United States Department of the Interior

FISH AND WILDLIFE SERVICE

911 NE 11th Avenue
Portland, Oregon 97232-4181

MAY 24 2004

MBSP/MBHP

Dear Colleague:

We are requesting your comments on the Draft Regional Seabird Conservation Plan (Plan) for U.S. Fish and Wildlife Service (Service), Region 1, by July 9, 2004. An Adobe (.pdf file) version of the Plan is available for download at the Service internet site http://migratorybirds.pacific.fws.gov/what's_new.htm. The purpose of this Plan is to identify Service goals and priorities for seabird conservation in the Pacific Region. The Plan will also serve to direct and coordinate Service activities towards seabird conservation in the future.

The Service cannot achieve conservation of seabirds alone. Seabirds cross international, state, and agency boundaries. Effective management depends upon the collective efforts of numerous individuals, organizations, agencies, and nations. Input from the many partners and stakeholders who have an interest in, a responsibility for, or are actively involved in seabird conservation is essential in the development of this Plan. We are requesting your help in reviewing and improving this Plan.

The Plan includes a comprehensive review of the seabird resources and their habitats in the Region, a discussion of threats and management issues, a summary of the current Service monitoring and management activities with respect to seabirds, and a prioritized list of monitoring, management, research, outreach, and coordination/planning goals and objectives. Also included are species profiles, with recommended conservation action items, for each of the 60 species of seabird that breed in the Region.

Please direct your questions and comments on the Plan to Maura Naughton, Regional Seabird Program Coordinator, Migratory Birds and Habitat Programs, 503-231-6164, maura_naughton@fws.gov, by July 9, 2004. If you would like a hard copy of the Plan or an electronic copy on CD, please contact Maura Naughton.

Sincerely,

Acting Regional Director

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DRAFT

REGIONAL SEABIRD CONSERVATION PLAN

U.S. FISH AND WILDLIFE SERVICE
PACIFIC REGION

Comments Due:

July 9, 2004

List of Authors

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

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EXECUTIVE SUMMARY

The USFWS Pacific Region (Region 1), 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 Hawaii and other U.S. Pacific Islands.

PURPOSE

The purpose of this Plan is to identify the Service's priorities for seabird monitoring, management, 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 monitoring, management, and outreach efforts. All species are prioritized by conservation concern at the regional scale and recommendations for conservation actions are identified and prioritized. Individual breeding species are discussed in brief species profiles that summarize current information on population size, status, ecology, distribution, habitats, and threats.

SCOPE

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

Sixty species of seabirds representing 3 Orders and 10 Families, nest in the Region including: 3 albatross,[1] 6 petrels, 4 shearwaters, 7 storm-petrels, 3 cormorants, 1 pelican, 2 frigatebirds, 3

[1] Short-tailed albatross have laid eggs at Midway Atoll but there is no documentation that these eggs hatched. Accounts of chicks fledging in the 1950s/60s have not been substantiated. They are included.

boobies, 2 tropicbirds, 5 gulls, 12 terns, 3 noddies, 1 skimmer, 1 murre, 1 guillemot, 3 murrelets, 2 auklets and 1 puffin. Many of these populations are of global or national importance. All species were classified according to regional conservation concern using the ranking system of the North American Waterbird Conservation Plan (Tables 2 and 3). Almost half (47%) of the seabird species breeding in the Region fall into the two highest categories of conservation concern: "Highly Imperiled" and "High Concern". Procellariiformes have the highest representation (75% of 20 species), including all albatrosses. Alcids are also heavily represented (62% of 8 species).

THREATS

The most serious threats to seabirds in the Region involve invasive (non-native) species, interactions with fisheries, oil and other contaminants, habitat loss and degradation, and disturbance. Invasive species, especially introduced predators have had devastating effects on seabirds worldwide, especially at island colonies. Introduced plants, herbivores, and insects have resulted in drastic habitat changes, often to the detriment of breeding seabirds. Thousands of birds are killed each year in interactions with fishing gear, especially longline and gillnet fisheries. Indirect effects of fishing activities, such as the bright lights of squid fishing operations in the vicinity of seabird colonies or overfishing of 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 could cause even greater mortality. Contaminants such as organochlorines and heavy metals caused major seabird declines historically and are still present and affecting seabirds both at sea and at the colonies. Habitat loss and degradation and human disturbance have resulted in population declines at the local and range-wide scales. As the human population continues to grow and increasing numbers of people reside near the coastlines, this will remain a continual challenge.

CURRENT USFWS PROGRAM

The Fish and Wildlife Service is the principal federal agency, in the United States, 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[2] (including Endangered Species, Environmental Contaminants, and Habitat Conservation branches); Law Enforcement; and the National Wildlife Refuge System. The largest seabird colonies in the Region are located on refuges and numerically, over 80% of the seabirds nest on these lands.

To date, Service activities have focused primarily on the protection and restoration of seabird nesting habitats, broad scale monitoring and inventory of breeding populations, research and monitoring of contaminant issues, coordination with other agencies and partners to address threats such as fisheries interactions and invasive species, as well as the specific responsibilities associated with endangered species management and oil spill and contaminant issues.

RECOMMENDED SERVICE PRIORITIES, PACIFIC REGION

Based on the review of seabird and habitat resources and threats the following priorities were identified.

INVENTORY AND MONITORING

- Design and implement a standardized program for inventory and monitoring of seabird populations. Work with USGS and other seabird scientists to develop a standardized system for data collection and analysis that is science based and statistically rigorous. Develop two manuals containing comprehensive designs for monitoring population status and trends for the California Current System and U.S. Pacific Island seabirds, including detailed, standardized protocols for data collection, analysis, and reporting.

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

[2] This plan does not contain detailed coverage of the specific responsibilities associated with Ecological Service's programs.

HABITAT MANAGEMENT

- Maintain, protect and enhance seabird habitats (breeding, roosting, foraging, migrating, and wintering) to meet seabird needs. Identify important habitats and through various means such as acquisition, easement, regulation, overlay NWR, buffer zones, or special designations provide protection (*e.g.,* from threats such as habitat degradation and disturbance) for those area currently not protected.

- Restore lost or degraded seabird habitats by activities such as removing hazards, eradicating invasive plant species, restoring native vegetation, and restoring or simulating natural ecological function.

THREAT MANAGEMENT

The goals of Service activities with respect to threat management are identification 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 and should be considered in the development of the monitoring program discussed above.

- ***Invasive Species*** Eradicate or control introduced predators and other invasive species that have negative impacts on seabird populations. Work with partners and support national and international efforts to prevent the introduction of invasive species to important seabird areas and to eradicate/control these species on lands outside our direct control. Support research to develop new technologies to control invasive plants and animals.

- ***Fisheries Interactions*** Work with other state and federal agencies, fisheries councils, industry, research scientists, and other partners to identify problems and minimize the negative impacts of fisheries interactions. This includes providing technical assistance to state and federal agencies in the identification of problematic fisheries and development of observer programs; and, supporting 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 a spill to seabirds and other wildlife. Also provide technical information on seabird distribution and abundance that will increase the effectiveness of spill response efforts and increase Service participation in spill prevention and pre-spill planning activities. Establish, train, and maintain a regional strike team to respond to oil and hazardous substance spills.

- ***Contaminants*** Identify 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 problems and support research into the source and effects of contaminants on seabirds.

RESEARCH

The Service will focus on research necessary to make informed conservation and management decisions. Priority will be given to birds of conservation concern and those listed under the Endangered Species Act.

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

- Support research directed at evaluating, ameliorating, or eliminating the effects of threats. For example support research to minimize the negative impacts of fisheries interactions or to devise methods to eradicate/control invasive species such as scale insects that are defoliating tropical forests.

