. The largest Caspian Tern and Double-crested Cormorant colonies in the west are located at East Sand Island in the Columbia River Estuary[23] - a natural island enhanced with dredge spoils. Many species that historically nested along the coast on beaches, sand dunes and estuarine islands now nest on artificial habitats such as dredge-spoil islands, dikes, and wetland fill sites. Several of these species are federally listed under ESA (*i.e.*, California Least Tern), or are BCC (*e.g.*, Gull-billed, Caspian and Elegant Terns), or are state threatened/endangered species. These artificial sites usually require ongoing management to maintain an early seral stage.

The relatively inaccessible cliffs and headlands along the mainland coast and larger islands are another important habitat for seabirds in the CCS. It is difficult for humans or predators to access these sites, so disturbance and predation are low. Cormorants, crevice nesting alcids, and storm-petrels utilize this habitat. In a few locations, Double-crested Cormorants have established coastal colonies in trees, but cliffs constitute the most important natural habitat for this species along the mainland coast. Sea caves, especially on the larger Channel Islands, appear to be less accessible to predators and Xantus's Murrelets and Ashy Storm-Petrels are often found nesting in this habitat.

Finally, mature forests of the Pacific Northwest and central California are the primary breeding habitat for Marbled Murrelets. Loss of habitat to timber harvest resulted in significant isolation and declines in murrelet populations which ultimately led to the listing of these segments of the Marbled Murrelet population as threatened under ESA.

U.S. Pacific Islands Terrestrial Habitats

Spread over millions of square kilometers of ocean, the USPI comprise only 17,860 km^2 of dry land (Figure 1). The Hawaiian Islands account for more than 90% of this land area, and greater than 58% is attributable to the single island of Hawai`i ("Big Island").

The islands of the USPI can be classified into three types: high volcanic, low limestone, and raised limestone (see box). More than 99% of the land is located on the volcanic islands; however, most of the seabirds occur on the low, sandy islands or atolls that have remained uninhabited or nearly so. Human populations are concentrated on volcanic and raised limestone islands due to location, size, and water availability. The large inhabited islands have suffered the greatest habitat loss and degradation, although no Pacific island has escaped human alterations.

The low islands and atolls of the central, equatorial Pacific are extremely isolated and fall into two broad categories: forested and non-forested. Rose and Palmyra atolls, located south and north of the equator, respectively, receive large amounts of rainfall and are densely forested. Arboreal species such as Red-footed Boobies, Great Frigatebirds, and Black Noddies flourish in these habitats. The largest Black Noddy colony in the Central Pacific and one of the largest Red-footed Booby colonies

Types of islands in the USPI

Type I: Volcanic islands rising from the seafloor, often to high elevations that intercept tropical moisture to create a variety of habitats including dense forests, *e.g.,* the main islands of Hawai`i and American Samoa (also referred to as "high islands" or "main islands").

Type II: Low limestone/coralline islands usually truncated volcanoes fringed with coral, forming isolated islands or atolls. These islands typically have limited habitat diversity, little fresh water, and several have lagoons, *e.g.,* the Northwestern Hawaiian Islands and U.S. possessions in the Line and Phoenix archipelagos.

Type III: Raised limestone islands ancient coral reefs pushed above sea level by tectonic movements. These islands generally consist of uplifted, flat terraces separated by steep cliffs. They support numerous caves and cliffs, *e.g.,* Guam and the southern Mariana Islands, CNMI.

[23] Wires and Cuthbert 2000, Shuford and Craig 2002

are located on Palmyra Atoll. Red-footed Boobies and Great Frigatebirds nest in high densities at Rose Atoll. The non-forested, tropical islands receive little rainfall and are vegetated with grasses, forbs, shrubs and some low-stature trees (*e.g.,* tree heliotrope). Surface nesting species predominate on these islands and some of the largest Sooty Tern colonies in the world are found at Howland, Baker, and Jarvis islands.

Farther north, the subtropical low islands and atolls of the Northwestern Hawaiian Islands (NWHI) are typified by bunchgrass, shrubs, and short trees. Surface and burrow nesting species abound. More than 95% of the world's populations of Laysan and Black-footed Albatrosses and a significant proportion of the world's Bonin Petrels nest here. Sooty Terns are the most numerous breeding species with annual breeding populations estimated at more than 2.5 million birds. In a natural state, none of the NWHI are forested, although Laysan and Nihoa historically supported small groves of native palms and Laysan had native coast sandalwood. Ironwood trees were introduced to Midway Atoll in the early 1900s and large tracts of Midway's Sand Island are densely forested. White Terns and Black Noddies nest year-round in these trees, constituting the largest colonies in Hawai`i.

The high "main" islands of the Hawaiian Islands and American Samoa have been greatly altered by human habitation beginning with the earliest Polynesians. At one time, these islands supported large and diverse populations of nesting seabirds. Today many of the seabirds nest on the smaller rocks and islets off the main islands that are relatively free from disturbance and predators. However, the main islands are still the primary nesting area for several species of petrels (Hawaiian, Tahiti, and Herald's), shearwaters (Audubon and Newell's) and Band-rumped Storm-Petrels, that do not nest on low islands. These species are now restricted to steep, densely forested mountain valleys or high elevations. All of these species are threatened by predators and habitat degradation. The Hawaiian Petrel, once the most abundant seabird on the main Hawaiian Islands, nested from sea level to the mountain tops, but is now endangered, with small colonies at high elevations.

The Mariana archipelago is situated at the northern end of Micronesia. The total land area is 1,119 km^2, with one island, Guam, accounting for approximately half (550 km^2) of the total land area. The southern six islands of Guam, Rota, Aguijan, Tinian, Saipan, and Farallon de Medinilla are raised limestone islands while the northern islands are volcanic. All of the raised limestone islands are inhabited, except Farallon de Medinilla which is used by the military as a bombing range. Like the main Hawaiian Islands, the southern Marianas have been extensively altered by humans and support a wide array of introduced predators. The northern islands receive little rainfall and are largely barren, but they do provide habitat for surface nesting species, especially Sooty Terns. Seabird populations in the archipelago are relatively small (~265,000 birds) but are significant for Micronesia. The largest islands, Guam, Rota, Saipan and Tinian are inhabited and support less than 4% of the breeding birds; most of these birds nest on Naftan Rock, an islet off Saipan. Except for a few Wedge-tailed Shearwaters, the islands are devoid of burrowing seabirds and surface nesting species predominate.

Habitat Protection

With notable exceptions, most of the important seabird nesting habitat in the CCS and USPI, that remains today has some type of protected status. Many are managed by state or federal agencies as NWRs, National Parks (NPs), National Monuments, or state parks, reserves, and sanctuaries. Non-governmental organizations (NGOs) such as The Nature Conservancy (TNC) own lands and work with the Service (*e.g.*, at Palmyra Atoll) or the National Park Service (NPS) (*e.g.*, at Santa Cruz Is., CA) to manage these areas. Most of the NWRs referenced in this Plan were created specifically to protect seabirds (*e.g.,* Three Arch Rocks, OR). Seabird conservation may or may not be the primary management objective for other federal, state or privately managed areas.

The National Wildlife Refuge System (NWRS) encompasses many important seabird colonies along the west coast. In Washington, all but two of the 600 or more islands, rocks, sea stacks, and reefs along the outer coast are encompassed by the Washington Island NWR Complex. The largest seabird colonies in Puget Sound and the Straits of Juan de Fuca are also NWRs. In Oregon, all of the 1400 marine rocks, reefs, and islands (except Chief's Island) are encompassed within the NWRS. In California, the two largest seabird colonies (Farallon Islands and Castle Rock, in northern California) are NWRs. The Bureau of Land Management (BLM) oversees the California Coastal National Monument which includes thousands of rocks and islands off California. NPS manages the Channel Islands NP,

Point Reyes National Seashore, and Golden Gate National Recreation Area. State Parks, reserves, and sanctuaries encompass seabird colonies in all three states. Some of these state lands, such as Año Nuevo Is., CA, are managed for seabird and pinnipeds but often seabird conservation is not the primary goal of these areas. Habitat loss at southern California sandy beaches is high, and there is little protection. The land may be public domain (*e.g.,* public beaches) but human use and disturbance are high.

In the USPI, the largest seabird colonies and the vast majority of breeding seabirds nest on NWRs. The NPS manages large parks on the high islands of American Samoa and the Hawaiian Islands that support key seabird colonies. The NP of American Samoa includes two rainforest preserves on Ta`u and Tutuila where petrels and shearwaters nest. in the Hawaiian Islands, Haleakala, Hawai`i Volcanoes, and Kalaupapa NPs support endangered Hawaiian Petrels, Band-rumped Storm-Petrels and other seabirds. Kure Atoll and islets offshore of the main Hawaiian Islands are managed by the State of Hawai`i, Department of Land and Natural Resources as seabird sanctuaries. In the Mariana Islands, the three islands of Maug are managed as a Bird Reserve by the CNMI.

Conservation and management of seabirds is not a primary goal of the U.S. Department of Defense, however, due to land management practices and public access restrictions, they often support important seabird colonies, especially bases located in areas of heavy urban development (*e.g.,* southern California). Military bases have Integrated Natural Resource Management Plans and according to these plans engage in numerous activities to benefit seabirds. The Service works with the military and other federal, state, county, and city agencies and private citizens to protect and restore habitats important to seabirds.

National Marine Sanctuaries, Marine Protected Areas, and other state and federal designations provide for the management of water and other marine resources in and around seabird colonies and they can provide protection to seabirds by limiting human disturbance, maintaining ecosystem functions (*e.g.,* foraging opportunities), and minimizing negative seabird fisheries interactions. The role of marine protected areas in ocean management is growing and could be of great benefit to seabird conservation.

Ocean Habitats and Seabirds At Sea

Seabirds derive their food from the sea and their distribution at sea is influenced by oceanographic and biological processes operating at various temporal and spatial scales. Understanding the fundamental processes affecting ocean habitats is important to the conservation of seabirds.

The ocean appears deceptively homogeneous, but in reality is composed of distinct, interacting habitats. The dominant circulation pattern of the North Pacific Ocean is the clockwise North Pacific Subtropical Gyre[24] (Figure 3). As the North Pacific and the Subarctic currents approach North America, the flow diverges with one branch flowing to the north while the other turns southeast, parallel to the coastline, forming the California Current. At the center of the gyre, the warm salty surface waters of the North Pacific Central Water are among the least productive of the ocean,[25] whereas the California Current System is known for its diverse and abundant marine communities. In general, highly productive coastal regions sustain greater overall seabird densities than less productive pelagic waters.[26] Greater numbers of diving seabirds are found in coastal areas along the west coast (*e.g.,* murres, auklets, puffins and cormorants); while areas of lower ocean productivity in the equatorial Pacific sustain less diverse and abundant seabird communities that feed by surface-picking and plunging.[27]

Ocean habitats are dynamic - changing in size, shape, magnitude and even location through time as water masses of varying temperature, salinity and/or velocity converge and diverge. Some habitats, such as the edges of major currents (*e.g.,* California and Equatorial currents), are relatively predictable and persistent, but others are unpredictable and ephemeral. Dynamic ocean habitats are also formed

[24] Gyre: circular motion

[25] Seki and Polovina 2001

[26] Ashmole 1971, Briggs *et al.* 1987a, Ballance *et al.* 1997

[27] Ainley 1977, Ballance *et al.* 1997, Spear *et al.* 2001

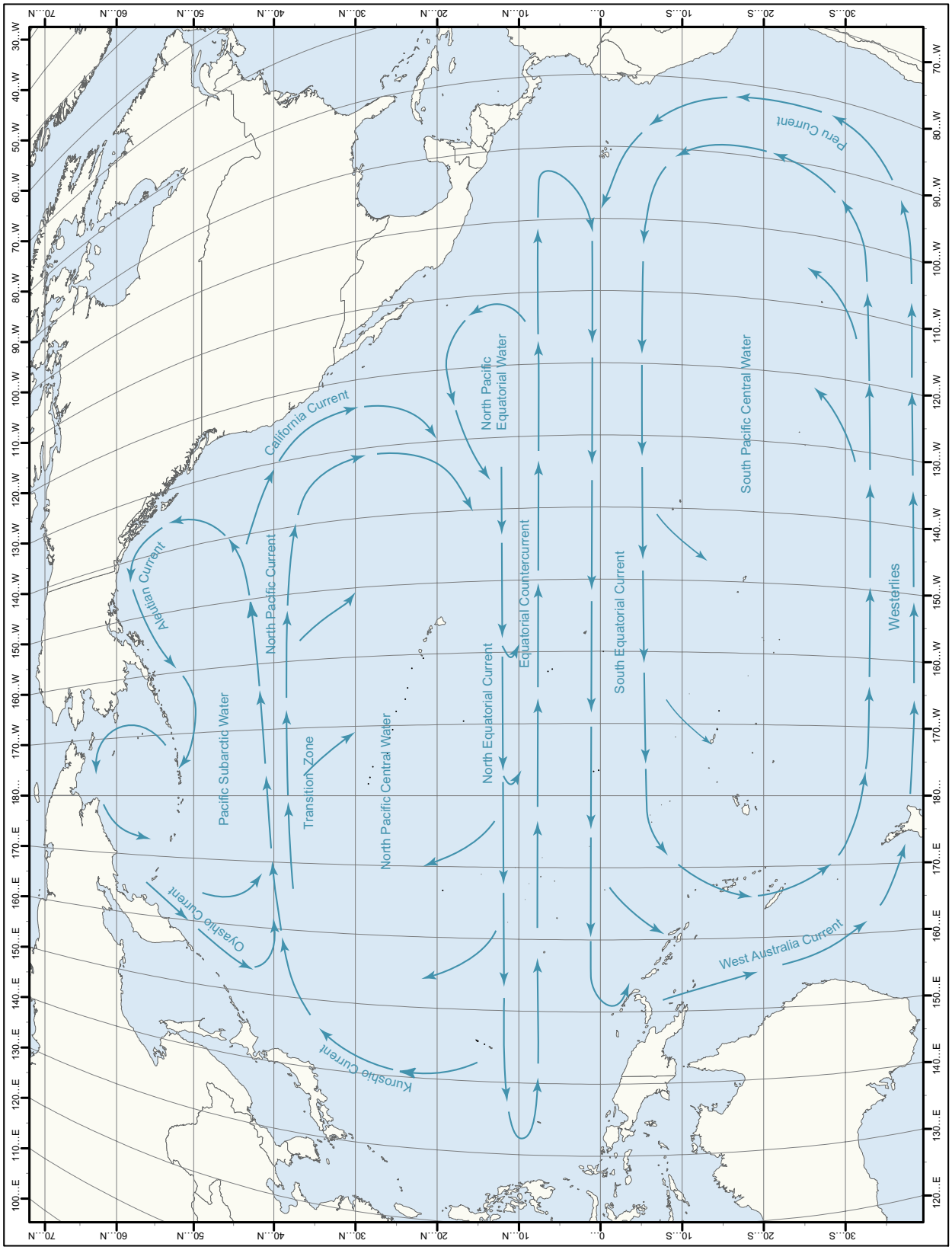

Figure 3. Diagram of Major Currents of the North Pacific Ocean. (adapted from King et al. 1967)

when water interacts with static features such as an irregular coastline or topography of the ocean floor (*e.g.,* continental shelves or seamounts). Along the west coast, the continental shelf is relatively shallow (<100 m). At the continental shelf break and slope, water depth increases from about 100 m to 2000 m. Along the outer continental shelf, a front often appears due to the transition from colder, less saline coastal waters to the warmer and saltier offshore waters; this convergence results in concentration of prey and wind stress can lead to localized upwelling along the shelf break.

Shelf break/slope fronts and convergences, eddies, and upwellings are important habitats for seabirds due to physical processes that promote productivity and/or concentrate prey. Many species of alcids (*e.g.,* Common Murres, auklets) and shearwaters forage within the shelf break/slope convergences.[29] Moreover, the shelf break/slope habitat is a complex region interspersed with submarine canyons, tables, sills and seamounts. Upwelling can be enhanced by an order of magnitude in the vicinity of submarine canyons[30] and the increased abundance of seabirds foraging in the vicinity of seamounts and canyons is likely a result of processes that promote the aggregation of macro-zooplankton and fish.[31]

In the central Pacific Ocean, there is no continental shelf, but islands, seamounts and even shallow reefs create localized upwelling and convergence fronts throughout the region.[32] Shallow waters are limited in this open ocean/island ecosystem and seabirds in the tropics are much more pelagic than those in temperate areas.

California Current System. The CCS is a complex and extremely productive system of currents, counter currents, undercurrents and other oceanographic processes such as upwelling, that supports millions of breeding and migrant seabirds. Surface flow along the coast (north of Pt. Conception) is generally northward during winter, but during the spring there is a dramatic reversal, or "spring transition", as the current shifts to predominantly southward.[33] Upwelling of cold, nutrient-rich waters along the coast is greatest in spring and summer, coincident with seabird breeding seasons. The irregular coastline, ocean floor topography and climate variability all contribute to spatial and temporal variability in the system (*e.g.,* changes in upwelling intensity, formation of eddies and jets).

Within the CCS, the greatest seabird concentrations occur over the continental shelf, with moderate productivity over the shelf break/slope, and lowest productivity in offshore waters >2000 m deep.[34] The high abundance of prey over the continental shelf attracts millions of seabirds that breed, winter, or migrate through this region annually.[35] Gulls, murres, auklets, and shearwaters are the most abundant seabirds in the CCS. The coastal avifauna is comprised of locally breeding species such as Common Murres, Brandt's Cormorants, and Cassin's Auklets, but Sooty Shearwaters (migrants from the southern hemisphere) are numerically dominant during most of each year. Seabird diversity and biomass are greatest during late spring and fall migration. Overall, seabird density and diversity are lower in the winter, when birds in offshore waters are mainly local breeders or visitors from northern and inland colonies (*e.g.,* kittiwakes, California and Herring Gulls). Beyond the shelf and slope region, *Pterodroma* petrels and Leach's Storm-Petrels are the numerically dominant species.