- Work with partners to support studies into 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 website dedicated to seabirds with links to current monitoring and investigations; presentations for field offices and general distribution; interpretive displays, brochures, posters, and other outreach materials; and provide increased opportunities for the public to view and experience seabirds in the wild though viewing stations and remote cameras feeds.

Planning and Coordination

Seabirds are a shared resource that cross international, state, Tribal, and agency responsibility boundaries. Coordination is essential.

- Coordinate with other countries, US 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. This includes developing and implementing 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. Participation 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.

INTRODUCTION

U.S. Fish and Wildlife Service (Service) is the federal agency with the primary responsibility for the management of migratory birds.[3] The Service's Pacific Region (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 Hawaii and the 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.[4] Six more are listed under the Endangered Species Act (see Appendix 3).

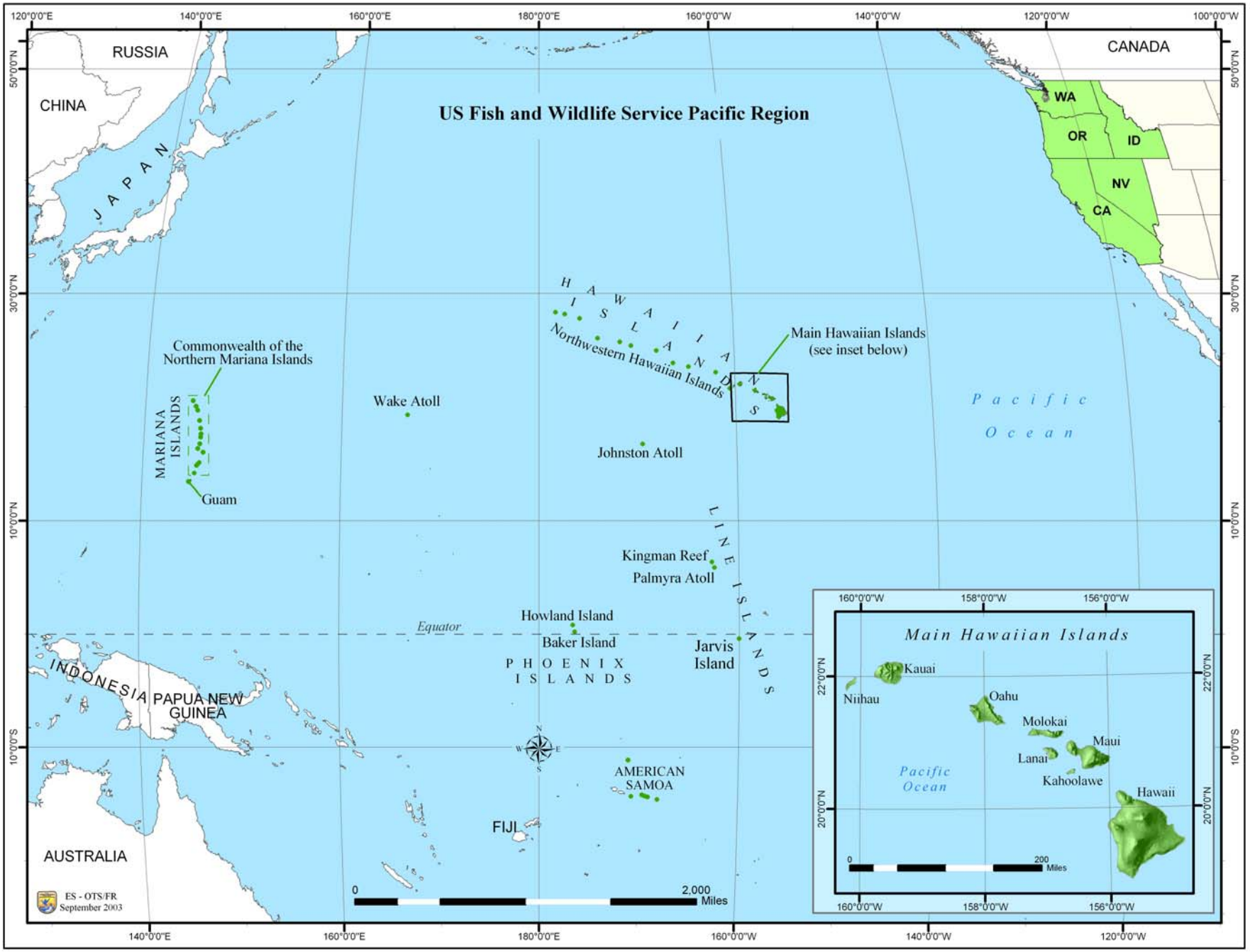
The Region is vast, stretching across the north Pacific from the coast of California, Oregon and Washington in the east, to the Mariana Islands in the far western Pacific, and south of the equator to the islands of American Samoa (Figure 1). The Region spans a distance of approximately 5,000 miles from east to west and 4,000 miles from north to south.

Within this vast expanse, significant numbers of breeding seabirds nest on 25 National Wildlife Refuges, 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 at the Regional scale and to foster conservation of seabirds at the eco-region scale in coordination with our partners.

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

[4]USFWS 2002

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



The vision of the of the Regional seabird conservation program is:

Through sound management, diverse partnerships, and science, work to restore and sustain healthy seabird populations and the natural systems on which they depend.

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 population size 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.

PURPOSE AND OBJECTIVES

The purpose of this Plan is to identify the Service's priorities for seabird monitoring, management, research and outreach within the Pacific 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 monitoring, management, 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 six western states: Washington (WA), Oregon (OR), California (CA), Idaho, Nevada and Hawaii (HI); and the U.S. island possessions, territories, and commonwealths in the Pacific that constitute the U.S. Pacific Islands (USPI). 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 at 14° S – 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, marshes and offshore islands of the coastal states listed above and the USPI, including: Midway Atoll; Johnston Atoll; Wake Atoll; Guam and the islands of the Commonwealth of the Northern Marianas (CNMI); Palmyra Atoll, Kingman Reef and Jarvis Island in the Line Island Archipelago; Baker and Howland Islands in the Phoenix Island Archipelago; and the islands of American Samoa (Appendix 2).

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 (Table 1). Loons, grebes, sea ducks, and shorebirds are not included. The Plan also does not cover inland nesting "seabirds" such as White Pelicans[5] or Black Terns, nor does it include the inland breeding segments of wide-spread species such as Double-crested Cormorants. Non-breeding species that winter or migrate through the Region are an important component of the seabird community and they are discussed in the section Ocean Habitats and Seabirds at Sea, however, they are not covered in detail in this plan.

Six species/subspecies are listed under the federal Endangered Species Act (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 and they are not covered in detail in this plan. For in-depth discussion of the ecology, conservation, recovery goals, and priorities for these species, readers are directed to the respective Recovery Plans.[6] Short-tailed Albatross were listed in the U.S. in 2000 and a recovery plan is in development.

SEABIRD OVERVIEW

Sixty species of seabirds representing 3 Orders and 10 Families, nest in the Region: 3 albatross,[7] 6 petrels, 4 shearwaters, 7 storm-petrels, 3 cormorants, 1 pelican, 2 frigatebirds, 3 boobies, 2 tropicbirds, 5 gulls, 12 terns, 3 noddies, 1 skimmer, 1 murre, 1 guillemot, 3 murrelets, 2 auklets and 1 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.

[5]Scientific names used in this plan are listed in Appendix 6

[6]USFWS 1983a, USFWS 1983b, USFWS 1985, USFWS 1997

[7] Short-tailed albatross have laid eggs at Midway Atoll but there is no documentation that these eggs hatched. Accounts of chicks fledging in the 1950s/60s have not been substantiated. They are included.

population; this includes many of the central Pacific albatross, 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.

Seabirds spend most of their lives in the marine environment. They are a diverse group and while many generalizations can be made, each is likely to be qualified with at least one exception. In this section, we will briefly describe some of the characteristics that make seabirds unique. Each species is discussed more thoroughly in the individual species profiles.

Seabirds are long-lived, with delayed maturity, low fecundity and high adult survival.[8] They are almost invariably monogamous with relatively high rates of mate retention.[9] Seabirds are often grouped in relation to their basic foraging ecology: coastal or pelagic. Coastal seabirds rarely range far from land and forage in marine, estuarine, freshwater, and sometimes even terrestrial habitats. Gulls, temperate terns, pelicans, and cormorants 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. In contrast, pelagic species such as the albatrosses, petrels and tropical terns are strictly marine, ranging far out to sea and returning to land only to breed. After fledging, Laysan Albatross remain at sea for 3-4 years before returning to land.[10] Sooty Terns spend their first 2-5 years on the wing, because they quickly become waterlogged if they sit on the water. In contrast, coastal species often return to land to roost at night or during the day. Cormorants and Brown Pelicans, which have wettable feathers, 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 4.8 hours[11] while at Midway Atoll male Laysan Albatrosses average 22.6 days during their first incubation shift.[12]

[8]Weimerskirch 2002

[9] Furness and Monaghan 1987

[10]Rice and Kenyon 1962b

[11]Ainley *et al.* 1990

[12]Fisher 1971

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

		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		

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

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

		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 browni	California 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 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

About 98% of all seabird species typically nest in colonies.[13] While individuals from many species might occasionally nest solitarily, 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. Clutch sizes typically are small, with most 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.[14] 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.[15]

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.,* flying fish), dipping, pattering, skimming, surface-seizing, scavenging, and even 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) may migrate or disperse after the breeding season, north to Canadian waters or south to Mexico, Central or South America. Many Hawaiian and 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. They breed in the southern hemisphere and then migrate to the rich waters of the north Pacific during the non-breeding season. Several other southern hemisphere seabirds (*e.g.,* Short-tailed and Pink-footed

[13]Furness and Monaghan 1987

[14]Johnsgard 1993

[15]Nelson 1976

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.

Pacific Region seabirds face a range of threats. At the breeding colonies, invasive (non-native) species, disturbance, contaminants, and loss of habitat are the most serious issues. Introduced predators such as rats, cats, foxes, and brown tree snakes can decimate colonies to the point of extirpating breeding species. A *Pterodroma* petrel known only from the fossil records, went extinct after Polynesians arrived in Hawaii, bringing with them the first mammalian predators.[16] Human-enhanced populations of native predators can also have significant negative effects on breeding seabirds. Introduced plants can alter habitats, ultimately limiting breeding space, reducing nesting densities, or negatively affecting reproductive success. Introduced insects such as the mosquitoes at Midway Atoll serve as vectors for avian disease and scale insects are destroying the rain forest at Palmyra Atoll. The negative impacts of large oil spills and other chemical contaminants (*e.g.,* DDT) have long been recognized in marine systems, but the lethal and sub-lethal effects of smaller spills and chronic low-level pollution may have greater impacts but are not as well understood. Human activities such as fishing cause direct mortality when birds are caught and killed in the fishing gear, but indirect effects can also occur via changes in food webs or disturbance to the colonies.

The 60 species of seabirds in this Plan were classified according to regional conservation concern using the ranking system of the North American Waterbird Conservation Plan (Tables 2 and 3). 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 *Waterbird Conservation for the Amercias: North American Waterbird Conservation Plan,*[17] seabirds were classified at the larger scale of that plan, however, regional population trends and threats can vary greatly, especially for seabirds that breed in both the Pacific and the Carribean. Conservation scores were assessed at the regional scale for this plan. A more detailed description of the scoring and ranking process is presented in Kushlan *et al.* (2002).

[16]Olson and James

[17]Kushlan et al. 2002

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

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

[a] Federal Endangered Species or Birds of Conservation Concern Status: E=Endangered, T=Threatened, 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] Regional classifications for the CCS region may differ from continental classification (Kushlan et al. 2002) due to regional differences in population trends or threats. The Continental classification encompasses lands and waters of North and Central America, the Caribbean and western Atlantic, U.S.-associated Pacific islands, and Pelagic waters of the northeastern Pacific.

[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 Hawaii and U.S. Pacific Islands.

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

[a] Federal Endangered Species or Birds of Conservation Concern Status: E=Endangered, T=Threatened, 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] Regional classifications for the USPI region may differ from continental classification (Kushlan et al. 2002) due to regional differences in population trends or threats. The Continental classification encompasses lands and waters of North and Central America, the Caribbean and western Atlantic, U.S.-associated Pacific islands, and Pelagic waters of the northeastern Pacific.

[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.

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

Family	Common Name	Number Breeding Species [a]	Number of Species Ranked High Conservation Concern [b]		% Ranked High Conservation Concern
			Regional	Continental [c]	Regional
Diomedeidae	albatrosses	3	3	3	100%
Procellariidae	petrels, shearwaters	10	7	7	70%
Hydrobatidae	storm-petrels	7	5	4	71%
subtotal	*Procellariiformes*	*20*	*15*	*14*	*75%*
Phaethontidae	tropicbirds	2	0	1	-
Sulidae	boobies	3	0	3	-
Pelecanidae	pelicans	1	1	0	100%
Phalacrocoracidae	cormorants	3	1	2	33%
Fregatidae	frigatebirds	2	1	0	50%
subtotal	*Pelecaniformes*	*11*	*3*	*6*	*27%*
Laridae	gulls, tern, skimmers	21	5	7	24%
Alcidae	murres, murrelets, auklets, puffins	8	5	3	62%
subtotal	*Charadriiformes*	*29*	*10*	*10*	*34%*
TOTAL		**60**	**28**	**30**	**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).
[c] Continental scores from 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 "High Concern" (Table 4). Procellariiformes have the highest representation (75% of 20 species), including all albatrosses. Alcids are also heavily represented (62% of 8 species). There are more high priority seabirds in Hawaii and 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, and the impacts of commercial fisheries. Along the West Coast, oil and other contaminants, habitat loss, and interactions with fisheries are the primary factors that resulted in high priority 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.

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 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 low 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 often resulted in seabird population declines, range contractions, and colony extirpations. Today, relatively small islands[18] 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 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 Birds of Conservation Concern (BCC).[19]

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, all species of storm-petrels nest under cover, but Black, Ashy, and Polynesian Storm-Petrels typically nest in rocky crevices or among boulders, while Leach's and Tristram's Storm-Petrels more often excavate burrows in soil. Surface nesters may prefer 1) narrow ledges on steep cliffs (Pelagic Cormorants), 2) broad ledges and flat tops of offshore islands (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 species nest in association with cover, nesting under vegetation or man-made objects such as buildings (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 Hawaii and the USPI birds nest year-round and there is temporal segregation in the use of breeding habitat. For example, Bonin Petrels and Wedge-tailed Shearwaters both nest in

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

[19]USFWS 2002

Table 5. Spatial Segregation of 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 Noddy Brown Noddy	Black-footed Albatross Masked Booby Gray-backed Tern Little Tern 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* 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 Black Storm-Petrel Pigeon Guillemot Xantus's Murrelet Ancient Murrelet Cassin's Auklet Rhinoceros Auklet* Tufted Puffin*

* indicates that this is not the most common habitat for this species

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 seabirds such as albatrosses, petrels, Sooty Terns, and several alcids, return to land only during the breeding season and roost at the colonies. Other 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 important roost sites can be located at or away from colonies. The plumage of some seabird species, such as pelicans and cormorants, is not waterproof; therefore, roosting on dry land is necessary for drying feathers.[20]

California Current System Terrestrial Habitats

The coastal and offshore areas of California, Oregon, and Washington provide a variety of roosting and nesting habitat, 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 beaches and associated sand dunes, coastal marshes, and estuarine islands. Some offshore rocks and islands have also been affected, but due to their relative inaccessibility, they have not been degraded to the same degree as mainland and inshore habitats.