The Southern California Bight[36] is the recessed coastline between Pt. Conception, CA and Cabo Colnett, MX (Figure 2). The dramatic indentation of the coastline creates a large backwater eddy - a transition zone between warm equatorial waters and the cold subarctic waters of the California Current. This dynamic ecotone delineates the nesting ranges of many subarctic and subtropical marine bird species, *e.g.,* the southern extent of the nesting range for Pigeon Guillemots and Pelagic Cormorants and the northern extent for Black Storm-Petrels, Brown Pelicans, and

[29] Oedekoven *et al.* 2001
[30] Hickey and Royer 2001
[31] Hunt 1991
[32] Mann and Lazier 1996
[33] Hickey and Royer 2001
[34] Tyler *et al.* 1993
[35] Ainley 1976, Briggs *et al.* 1987a, Tyler *et al.* 1993
[36] A "bight" is defined as a bend in the coastline.

Xantus's Murrelets.[37] However, this region is also characterized by substantial seasonal, interannual and interdecadal variability in oceanographic conditions that may lead to changes in the seabird community structure. For example, there are relatively more subtropical taxa found in this region under warm ocean conditions (*e.g.,* Heerman's Gulls, Black-vented Shearwaters, and Black and Least Storm-Petrels) compared to cooler periods.[38]

North Pacific Central Water, Transition Zone, and the Equatorial Pacific. The North Pacific central water is in the center of the subtropical gyre. Hawai`i is located in this region. Compared to the highly productive waters of the CCS, the warm, salty waters of this area are biologically impoverished. Most seabirds here are associated with schools of predatory fish (especially tunas) that drive prey to the surface making it available to seabirds.[39] Further south, the clear, warm waters of the tropics are also characterized by low productivity in the surface waters. Along the equator, however, the oceanographic system is more dynamic with Equatorial upwelling. Another feature is the Equatorial Front where surface waters between the South Equatorial Current and the North Equatorial Countercurrent converge.[40] Planktivorous seabirds such as storm-petrels concentrate in the area of the Equatorial Front, but piscivorous seabirds do not.[41] Here, as elsewhere in the tropical Pacific, the distribution of piscivorous seabirds is tied to the distribution of schooling tunas.

The transition zone between the North Pacific Central Water and the Pacific Subarctic Water is an area of enhanced productivity in the open ocean.[42] This broad region is characterized by a series of fronts where the cooler, nutrient rich subarctic water sinks below the warmer, more saline subtropical water.[43] These fronts support high concentrations of small squids, fishes and crustaceans during spring and summer, creating important feeding grounds for seabirds and other top marine predators.[44]

Large Scale Ocean/Climate Processes

El Niño, La Niña, the Southern Oscillation, and Currents. El Niño and La Niña are linked via changes in global pressure systems of the southwestern Pacific Ocean (Southern Oscillation). The connection of El Niño with the Southern Oscillation has led to the acronym, ENSO. Declines and increases in zooplankton, squid and fish populations that compose the food webs of most seabirds in the Pacific Ocean can be linked directly to physical oceanographic changes that occur during ENSO events. Under El Niño conditions (periodic, every 4-7 years, ocean warming), biological productivity in the upper water column declines markedly,[45] with consequent negative effects on survival and reproduction of seabirds.[46] The inverse of El Niño is La Niña (periodic, ocean cooling). During La Niña, enhanced upwelling has positive effects on food web development and seabird productivity and population dynamics.

ENSO has been linked to the population dynamics of seabirds[47] suggesting an important natural mechanism for understanding seabird population changes. Seabird responses can vary in relation to the intensity and timing of each El Niño.[48] Life history and demographic parameters affected by El Niño and La Niña include reproductive success, adult mortality, mortality of hatch-year birds, colony attendance, and breeding effort.[49] The El Niño of 1982-1983 dramatically focused attention on the effects of ENSO on biological communities

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[37] Hunt *et al.* 1980

[38] Hyrenbach and Veit 2003

[39] Au and Pitman 1986; Ballance and Pitman 1999

[40] Barber 2001, Spear *et al.* 2001

[41] Spear *et al.* 2001

[42] Seki and Polovina 2001

[43] Hyrenbach *et al.* 2002

[44] Seki and Polovina 2001, Hyrenbach *et al.* 2002

[45] Barber and Chavez 1986

[46] Ainley *et al.* 1995, Chavez 1996

[47] *e.g.,* Schreiber and Schreiber 1984

[48] PRBO unpubl. data

[49] Hodder and Graybill 1985, Bayer *et al.* 1991, Wilson 1991, Boekelheide and Ainley 1989, Nur and Sydeman 1999, Massey *et al.* 1992

worldwide.[50] Along the west coast, sea surface temperatures rose and mass mortality of many temperate region fish, marine birds and mammal species occurred.[51] Starvation is the likely cause of elevated mortality of young and adults, but direct evidence of this mechanism is often lacking. Researchers investigating tropical seabirds, have also documented decreases in breeding probabilities and reproductive success of seabirds during El Niño years, at specific colonies.[52]

In contrast, strong La Niña years may result in exceptional production which can sustain seabird populations for decades.[53] It is important to note that generalizations regarding the effects of ENSO on seabirds, especially in the tropical Pacific are based on data for specific species nesting at a few well studied colonies. More data from various species and locations throughout the central Pacific are needed to fully understand the effects.

Pacific Decadal Oscillation. In addition to ENSO/LNSO there are other natural cycles that occur on time scales of decades or centuries.[54] In the North Pacific, one of these "low frequency" marine climate shifts is called the Pacific Decadal Oscillation (PDO). The PDO is "an El Niño-like phenomenon operating on time scales of decades" comprised of a 50-60 year periodicity of "warm" and "cold" phases.[55]

Biological communities have responded to PDO-related ocean warming and cooling in the Pacific Ocean. For example, zooplankton biovolume in the Southern California Bight has declined significantly over the past 40 years.[56] In California and Hawai`i, some seabirds showed long-term declines in productivity while others did not after the PDO shifted from a cool to a warm phase in 1976-1977.[57] However, after a hypothesized shift back to a cool era in 1998-1999, colony data from the Farallon Islands clearly demonstrated an increase in productivity for six species of seabird.[58] In the central north Pacific, increases in ocean productivity following the 1977 shift correlated with increases in reproductive success of Red-tailed Tropicbirds and Red-footed Boobies in Hawai`i.[59]

An increased understanding of the fundamental processes affecting the ocean habitats and food webs of seabirds is key to effective management and sound conservation decisions for seabirds. The manner in which year-to-year and decade-to-decade (or possibly century- to-century), changes in ocean characteristics affect ocean habitats, foraging ecology and demographic processes will require great attention in the next decade. Functional relationships between seabird life history parameters, demographic traits, and environmental conditions have rarely been documented,[60] yet knowledge of such relationships is critical to understanding causes of seabird population fluctuations in relation to climate variability and change. The need to both interpret population change and enact appropriate conservation actions in relation to climate variability and change will likely expand in the future. For example, coupling of natural warming cycles of the PDO and El Niño with anthropogenic changes such as global warming could have devastating effects on seabirds. Developing an understanding of the relative effects of anthropogenic and natural factors on ocean warming at multiple temporal scales remains a serious conservation challenge.

[50] reviewed by Glynn 1988

[51] Wooster and Fluharty 1985

[52] Schreiber and Schreiber 1989, Ainley *et al.* 1986, Polovina *et al.* 1994

[53] Nur and Sydeman 1999

[54] Aebischer *et al.* 1990

[55] Francis and Hare 1994, Mantua *et al.* 1997

[56] Roemmich and McGowan 1995, Hayward 1997

[57] Polovina *et al.* 1994, Sydeman *et al.* 2001

[58] Schwing *et al.* 2002

[59] Polovina *et al.* 1994

[60] reviewed by Hamer *et al.* 2002, Weimerskirch 2002

Threats and Issues

Seabirds face a wide range of threats. Some of these have existed for centuries, while others have developed more recently. Habitat loss, fisheries conflicts, oil spills, introduced species, contaminants, and human disturbance have long been recognized as threats, but as human populations and marine resource exploitation have increased, new threats have emerged.

Because of their low fecundity, seabirds are extremely vulnerable to factors that reduce survival, which is typically high compared to other birds. Small decreases in adult survival can result in population declines and hamper recovery. As a result, factors that increase seabird mortality or limit production can seriously jeopardize seabird populations, especially if population levels are already low. It is important, therefore, that threats be identified early, seabird populations be monitored appropriately, and negative impacts be detected quickly, so that actions can be taken.

Commercial and Recreational Fisheries

Fisheries target a diversity of sea life and use a variety of vessels and gear including: longlines, gillnets, trawls, purse seines, pots, throw and dip nets, hook and line, and harpoons. Seabirds are killed or injured when they are hooked or entangled in fishing gear. This occurs in all oceans and almost all fisheries and gear types; however, only particular fisheries pose a serious threat to certain species of seabirds. Gillnets and longlines kill the greatest number of seabirds in this Region.

Fishery observer programs are crucial for documenting seabird mortality and injury, but few exist, and there is little quantitative or qualitative information regarding seabird bycatch for most of the fisheries in the north Pacific. Seabird mortality has been documented in 10 of 84 fisheries that occur in this Region (Table 6), affecting a minimum of 20 species of seabirds.[61] Currently, observer programs monitor 8 of these 84 fisheries that operate from CCS and USPI ports, and only 4 of these programs are mandatory. Additionally, seabird bycatch occurs in many fisheries that operate in international waters and the Exclusive Economic Zones (EEZs) of other North Pacific nations, although there is little documentation for most areas.[62] Many seabirds are migratory and do not remain within U.S. waters, thereby necessitating international cooperation in resolving seabird-fishery conflicts.

It is more difficult to substantiate and quantify the indirect effects of fisheries, such as overfishing that could result in reduced abundance or availability of prey, or increased disturbance to seabirds on colonies or at foraging areas, or introduction of debris or contaminants into the marine environment. Not all fishery effects are negative, for example offal discarded from fishing vessels may enhance seabird feeding opportunities,[63] unfortunately, this also attracts seabirds to vessels and can lead to hooking or entanglement.[64] In the North Sea, fisheries targeting predatory fish resulted in more forage fish available to seabirds.[65]

[61] A database of U.S. fisheries that operate in the Region was compiled from NMFS and state sources (database available upon request). This database identified fisheries with documented seabird bycatch and those with high potential for problems.

[62] Melvin and Robertson 2000

[63] Camphuysen *et al.* 1995

[64] Wahl and Heinemann 1979, Moreno *et al.* 1996

[65] Furness 1982c

Table 6. Current U.S. Fisheries with Documented, or High Potential for, Seabird Bycatch in USFWS Pacific Region.

Fishery Name	Target Catch	Mgmt. Agency[1]	Seabird Species[2]	Notes
CA angel shark/halibut set gillnet	main target is halibut but few angel shark also taken	CDFG, NMFS	alcids, cormorants, loons, grebes COMU, BRAC, PECO, DCCO	Thousands of murres were killed annually in the 1980s, contributing to declines in the central California murre population. Recent regulations have closed areas of highest bycatch.
CA other species, large mesh, set and drift gillnet	white seabass and yellowtail	CDFG, NMFS	cormorants	
CA tuna with surface drift net	tuna	NMFS		Emerging fishery with high potential for bycatch of seabirds. Demersal seabass nets are being used at surface. Out of Morro Bay. During summer 2002-2003 NMFS observers noted zero seabird interactions.
WA Puget Sound Region salmon drift gillnet	salmon	WDFW, NMFS	COMU, RHAU, PIGU, MAMU	Research identified mitigation measures to reduce bycatch. WA state fishery bycatch greatly reduced when regulations requiring mitigation measures were enacted; Tribal fisheries continue with no mitigation regulations.
CA/OR thresher shark/ swordfish drift gillnet	thresher shark, swordfish	CDFG, ODFW NMFS	NOFU	Well observed fishery with very low rates of seabird bycatch.
HI pelagic longline	tuna, billfish, oceanic sharks, swordfish	HDAR, NMFS	BFAL, LAAL	High albatross mortality associated with this fishery; mortality decreased while swordfish fishing was banned in 2001-2004.
U.S. West Coast pelagic longline	Highly migratory species (HMS) -swordfish, tuna	NMFS	BFAL, LAAL	Fishery expanded in 2001 as HI fishers moved to CA with increased restrictions on the HI fishery (see HI pelagic longline). Preliminary observer results indicate high rate of BFAL bycatch until shallow setting that targeted swordfish was prohibited in 2004 & part of the fishery shifted back to HI with the lift of the swordfish ban .
WA, OR, CA groundfish trawl	groundfish (hake, flatfish, sablefish, lingcod, rockfish)	WDFW, ODFW, CDFG, NMFS	BFAL	Preliminary results indicate seabird bycatch as birds hit the gear.
WA, OR, CA, HI commercial passenger fishing vessel	various species	WDFW, ODFW, CDFG, NMFS, HDAR	BRPE, LETE, MAMU, CORM, RFBO, MABO, BRBO	Most entanglement of pelicans and boobies is in the hook-and-line troll fishery.
Recreational hook and line	various species	WDFW, ODFW, CDFG, NMFS, HDAR	BRPE	Most entanglement is of pelicans.

[1] Agencies: NMFS=National Marine Fisheries Service; CDFG=California Dept. of Fish & Game; ODFW=Oregon Dept. of Fish & Wildlife; WDFW=Washington Dept. of Fish & Wildlife; HDAR=Hawai`i Div. of Aquatic Resources.

[2] BFAL=Black-footed Albatross; BRAC=Brandt's Cormorant; BRBO = Brown Booby; BRPE=Brown Pelican; COMU=Common Murre; CORM=cormorant; DCCO=Double-crested Cormorant; LAAL=Laysan Albatross; LETE=Least Tern; MABO=Masked Booby; MAMU=Marbled Murrelet; NOFU=Northern Fulmar; PECO=Pelagic Cormorant; PIGU=Pigeon Guillemot; RFBO=Red-footed Booby; RHAU=Rhinoceros Auklet.

Direct Effects

Set and Drift Gillnets. Millions of seabirds of various species have been killed by set and drift gillnets. It is estimated that more than 500,000 seabirds, primarily shearwaters, were killed by the North Pacific high seas drift gillnet fishery in a single year, 1990[66], and this fishery operated for over a decade. Large numbers of Black-footed and Laysan Albatrosses were taken in the Japanese salmon and squid drift gillnet fishery, with almost 10,000 killed during 1990 in the squid driftnet fishery alone.[67] The North Pacific high seas drift gillnet fishery was internationally banned in 1992, in part, because of the high numbers of seabirds killed.[68]

Most of the seabirds that are killed in coastal gillnet fisheries are diving seabirds, in particular alcids, although cormorants are also commonly caught.[69] It is estimated that at least 70,000 Common Murres died in set gillnets targeting halibut off central California between 1979 and 1987.[70] Large population declines at central California murre colonies during the 1980s were attributed primarily to gillnet mortality, with El Niño effects and oil spills as contributing factors. Common Murre populations continued to suffer high gillnet mortality in the 1990s (1,000 - 3,000 killed annually), even though most of the fishery was closed in 1987 and 1989 (a small fishery remained in Monterey and Morro bays). This chronic mortality may have limited population growth for the murre colonies closest to the fishing area.[71] A recent law, changing the area and depth closures, is expected to essentially eliminate seabird bycatch in central California gillnet fisheries. There are unobserved set gillnet fisheries that operate in southern California.

Common Murres and Rhinoceros Auklets constituted the greatest portion of the bycatch mortality in coastal drift gillnet salmon fisheries in Puget Sound, WA, although Pigeon Guillemots and Marbled Murrelets, were also killed.[72] Thompson *et al.* (1998) estimated over 2,700 murres and 1,000 Rhinoceros Auklets were killed in 1994 alone in just a portion of the sockeye salmon fishery. Mortality of Rhinoceros Auklets in gillnets is suspected to be an important factor in population declines at Protection Island NWR colonies.[73] The coastal salmon gillnet fishery in the border waters has three governing entities: Canada, the state of Washington, and the Tribes. Each entity enforces different regulations underscoring the need for local, national, and international coordination. Seabird bycatch was reduced by up to 75% in the Puget Sound sockeye salmon gillnet fisheries by regulating the use of visible mesh panels and eliminating dawn fishing.[74] Local Tribes, however, did not adopt similar regulations, resulting in continued bycatch.

The thresher shark/swordfish drift gillnet fishery off California documented bycatch of fulmars, but the incidence and numbers of dead seabirds are very small (42 birds over a 10 year period).[75]

Pelagic and Demersal Longlines.[76] Longline fisheries world-wide pose a serious threat to many seabird populations and affect between 40-60 species of seabirds, predominantly Procellariiformes,[77] and particularly surface-feeding albatrosses. Birds are caught both during setting and retrieval of gear, with the highest mortality during setting.

Pelagic longlining, which targets mainly tuna and swordfish, kills thousands of seabirds annually.[78] This type of fishing increased after high seas drift

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[66] DeGange *et al.* 1993, Ogi *et al.* 1993

[67] Jones and DeGange 1988, Ogi *et al.* 1993, Yatsu *et al.* 1993

[68] Northridge 1991, DeGange *et al.* 1993, Johnson *et al.* 1993

[69] Julian and Beeson 1998, Melvin *et al.* 1999

[70] Takekawa *et al.* 1990

[71] Forney *et al.* 2001, Julian and Beeson 1998

[72] Melvin *et al.* 1999

[73] U. Wilson, USFWS, Washington Maritime NWR, pers. comm., 2003

[74] Melvin *et al.* 1999

[75] Julian and Beeson 1998

[76] Pelagic longlines fish in the water column versus demersal longlines that fish at or near the sea floor.