The mainland coast from Canada to Mexico stretches approximately 2,500 km,[21] 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

[20]Rijke 1970, Johnsgard 1993

[21] 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. This includes data from charts between years 1988-1992, with an average mapping scale of approximately 1:70,000. From this source PRBO's GIS specialists estimated values for the coastlines of the mainland and offshore islands.

River Estuary on the border between Oregon and Washington; 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 the coast. Almost half of the seabirds nest in Oregon where the largest offshore island is <8ha (20ac). The two largest colonies in California are Farallon Islands (7 islands; the largest, Southeast Is., is 26ha/65ac) and Castle Rock (6ha/14ac).

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 often restricted to steep cliffs and remote areas. Smaller islets just off main islands often support larger numbers of breeding seabirds.

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, presence or absence of soil, extent and depth of soil, plant and animal communities, and history of seabird and human utilization, 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 support little or no vegetation and provide important nesting and roosting habitat for coastal species, especially 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[22] – 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 the ESA (*i.e.*, California Least Tern), Birds of Conservation Concern 2002 (*e.g.*,Gull-billed, Caspian and Elegant Terns), or appear on state threatened/endangered species lists. 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. 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.

Finally, mature forests of the Pacific Northwest are the primary breeding habitat for Marbled Murrelets. Loss of habitat to timber harvesting resulted in significant declines in populations and ultimately the listing of this segment of the population as threatened under the ESA.

HAWAII AND THE U.S. PACIFIC ISLANDS TERRESTRIAL HABITATS

Spread over millions of square kilometers of ocean, Hawaii and the USPI comprise only 17,860 km^2 of dry land (Figure 2). The Hawaiian Islands account for more than 90% of this land area, and greater than 58% is attributable to the single island of Hawaii ("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 (Type I) islands;

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

however, most of the seabirds occur on the low, sandy islands or atolls (Type II) that have remained uninhabited or nearly so. Human populations are concentrated on Type I and III islands due to location, size, and water availability. The large inhabited islands have suffered the greatest habitat loss and degradation, though no Pacific island has escaped human alterations.

The tropical Type II islands 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 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 and some of the largest Sooty Tern colonies in the world are found at Howland, Baker, and Jarvis islands.

Types of islands in the USPI

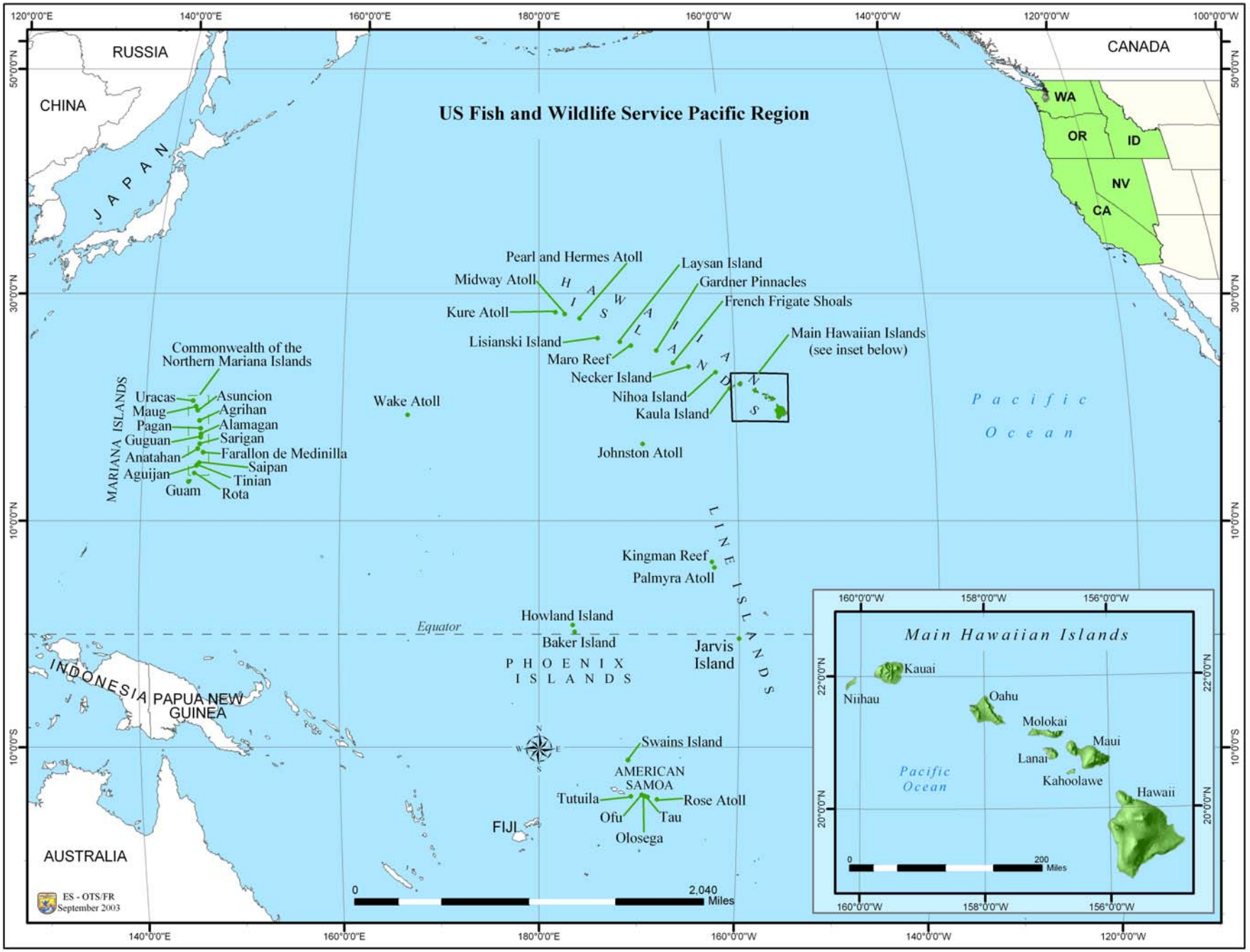
Type I: Volcanic islands rising from the seafloor, often to high elevations that intercept tropical moisture to create a variety of habitats including dense forests, *e.g.,* the main islands of Hawaii and American Samoa (also referred to as "high islands").

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.

Farther north, the subtropical Type II Northwestern Hawaiian Islands (NWHI) are typified by bunchgrass, shrubs, and short trees (*e.g.,* tree heliotrope). Surface and burrow nesting species abound. More than 95% of the global population of Laysan and Black-footed Albatross 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, but ironwood trees were

Figure 2. Map of Hawaii and U.S. Pacific Islands.



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, forming the largest colonies in Hawaii.

The high, "main" islands (Type I) of Hawaii 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 islands 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, Herald's), shearwaters (Audubon, 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, habitat loss and degradation. The Hawaiian Petrel, once the most abundant seabird on the main Hawaiian islands, nesting from sea level to the mountain tops, is now endangered, with small populations restricted to high elevations.

The Mariana archipelago is situated at the northern extent 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 (Type III) 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 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 that remains today has some type of protected status. Most of the National Wildlife Refuges (NWRs) included in this Plan were created specifically to protect important seabird colonies. Seabird conservation may or may not be the primary management objective for other federal and state managed areas. Non-governmental organizations (NGOs) such as The Nature Conservancy (TNC) own lands adjacent to federal lands and work with the Service (*e.g.*, Palmyra Atoll) and the National Park Service (NPS) (*e.g.*, Santa Cruz Is., CA) to manage these areas.

The National Wildlife Refuge System encompasses many of the important seabird colonies. In Washington, all but two of the islands along the outer coast of Washington and the largest seabird colonies in Puget Sound and the Straits of Juan de Fuca are NWRs. In Oregon, all of the marine rocks and islands (except Chiefs Island) are NWRs. In California, the two largest seabird colonies (Farallon Islands and Castle Rock) 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 National Park, Point Reyes National Seashore, and Golden Gate National Recreation Area. State Parks, Reserves, and sanctuaries encompass seabird colonies in all three states. Habitat loss from 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. The states manage areas that support important seabird colonies such as Año Nuevo Is., CA, which is managed for pinnipeds and seabirds, but often seabird conservation is not the primary goal of these areas.

In the USPI, the largest seabird colonies and the vast majority of breeding seabirds nest on National Wildlife Refuges. The NPS manages large parks on the high islands of American Samoa and Hawaii that support key seabird colonies. The National Park of American Samoa includes two rainforest preserves on Ta'u and Tutuila where petrels and shearwaters nest. Haleakala and Volcanoes NPs (Hawaii) support endangered Hawaiian Petrels. Hakalau Forest NWR on the Big Island of Hawaii also supports petrels and possibly Newell's Shearwaters. Kure Atoll and islands offshore the main Hawaiian Islands are managed by Hawaii 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 Commonwealth of the Northern Marianas.

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. It is important that the Service work 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 and Marine Protected Areas 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.

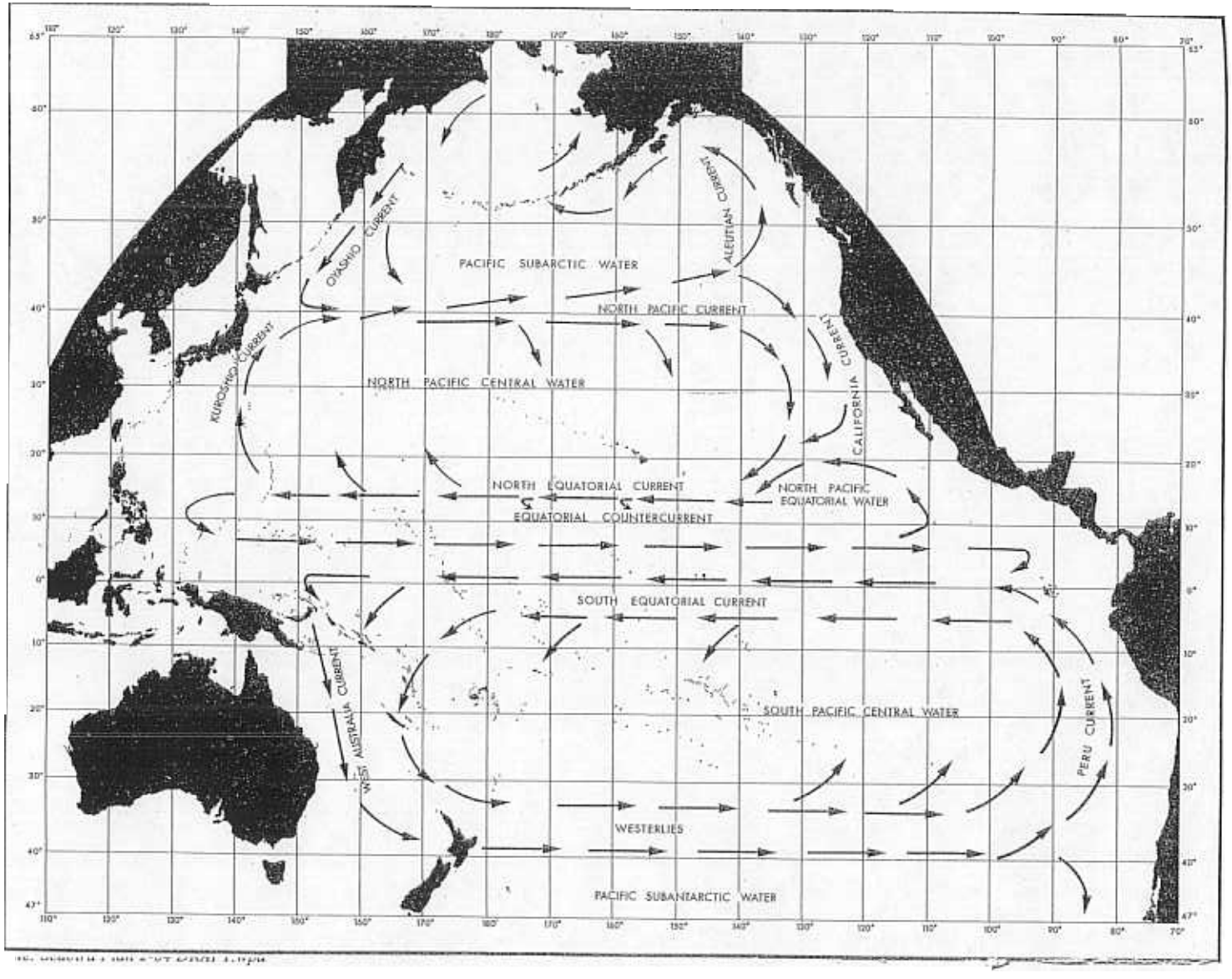
OCEAN HABITATS AND SEABIRDS AT SEA

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 is the clockwise North Pacific Subtropical Gyre[23] (Figure 3). The North Pacific and the Subarctic currents flow eastward across the north Pacific, fed by the Kuroshio and Oyashio currents off Japan and Russia. As these 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. The North Equatorial Current transports water back to the western Pacific completing the gyre. At its center, the warm salty surface waters of the North Pacific Central Water are among the least productive

[23]Gyre: circular motion

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



waters of the ocean,[24] 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.[25] Greater numbers of diving seabirds are found in coastal areas along the U.S. West Coast (*e.g.,* murres, auklets, puffins and cormorants). Areas of lower ocean productivity in the equatorial Pacific sustain less diverse and abundant avifaunas, dominated by seabird species that feed by surface- picking and plunging.[26]

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 formed when water interacts with static features of an irregular coastline or topography of the ocean floor (*e.g.,* continental shelves or seamounts). Along the west coast of the U.S., the continental shelf is relatively shallow (<100 m). It is widest (≥75 km) off southern California and relatively narrow (~15 km) off Washington and Oregon.[27] 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 also leads to localized upwelling along the shelf break.

Shelf break/slope fronts and convergences 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.[28] 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

[24]Seki and Polovina 2000

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

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

[27]Huyer 1983

[28]Oedekoven *et al.*, 2001, Yen et al. in press

vicinity of submarine canyons[29] 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.[30]

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.[31] 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.[32] Upwelling of cold, nutrient-rich waters along the coast is greatest in spring and summer, coincident with seabird breeding seasons. Contours of the coastline, ocean floor topography and weather 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.[33] The high abundance of prey over the continental shelf attracts millions of seabirds that breed, winter, or migrate through this region annually.[34] Gulls, murres 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 and Pelagic Cormorants, and

[29]Hickey and Royer 2001

[30]Hunt 1991

[31]Mann and Lazier 1996, Xie et al. 2003

[32]Hickey and Royer 2001

[33]Tyler *et al.* 1993

[34]Ainley 1976, Briggs *et al.* 1987a, Tyler *et al.* 1993

Figure 4. Diagram of the Major Currents of the California Current System (in prep).