[77] Brothers *et al.* 1999

[78] Brothers *et al.* 1999, Cousins *et al.* 2000

gillnetting was banned in 1992, coupled with a growing demand for tuna, swordfish, and shark products. Longlining, both domestic and foreign, currently comprises the highest effort for industrial fisheries in the Pacific. The U.S. North Pacific longline fleet accounted for 16% of the total hooks set between 1991-1997.[79] Other countries that have large North Pacific longline operations include Japan, Taiwan and Korea, none of which carries observers.[80] Cousins *et al.* (2000) estimated 13,000 albatrosses were killed annually in the swordfish and 23,000 in the tuna fisheries in the North Pacific. The relatively small (<200 vessels) pelagic longline fishery based in Hawai`i killed an estimated 1,000-3,000 each, Laysan and Black-footed Albatrosses annually between 1994-1998.[81]

Mitigation measures to reduce the bycatch of albatross[82] have been identified through research, and these measures are now required on Hawai`i-based longline vessels. Most of the albatross mortality occurred in the swordfish fishery, which was closed by court order in 2001 to protect sea turtles. In response, many Hawai`i-based fishers shifted their operations to California, where regulations were less restrictive. An observer program documented relatively high rates of Black-footed Albatross mortality and, to a lesser degree, Laysan Albatross mortality in this fishery.[83] For several years, use of mitigation measures was voluntary and area closures defined by the Hawai`i court order did not apply to California fishers, even though there was considerable overlap in fishing areas. Area closures and mandatory use of mitigation measures, similar to those for Hawai`i fishers, became effective in April/May 2004, for California fishers. The swordfish fishery out of Hawai`i is expected to reopen in 2004 with new gear regulations designed to limit the bycatch of sea turtles.

Beginning in 1995, pelagic longline fishing replaced most of the troll-based fishery in American Samoa, and unlike Hawai`i, longline permits for the CNMI, Guam, and American Samoa fisheries are not limited.[84] In addition, fish landed in these ports by foreign fishers can be shipped, duty-free, to other U.S. ports. It is currently unknown what effects these practices are having on seabirds. It is probable that these fisheries will continue to increase in the future.

Seabirds are also killed in demersal longline fisheries. An estimated 10,000-27,000 seabirds were hooked each year in Alaska longline fisheries, mostly (75%) fulmars and gulls.[85] Although Alaska is outside the scope of this Plan, it is mentioned here because albatross, especially Laysan Albatross, that breed in Hawai`i are killed in these fisheries. As a result of high seabird bycatch, regulations were adopted in 1997 and 2004 to reduce bycatch in the Alaska fisheries.[86] Paired tori lines[87] were found to be an effective deterrent, reducing seabird bycatch by 71-96%.[88]

A demersal longline fishery for groundfish and halibut operates off the west coast of Washington, Oregon, and California. In the fall of 2001, an observer program was initiated on the groundfish portion of this fishery and preliminary data indicate interactions with Black-footed Albatross, but no take has been documented to date.[89]

Other Direct Effects. Lost and discarded fishing gear such as gillnets can "ghost fish" for years, traveling long distances and killing large numbers of seabirds before the nets sink, wash ashore, or eventually degrade. Monofilament line also poses a threat if seabirds ingest the line or become entangled. When birds take bait from recreational hook-and-line fisheries, anglers sometimes cut

[79] URS 2001

[80] Cousins *et al.* 2000

[81] Cousins *et al.* 2000

[82] McNamara *et al.* 1999

[83] Peterson *et al.* 2003

[84] URS 2001

[85] Melvin *et al.* 2001

[86] Melvin and Parrish 2001

[87] Tori lines are streamers attached to a line designed to trail behind the boat as it deploys and retrieves the gear. These streamers form a moving "fence" that acts as a deterrent to keep the birds away from the hooks.

[88] Melvin *et al.* 2001

[89] Nordeen, NOAA Fisheries, pers. comm., 2003

the line, leaving the hook in the bird with trailing monofilament line which eventually entangles the bird. If not treated, this type of interaction/injury often results in death. Off the California coast, Brown Pelicans are one of the primary species affected, although currently no data exist to quantify the magnitude of the problem.

Indirect Effects

There is growing concern about bright lights used by squid fishers near the Farallons and Channel Islands, CA. Some experts believe that lights were a factor in Brown Pelican nest abandonment and low reproductive success at Anacapa Island in 1999.[90] Lights may also affect nocturnal species such as Xantus's Murrelet and Ashy Storm-Petrel. The bright lights disorient birds as they fly to and from the islands, attract birds to the boats or gear, cause birds to alter their behavior, or render these nocturnal seabirds more vulnerable to predation by gulls or owls.[91] This is especially true during inclement weather. The colonies affected by these fishing operations include some of the largest seabird colonies along the west coast (*e.g.,* Farallon Islands), and affect ESA and BCC listed seabirds (*e.g.,* Ashy Storm-Petrels, Brown Pelicans, and Xantus's Murrelets at Anacapa and Santa Barbara Islands). Even far out to sea, seabirds become disoriented by the bright lights on ships and injure themselves when they collide with the ship.

Reduction of seabird prey abundance by commercial fisheries and the effects on seabird populations are difficult to assess. In some ecosystems, it has been estimated that seabirds consume up to 30% of the annual pelagic production of fish,[92] placing them in direct competition with fisheries. Even where it is documented that seabirds are affected by a reduction in prey, it is difficult to prove a causal relationship to fishery harvest.[93] Seabirds can be affected by a direct depletion of their food when seabirds and fisheries target the same species and age classes. Similarly, if fisheries target reproductive fish, reduced spawning biomass may reduce the availability of juvenile fish for seabirds. However, spawning biomass and recruitment are not always correlated in fish populations. The seabird species that are most vulnerable to these types of indirect effects are those that have a restricted foraging range or those with specialized feeding methods or diet.[94] In the tropics, most seabirds feed in association with predatory fish, primarily tuna, that drive prey to the surface; overfishing of predatory fish stocks could potentially affect seabirds by reducing the availability of these patchily-distributed prey resources.

There are several emerging and evolving fisheries that have potential to adversely affect seabirds. The anchovy fishery off the west coast currently occurs at a small scale, but there is interest in developing it further. A potential krill fishery is also of particular concern. In 2001, a ten-year moratorium was imposed on this fishery. Both of these fisheries have the potential to negatively affect seabirds by disrupting the marine food web and decreasing seabird prey stocks.

Introduced/Non-native Species

The majority of all bird extinctions since 1800 have been caused, either entirely or partially, by introduced species.[95] Referred to as non-native, invasive, introduced, exotic, or alien species, these animal and plant introductions have resulted in disastrous consequences for seabird populations worldwide and they continue to pose one of the greatest threats to seabirds. Roughly 90% of all extinctions during the last two centuries have been on islands. Most seabirds breed on islands where they evolved in the absence of ground predators; consequently, seabirds are extremely vulnerable to introduced predators. Introduced plants and herbivores have substantially altered and degraded the composition and quality of seabird nesting habitats. The effects of introduced invertebrates, other than mosquitoes, have not been well studied, but the impacts of mosquitoes alone, as vectors of disease, are significant, especially in Hawai`i.

[90] Frank Gress, California Institute of Environmental Studies, pers. comm., 2003

[91] Anderson *et al.* 2001

[92] Furness 1982a, Furness 1982b

[93] Rindorf *et al.* 2000, Furness 1990

[94] Furness 1982a

[95] BirdLife 2000

Predators

Introduced predators have repeatedly been identified as the foremost threat to seabird populations on islands, causing population declines, extirpation of species or colonies, and in rare instances extinction (*e.g.,* Guadalupe Storm-Petrel). Small, ground-nesting petrels, shearwaters, and terns are the species most frequently affected.[96] In this Region, rats and feral cats have had the greatest effects.[97] They are responsible for colony extirpations and range-wide population declines of numerous species.[98]

Rodents have become established on approximately 82% of the world's islands.[99] Virtually all large Pacific Islands have at least one species of introduced rodent and often several species are present. Black rats, Norway rats, and Pacific rats eat birds and eggs and are the most destructive. Even on islands with native predators (*e.g.,* Channel Island deer mice) introduced rats have caused seabird population declines (*e.g.,* Xantus's Murrelet declines at Anacapa Is.).[100] House mice prey on the eggs and potentially the chicks of smaller seabirds, especially storm-petrels, but population-level effects are poorly understood and not well documented. At the Farallon Islands, CA, it is hypothesized that house mice sustain migrant Burrowing Owls on the island through the winter and early spring (when they would normally migrate through) affording them access to Ashy Storm-Petrels that return to the islands in April.[101] Introduced rats have been eliminated from all but a few NWR islands but they remain a serious problem on the larger, inhabited islands of both the USPI and CCS (Appendix 6).

Feral cats prey upon adults and eggs and they can kill larger seabirds than those typically taken by rats[102] (although rats have been documented killing adult albatross[103]). At Jarvis Island, cats killed an estimated 24,000 seabirds each year and all but four breeding seabird species were extirpated before the cats were finally eradicated.[104] Cats have been eradicated from all NWR islands in the Region and from many of the smaller NP islands, but they are still present on all of the main islands of Hawai`i, American Samoa, Guam and the Marianas, and many of the larger islands off California and in Puget Sound, WA (Appendix 6). In Hawai`i, cats are found from sea level up to 10,000 feet on Mauna Loa, where they feed on Hawaiian Petrels, limiting the population of this endangered petrel.[105]

Dogs were first introduced to the USPI by Polynesians and again with European colonization. Today, they are found on almost all inhabited islands. Feral and uncontrolled domestic dogs threatened the existence of the albatross colony at Kilauea Point NWR, HI until fences were erected. Red foxes were introduced to California for fox hunting and fox farming; they prey on terns and gulls including endangered California Least Terns.[106] In Oregon, red foxes recently invaded several offshore rocks within Oregon Islands NWR which were accessible at low tide. Foxes destroyed all seabird eggs and chicks on these islands in 2002, resulting in total colony failure for Western Gulls, Brandt's and Double-crested Cormorants, Common Murres and Tufted Puffins; only Pigeon Guillemots and Pelagic Cormorants nesting in crevices and on steep cliffs successfully reproduced.[107]

Indian mongoose were introduced to all of the main Hawaiian islands except Ni`ihau, Kaua`i, and Kaho`olawe, and they have been implicated in the near extinction of Hawaiian Petrels and Newell's Shearwaters.[108] The last stronghold of Newell's Shearwaters is on the steep mountainsides

[96] Moors and Atkinson 1984

[97] Moors *et al.* 1992

[98] Drost and Lewis 1995, McChesney and Tershy 1998, Rauzon 1983

[99] Atkinson 1985

[100] McChesney and Tershy 1998; McChesney *et al.* 2000

[101] Mills *et al.* 2002

[102] Smith *et al.*2002; Nogales *et al.* 2004

[103] Kepler 1967

[104] Rauzon 1983

[105] Simons and Hodges 1998

[106] Minsky 1980

[107] Roy Lowe, USFWS, pers. comm., 2004

[108] Munro 1960, Berger 1972

of Kaua`i[109] and there is concern that this will be jeopardized if mongoose become established on this island.

Pigs were widely introduced throughout the Pacific, first by Polynesians and then by Europeans.[110] Feral pig populations are present on most of the main islands of the USPI. They trample burrows and eat chicks and eggs. Destruction of vegetation by pigs results in erosion that degrades island forests and promotes mosquito breeding habitat, thus facilitating the spread of mosquito-borne avian diseases. Feral pigs are also present on several of the Channel Islands, CA.

Along the mainland coast, seabirds evolved with avian predators such as owls, eagles, falcons, gulls and corvids. However, populations of these native predators, especially gulls and corvids, have increased near urban centers and can have negative impacts on breeding seabird populations, especially the coastal terns in southern California. In the USPI native avian predators are rare (frigatebirds, Hawaiian Hawk, Pueo, and night herons) and the population-level impacts of introduced avian predators are not known. Barn Owls have naturally dispersed over much of the Pacific, but they were introduced to Hawai`i. Barn Owls take seabird adults and fledglings.[111] Introduced Cattle Egrets eat seabird eggs and chicks, and compete with Red-footed Boobies for nesting habitat on Lehua Island.[112] Common Mynas are widespread in the main islands of American Samoa and Hawai`i, and Midway Atoll. They were documented as an important predator of Wedge-tailed Shearwater eggs at Kilauea Pt. NWR, Kaua`i,[113] but impacts of myna predation elsewhere are undocumented.

The brown tree snake is an extremely effective predator that has eliminated all but four of the native forest birds from Guam. It is likely they also eat seabird eggs and chicks, though population level effects are not known. Monitor lizards on several of the Mariana Islands, including Guam, may also limit ground-nesting seabirds. Spread of these pests, especially the brown tree snake, to other Pacific Islands is a serious threat. Restricting the spread of snakes and lizards from Guam is the goal of a multi-million dollar U.S. Department of Agriculture program.

Herbivores

A wide range of herbivores, including deer, goats, sheep, cattle, horses, mules, rabbits, and hares have been introduced to islands. Feral goats and rabbits can denude small islands of vegetation leading to erosion and loss of nesting habitat. Over the past two centuries, most of the California Channel Islands were ranched. Overgrazing, drought, and introduced forage plants forever altered the habitat of these islands.[114] The main Hawaiian Islands harbor non-native populations of deer, feral goats and sheep that cause habitat alteration and erosion problems. Rabbits, introduced to Laysan and Lisianski islands in the early 1900s, denuded the islands of vegetation and fierce sand storms buried nests and filled burrows.[115] Within two decades, seabird populations crashed and three endemic landbirds went extinct before the rabbits finally ate themselves to near extinction and the remaining few were killed.[116] Rabbits are still a problem at Lehua Is., HI. There is some debate whether rabbits have a positive or negative effect on seabird populations at Destruction Is., WA. Rabbit grazing reduced the height of vegetation and may have enhanced nesting habitat for Rhinoceros Auklets on this island.[117]

Plants

Non-native plants can displace native plants and may limit, destroy, or degrade seabird nesting and roosting habitat. Aggressive species such as European beachgrass and sea fig, reduce the amount of open coastal strand habitat preferred by California terns. Golden crown-beard forms tall, dense, and almost impenetrable stands that exclude many surface nesting seabirds on the Northwestern Hawaiian Islands. In contrast,

[109] Byrd *et al.* 1984, USFWS 1983a

[110] Atkinson and Atkinson 2000

[111] VanderWerf *et al.* 2004

[112] VanderWerf *et al.* 2004; USFWS unpubl. data

[113] Byrd 1979

[114] Johnson 1980, Brumbaugh 1980

[115] Bailey 1956

[116] Ely and Clapp 1973

[117] Ulrich Wilson, USFWS, pers. comm., 2003

sandbur lacks the height and physical structure preferred by Hawaiian seabirds that nest under vegetation.[118] Many invasive plants have shallow root systems that provide poor soil stabilization and consequently affect burrow stability and reproductive output (*e.g.,* sandbur and Bonin Petrels in Hawai`i). At the Farallons, New Zealand spinach forms dense mats over the soils and may influence densities of burrow nesting seabirds. At Midway Atoll, beggar's tick provides cool, humid habitat for introduced mosquitoes that transmit avian pox. Bufflegrass creates and perpetuates a fire cycle in the Red-footed Booby colony at Ulupa'u Crater, O`ahu. Dense forests of introduced ironwood trees at Midway Atoll, limit habitat for surface nesting species such as Laysan Albatross; but tree nesting species such as Black Noddies and White Terns benefit.

Insects and Other Invertebrates

Of the thousands of introduced invertebrates occurring in seabird colonies, mosquitoes, ants, and scale insects are the only ones documented to have negative impacts. Mosquitoes are vectors for avian malaria and avian pox, and both diseases are known to infect seabirds. Several species of ants including: crazy, bigheaded, Argentine, and little fire ants have been recorded from Hawai`i and other USPI. Several ant species (*e.g.,* crazy, long-legged, fire, and bigheaded ants) have been documented attacking small chicks or pipping eggs, but population level effects are unknown. More important than direct effects may be the indirect effects; native woody vegetation is damaged and destroyed by introduced scale insects and sooty molds, which are promoted by the presence of ants.[119] Pu'avai or Pisonia, a tropical tree much favored by tree nesters such as Red-footed Boobies and Black Noddies has disappeared from Rose Atoll, American Samoa. The forest on Palmyra Atoll is seriously compromised by an introduced scale insect, *Pluvinaria urbicola*. The negative impacts of other invertebrates, though undocumented, could be considerable.

Control and Eradication of Non-Native Species

Eradication of introduced vertebrates from islands where seabirds nest has been increasingly successful with a growing arsenal of tools. In this Region, there are many examples of federal, state, and private land owners successfully eradicating black rats, Norway rats, Pacific rats, feral cats, dogs, pigs, goats, and rabbits (Appendix 6). The Service has been very active in invasive species management in the USPI, and rats and cats have been eradicated from all but one of the Pacific and Remote Islands NWRs. Currently, the Service is seeking funds to eradicate rats from the one remaining refuge, Palmyra NWR. The state of Hawai`i has an active program to control and eradicate introduced predators from important seabird colonies. In the CCS, many agencies are working to control or remove rodents from seabird colonies. For example, the NPS in coordination with the NGO Island Conservation, recently completed a program to eradicate rats from Anacapa Is. with restoration funds from the American Trader oil spill.

In response to these eradication programs, seabird populations have increased, extirpated native species have returned, and social attraction projects are underway to attract seabirds of high conservation concern that have not recolonized (*e.g.*, Tristram's Storm-Petrels at Midway Atoll and Phoenix Petrels at Jarvis Is.). Complete eradication is not feasible for many introduced species on the mainland or large inhabited islands, but programs have been initiated at many of the key seabird colonies to exclude predators or reduce predator densities in the area of the colony. The highest priority colonies for predator control in the Region are listed in Table 7.

Table 7. Top Priority Colonies for Predator Control

Colony	Predators
Newell's Shearwater and Hawaiian Petrel Colonies in Hawai`i	cats, rats, mongoose
Palmyra Atoll	rats
Lehua Islet, HI	rats
Kaula Rk, HI	rats
Petrel and Shearwater colonies in Samoa	cats, rats
Wake Atoll	cats, rats
San Miguel Is., CA	rats
Cocos Is., Guam	rats, monitor lizards
Oregon Islands NWR, OR	mammalian
Farallon NWR, CA	mice

[118] Flint and Rehkemper 2002

[119] Nishida and Evenhuis 2000

Military bases throughout the Pacific have a high incidence of introduced predators. World War II resulted in significant increases in rat colonization of islands in the period between 1840-1980.[120] Today, many of the remote island bases have initiated predator control or eradication programs. In accordance with recent policy, Navy commands must now ensure the humane capture and removal of free roaming cats and dogs. With 186 Navy bases worldwide, implementation of this policy could have a very positive effect on nesting seabirds.