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. During winter, when birds in offshore pelagic waters are mainly local breeders or visitors from northern and inland colonies (*e.g.,* kittiwakes, California and Herring Gulls), overall avifaunal density and diversity are lower. Beyond the shelf and slope region, *Pterodroma* petrels and Leach's Storm-Petrels are the numerically dominant species.

The Southern California Bight[35] represents a physical oceanographic and faunal barrier separating the cold California Current subarctic waters from warmer subtropical waters to the south. 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 Xantus's Murrelets.[36] 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.[37]

North Pacific Central Water, Transition Zone, and the Equatorial Pacific The North Pacific central water is in the center of the subtropical gyre. Hawaii 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.[38] 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 upwelling along the Equatorial Front where surface waters between the South Equatorial Current and the North

[35] Southern California Bight: the area off southern California, south of Point Conception where the coastline indents to the east.

[36] Hunt *et al.* 1980

[37] Hyrenback and Viet 2003

[38] Au and Pitman 1986, Ballance and Pitman 1999

Equatorial Countercurrent diverge.[39] This semi-permanent front varies spatially (more intense in the eastern Pacific), seasonally (stronger during autumn than spring), and in response to El Niño and La Niña conditions. Planktivorous seabirds such as storm-petrels were found to concentrate in the area of the Equatorial Front, but piscivorous seabirds did not.[40] Here, as elsewhere in the tropical Pacific, the distribution of piscivorous seabirds was tied to the distribution of schooling surface-feeding 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.[41] 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.[42] These fronts support high concentrations of small squids, fishes and crustaceans during spring and summer and creating important feeding grounds for seabirds and other top marine predators.[43]

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 a variety of 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,[44] with consequent negative effects on survival and reproduction of seabirds.[45] The inverse of El Niño is La Niña (periodic, ocean cooling). During La Niña, enhanced upwelling has positive effects on

[39]Barber 2000, Spear *et al.* 2001

[40]Spear *et al.* 2001

[41]Seki and Polovina 2001

[42]Hyrenbach *et al.* 2002

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

[44]Barber and Chavez 1986

[45]Ainley *et al.* 1995a, Chavez 1996

food web development and seabird productivity and population dynamics.

The El Niño of 1982-1983 dramatically focused attention on effects of large-scale changes in circulation patterns of the tropical Pacific Ocean on biological communities worldwide.[46] Along the west coast of North America, sea surface temperatures rose and mass mortality of many temperate region fish, marine birds and mammal species occurred.[47] 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] Researchers investigating tropical seabirds, have also documented decreases in breeding probabilities and reproductive success during El Niño years.[50] Starvation is the likely cause of elevated mortality of young and adults, but direct evidence of this mechanism is often lacking. El Niño has been linked to the population dynamics of seabirds[51] suggesting an important natural mechanism for understanding seabird population changes. In contrast, strong La Niña years may result in exceptional production of cohorts which can sustain seabird populations for decades.[52]

Pacific Decadal Oscillation In addition to ENSO/LNSO there are other natural cycles that occur on time scales of decades or centuries.[53] 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.[54]

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[46]reviewed by Glynn 1988

[47]Wooster and Fluharty 1985

[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.* 1994

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

[51]*e.g.,* Schreiber and Schreiber 1984b

[52]Nur and Sydeman 1999

[53]Aebischer *et al.* 1990

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

Biological communities have responded to PDO-related ocean warming and cooling in the Pacific Ocean. For example, zooplankton biomass in the Southern California Bight has declined significantly over the past 40 years[55] but there have been few studies of the effects of low-frequency ocean climate shifts on seabirds. In California and Hawaii, 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.[56] 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.[57] 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 Hawaii.[58]

In conclusion, 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,[59] 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, but we do not fully understand the possibilities at present. Developing an understanding of the relative effects of anthropogenic and natural factors on ocean warming at multiple temporal scales remains a serious conservation challenge.

[55]Roemmich and McGowan 1995, Hayward 1997

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

[57]Schwing *et. al.* 2002

[58] Polovina *et al.* 1994

[59]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, native and non-native predators, contaminants, human disturbance and climate change have long been recognized as threats, but as human populations and marine resource exploitation have increased, the magnitude of threats has changed. Uncertainty in forecasting patterns of change heightens the need for increased awareness of existing and potential.

Seabird populations are extremely vulnerable to changes in survival. Small decreases in adult survival can result in population declines and hamper recovery. As a result, natural and anthropogenic factors that cause seabird mortality or limit production can seriously jeopardize seabird populations, especially if populations are already low. Therefore it is important that threats be identified early and seabird populations be monitored appropriately to detect negative impacts quickly.

COMMERCIAL AND RECREATIONAL FISHERIES

Commercial and recreational fisheries have existed for centuries, although only within the past few decades has there been growing awareness of the negative impacts of fisheries on seabird populations. 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 that operate in the north Pacific. Currently, observer programs monitor 8 of the 84 fisheries that operate from CCS and USPI ports, and only 4 programs are mandatory. Moreover, many seabirds are migratory and do not remain within U.S. waters, necessitating international cooperation in resolving seabird-fishery conflicts. Seabird bycatch occurs in 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.[60]

Fisheries target a diverse group of species and use a variety of vessels and gear including: longlines, gillnets, trawls, purse seines, pots, throw and dip nets, and harpoons. Seabirds are

[60]Melvin and Robertson 2000

killed or injured when 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 specific seabird species. Seabird mortality has been documented in 10 of 84 fisheries that operate in this Region (Table 6), with a minimum of 20 seabird species affected.[61] Set and drift gillnets, and pelagic and demersal longlines kill the greatest number of seabirds in this Region.

It is more difficult to substantiate the indirect effects of fisheries, such as overfishing that could Not all fishery effects are negative. Positive effects can result from offal discarded from fishing vessels which enhances seabird feeding opportunities,[62] but this also attracts seabirds to vessels and can lead to hooking or entanglement.[63] In the North Sea, fisheries targeting predatory fish that fed on seabird forage benefitted seabirds by increasing number of forage fish available.[64]

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 one year, 1990.[65] Large numbers of Black-footed and Laysan Albatross were taken in the Japanese salmon and squid drift gillnet fishery, with almost 10,000 killed during 1990 in the squid driftnet fishery alone.[66] The North Pacific high seas drift gillnet fishery was internationally banned in 1992, in part, because of the high numbers of seabirds killed.[67]

Most of the seabirds that are killed in coastal gillnet fisheries are diving seabirds, in particular

[61]A database of all U.S. fisheries that operate from 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]Camphuysen *et al.* 1995

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

[64]Furness 1982c

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

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

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

Table 6. Current U.S. Fisheries with Documented Seabird Bycatch in USFWS Pacific Region.

FISHERY NAME	TARGET CATCH	AGENCY[1]	SEABIRD SPECIES[2]	NOTES
CA angel shark/halibut set gillnet	main target is halibut but also catch angel shark	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; fishing outside EEZ.
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	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 has decreased since swordfish fishing was banned in 2001.
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.
WA, OR, CA groundfish trawl	groundfish (hake, flatfish, sablefish, lingcod, rockfish)	WDFW, ODFW, CDFG, NMFS		Preliminary results indicate seabird bycatch as birds hit the 3rd wire.
WA, OR, CA, HI commercial passenger fishing vessel	various species	WDFW, ODFW, CDFG, NMFS	BRPE, LETE, MAMU, CORM, RFBO, MABO, BRBO	Most entanglement of pelicans is in the hook-and-line troll fishery.

[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=Hawaii Div. of Aquatic Resources.
[2] BFAL=Black-footed Albatross; BRAC=Brandt's Cormorant; 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;

alcids, although cormorants are also commonly caught.[68] It is estimated that at least 70,000 Common Murres died in set gillnets targeting halibut off central California between 1979 - 1987.[69] Large population declines at the central California murre colonies during the 1980s were attributed primarily to gillnet mortality, with El Niño effects and oil spills 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 limited population growth for the murre colonies closest to the fishing area.[70] A recent law, changing the area and depth closures, is expected to essentially eliminate seabird bycatch in central California gillnet fisheries.

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.[71] 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.[72] 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 using visible mesh panels and eliminating dawn fishing.[73] This research led to new state regulations to reduce bycatch; however, the Tribes 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 observed

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

[69]Takekawa *et al.* 1990

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

[71]Melvin *et al.* 1999

[72] (U. Wilson pers. comm., USFWS, Washington Maritime NWR)

[73]Melvin et al. 1999

period).[74] An emerging fishery is the California gillnet tuna fishery. This fishery, which began in 1999, deploys smaller mesh nets at the surface where there is potential for seabird bycatch. To date, there are no observer programs or regulations to quantify or reduce bycatch in this fishery.

Pelagic and Demersal Longlines[75] Longline fisheries world-wide pose a serious threat to many seabird populations and affect between 40-60 species of seabirds, predominantly Procellariiformes,[76] and particularly surface-feeding albatrosses. Birds are caught both during setting and retrieval of gear, with the highest mortality during set.

Pelagic longlining, which targets mainly tuna and swordfish, kills thousands of seabirds annually.[77] This type of fishing increased after high seas drift 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.[78] Other countries that have large North Pacific longline operations include Japan, Taiwan and Korea, none of which carry observers.[79] Cousins *et al.* (2000) estimated 13,000 North Pacific albatrosses were killed annually in the swordfish and 23,000 in the tuna fisheries. The relatively small (<200 vessels) pelagic longline fishery based in Hawaii killed an estimated 1,000-3,000 each, Laysan and Black-footed Albatrosses each year between 1994-1998.[80]

Research identified mitigation measures to reduce the bycatch of albatross,[81] and these measures are now required on Hawaii-based longline vessels. Most of the albatross mortality occurred in the swordfish fishery, closed by court order in 2001 to protect sea turtles. In response, many

[74]Julian and Beeson 1998

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

[76]Brothers *et al.* 1999

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

[78]URS 2001

[79]Cousins *et al.* 2000

[80]Cousins *et al.* 2000

[81]McNamara *et al.* 1999

Hawaii based fishers shifted their operations to California, where regulations were less restrictive. For several years, use of mitigation measures was voluntary and area closures defined by the Hawaii court order did not apply to California fishers, even though there was considerable overlap in fishing areas. Area closures and required use of mitigation measures, similar to those for Hawaii fishers, became effective in April/May 2004, for California fishers. An observer program has documented relatively high rates of Black-footed Albatross mortality and, to a lesser degree, Laysan Albatross mortality in this fishery.[82] The swordfish fishery out of Hawaii 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 Hawaii, longline permits for the CNMI, Guam, and American Samoa fisheries are not limited.[83] 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.[84] Albatross, especially Laysan Albatross, are also killed. As a result of high seabird bycatch, regulations were adopted in 1997 and 2004 to reduce bycatch in the Alaska fisheries.[85] Paired tori lines[86] were found to be an effective deterrent, reducing seabird bycatch by 71-96%.[87] 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.[88]

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[82]Peterson *et al.* 2003

[83]URS 2001

[84]Melvin *et al.* 2001

[85]Melvin and Parrish 2001

[86]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.

[87]Melvin *et al.* 2001

[88]Nordeen *et al.* in press

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 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 Farallon and Channel Islands, CA. Some experts believe that lights were a factor in Brown Pelican nest abandonment and low reproductive success on Anacapa Island in 1999.[89] 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.[90] 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 seabirds of conservation concern or listed under ESA (*e.g.,* Ashy Storm-Petrels, Brown Pelicans, and Xantus's Murrelets at Anacapa and Santa Barbara Islands).

Reduction of seabird prey abundance by commercial fisheries and the effects on seabird populations are difficult to document. In some ecosystems, it has been estimated that seabirds consume up to 30% of the annual pelagic production of fish,[91] 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.[92] Seabirds can be affected by a direct depletion of their food when seabirds and fisheries target the same species and age classes.

[89]Frank Gress, pers. comm.

[90]Anderson *et al.* 2001

[91]Furness 1982a, Furness 1982b

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

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 a specialized feeding method or prey.[93] In the tropics, most seabirds feed in association with predatory fish, primarily tuna, and overfishing of these stocks could potentially affect seabirds by reducing the availability and/or distribution of these patchy prey resources, that tuna drive to the surface.

There are several emerging and evolving fisheries that have potential to adversely affect seabirds. The anchovy fishery 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 severely 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.[94] 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. Many 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 Hawaii.

PREDATORS

Introduced predators have repeatedly been identified as the foremost threat to seabird populations

[93]Furness 1982a

[94]BirdLife 2000

on islands, causing population declines, extirpation of species or colonies, and in rare instances extinction (*e.g.,* Guadalupe Storm-Petrel). Small, ground-nesting procellarids and terns are the species most frequently affected.[95] In this Region, rats and feral cats have had the greatest effects.[96] They are responsible for colony extirpations and range-wide population declines of numerous species.[97]

Rodents have become established on approximately 82% of the world's islands.[98] 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, for example Xantus's Murrelet declines at Anacapa Is.[99] 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 when storm-petrels return to the islands in April.[100] Introduced rats have been eliminated from all but a few NWR islands in the USPI (Appendix 9) but they remain a serious problem on the larger, inhabited islands of both the USPI and CCS.

Feral cats prey upon adults and eggs and they can kill larger seabirds than those typically taken by rats (although rats have been documented killing adult albatross[101]). 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.[102] Cats have been eradicated from all NWR

[95]Moors and Atkinson 1984

[96]Moors *et al.* 1992

[97]Drost and Lewis 1995, McChesney and Tershey 1999, Rauzon 1983

[98]Atkinson 1985

[99]McChesney and Tershy 1999; McChesney *et al.* 2000

[100]Mills *et al.* 2001

[101]Kepler 1967

[102]Rauzon 1983

islands in the Region and from many of the smaller National Park islands, but they are still present on all of the main islands of Hawaii, American Samoa, Guam and the Marianas, and many of the larger islands off California and in Puget Sound, WA (Appendix 9). In Hawaii, 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.[103]

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, Kauai until fences were erected. Foxes are a major problem on Alaska seabird islands. Red foxes were introduced to California for fox hunting and fox farming; they prey on terns and gulls including endangered California Least Terns.[104] 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, respectively, survived.[105]

Indian mongoose were introduced to all of the main Hawaiian islands except Kauai and Kaho'olawe, and they have been implicated in the near extinction of Hawaiian Petrels and Newell's Shearwaters.[106] The last stronghold of Newell's Shearwaters is on the steep mountainsides of Kauai[107] 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.[108] Feral populations are present on most of the main islands of the USPI. They

[103]Simons and Hodges 1998

[104]Minsky 1980

[105]Roy Lowe, USFWS, pers. comm.