Control and eradication of introduced plants has been implemented at a few colony sites. At Midway Atoll, ironwood and golden crown-beard are actively controlled and sandbur is nearly eradicated from Laysan Is. These projects are labor intensive and expensive, and much more needs to be done. The same is true of control and eradication of introduced insects. USGS, in cooperation with the Service, initiated research into the control of scale insects at Palmyra in 2004.

Issues associated with Control and Eradication of Non-Native Species

Control and eradication of non-native species is costly in both time and money. Control programs are often controversial and outreach to the public and others is an important component of a successful eradication program. Care needs to be exercised in the planning and execution of control programs. Unsuccessful eradication programs can be extremely expensive and may produce results that are worse than no action at all. It is also important to carefully examine the predator prey relationships prior to initiating control programs, especially in complex situations where more than one predator is present. For example, eradication of top predators (*e.g.*, cats) could result in an increase in the abundance of lower level predators (*e.g.*, rats) that could potentially cause greater damage to seabird populations than the initial situation. Monitoring seabird populations before, during and after control programs is an important component of the project.

Preventing introductions of non-native species is the best conservation strategy. Many pests reach islands through human transport (*e.g.,* vessel groundings, boats moored to or near an island, in cargo, on flotsam). Regulating access to islands, immediate response to shipwrecks, regular monitoring of islands, and general vigilance by resource managers should enable early detection. Introduction of non-native species, especially predators, is an emergency and should be treated like an oil spill, with a rapid response to minimize damage and restoration cost.

Oil Pollution

During the 20th century, seabird mortality from various petroleum products (hereafter generalized as oil pollution) has been a significant seabird conservation issue worldwide. Oiled seabirds received international attention during the 1969 Santa Barbara oil spill when an offshore oil production platform experienced a blowout,[121] and during the 1971 San Francisco oil spill when two oil tankers collided in the entrance to San Francisco Bay.[122] While these dramatic events awakened public concern, smaller oil spills occur regularly and some can kill larger numbers of seabirds than major events (*e.g.,* Apex Houston spill).[123] Recent federal and state legislation towards the prevention of oil spills have been implemented; nevertheless, spills continue to occur.

Oil in the Marine Environment

While most spills in the Region have involved crude or bunker oil, many types of petroleum products (*e.g.,* diesel, gasoline, kerosene, lubricant, various industrial oils) enter the marine environment through diverse anthropogenic pathways, and from natural seeps.[124] Chronic release of very small amounts of oil from bilge pumping, outboard engines, and mishandling of petroleum products in marinas is an often overlooked source of oil pollution.

Most oil spills and chronic oil pollution have occurred in shipping lanes near large ports[125]

[120] Atkinson 1985

[121] Straughan 1971

[122] Smail *et al.* 1972

[123] Page *et al.* 1990, Carter *et al.* 2003

[124] see review in Ohlendorf *et al.* 1978

[125] Burger and Fry 1993, Carter 2003

(Figure 4). Several oil spills with documented seabird mortality also have occurred near smaller ports in the Strait of Juan de Fuca and off the outer coast of Washington, but few spills have been documented in Oregon where there are relatively few shipments of oil up the Columbia River (Figure 5).

Since the 1970s, biologists have recognized chronic oil pollution in central California, based on regular occurrence of oiled birds on beaches.[126] Long-term monitoring of oiling rates of beached birds has helped document this problem. Most of the chronic oil pollution appears to result from the dumping of bilges and slops after or before entering major oil ports.[127] Leakage from sunken vessels is another source. In 2002, the tanker *Jacob Luckenbach* which sank in the Gulf of the Farallones in 1953, was determined to be the source of large "mystery" spills in this area.[128] This discovery established growing concerns about sunken vessels leaking oil. During WWII, more than 50,000 vessels sank near islands, many in the USPI. Many of these wrecks contain petroleum products that are leaking or will leak in the future. In the past few years, spills involving thousands of gallons of oil at Yap, Guam, and elsewhere in Micronesia apparently originated from these vessels, but the impacts of these spills on seabirds were not investigated.

Effects of Oil on Seabirds

Oil pollution affects a wide array of seabird species to varying degrees.[129] Large numbers of dead and alive oiled birds have been recovered after individual spills and certain species tend to predominate. Of the seabirds, alcids (especially Common Murre, Rhinoceros and Cassin's Auklets) are the most vulnerable, although other species with small populations (*e.g.,* Marbled Murrelet and Brown Pelican) have also been recovered, in relatively high numbers after certain spills.[130] When seabirds contact floating oil, feathers and skin may be coated, ingestion typically occurs during preening, and fumes can be inhaled. Oiling causes both lethal and sublethal effects and can affect thermoregulation, flight ability, reproductive behavior, and a variety of physiological processes.[131] The degree of effect varies, depending on the type of oil product and seabird involved, amount of oiling, time of year, and weather. Even a small amount of fresh or weathered oil can result in death of a seabird or impaired biological function. In addition, chemical compounds used to disperse floating oil can injure or kill seabirds, and the effects of these compounds requires further investigation.

Assessments of seabird mortality associated with spills have been conducted regularly since the 1980s with models that use beached bird counts and other information to extrapolate to total mortality estimates. However, not all dead oiled birds reach shore or are detected after reaching the shore. Offshore and small-bodied species tend to be under represented or completely absent from data collections. This problem is greatly exacerbated in the USPI where currents, winds, geography, and the vast foraging range of the seabirds combine to minimize the likelihood that any dead birds will wash ashore or be recovered. Spills are often signaled by the appearance of oiled birds returning to colonies or roost sites.

Long-term monitoring of seabird demographic processes (*i.e.,* survival, reproductive success, recruitment, age at first breeding) is crucial for assessing impacts of oil spills on seabird populations and in designing and evaluating restoration projects.[132] Common Murre population declines in central California in the 1980s were linked to mortality from the 1984 *Puerto Rican* and 1986 *Apex Houston* oil spills, as well as to mortality from gillnet fishing and El Niño.[133] In Washington, the Common Murre population failed to recover from declines in the early 1980s and mortality from the

[126] Carter 1997, Nur et. al. 1997, Stenzel *et al.* 1988

[127] Hampton *et al.* 2003a

[128] Hampton *et al.* 2003b

[129] Loons, grebes, seaducks, and phalaropes are not included in the scope of this plan but it is important to note that these marine bird species occur in great abundance in the Region and are extremely vulnerable to oil spills.

[130] Carter 2003, McShane *et al.* 2004, Carter and Kuletz 1995

[131] see reviews in Ohlendorf *et al.* 1978, Burger and Fry 1993

[132] Nur and Sydeman 1999

[133] Takekawa *et al.* 1990; Carter *et al.* 2001

Figure 4. Oil spills off California, Oregon, and Washington 1969–2001 (spills with >10 oiled birds documented; updated from USFWS 1997; see Carter 2003, McShane *et al.* 2004).

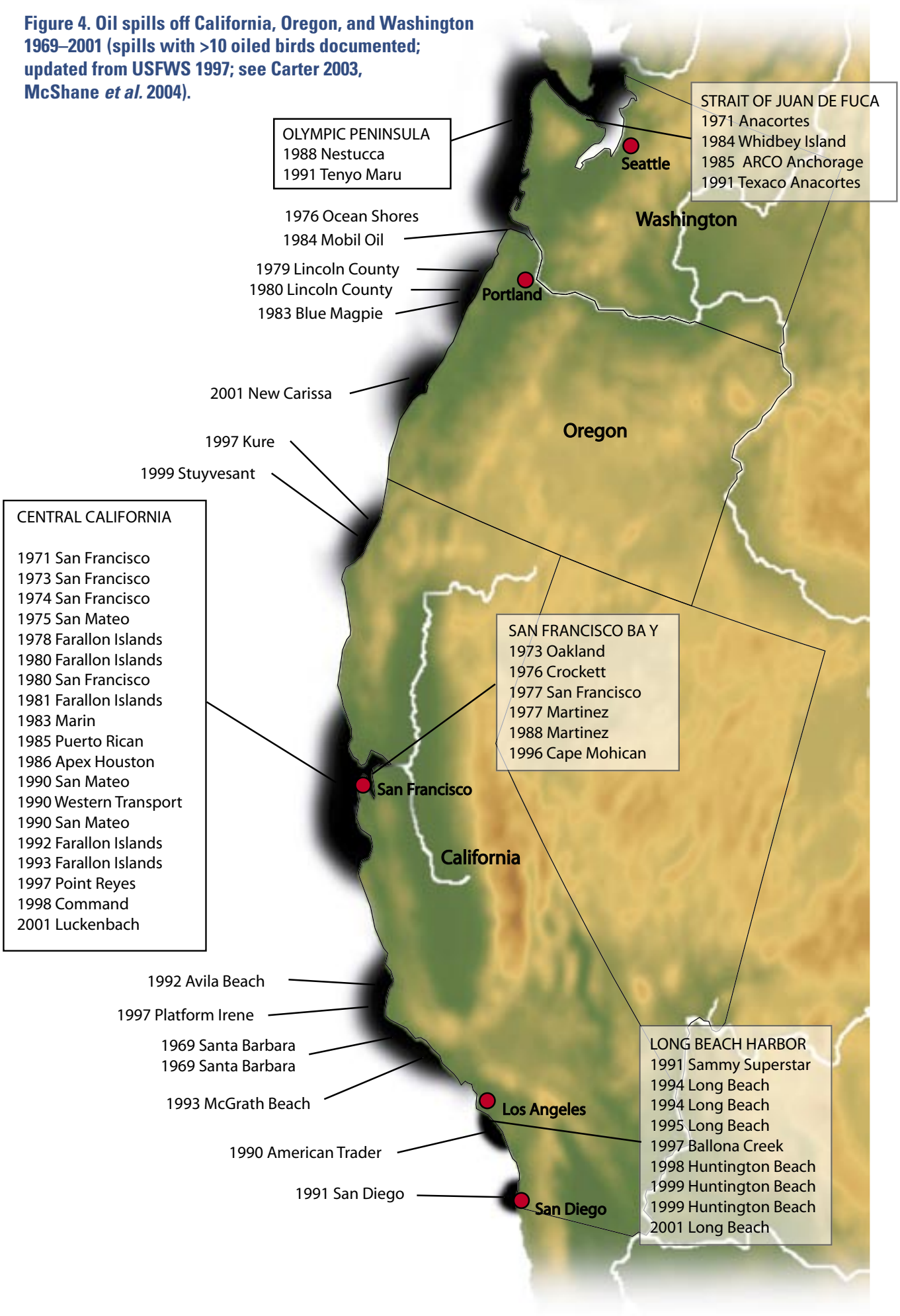
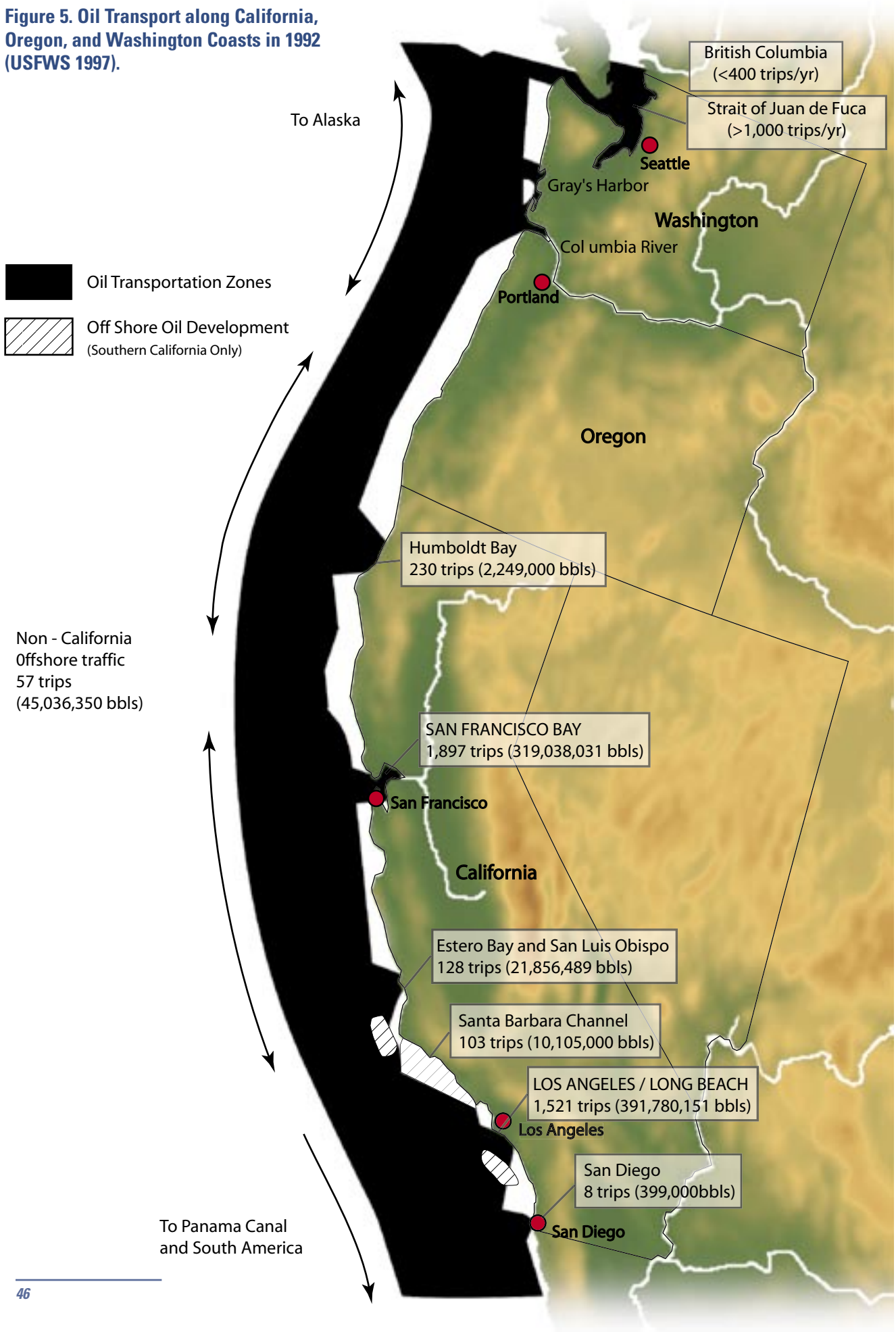


Figure 5. Oil Transport along California, Oregon, and Washington Coasts in 1992 (USFWS 1997).



1988 *Nestucca* and 1991 *Tenyo Maru* oil spills were identified as contributing factors.[134] Hundreds of Marbled Murrelets were killed in the 1991 *Tenyo Maru*, 1997 *Kure*, 1999 *Stuyvesant*, 1997-98 Point Reyes Tarball Incidents, and 1999 *New Carissa* oil spills. This mortality likely contributed to Marbled Murrelet population declines.[135] Oil pollution is a serious concern for localized endemics such as Xantus's Murrelets, a species whose key breeding colonies all occur near shipping lanes and offshore oil platforms.[136]

Oil spills occur throughout the central Pacific but, to date, they have been poorly documented. Oiled seabirds have been noted at the breeding colonies, but seabird injuries have been assessed for only two Hawaiian spills (*Hana* 1987 and *Tesoro* 1998) and population models to estimate total mortality have not been developed yet. There have been major spills where seabird injuries were not examined: 1) 10 million gallons of crude oil from *Irene's Challenge,* north of Lisianski, in 1977; 2) 31.2 million gallons of crude oil from the *Hawaiian Patriot,* west of Kaua`i, in 1977; and 3) an estimated one million gallons that leaked over a two-year period from a power plant on Guam during the early 1990s.[137]

In contrast to the well-developed oil spill response and seabird injury assessment programs in California and Washington, the programs in the USPI are relatively small or non-existent. Nevertheless, a large volume of oil is transported by oil tanker to O`ahu and vessel traffic is high.[138] Increased attention to the impacts of oil pollution on seabirds is needed in the islands. Birds are highly concentrated in relatively few colonies and there is potential for a spill to cause significant population-level impacts. Specialized response techniques need to be developed for detecting and assessing impacts to seabirds in this ecosystem.

Other Contaminants and Hazardous Substances

In addition to fuel discharges, there are four major sources of contaminants present in the Region: 1) industrial and mining discharges, both historic and current; 2) agricultural runoff, encompassing pesticides, sediment, and nutrients; 3) urban runoff and sewage outfalls; and, 4) military base contaminants.

The contaminants widespread within the Region that pose the greatest potential exposure hazard to seabirds are persistent organic pollutants (*e.g.*, pesticides, dioxins, PCBs, and poly-aromatic hydrocarbons); metals (primarily mercury, lead, arsenic, cadmium, chromium, and copper); and the trace mineral selenium. All of these classes of chemicals are regulated with the exception of plutonium contamination at Johnston Atoll from above ground nuclear tests.

Organic and halogenated pollutants have been lumped into the catch-all class "persistent organic pollutants" (POPs), because they are generally found as complex mixtures in sediments and in fat of exposed animals. Newer persistent contaminant threats include polybrominated diphenyl ethers used as fire retardants, and several fluorinated organics used widely in plastic and electronics manufacturing.[139] Other "emerging" contaminant threats include endocrine disrupting chemicals (alkylphenols, estrogenic hormones, pesticides and industrial chemicals); pharmaceuticals released from non-point sources such as agricultural feedlots and public operated waste-water treatment works. The extent of regional exposure and persistence of many of these compounds is uncertain as the USGS has only recently begun to monitor these chemicals.[140]

The "traditional" organochlorine POPs (pesticides, PCBs and dioxins) are generally fat soluble, and they are biomagnified through the food web.

[134] Wilson 1991, Warheit 1996, TMOSNRT 2000; Carter *et al.* 2001

[135] Carter and Kuletz 1995, McShane *et al.* 2004

[136] Carter *et al.* 2000

[137] USFWS 1996

[138] Demarest and Elliot 1997

[139] Inoue 2004

[140] National Research Council 1999, Kolpin *et al.* 2002, Dawson 2000

Wide ranging and long-lived top predators such as seabirds have an increased exposure risk. Adverse reproductive consequences include eggshell thinning, developmental malformations and mortality of embryos and juveniles, and immune suppression leading to increased disease susceptibility. Global atmospheric transport of POPs, including DDT, dioxins, and PCBs, results in diffuse deposition on the surface of the oceans, where surface feeding seabirds such as storm-petrels and albatross become exposed at measurable levels.[141]

Endocrine disruptors have been grouped together as a class of contaminants, but several (DDT, dioxins and PCBs) have been persistent pollutants for decades.[142] DDT pollution of the Southern California Bight resulted in seabird reproductive failures from eggshell thinning, as well as endocrine disruptive effects on gulls leading to sex ratio skews and population declines.[143] The non-persistent pesticides and industrial chemicals pose threats in localized "hot spots", such as estuaries, lagoons, and harbors, or adjacent to outfalls of major industrial or agricultural areas.

The lack of dose-response data for seabirds is a significant problem in the monitoring and evaluation of contaminant problems.

Summary of Contaminants by State

California. Major sites of contamination in California include the Southern California Bight with historic DDT contamination from the Montrose Chemical Company and PCB contamination from industrial sources; Monterey Bay contaminated by agricultural discharge and residual DDE from the Salinas River; and, San Francisco Bay with historic mercury from the 19th century gold rush, DDT from agriculture and the United Heckathorn Superfund site, metals and PCBs from industrial and military sites, and selenium from industry and agriculture. Although the contamination is centered in these areas, effects are widespread due to dispersion in the marine environment and uptake into the food web. Local hotspots in California include mercury discharges into Tomales Bay and pulp mill discharges into the ocean at Eureka.

Mercury has been detected in Caspian and Forster's Tern eggs in San Francisco Bay and Least Terns nesting at Alameda have been affected by PCBs.[144] Double-crested Cormorants in San Francisco Bay exhibit PCB and dioxin-like effects, but at levels below the threshold for adverse population effects.[145] The exposure risk to seabirds in California has been reduced over the past 30 years because of bans on DDT and PCBs, and reduced emissions of metals and other industrial pollutants. However, hotspots of contamination remain in the Southern California Bight and San Francisco Bay, near some of the largest concentrations of nesting seabirds in the state (the Channel Islands and the Farallons). The DDT contamination of the Southern California Bight still causes eggshell thinning in some seabirds (*e.g.*, cormorants, pelicans and storm-petrels).[146] Updated contaminant surveys are needed for the majority of the seabird species in the Southern California Bight that demonstrated eggshell thinning in 1992 due to DDT contamination.

Oregon. Seabird colonies on small offshore islands have shown very little impact from chemical contaminants, except for widely ranging Fork-tailed Storm-Petrels that bioaccumulate DDE at sea.[147] Coos Bay estuary remains contaminated from shipyard operations and is in the process of superfund site cleanup. The major concern is the Columbia River estuary, where large populations of Double-crested Cormorants and Caspian Terns nest. Cormorant monitoring during the 1990s showed significant adverse effects from pulp mill effluent and metals, with egg mortality as high as 23%.[148] Contaminant discharge from pulp mills was regulated in the 1990s, with conversion of mills to non-chlorine bleaches, and future contaminant levels should be reduced.

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[141] Fry 1994, Fry 1995, Ludwig *et al.* 1998

[142] National Research Council 1999, Fry and Toone 1981, Fry *et al.* 1987

[143] Fry and Toone 1981, Fry *et al.* 1987

[144] Schwarzback and Adelsbach, 2002

[145] Davis *et al.* 1997

[146] Fry 1994, Fry 1995

[147] Henny, Blus and Prouty 1982

[148] Buck and Sproul 1999

Washington. The sediments of Commencement and Elliott Bays remain highly contaminated and continue to pose risks to breeding seabirds, especially gulls, Caspian Terns and Pigeon Guillemots nesting in the inner harbors.[149] The north portions of Puget Sound and the Straits of Juan de Fuca have remained much less contaminated, as demonstrated by monitoring of several alcid species.[150] Bald Eagles nesting in Hood Canal bioaccumulated PCBs throughout the 1990s with reduced nesting success.[151] Investigations of seabird contamination in this area may be warrented. Several large Superfund site cleanups continue to make progress in Puget Sound.

USPI. Hawai`i has contaminant issues on many islands stemming from historic and continuing military operations. Laysan and Black-footed Albatrosses at Midway are exposed to soils contaminated by lead-based paint, especially around old buildings. Chicks ingest contaminated soil and paint chips and the subsequent lead poisoning results in poor fledging success.[152] Localized lead contamination is a risk to surface nesting seabirds on most islands with historic military operations.[153]

Lagoons and harbors of Pacific islands with military bases remain contaminated with PCBs, petroleum, dioxin, selenium, lead, mercury, tributyl tin and plutonium. A portion of the Red-tailed Tropicbird colony on Johnston Is. was at risk from dioxin exposure from contaminated soil left from military operations,[154] but military cleanup of Johnston has reduced that risk. Risk to burrowing seabirds still exists from buried plutonium and metals (*e.g.*, lead, arsenic) on Johnston.

PCB contamination occurs on many Pacific Islands including Johnston, Midway, Kure, and French Frigate Shoals with possible exposure risk for ground nesters, and shearwaters and petrels that burrow in contaminated sites such as landfills and buried disposal sites. Organochlorine concentrations in Laysan and Black-footed Albatrosses are at least an order of magnitude higher than levels in southern hemisphere albatrosses and PCB and DDT concentrations were similar to those in Great Lakes fish eating birds which suffered embryo deformities and mortality.[155] Contamination levels were high enough to cause eggshell thinning and embryonic effects, and a small but measurable reduction in productivity was documented for Black-footed Albatross at Midway due to a combination of organochlorine contaminants and fisheries bycatch.[156]

Plastic Pollution

Plastic pollution is ubiquitous in the marine environment and several studies have documented the vulnerability of seabirds to this threat. Most often seabirds are entangled or ingest the plastics. Entanglement can compromise flight and swimming capabilities, and result in injury or death. In this respect, discarded monofilament line and nets present the greatest threats to seabirds.

Seabirds ingest a wide variety of plastics from small industrial pellets to cigarette lighters, bottle caps, light sticks used in fishing, and broken bits and pieces. Spear *et al.*[157] found a strong negative correlation between the amount of ingested plastic and body condition of seabirds. Laysan Albatross chicks at Midway with heavy loads of plastics had significantly lower fledging weights than chicks with less plastic.[158] The possible effects of ingested plastics include starvation, suppressed appetite, impaction/obstruction, decreased fat deposition, and increased organochlorine contamination.[159] Plastics floating on the ocean absorb PCBs and

[149] Spiech *et al.* 1992, Calambokidis *et al.* 1985, Mahaffy *et al.* 2001

[150] Spiech *et al.* 1992, Grettenberger *et al.* 2004, USFWS unpubl. data

[151] Mahaffy *et al.* 2001

[152] Work and Smith, 1996, Burger and Gotchfeld, 2000, Finkelstein *et al.* 2003

[153] Finkelstein *et al.* 2003

[154] Fry *et al.* 2000

[155] Auman *et al.* 1997, Jones *et al.* 1996, Gilbertson *et al.* 1991

[156] Auman *et al.* 1997, Ludwig *et al.* 1998

[157] Spear *et al.* 1994

[158] Sievert and Sileo 1993

[159] Reviewed in Auman *et al.* 1998.

other organochlorine contaminants[160] and ingestion of these materials may increase seabird contaminant loads.

Plastics are concentrated by ocean currents along the same fronts and convergences that concentrate prey items. Plastics degrade very slowly. It is not known how long it takes to recycle plastic in the ocean environment but some ecologists have estimated hundreds of years. Studies are showing the accumulation of vast amounts of plastics in the subtropical gyres.[161]

Disease

The colonial behavior of seabirds would presumably make them highly susceptible to epizootic[162] disease but outbreaks are rare in this Region. Like other animals, seabirds are susceptible to infectious disease (viruses, bacteria, parasites) and non-infectious disease (toxins, toxicants, metabolic).

Epizootic outbreaks of Newcastle disease have occurred in Double-crested Cormorants in Canada and the U.S.[163] Newcastle's is suspected in a small die-off of nestling and fledgling cormorants at East Sand Is, OR in 2002. Large die-offs have occurred at Salton Sea cormorant colonies, and while Salton Sea is outside the geographic coverage of this plan, interchange between Salton Sea and coastal cormorant colonies is suspected. Avian pox, another viral disease, is transmitted by direct contact or by biting flies or mosquitoes. Pox mainly affects nestlings (Red-tailed Tropicbirds and albatrosses) at breeding colonies, and mortality rates are low. Mosquitoes were introduced to Midway during WWII and this is the only northwestern Hawaiian island where avian pox outbreaks occur. Since seabirds have not had much exposure to other mosquito-borne diseases (arboviruses), they may be particularly susceptible to the newly emerging threat of West Nile virus. Seabirds are also known to harbor a variety of viruses transmitted by ticks. While such viruses can cause illness in humans, epizootic mortality due to these viruses has not been documented. However, heavy infestation by ticks has been implicated in the desertion of Sooty Tern colonies, elsewhere.[164]

Naturally occurring toxins (biotoxins) can cause mortality in coastal seabirds. Biotoxins produced by unicellular phytoplankton, mostly dinoflagellates, bloom in huge amounts, often for unknown reasons. During algal blooms, these microorganisms are consumed by seabird prey that concentrate the toxin. Ingestion by birds can lead to intoxication, nervous system disorders, and death. In 1991, there was a large die-off of Brown Pelicans and Brandt's Cormorants in Monterey Bay due to the toxin domoic acid.[165] Many scientists believe that harmful algal blooms are becoming more prevalent as agricultural runoff and pollution result in increased nutrient loading (especially nitrogen and phosphorus) creating ecological conditions that favor toxic algal blooms.

Although starvation is often not considered a disease, physical and environmental factors can also cause large seabird die-offs. Thousands of murres, most emaciated, wash onshore along the Oregon coast during some years, often associated with El Niño events or stormy weather when food is less abundant or foraging is more difficult.[166] Mortalities of chicks, especially during fledging, is a common phenomenon in a wide variety of seabirds.[167] Fledging is a stressful time for chicks as they are weaned of food provided by parents and are learning to fly and forage for themselves.

There is a need for more baseline health and disease information from free-ranging seabirds. When die-offs or disease outbreaks occur, documentation and increased diagnostic testing should be conducted.

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[160] Carpenter *et al.* 1972

[161] Moore 2003

[162] Epizootic - a disease affecting a greater number of animals than normal; typically occurrences involve many animals in the same area at the same time.

[163] Friend and Franson, 1999

[164] Feare, 1976

[165] Work *et al.* 1993

[166] Bayer *et al.* 1991

[167] Piatt and Van Pelt 1997

Habitat Loss and Disturbance

More than half of the U.S. population now lives and works within 50 miles of the coastline and the degradation and loss of natural habitats in this zone has been significant. This is not just a recent phenomenon. Native peoples harvested seabird eggs, chicks, and adults for thousands of years. In Oregon, village sites and seasonal camps were located near seabird colonies and on offshore islands. Radiocarbon dating of material from various Oregon sites have indicated that coastal rocks and islands were used by native peoples for thousands of years for food gathering.[168] In Hawai`i, early Polynesians cleared huge expanses of native forests and converted lands to agriculture. Today, coastal landscapes are being paved or otherwise altered for urban, industrial and military development. Wetlands and riverine systems are diked, drained, dredged, or dammed for agricultural and hydroelectric development. Powerlines are a problem in areas where they transect flyways between the colonies and the ocean.[169] Degradation and loss of habitat continues, resulting in significant losses of seabird nesting and roosting habitat in this Region. (See the Section on Seabird Nesting and Roosting Habitat for discussion.)

Much of the development in the USPI is concentrated along the coast. Bright lights, such as those associated with resorts, greatly impact seabirds, especially Procellariiformes. The lights disorient birds transiting to and from the high elevation colonies. Fledglings are particularly attracted to artificial lights and each year they are downed in large numbers on their first flight to the ocean.

Military management of land has both degraded and protected habitat for breeding seabirds. Loss of habitat to structures, runways and other military developments is significant. Live fire exercises and military maneuvers on the beaches alter habitats, and disturb and displace birds. Sea Lion Rocks off Washington were bombed and torpedoed in the years following World War II. Disturbance from these military activities affected seabirds on non-target rocks, some of which were bombed by mistake.[170] Farallon de Medinilla, CNMI and Kaula Rock, HI are still actively bombed. Scheduled maintenance by the military at remote sites that support seabird colonies are often conducted during the peak nesting period (*e.g.,* maintenance at Destruction and Smith islands, WA). On the other hand, military bases have protected large stretches of coastal and island habitat from development. Military bases along the west coast support several important seabird colonies, especially coastal terns. Colonies of the endangered California Least Tern occur at military bases in San Diego, Seal Beach, and Vandenberg Air Force Base. Midway Atoll NWR, a Naval Air Station until it was decommissioned in 1998, supports the largest Laysan Albatross colony in the world despite the loss of tens of thousands of nesting birds during the 1960s in military control programs intended to ensure aircraft safety.

Towers, Powerlines and Obstructions

Obstructions to bird flight are increasingly common features of the land- and seascape. Long recognized as a hazard to migrating landbirds, ill-placed powerlines and other tall structures, sometimes lit and with guy wires, are hazards to seabirds as well. The imminent likelihood of wind turbine development along coastlines and offshore raises new concerns.

Studies have documented lighting and power line impacts to Newell's Shearwaters.[171] During the first nocturnal flights of fledglings from nests to the ocean, a high percentage ($\geq$2 to $\geq$10 %) of fledglings were reported disoriented by man-made lighting and killed while colliding with lights, utility poles, wires, buildings, and automobiles. The Save Our Shearwaters Program that was initiated on Kaua`i in the 1970s has rescued more than 30,000 Newell's Shearwater fledglings that would otherwise have perished because of this coastal development. Contrary to recommendations by the Avian Power Line Interaction Committee, wide spacing of power transmission lines appeared to increase collisions of shearwaters and petrels during their nocturnal and crepuscular flights to and from colonies. Wide spacing seemed to increase the incidence of

[168] See discussion in Carter *et al.* 2001

[169] Harrison 1990, Podolsky *et al.* 1998

[170] Speich and Wahl 1989

[171] Podolsky *et al.* 1998, Ainley *et al.* 2001

collisions as birds attempted to avoid hitting one line only to hit another. Burying power lines is recommended for particular hot spots.

Lighting on towers may also affect other seabirds such as the Hawaiian Petrel.[172] The increased intensity and duration of lighting may be an attractant, becoming more problematic if towers are supported by guy wires. Reducing light intensity, reducing light duration (*e.g.,* using minimum intensity white strobes that flash once per 3 seconds), shielding lights from shining upward, using lattice or monopoles as opposed to guyed towers, and deploying bird deterrents (*e.g.*, flappers, marker balls, or swivels on towers which must be guyed) all merit additional research and may be of promise in minimizing collisions by seabirds.[173] In experimental areas, light shielding was shown to reduce attraction by as much as 40% while reducing light intensity also lowered deaths significantly. Proposals to build new communication towers or structures near seabird nesting colonies should be un-guyed and preferably unlit. The Service has prepared voluntary communication tower guidance to help reduce and avoid problems with strikes (http://migratorybirds.fws.gov/issues/towers/comtow.html).

The development of strings of wind turbines along coastlines and off-shore could be a source of mortality in the near future. Where wind energy is being considered, care should be taken to avoid using guy-wire structures to support meteorological towers and wind turbine nacelles. While European research indicates some problems with offshore wind developments (*e.g.*, site avoidance and disturbance, and varying degrees of strikes), virtually no research has been conducted in this Region to assess potential problems. Offshore wind energy generating facilities should be scrutinized carefully, preceded preferably by detailed surveys, site assessments, and evaluations.

Global Climate Change

Sea-surface temperatures have risen 1°C over the past century and are expected to increase by up to another 3°C over the next 100 years if current trends continue. These increases in temperature can reduce the availability of phytoplankton, a major source of food for small schooling fishes that are in turn preyed upon by a variety of seabirds, producing a cascading effect at higher trophic levels. Declines in breeding populations and reproductive success attributed, at least in part, to the effects of global warming have recently been documented at seabird breeding colonies in the Arctic and Antarctic. Sea-level rise associated with global warming could significantly diminish the availability and quality of coastal nesting habitat. The low-lying islands and atolls of the tropical Pacific are among the world's most threatened by such inundation.

[172] Banko *et al.* 2001

[173] Manville in press

Current USFWS Monitoring and Management Program

The Service's conservation activities in the Region can be summarized in two broad categories: monitoring and management.

Inventories, Monitoring, and Special Surveys

During the past 30 years, population inventories have been conducted, at least once, for all accessible seabird breeding colonies in the Region. Initial inventories of the west coast states (California, Oregon, Washington) during the 1970s and early 1980s, provided a complete inventory of seabird nesting colonies along the continental U.S. west coast including Alaska. Subsequent inventories were generally coordinated at the state, island, or archipelago scale. More intensive monitoring has focused primarily on breeding population trends and reproductive success for selected species at a few locations.

Threatened and endangered species are monitored according to recovery plan guidelines. The majority of the monitoring programs for non-listed species have been organized and coordinated at the NWR level or they have been associated with specific projects such as oil spill monitoring. Coordinated range-wide inventories for seabirds are rare, but they have been conducted for declining species in association with species status assessments; however, many status assessments rely on existing population information rather than new survey data.

Seabird data derived from these programs are managed/stored at the NWRs, although several NWRs (most notably Pacific Remote Islands NWR Complex, Midway Atoll NWR, and Oregon Coast NWR Complex) enter data into the Pacific Seabird Monitoring Database developed under the auspices of the Pacific Seabird Group and USGS-BRD.

Inventories

The goal of an inventory is to identify all colonies within a given area and enumerate the total breeding population (*e.g.,* breeding birds, pairs, or nests) at each colony. They provide a broad representation of the resource and delineate the distribution and abundance of breeding birds. The disastrous oil spills during the 1960s and 1970s killed large numbers of seabirds and highlighted the need for comprehensive information on the distribution and abundance of seabirds along the West Coast. In response to this need, the Service, Minerals Management Service (MMS), and the Bureau of Land Management - Outer Continental Shelf Office funded a series of surveys to inventory and catalog seabird colonies.

Seabird colonies along the California coast were inventoried between 1975-1980 and reported in the *Catalog of California Seabird Colonies*.[175] The Service and MMS funded another complete seabird inventory of California in 1989-1991 which produced a draft report: *Breeding Populations of Seabirds in California, 1989-1991.*[176] The Service also commissioned an inventory of Oregon seabird colonies, conducted in 1979. An unpublished draft colony catalog was produced: *Oregon Seabird Colony Catalog*.[177] Oregon Coast NWR Complex completed another inventory in 1988.[178] In Washington, Speich and Wahl (1989) compiled information from numerous sources to complete the *Catalog of Washington Seabird Colonies*. This report summarized colony surveys conducted between 1978 - 1982.

Migratory Birds and Habitat Programs is working with NWR staff and other cooperators to update and disseminate colony catalog information. Data are being compiled in GIS databases that are compatible with seabird colony catalog information for Alaska,

[175] Sowls *et al.* 1980

[176] Carter *et al.* 1992

[177] Varoujean and Pitman 1980

[178] USFWS in prep.

Russia, and other north Pacific Rim states/nations. Cataloging of more current California and Oregon seabird colony data is underway. These efforts are being coordinated with the Service's Region 7 (Alaska), and other federal and state land management agencies. Ultimately, colony catalog information with mapping capabilities will be available on the web.

Surveys of the central Pacific Islands were conducted during the 1960s as part of the DOD-funded Pacific Ocean Biological Survey Program (POBSP). The POBSP conducted extensive surveys and research of Pacific seabird distribution, numbers, movements, and natural history. Results of these surveys were published for many individual islands, or island groups, however, a comprehensive catalog of seabird colonies in the USPI was not compiled. In 1975, a formal agreement among the Service, NMFS, and Hawai`i Department of Land and Natural Resources was established to survey and assess the marine resources of the Northwestern Hawaiian Islands. An inventory of all seabird colonies from Nihoa to Kure was conducted between 1978-1982. These data were combined with data collected by Service research scientists and state biologists working on the main Hawaiian Islands, to produce a *Draft Atlas of Hawai`i Seabird Colonies*.[179] A final Atlas or Colony Catalog was never published but summaries of the data were presented in various publications (*e.g.* Harrison *et al.* 1984).

The Service commissioned a study (1975-1976) to document the status of wildlife and wildlife habitats of American Samoa, including seabirds.[180] The status and conservation of seabirds in the Mariana Islands was synthesized and reported by CNMI biologists from data collected during the period 1979 - 1988.[181] There are very little data for the other more isolated USPIs in the central Pacific, except Johnston Atoll. The Service has maintained a small staff at Johnston Is. NWR since 1982 and inventories of all nesting seabirds are available for this atoll.[182] A NWR was established at Palmyra Atoll in 2002 and year-round data on seabird populations were collected for selected seabird species for the first time in 2002/2003.[183] Access to Howland, Baker, and Jarvis NWRs is extremely difficult and costly, and surveys have been conducted opportunistically whenever biologists can access the islands. It is unknown if any of these visits coincided with peak numbers of nesting seabirds.

Population Monitoring

Inventories provide invaluable information on seabird distribution and abundance at a large-scale. However, the large-scale inventories are insufficient to accurately detect or monitor population trends. Given the long life span, low fecundity, and high adult survival typical of seabirds, very small annual changes in breeding populations may signal profound long-term changes in population growth rates. Rigorous collection of population data is needed to accurately detect these trends but is currently conducted at very few sites.

California Current System. Seabird population monitoring along the West Coast has traditionally been coordinated at the NWR- or state-level and has focused on a relatively small group of highly visible, surface nesting species (*e.g.,* murres and cormorants).

Common Murres are the most abundant breeding seabird in the Region and their breeding populations have been monitored via aerial photography of the colonies since 1979. Washington has conducted annual aerial surveys since 1979 and Oregon since 1986. Surveys began in California in 1979, but they were conducted sporadically until 1993 when annual surveys began. All major colonies are photographed during each survey and the photographs are labeled and archived. A synthesis of Common Murre data from the 1970s through 1995 is summarized in *Biology and Conservation of the Common Murre in California, Oregon, Washington, and British Columbia. Volume 1: Natural History and Population Trends.*[184] Washington is the only state where all colonies are counted annually (USFWS unpubl. data, Washington Maritime NWR), but

[179] USFWS 1983c
[180] Amerson *et al.* 1982
[181] Reichel 1991
[182] USFWS unpubl. data
[183] Depkin 2003
[184] Manuwal *et al.* 2001

<2% of the Region's murre population breeds in Washington. In Oregon and California, a subset of the colonies is designated for annual counts. Counting murres from aerial photographs is more accurate than visual estimates but it is extremely labor intensive and counts of the designated colonies are years behind schedule. There is a great need to develop a less labor intensive method of monitoring this key species.

Brandt's and Double-crested Cormorant colonies from California through Oregon are photographed each year, and the photographs are labeled and archived. A subset of the colonies have been counted every year since 1988 and 1991, in California and Oregon, respectively.[185] As with the murre surveys, colony counts from aerial photographs are labor intensive and some counts are completed years after the survey flight. All major cormorant colonies along the outer coast of Washington were surveyed and counted annually between 1979 - 1991. On NWR islands in Puget Sound and the Straits of Juan de Fuca, cormorant colonies have been monitored annually since 1983.

In 2003, the Service coordinated surveys of Brandt's and Double-crested Cormorants in California, Oregon and Washington to assess the current status and distribution of these two species. Pelagic Cormorants were also surveyed in Oregon and Washington. Efforts to complete the cormorant surveys in Mexico are planned for 2005.

At Washington Maritime NWR breeding populations of Pigeon Guillemots and Rhinoceros Auklets are also monitored at regular intervals. Adult Pigeon Guillemots are counted annually on the water adjacent to the major colonies, using standardized protocols. Between 1999-2003, biologists from the Service, Washington Department of Fish and Wildlife, and private parties collaborated to inventory Pigeon Guillemots throughout the inner marine waters of Washington. As a result of this effort, the estimated population for this area increased approximately 4-fold (4,000 to 16,000).[186] This increase was not reflective of an increase in the guillemot population but rather the result of application of science based, standardized protocols over a large area.[187] Rhinoceros Auklet breeding populations are monitored at Protection and Destruction Island NWRs (the largest colonies in the Region) at irregular intervals (four surveys between 1983 - 2003) through burrow counts and estimates.

The most intensive population monitoring along the U.S. West Coast occurs at Farallon NWR where a cooperative agreement between the Service and PRBO Conservation Science (formerly Point Reyes Bird Observatory) has resulted in long-term population monitoring of selected species. Since 1971, eleven seabird species have been monitored: Ashy and Leach's Storm-Petrels; Brandt's, Double-crested, and Pelagic Cormorants; Western Gulls; Common Murres; Pigeon Guillemots; Cassin's and Rhinoceros Auklets; and Tufted Puffins.[188] Under the Service-PRBO cooperative agreement, annual estimates of breeding population size and reproductive success are provided; detailed protocols have been established and are implemented for this monitoring.

Coastal gulls and terns are monitored on NWR lands at San Diego, San Francisco, and Humboldt bays, CA. At San Francisco Bay NWR, seabird colonies are monitored by the San Francisco Bay Bird Observatory, through a cooperative agreement with the Service. In southern California, tern and skimmer colonies are closely monitored on NWRs, but monitoring of colonies on non-NWR lands is intermittent. Since 1997, USGS has annually monitored Caspian Terns in the Columbia River estuary in association with research to determine the magnitude and significance of tern predation on ESA listed salmonid smolts.[189]

The Service, in conjunction with the states, federal agencies (including the military), and other researchers, annually monitors populations of ESA listed species (*e.g.,* Brown Pelicans, California Least Terns and Marbled Murrelets). Brown Pelicans are monitored at the California breeding colonies and during post breeding migration in Washington and Oregon.

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[185] USFWS unpubl. data, Carter *et al.* 1992, Wilson 1991

[186] Evenson *et al.* 2002

[187] D. Nysewander, Washington Department of Fish and Wildlife, pers. comm., 2004

[188] Ainley and Boekelheide 1990

[189] Roby *et al.* 2002; Collis *et al.* 2003

USPI. Seabird monitoring in the tropical and subtropical islands of the central Pacific presents some unique challenges compared to the temperate species of the CCS. Several seabird species breed year-round in the tropics, and some species successfully reproduce more than one brood per year. Monitoring efforts are concentrated at four NWR locations: Tern Is. (French Frigate Shoals), Laysan Is., and Midway Atoll NWRs in the northwestern Hawaiian Islands and Johnston Is. NWR, in the central Pacific. Year-round Service staffing of Palmyra NWR started in 2002 and the establishment of a research station in 2005, with seven participating academic institutions and museums, will increase the probability that comprehensive monitoring of Palmyra seabirds will continue. Permanent Service staff have been stationed at Tern Is. and Midway Atoll since 1979 and 1992, respectively. A field camp has been staffed year-round at Laysan Is. since 1991. Breeding populations of Black-footed Albatross have been counted every year at each site since 1992. This effort represents a count of ~75% of the world breeding population. Laysan Albatross breeding populations are counted at least every five years at Midway. They are sampled every year at Laysan and at French Frigate Shoals they are counted annually. The Service and USGS are collaborating to design a more detailed albatross monitoring program with standardized protocols to determine albatross population trends and adult survival.

At Tern Is. and Johnston Atoll, breeding populations have been monitored year-round for all seabird species since 1980 and 1987, respectively (USFWS unpubl. data). At Midway Atoll, year-round monitoring of breeding populations of several species started in 1989.

Detailed Demographic Monitoring

Washington Maritime NWR Complex and Farallon NWR are the only locations in the CCS where long-term programs to monitor other demographic and life history parameters have been implemented. At Washington Maritime NWR, Rhinoceros Auklet reproductive success and chick growth rates are monitored at Protection Is. NWR.

The most intensive demographic studies for seabirds occurs at Farallon NWR where PRBO studies seven species (Ashy Storm-Petrels, Brandt's Cormorants, Western Gulls, Common Murres, Pigeon Guillemots, Cassin's and Rhinoceros Auklets). For many species, banding programs were established in the early 1970s to provide estimates of annual and age-specific survivorship, breeding propensity (the probability of attempting to reproduce), reproductive success, recruitment, and age-at-first-breeding. These data have been synthesized in population models to estimate rates of population growth/decline and evaluate population viability. In addition, PRBO studies the diet of six species (Brandt's Cormorants, Western Gulls, Common Murres, Pigeon Guillemots, Cassin's and Rhinoceros Auklets) and collects information on atmospheric and oceanographic conditions daily. Special studies and investigations on numerous aspects of seabird ecology (energetics, effects of sub-lethal oiling, assessing contaminant levels in eggs, etc.) have also been conducted. this research emphasizes the effects of climate variability and change on seabird population biology and foraging ecology.

In the USPI, the most intensive population monitoring is conducted at Tern Island, French Frigate Shoals NWR, where populations of 16 seabird species nesting on the island are censused at regular intervals throughout the year. Breeding chronology is recorded, and the reproductive performance of 11 species is monitored annually. At Midway Atoll NWR, breeding chronology is recorded for all species and reproductive performance and population size is measured for Laysan and Black-footed Albatrosses, Masked Boobies, and Christmas Shearwaters. Breeding populations and reproductive performance are monitored for Laysan and Black-footed Albatross at the colonies in the main Hawaiian Islands (Kilauea Point NWR and Kaena Point).

The Service is working with USGS to analyze 50 years of albatross banding data from the northwestern Hawaiian Islands. These data were collected by different researchers for various purposes over the years. USGS has compiled a database with all available bands and recoveries to see if population growth rates and adult survival can be derived from the data. In 2003, the Service compiled and computerized 25 years of Laysan and Black-footed Albatross data on breeding population counts and estimates, breeding phenology, reproductive success, incubation shifts, and other breeding parameters. These data will be analyzed and, along with the USGS demographic analysis of banding data, will form a basis for a status assessment for these two BCC species.

Status Assessments and Special Surveys

In addition to long-term monitoring, special surveys and assessments are designed specifically for ESA and BCC listed seabirds.

In 1995, the Service supported surveys of Xantus's Murrelets in the California Channel Islands and on Islas Coronados, Mexico to determine breeding distribution and abundance, and to assess conservation problems. In 1996, the Service also helped to support population viability analysis for Xantus's Murrelets and Ashy Storm-Petrels, conducted by PRBO. Both species are on the BCC 2002 list.[190] This status information was critical for a review of the petition to list Xantus's Murrelets under ESA that was submitted to the Service by the Pacific Seabird Group in 2002.

Due to the recent conflicts with endangered salmonid management in the Pacific Northwest, Caspian Terns are closely monitored by USGS. The Service annually compiles the results of Caspian Tern monitoring throughout the Region. In 2001, the Service coordinated a status assessment of Caspian Terns and conducted a review of Caspian Tern nesting habitat in the Region, to assess the feasibility of management opportunities.[191] In 2003, the Service coordinated with Mexico to conduct a range-wide survey of Western Gull-billed Terns. The results of this survey will provide baseline data for a status assessment of this rare tern.[192]

Contaminants Monitoring

Several of the largest seabird colonies are located on islands with ongoing or historic military activity. Contaminants are an issue at many of these locations. Pacific Remote Islands NWR Complex implements a research and monitoring program to compile baseline information on exposure levels in breeding seabirds, identifying the source of contaminants, and measuring the effects. Most of this work is conducted at Midway Atoll and Tern Is., French Frigate Shoals NWR. Heavy metals (*e.g.,* lead) and persistent organochlorine compounds have been found in high levels in seabirds. Contaminant monitoring of soils and prey resources are underway to determine the source of contamination. A proposal for clean-up of lead contamination at Midway Atoll has been approved.

Management

To date, the Service's management has focused primarily on acquisition and protection of breeding habitat; threat abatement; and environmental education and outreach.

Habitat Protection and Restoration

Nearly all of the major seabird colonies in the Region are protected by the Service, other federal agencies, territorial governments, or the states as NWRs, NPs, national monuments, state parks, sanctuaries, wildlife areas, etc. Most recently Palmyra Atoll was acquired as a NWR in 2001. There are still a few key colonies where seabird conservation is not a primary emphasis, (*e.g.,* Wake Atoll and Farallon de Medinilla, CNMI). Service efforts to secure protection for all important breeding and roosting sites is an ongoing activity.

Disturbance to seabird colonies during the breeding season can cause lowered reproductive success, breeding failure, and even colony abandonment. NWR staffs work with communities, industry, the military, and state agencies to educate these groups on the effects of disturbance, and to enforce regulations that protect nesting seabirds. For example, staff from Oregon Coast NWR Complex meet regularly with U.S. Coast Guard personnel regarding the effects of low level "fly-overs" on seabirds and provide guidelines to minimize this disturbance. Oregon Coast NWR Complex also worked with the state to create a buffer zone around the important seabird colonies at Three Arch Rocks NWR. Buoys are placed each spring to restrict all boat traffic within 500 feet of the rock during the breeding season. All seabird NWRs carefully regulate human entry into seabird colonies to minimize disturbance to nesting birds.

Due to the intrinsic isolation and rugged nature of most of the offshore rocks and islands, active habitat management is typically not necessary on most of the NWRs. Exceptions include the low inshore islands in bays and estuaries. For example,

[190] USFWS 2002, Sydeman *et al.* 1998

[191] Shuford and Craig 2002, Seto *et al.* 2003

[192] Palacios and Mellink 2003, Molina 2003

the San Diego Bay NWR Complex is preparing a Comprehensive Conservation Plan for Sweetwater Marsh and South San Diego Bay NWR. All habitat management and restoration alternatives in the plan include proposals for seabird conservation such as the expansion and creation of new nesting sites and nesting substrate enhancement. Projects already underway include annual vegetation management at nesting areas and the addition of clean coarse sand on the tops of levees within the salt ponds of the south bay. The levees in south bay also provide relatively safe roosting areas for many species of seabirds including California Brown Pelicans and cormorants. In USPI, extensive projects have been conducted at Midway Atoll NWR, Johnston Is. NWR, and Kilauea Pt. NWR to restore native vegetation to enhance seabird habitat.

Threat Abatement

Management activities directed towards limiting or eliminating threats include; invasive species control, coordinating with other agencies and industry to minimize the negative interactions between seabirds and fisheries, minimizing disturbance to colonies, response to oil spills, and identification and investigation of contaminant sites on NWRs. Considerable emphasis has been placed on the control and eradication of introduced species that threaten seabird populations. Control/eradication of introduced predators, herbivores, and specific invasive plants have been implemented in conjunction with projects to re-establish native vegetation and extirpated seabirds. The Service has conducted this work both on and off Service lands. Examples of these activities are discussed in the section on Threats: Introduced/Non-native Species. Aerial broadcast of toxicants is an important tool in the eradication of rodents from islands and the Service is working secure EPA registration for this use. Service activities with respect to oil spills and contaminants are ongoing.

The natural resource damage assessment and spill response program conducts spill response and associated injury assessment activities whenever released oil or toxic chemicals potentially or actually come into contact with birds. Through the damage assessment process, funds are obtained from the parties responsible for the releases, to restore injured natural resources, such as seabirds. For example, the Service is using restoration funds to reestablish a murre colony at Devil's Slide Rk. in central California.

Seabird bycatch in commercial fisheries and some sport fisheries continues to be a major source of mortality for some species. The Service is working at the Regional, Field Office and NWR level to address this issue. Activities include monitoring seabird populations to assess the impacts; coordinating with NOAA-Fisheries, the states and fisheries councils to develop regulations to minimize bycatch; training fisheries observers in bird identification; supporting research into new gear types or mitigation measures that reduce bycatch; and educating anglers, industry, and the public about the issue and potential solutions. Service staff are also represented on the Interagency Seabird Working Group with NOAA-Fisheries, Fisheries Councils, and Department of State to implement the National Plan of Action for the Reduction of Seabird Bycatch in longline fisheries.

Conflict Management

Today with so many species and ecosystems facing tremendous challenges, conflicts sometimes arise between conservation management for seabirds and other natural resources or human interests. Conflicts may range from the management of endangered species (*e.g.*, ESA listed salmonids and Caspian Terns in the Columbia River) to the protection of commercial or personal property interests (*e.g.*, Double-crested Cormorants foraging at aquaculture facilities and Glaucous-winged Gulls nesting on rooftops or foraging at landfills). Resource conflicts concerning seabirds typically involve coastal nesting species that forage in estuarine, freshwater, and even terrestrial habitats. These species can occupy highly altered ecosystems (*e.g.*, dredge material islands, large ports, and marinas) and may forage opportunistically in these and other altered landscapes. Conflicts also arise when ESA and BCC listed species compete among themselves or with other species for limited nesting habitat (*e.g.*, Southern California open beach habitat). There is considerable pressure to resolve these conflicts but the relationship between endangered species recovery and predators, including seabirds, is complex and not well understood. Similarly, the management of seabirds in highly altered landscapes presents unique challenges to resource managers.

Outreach and Education

Service personnel throughout the Region provide information on seabirds for tourists, community members, and students in grades K-12. Presentations and research lectures focus on seabird biology, monitoring, recovery efforts, threats, and the best places to view seabirds. Interpretive displays, guided birdwatching trips, workshops, and posters focus on seabird ecology and what boaters, fishers, pilots, and visitors can do to help protect seabirds. Several special programs such as the Common Murre Restoration Education Program at San Francisco Bay NWR serve to educate K-5 students about the hazards that face seabirds.

Goals and Objectives

The Service has trust resource responsibilities for the range-wide conservation of seabirds as well as site specific management responsibilities associated with the NWRS. Habitat management, threat abatement, population monitoring, and recovery of ESA and BCC listed seabirds represent responsibilities that require a broad range of activities to affect the desired response and to support informed management decisions. In this Section we identify and group primary goals and objectives to address these responsibilities and needs under the broad categories of:

- management
- inventory & monitoring
- research
- education & outreach
- planning and coordination

These goals and objectives represent activities the Service views as key components of seabird conservation. They may be addressed or implemented by various Service programs and divisions including Migratory Birds and Habitat Programs (MBHP); National Wildlife Refuge System (NWRS); and Endangered Species, Environmental Contaminants, and Habitat Conservation (AES). Lead programs/divisions are identified after each objective. Many of these activities, particularly in the areas of management and monitoring, are critical conservation needs. Some activities are implemented on an ongoing basis (*e.g.* technical support and interagency coordination) while others are discreet actions with measurable outcomes (*e.g.* rat eradication). In most cases, implementation will be dependant upon annual budgets and increasingly, the cooperation and collaboration of other public agencies and partners with a stake in seabird conservation.

This list represents a comprehensive overview of seabird conservation needs in the CCS and Pacific Islands expressed as goals and objectives. Species specific conservation recommendations can be found in the individual Species Accounts. Objectives that the Service considers to be high priority for implementation (*i.e.* in fiscal years 2005 and 2006) are identified with a "[2005-2006]" notation at the end of the objective statement. Regularly occurring activities are noted as "[Ongoing]". Out-year priorities stemming from the goals and objectives presented in this plan will be identified in Biannual Strategic Plans for the Pacific Region's seabird conservation program. Biannual Strategic Plans will serve to update and focus Service seabird conservation activities, budget allocations, and budget requests on those activities that are deemed the highest priority. Biannual priorities may include activities that address immediate threats to seabirds, those representing common interests among partners, and those necessary to inform management. While these goals and objectives were developed to guide Service efforts in seabird conservation, they are also intended to clarify our roles, and responsibilities to our partners, and to facilitate a partnership approach to seabird conservation at an ecosystem scale.

Management

Goal 1. Habitat Management - Maintain, protect and enhance seabird habitats (breeding, roosting, foraging, migrating and wintering) in sufficient quantity and quality to meet seabird needs.

Most of the important nesting and roosting areas in the Region have been identified for the more readily observable seabird species and the information is compiled in published or unpublished Seabird Colony Catalogs. Information on important foraging and wintering habitats are not as well defined. For several of the ESA and BCC listed species, information on breeding habitats is insufficient for management purposes.

Objective 1. a. Identify and protect important breeding, roosting, and foraging habitats through acquisition, easement, overlay NWR, special designation (*e.g.*, marine protected area), regulation, cooperative agreements, etc.

i. Identify important breeding habitat for poorly known species, emphasis on ESA and BCC species. Projects include, but are not limited to:

   (1) Hawaiian Petrel, Newell's Shearwater and Band-rumped Storm-Petrel [AES/MBHP; ongoing]
   (2) Tahiti and Herald Petrels, Audubon's Shearwater and Polynesian Storm-Petrel [AES/MBHP]
   (3) Gull-billed Tern [MBHP/AES; 2005-2006]

ii. Compile and prioritize a list of highest priority sites in need of protection and work with partners to establish protected status. [MBHP/AES/NWR; 2005-2006]

   Known sites in need of protection include but are not limited to:

   (1) Tern nesting habitat in southern and central California (*e.g.*, Port of Los Angeles, Santa Ana River mouth, and Alameda Point).
   (2) Newell's Shearwater nesting habitat on the island of Kaua`i.

iii. Coordinate with Tribes on a cooperative management plans or other means to protect seabird colonies on tribal lands (*e.g.*, Chief's Island, OR [NWR; ongoing]

iv. Coordinate with other federal and state agencies to protect important seabird colonies (*e.g.*, DOD to protect colonies on military bases [*e.g.*, Wake Atoll]; U.S. Army Corps of Engineers for colonies in the Columbia River estuary). [AES/NWR/MBHP; ongoing]

v. Develop and maintain a GIS database of all seabird breeding locations and key roost sites in the Region, with information on ownership and protected status. Integrate this with the Seabird Colony Catalog Database (Obj. 6.b). [MBHP/NWR/AES; 2005-2006]

vi. Coordinate with other state and federal agencies, conservation organizations, researchers, and other stakeholders to identify and protect important marine foraging habitats. [MBHP/NWR/AES; ongoing]

Objective 1. b. Protect seabird habitats from adverse human impacts such as disturbance through regulation, cooperative agreements, buffer zones, restricted access, public outreach, enforcement, etc.

i. Coordinate with the military to minimize disturbance to breeding seabirds in areas affected by military operations, such as overflights, base and maintenance operations, and live fire training exercises. [AES/NWR/MBHP; ongoing]

ii. Coordinate with State, City and County wildlife and beach management agencies to minimize disturbance to west coast tern nesting areas *e.g.*, seasonal fencing, restricted access, modification of beach raking practices [AES; ongoing]

iii. Work with the general public, industry, government agencies, and NGOs to minimize disturbance to colonies. [NWR/AES/MBHP; ongoing]

Objective 1.c. Restore lost or degraded seabird habitats. Specific projects include but are not limited to:

i. Restore, protect and maintain sandy beach, dune, and other open habitats preferred by coastal terns in central and southern California (*e.g.*, sites in San Diego Bay, Seal Beach NWR, Bolsa Chica Restoration Project, Ormond Beach, Alameda and San Francisco Bay). [AES/NWR/MBHP; ongoing]

ii. Eradicate or control invasive vegetation that degrades seabird nesting or roosting habitat (*e.g.*, golden crown-beard and bufflegrass in the northwestern Hawaiian Islands; iceplant and European beachgrass along west coast beaches; and, invasive grasses, New Zealand spinach and cheeseweed at Farallon NWR). [NWR/AES/MBHP; ongoing]

iii. Restore native habitat that has been lost or degraded at important seabird sites such as Midway Atoll NWR (coordinate with DOD). [AES/NWR/MBHP; ongoing]

iv. Remove or ameliorate hazards to seabirds at nesting and roosting sites such as concrete structures at Southeast Farallon Island; unnecessary buildings and other structures at Midway Atoll and Johnston Is. NWRs. [NWR; ongoing]

Goal 2. Invasive Species Management - Eradicate or control introduced predators and other invasive species that have negative impacts on seabird populations.

Most control and eradication projects are multi-year undertakings and require the support and coordination of other public and private partners at the local, regional, and international scale. A more complete list of invasive species problems in the Region is contained in Appendix 9. Objectives for eradication of invasive plants are included under Goal 1 (Habitat Management).

Objective 2. a. Plan and implement programs to eradicate non-native predators from key seabird colonies. The Service's top priority sites are listed in Table 7. Implementation of these projects is pending funding.

i. Develop a plan and supporting NEPA documentation for the eradication of rats from Palmyra. [NWR/AES/MBHP/partners; 2005-2006]

ii. Develop a plan and supporting NEPA documentation for the eradication of rats and rabbits from Lehua. [AES/MBHP/partners; 2005-2006]

iii. Work with DOD and USDA to secure funds to implement the existing plan to eradicate rats from Wake [AES/MBHP; pending funding and cooperators schedule]

Objective 2. b. Where eradication programs are not feasible, work with partners at the local scale to control introduced, feral, domestic, and non-native species in the vicinity of seabird colonies.

i. Continue ongoing control programs for predators along the west coast (CCS) and the main islands of the USPI (*e.g.*, Kilauea Pt. Kaua`i and California tern colonies). [NWR/AES; ongoing]

ii. Control non-native cats, dogs, rats, mongoose, Cattle Egrets, and Barn Owls in Hawai`i where they negatively affect seabird populations, especially in Newell's Shearwater and Hawaiian Petrel colonies. [AES/NWR; ongoing]

(1) Continue support of programs to control predators at specific Kaua`i colonies to protect endangered species. [AES/partners; 2005-2006]

iii. Complete NEPA documentation, site specific plans, and secure funding for control of mammalian predators at Oregon Islands NWR, Three Arch Rocks NWR, and adjacent mainland areas. [NWR; 2005-2006 (plan and NEPA); implementation pending funding]

Objective 2. c. Fence and remove feral ungulates from forest habitats of Hawai`i NWRs, to restore habitat for petrels, shearwaters, and other native species. Eradicate feral ungulates and other herbivores from small islands where possible. [NWR/AES; ongoing]

i. Complete and implement a plan and supporting NEPA documentation for the eradication of rabbits from Lehua. [AES/MBHP; 2005-2006 (plan and NEPA); implementation pending funding]

Objective 2. d. Work with USPI territorial and commonwealth governments, to reduce impacts of introduced predators and ungulates on seabird habitats. [AES/MBHP; cooperators schedule]

i. Work with the governments of Guam and CNMI to investigate the potential for eradication of feral ungulates and introduced predators at Cocos (Guam) and select northern Mariana islands. [AES; 2005-2006]

ii. Provide technical assistance and support to NPS and the Government of American Samoa in their efforts to develop and implement plans to control predators in shearwater and petrel colonies on the main islands. [AES/MBHP; ongoing]

Objective 2. e. Coordinate with Canada, Mexico, and island nations of Oceania to control or eradicate introduced species on all islands where they negatively affect seabirds with emphasis on BCC and ESA listed species and shared seabird resources (*e.g.*, Phoenix and Tahiti Petrels, Band-rumped and Polynesian Storm-Petrels, Least and Gull-billed Terns, Brown Pelicans, Xantus's and Craveri's Murrelets). [MBHP/AES/NWR; ongoing]

Objective 2. f. Work with partners to develop a comprehensive analysis of introduced predators at island colonies within the Region and adjacent countries with shared seabird resources. [MBHP/AES]

i. Compile available data necessary to prioritize eradication projects.

ii. Develop a systematic plan to eradicate introduced predators from all small and medium islands in the Region.

iii. Seek cooperators and funding to implement priority predator control projects.

Objective 2. g. Obtain Special Local Need registration under Section 24c of FIFRA for aerial broadcast of diphacinone in Hawai`i. Support national effort to obtain EPA registrations for conservation use of diphacenone and brodificoum on islands. [AES; ongoing]

Objective 2. h. Support research to determine the effects of invasive species (especially invertebrates) on seabirds and their habitats; and, research into the development of new technologies to eradicate or control these species. Projects include, but are not limited to:

i. Research the effects and control of introduced scale insects at Rose Atoll and Palmyra NWRs where they are causing the destruction of the pu'avai (Pisonia) forests [NWR/USGS; ongoing]

ii. Research the effects and control of introduced grasshoppers at Nihoa NWR where they defoliate the island during population eruptions. [NWR]

iii. Research the effects and control of introduced ants at all USPIs where they directly attack seabirds and facilitate scale insect invasions. [NWR/AES]

iv. Research efforts to eradicate mosquitoes at Midway NWR where they are vectors for diseases such as avian pox and potentially West Nile Virus. [NWR/AES]

v. Research the control and eradication of invasive plant species such as golden crown-beard. [NWR/AES]

Objective 2. i. Develop operational programs including SOPs to prevent introductions of invasive species and to detect predator and invasive species "spills" at island colonies.

i. Prepare Response Plans that outline actions and responsible parties in the event of an introduction. Continue to coordinate this work with ongoing interagency efforts with Region 7 (Alaska), USGS, USCG, and other partners. [AES/NWR]

ii. Assess the need and, if deemed necessary, develop and implement SOPs for Service staff, researchers, and visitors regarding movement of personnel and gear to seabird islands to limit the potential for new introductions of invasive species. [NWR/AES]

iii. Conduct regular inventories to identify sites where invasive species are established, especially those sites where the population is still relatively small and restricted such that eradication efforts would be most cost effective. [NWR/AES; ongoing]

Goal 3. Seabird Bycatch - minimize bycatch and other negative impacts of fisheries interactions on seabird populations in coordination with other agencies, fisheries councils, industry, research scientists, and other partners.

Authorization and regulation of fisheries are the responsibility of various federal and state agencies (*e.g.*, NMFS and state fish and wildlife/game agencies) and the Tribes. The Service will work with these agencies, Tribes, and the Fisheries Councils to provide technical expertise regarding seabirds and to develop workable solutions in situations where fishing operations have negative impacts on seabirds. Quantifying the effects of fisheries interactions on seabird populations, requires coordination between all parties.

Objective 3. a. Assist in the development a National Waterbird Bycatch Action Plan to implement Service policy regarding elimination of seabird bycatch in fisheries. [DMBM/MBHP; 2005-2006]

Objective 3. b. Provide technical assistance to states and NOAA-Fisheries in the identification of fisheries that threaten seabirds and in the development and implementation of observer programs for fisheries that have known or high potential for seabird bycatch and other negative interactions. [AES/NWR/MBHP; ongoing]

Objective 3. c. Provide technical assistance to Fisheries Councils, industry, fishers, federal and state agencies, Tribes, and other stakeholders in support of workable solutions and studies to develop new gear, fishing techniques, and/or mitigation measures to reduce and eliminate bycatch and other negative interactions between fisheries and seabirds. [AES/NWR/MBHP; ongoing]

Fisheries of highest priority include but are not limited to:

i. West Coast groundfish and halibut fisheries - longline, trawl, and gillnet

ii. Highly Migratory Species fisheries based along the West Coast

iii. Hawai`i based longline fisheries for tuna and billfish

iv. Salmon gillnetting in the Pacific Northwest

v. West Coast squid fisheries and the effects of bright lights

vi. Recreational hook and line fishery

Objective 3. d. Review Fisheries Management Plans prepared by the states and Fisheries Councils to identify conflicts and recommend measures to reduce seabird impacts. [AES/MBHP/NWR; ongoing]

Objective 3. e. Conduct outreach to fishers regarding threats to seabirds and measures to minimize the problem. [AES/MBHP; ongoing]

Goal 4. Oil Spills - Improve the effectiveness of spill response efforts and work with other response agencies to minimize the impacts of a spill to seabirds and other wildlife.

The Service has responsibilities to protect seabird resources and to respond to oil and hazardous material spills. There is a Regional Oil and Hazardous Substance Spill Contingency Plan (rev. 1997) but there is a need to develop a regional "strike team" that can mobilize quickly and has the training, equipment, and experience to respond to these emergencies.

Objective 4. a. Establish a regional strike team to respond to oil and hazardous substance spills. This team will need training (*e.g.*, hazardous materials handling, animal handling, sampling protocols, incident command), equipment (personal protective gear, sampling, vehicles), funding, and the flexibility within their other duties to respond immediately to an incident. [AES/NWR]

Objective 4. b. Increase the Service's role in spill prevention and pre-spill planning activities, including development and revision of Area Contingency Plans, coordination with the Coast Guard and other response agencies in Area Committees, and participation in spill drills. [AES/NWR; ongoing]

Objective 4. c. Develop a list of seabird restoration projects that is continually updated, to provide the Trustees information on highest priority restoration projects. [AES/MBHP; 2005-2006]

Objective 4. d. Refine methods to document seabird mortality after oil spills. Support studies to improve the accuracy of models *e.g.*, factors that influence beached bird data such as searcher efficiency, scavenging, and carcass movement studies. [AES/MBHP; ongoing]

i. Develop protocols and models to assess impacts of oil spills in the USPI. [AES]

Goal 5. Contaminants/Hazardous Substances Identify problems and work with partners to ameliorate the effects and clean-up contaminated sites that negatively impact seabirds.

Objective 5. a. Develop and implement a coordinated regional monitoring program for early detection of contaminant problems. Emphasis on ESA and BCC species. Program will include but not be limited to:

i. Periodic monitoring of contaminant levels in birds and eggs of nesting seabirds. [AES/NWR]

ii. Follow-up contaminants monitoring of birds affected by the Montrose contamination [AES]

Objective 5. b. Identify, eliminate and/or neutralize contaminant sources at seabird colonies, important roost sites, and foraging areas. Projects include but are not limited to:

i. Clean-up lead contamination at Midway Atoll NWR [NWR/AES; 2005-2006]

ii. Clean-up contaminated "dead zone" at Laysan NWR [NWR; ongoing]

iii. Complete military clean-up of Johnston Island NWR [NWR/AES/DOD; ongoing]

Objective 5. c. Support research into the source and effects of contaminants on seabirds.

i. Albatrosses and storm-petrels: effects and sources of organochlorine contamination. [AES/NWR/MBHP]

ii. Coastal terns: effects of pollution and contaminants in coastal estuaries on nesting terns [AES/NWR/MBHP]

Goal 6. Powerlines, Towers, Turbines, and Lights - Work with industry, state and federal agencies, and other stakeholders to minimize the effects of powerlines, towers, wind turbines, and lights on seabirds.

Objective 6. a. Work with the state of Hawai`i, Kaua`i Electric, and other partners to minimize the take of Newell's Shearwaters and Hawaiian Petrels in powerlines and lights. [AES; ongoing]

Objective 6. b. Develop recommendations for industry regarding the siting of offshore wind turbines to minimize the negative impacts on seabirds. [MBHP/AES]

Objective 6. c. Remove unnecessary buildings and other structures (*e.g.*, light poles, powerlines) at Midway Atoll and Johnston Island NWRs. [NWR; ongoing]

Inventory and Monitoring

A coordinated Region-wide program to assess the status and trends of Pacific Region seabird populations is essential to provide a scientific basis for management decisions. Development of this program will involve establishing and implementing standardized protocols for data collection, analysis, and reporting. The program design must be scientifically sound and statistically capable of detecting trends in sufficient time to implement warranted management actions. The program will comprise two major components: 1) inventories of all seabird colonies at long-term intervals (*e.g.*, 10 years), and, 2) intensive quantitative monitoring of specific demographic and life history parameters for a select group of breeding seabird species ("focal" species) at short-term intervals (*e.g.*, annual, biennial). The development and implementation of this program will need to be coordinated with other agencies and organizations that manage and study seabirds at the regional and international scales (*e.g.*, states, Tribes, NPS, BLM, CWS, CICESE, NGOs, universities). ESA listed species will be inventoried and monitored in accordance with respective recovery plans.

Goal 7. Monitor breeding seabirds - Design and implement a comprehensive monitoring program for breeding seabirds in the CCS and Pacific Islands in coordination with USGS, seabird scientists, and other public and private stakeholders.

Objective 7. a. Develop standard operating procedures for the periodic inventory of each seabird species, or species group in the CCS and USPI. [MBHP/NWR/USGS; 2005-2006]

Objective 7. b. Develop Seabird Monitoring Manuals for the CCS and USPI that identify standard operating procedures for data collection, analysis, and reporting necessary to monitor seabird population trends and selected demographic parameters within these two marine ecoregions. [MBHP/NWR/USGS; 2005-2006]

Objective 7. c. Implement the monitoring program upon completion of the manuals and incorporate a feedback loop for program evaluations. [NWR/MBHP/AES]

Objective 7. d. Periodically assess the monitoring program for sufficiency in meeting objectives and adapt protocols accordingly. [NWR/MBHP/AES]

Objective 7. e. Develop a "data management system" for storage and retrieval of seabird monitoring data, archiving photographs and maps, and cataloging raw data and reports to ensure that these data are accessible for analysis, interpretation, and distribution.

i. Coordinate with ongoing efforts towards a Biological Data Management System for NWRs, the Pacific Seabird Group Monitoring Database, and NBII. [MBHP/NWR]

ii. Submit summarized data to the Pacific Seabird Group Monitoring Database which will provide a mechanism for data dissemination to the public. [MBHP/NWR; 2005-2006]

Objective 7. f. Compile and disseminate existing seabird colony inventory information (Colony Catalogs) in electronic and printed formats using standardized GIS databases developed in coordination with the Service's Region 7 (Alaska).

i. Finalize and publish the Oregon Seabird Colony Catalog. [MBHP/NWR; 2005-2006]

ii. Compile and distribute updated California and Washington Seabird Colony Catalog information. [MBHP/NWR; 2005-2006]

iii. Compile and distribute Hawai`i and USPI Seabird Colony Catalog information. [NWR/AES/MBHP]

iv. Annually update and distribute current inventory data. [NWR/MBHP; ongoing]

Objective 7. g. Develop an interactive web interface with GIS mapping capabilities for the Pacific Region Seabird Colony Catalog Database, to provide access to data and integration with other North Pacific seabird colony data. Coordinate with ongoing efforts by NBII, USGS, and the Service's Region 7 (Beringian Seabird Colony Catalog).

i. Develop a data management system whereby Service personnel can enter new data and extract tabular and mapped information via the web or desktop platforms. [MBHP]

ii. Coordinate with NBII to maintain the website and update databases annually with latest inventory data. [NWR/MBHP]

Objective 7. h. Extract, compile, computerize, and disseminate existing survey and monitoring data contained in Service files. Enter these data into standardized GIS databases (*e.g.*, Seabird Colony Catalog Database, Pacific Seabird Monitoring Database)

i. Count archived Common Murre and cormorant aerial photographs, from 1980 through the present, from California and Oregon colonies. Highest priority to photographs taken 1995 through the present. [NWR/MBHP]

ii. Compile and computerize seabird monitoring data from the northwestern Hawaiian Islands from 1996 through the present. [NWR/MBHP]

iii. Compile, analyze, and report Service data for Laysan and Black-footed Albatross. [NWR/MBHP, 2005-2006]

Objective 7. i. Annually review and report the results of seabird monitoring.

i. Identify seabird species with unstable or declining populations and identify research needed to determine causal relationships. [NWR/AES/MBHP]

ii. Identify conservation and management actions. [NWR/AES/MBHP]

Objective 7. j. Coordinate and conduct comprehensive range-wide surveys for select species of management concern *e.g.*, ESA and BCC listed species, and overabundant species. [MBHP/AES/NWR; ongoing]

i. Complete a range-wide survey to assess the current status, distribution of the ESA listed California Brown Pelican [AES/MBHP; 2005-2006]

ii. Complete the range-wide survey for Brandt's Cormorants and the western subspecies of Double-crested Cormorants initiated in 2003 (California, Oregon, Washington) by conducting surveys of Mexican colonies. [MBHP/AES/USGS; 2005-2006]

iii. Coordinate with Mexican biologists to repeat the range-wide survey of Western Gull-billed Terns in California and Mexico [MBHP/AES; 2005-2006]

Objective 7. k. Complete Status Assessments for BCC species. [MBHP/AES/NWR; ongoing]

i. Complete a Status Assessment for Gull-billed Terns [MBHP; 2005-2006]

ii. Complete a Status Assessment for Black-footed and Laysan Albatross [MBHP/NWR/AES; 2005-2006]

Goal 8. At-sea monitoring - Develop a comprehensive program for monitoring seabirds at sea in coordination with NOAA-Fisheries, USGS, seabird scientists, and other public and private stakeholders.

Monitoring seabirds at colonies does not provide information about the millions of seabirds that migrate to the Region from other areas. Even for breeding species, monitoring at the colonies is limited to the breeding season and provides very limited data on foraging areas, feeding associations, threats at sea, etc. Data on at-sea distribution and abundance are critical for effective seabird conservation. For many species (*e.g.*, burrow and crevice nesting procellarids) surveys at sea may provide better data for assessing population status and tracking population trends.

Objective 8. a. Integrate seabirds into existing and planned at-sea monitoring programs (*e.g.*, PACOS, NOAA-Fisheries protected species surveys). [MBHP; ongoing]

Research

Research is an integral component of seabird conservation and management. The Service's needs will focus on research necessary to make informed conservation and management decisions. Priority will be given to BCC and ESA listed species, specifically to understanding the cause of low or declining populations and activities that will aid in recovery. However, this focus will not be so stringent as to excluded needed research for more common seabirds. Research will often go hand-in-hand with monitoring *e.g.*, investigating the causal relationships between changes in demographic parameters and environmental factors.

Goal 9. Identify and support research that furthers conservation or assists in the management or monitoring of Pacific seabirds.

Objective 9. a. Develop methods to monitor population trends for selected species where current methods are inefficient or inadequate.

i. Investigate new technologies for remotely counting and monitoring regionally important seabirds that nest in large, dense colonies (*e.g.*, Common Murres) and improve the efficiency of current methodologies. [MBHP/NWR]

ii. Investigate new technologies or adapt/refine existing technologies (*e.g.*, radar, at-sea surveys, mark/recapture) to ascertain trends for seabird species that currently are not reliably monitored (*e.g.*, burrow and crevice nesters) and ESA and BCC listed species (*e.g.*, petrels, shearwaters, storm-petrels, and murrelets). [MBHP/AES]

Objective 9. b. Conduct investigations to compile or synthesize biological information fundamental to seabird conservation and management for poorly known species (*e.g.*, basic life history traits, habitat requirements, reproductive biology, population status, etc.) Emphasis on BCC species.

i. Tristram's and Band-rumped Storm-Petrels are high priority species for investigations and baseline studies preliminary to development of Status Assessments. [MBHP/NWR/AES]

ii. Investigate at-sea distribution and movement patterns for key species such as albatrosses by age, sex, and breeding status to evaluate vulnerability to threats such as fisheries bycatch and contaminants. [MBHP]

iii. Analyze data from colony and at-sea surveys to assess population status and trends for select BCC species (*e.g.*, Ashy Storm-Petrels). [MBHP]

Objective 9. c. Work with partners to initiate studies into the interrelationships of seabirds and their environment: foraging areas and feeding ecology; distribution, abundance, and ecology of prey; response of seabirds and prey to large and small scale oceanographic and climatological cycles; and impacts of commercial fishing on prey abundance or availability. [MBHP/NWR]

Objective 9. d. Investigate the efficacy of DNA markers to determine a bird's colony of origin. This information is important when assessing the effects of threats such as oil spills and fisheries bycatch. [AES/MBHP/NWR]

Outreach and Education

Seabirds spend much of their life at sea or on isolated specs of land, out-of-sight and experience of most people. A "seagull" may be the only familiarity the average person has with seabirds. Educating the public to appreciate the unique characteristics of seabirds and the many threats that jeopardize their existence can provide great returns when agencies look for support for conservation activities or compliance with rules and regulations.

Goal 10. Educate the public - Develop a coordinated program about seabird resources in the Region, including seabird ecology, threats, and conservation issues that affect seabird populations.

Objective 10. a. Develop a K-12 curriculums on seabirds with specific chapters on the California Current System and tropical/subtropical island systems. [MBHP/NWR/AES]

Objective 10. b. Develop presentations about various aspects of seabird ecology, research, monitoring, threats, and other issues that can be distributed to NWRs and Service field offices. [MBHP/NWR/AES]

Objective 10. c. Develop a website dedicated to seabirds with links to current and recent investigations and monitoring. Include interactive teaching modules. [MBHP]

Goal 11. Increase opportunities for the public to view and experience seabirds

Objective 11. a. Provide interpretive displays, brochures, posters and other outreach materials.

i. Install interpretive panels at key access points along the coastlines where seabirds can be viewed or threats discussed (*e.g.*, problems with coastal nesting terns and disturbance). [NWR/AES/MBHP; ongoing]

ii. Establish remote camera systems on active seabird colonies to allow the public and students an opportunity to observe seabird behaviors. [NWR/MBHP]

iii. Develop watchable wildlife maps that show the best locations to view seabird colonies and roosts and individual species of seabirds without disturbing the birds. [MBHP/NWR]

iv. Design an "Oceans of Wings" poster that celebrates seabirds world-wide. [MBHP]

Objective 11. b. Increase the number and diversity of people reached by providing information about seabirds at visitor centers and public areas such as harbors, marinas, and piers. [NWR/AES/MBHP; ongoing]

Planning and Coordination

Seabirds are a shared resource. They cross international, state, Tribal, and agency responsibility boundaries. Careful planning and coordination are fundamental to successful conservation and management of seabirds throughout their life cycle.

Goal 12. Coordination with Partners - Coordinate with other countries, U.S. Territorial and Commonwealth governments, Tribes, federal and state agencies,

CONSERVATION AND INDUSTRY GROUPS, AND THE PUBLIC ON THE CONSERVATION AND MANAGEMENT OF SEABIRDS, AT THE INTERNATIONAL, NATIONAL, REGIONAL, AND LOCAL SCALES. EMPHASIS ON ESA AND BCC LISTED SPECIES AND SHARED SEABIRD RESOURCES.

Objective 12. a. Develop and implement seabird components of regional waterbird plans under the North American Waterbird Conservation Plan.

i. Foster the development of an international working group for the California Current System, to coordinate the development and implementation of regional waterbird and seabird plans. [MBHP/NWR/AES]

ii. Coordinate with partners in Hawai`i and the Pacific Islands to develop and implement a seabird component for the Regional Waterbird Plan for BCRs 67 and 68. [MBHP/NWR/AES]

Objective 12. b. Develop, Review and Revise Recovery Plans for ESA listed species as needed.

i. Assist in the development of a Recovery Plan for Short-tailed Albatross (Region 7 lead). [AES/NWR/MBHP; ongoing]

Objective 12. c. Biannually update a seabird conservation Strategic Plan to focus Service efforts on priority management, monitoring and research needs. [MBHP/AES/NWR]

Objective 12. d. Participate in working groups, interagency teams, professional societies (*e.g.,* Pacific Seabird Group), and other venues designed to further seabird conservation in the Region.

i. Participate in the North Pacific Albatross Working Group to facilitate communication and cooperation in the conservation of Laysan, Black-footed and Short-tailed Albatross. [AES/MBHP/NWR; ongoing]

ii. Participate in the development of an Oceania Flyway Working Group and continue participation in South Pacific Regional Environment Programme (SPREP) to further conservation of seabirds in Oceania. [MBHP/AES/NWR; ongoing]

iii. Provide input to the Service representative to NAFTA Trilateral Committee for Wildlife and Ecosystem Conservation for issues involving seabirds, to further seabird conservation efforts with Mexico and Canada. [MBHP/AES/NWR; ongoing]

iv. Establish contacts with ongoing seabird conservation efforts currently underway through groups such as BirdLife International, Audubon's Living Oceans, Wetlands International, etc. [MBHP; 2005-2006]

v. Continue support for development of a Central Pacific World Heritage Site. [MBHP/NWR/AES; ongoing]

Objective 12. e. Improve coordination on seabird monitoring and management issues within the Service and with other agencies/ landowners such as BLM, NPS, DOD, states, TNC, etc. [MBHP/NWR/AES; ongoing]

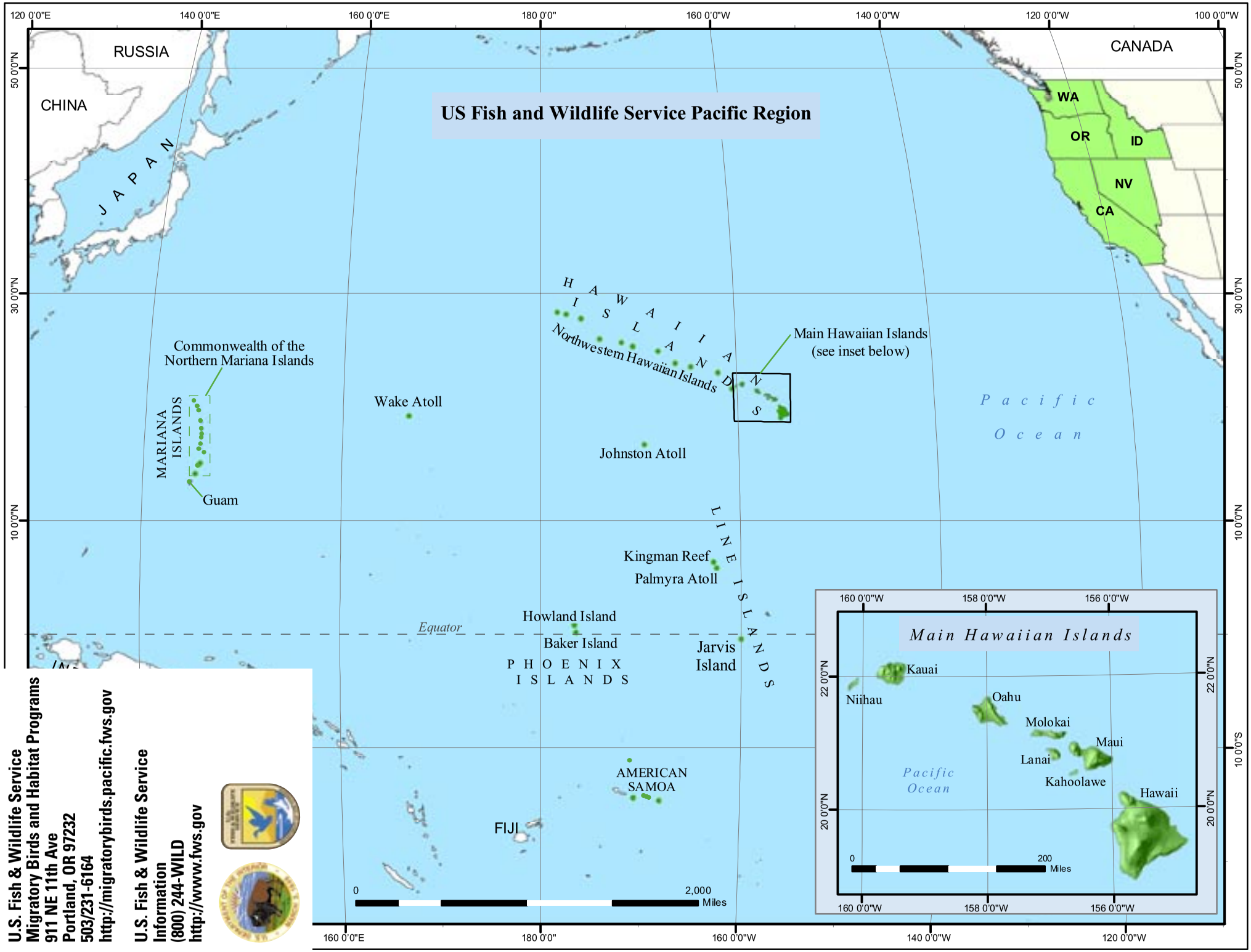
i. Improve coordination with NOAA-Fisheries on shared monitoring, management, and conservation issues.

(1) Participate in the Interagency Seabird Working Group (ISWG) to implement the National Plan of Action for the Reduction of Seabird Bycatch in Longline Fisheries (NPOA). [MBHP/NWR/AES; ongoing]

(2) Integrate Service activities with the developing NOAA-Fisheries Pacific Coast Ocean Observing System (PlCOOS) to include a monitoring program for seabirds at sea. [MBHP; 2005-2006]

(3) Technical assistance for observer programs that monitor the bycatch of seabirds in commercial fisheries. [MBHP/NWR/AES; ongoing]

ii. Improve coordination with USGS and support increased focus by this agency on key seabird issues. [MBHP/NWR/AES; ongoing]



U.S. Fish & Wildlife Service
Migratory Birds and Habitat Programs
911 NE 11th Ave
Portland, OR 97232
503/231-6164
http://migratorybirds.pacific.fws.gov

U.S. Fish & Wildlife Service
Information
(800) 244-WILD
http://www.fws.gov