[106]Munro 1960, Berger 1972

[107]Byrd *et al.* 1984

[108]Atkinson and Atkinson 2000

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 and Short-eared Owl, 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 Hawaii. Barn Owls take seabird adults and fledglings. Introduced Cattle Egrets eat eggs and small young, and compete with Red-footed Boobies for nesting habitat on Lehua Island. Common Mynas are widespread in the main islands of American Samoa and Hawaii, and Midway Atoll. They were an important predator of Wedge-tailed Shearwater eggs at Kilauea Pt. NWR, Kauai,[109] 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 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

[109]Byrd 1979

altered the habitat of these islands.[110] The main Hawaiian Islands harbor populations of deer, feral goats and sheep that cause habitat alteration and erosion problems. Rabbits, introduced to Laysan and Lisianski islands in the early 1900's in a failed marketing scheme, denuded the islands of vegetation and fierce sand storms buried nests and filled burrows.[111] 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.[112] There is some debate whether rabbits, have a positive or negative effect on seabird populations at Destruction Is., WA; rabbit grazing that reduces the height of vegetation may enhance nesting habitat for Rhinoceros Auklets.[113]

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, sandbur lacks the height and physical structure preferred by Hawaiian seabirds that nest under vegetation.[114] Many invasive plants have shallow root systems that do not stabilize the soil as well as native vegetation and consequently effect burrow stability (*e.g.,* sandbur at Laysan Island). At the Farallon Islands, 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, Oahu. Dense forests of introduced ironwood trees at Midway Atoll, limit surface nesting species such as Laysan Albatross; but tree nesting species such as Black Noddies and White Terns benefit.

[110]Johnson 1980, Brumbaugh 1980

[111]Bailey 1956

[112]Ely and Clapp 1973

[113]Ulrich Wilson, USFWS, pers. comm.

[114]Flint and Rehnkemper 2002

INSECTS

Of the thousands of introduced insects occurring in seabird colonies, mosquitoes, ants, and scale insects are the only ones know 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: bigheaded, Argentine, and little fire ants have been recorded from Hawaii and other Pacific islands. Some ant species have been documented attacking small chicks or pipping eggs (*e.g.,* long-legged, fire, and bigheaded ants) but the effect at the population level is unknown. More important than direct effects may be the indirect effects; native woody vegetation is damaged and destroyed by scale insects and sooty molds promoted by the presence of ants.[115] Pu'avai, a tropical tree much favored by tree nesters such as Red-footed Boobies and Black Noddies has disappeared from Rose Atoll, American Samoa and the forest on Palmyra Atoll is seriously compromised by an introduced scale insect*, Pluvinaria urbicola*.

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 9). The Service has been very active in the USPI and rats and cats have been eradicated from all but one of the Pacific and Remote Islands NWR Complex. Currently, the Service is trying to secure funds to eradicate rats from the one remaining refuge, Palmyra NWR. The state of Hawaii 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 important seabird colonies. For example NPS in coordination with the group Island Conservation, recently completed a program to eradicate rats from Anacapa Island with restoration funds from the American Trader oil spill.

In response to these eradication programs, seabird populations have increased, extirpated 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, Midway Atoll and Phoenix

[115]Nishida and Evanhuis 2000

Petrels, 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 with fencing or reduce predator densities in the area of the colony.

Military bases throughout the Pacific have a high incidence of introduced predators. World War II resulted in the only statistically significant increase in rat colonization of islands in the period between 1840-1980.[116] Today, many of the remote island bases have initiated predator control or eradication programs and 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 and USGS in cooperation with the Service initiated research into the control of scale insects at Palmyra.

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

[116]Atkinson 1985

oil production platform experienced a blowout,[117] and during the 1971 San Francisco oil spill when two oil tankers collided in the entrance to San Francisco Bay.[118] 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.[119] 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 (*e.g.,* southern California).[120] 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[121] (Appendix 5; Figure 5 and 6). 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 shipments of oil up the Columbia River are relatively few.

Since the 1970s, biologists have recognized chronic oil pollution in central California, based on regular occurrence of oiled birds on beaches.[122] Long-term monitoring of oiling rates of beached birds has helped document this problem. Most of the chronic oil pollution appears to result from

[117]Straughan 1971

[118]Smail *et al.* 1972

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

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

[121]Burger and Fry 1993, Carter 2003

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

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

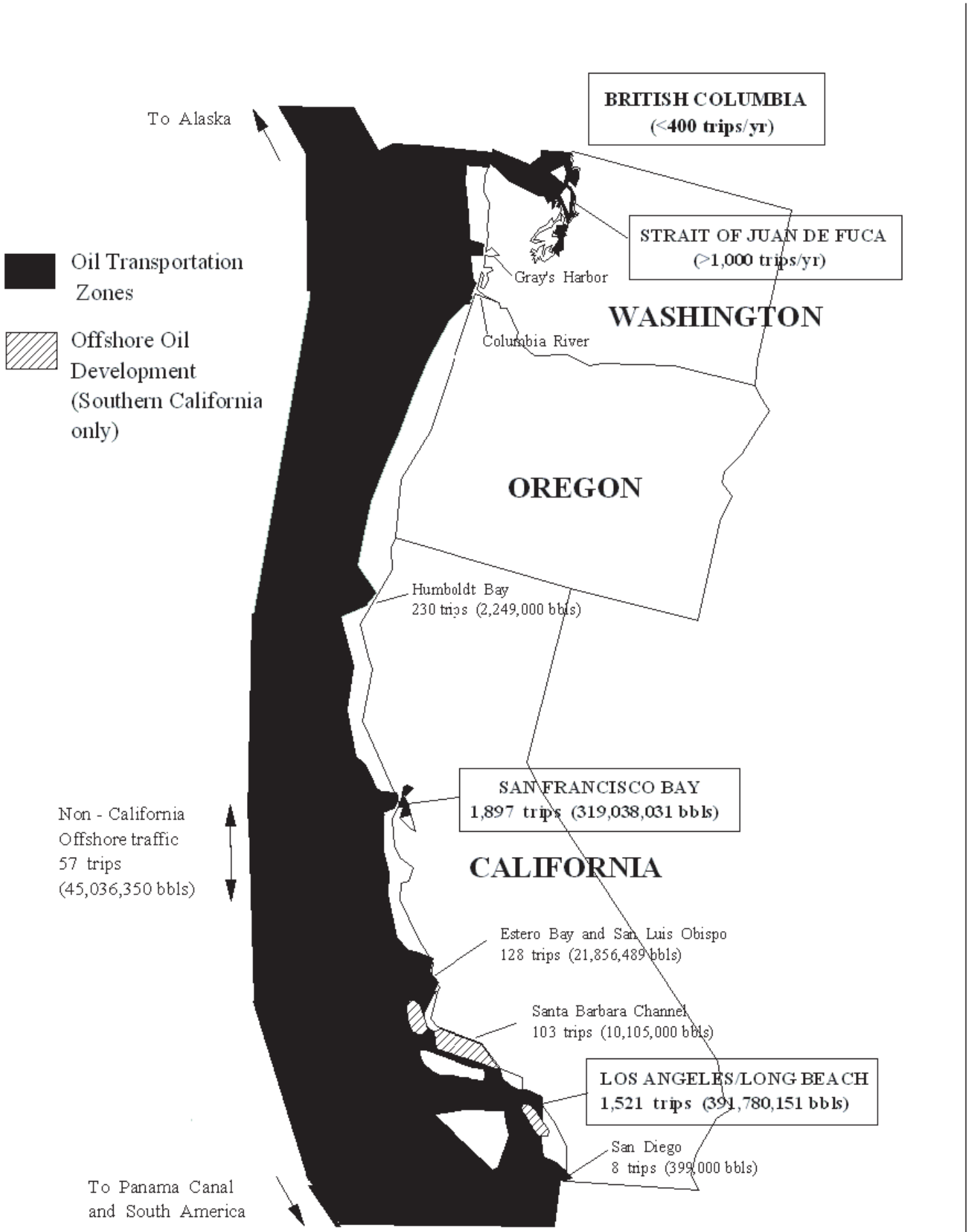
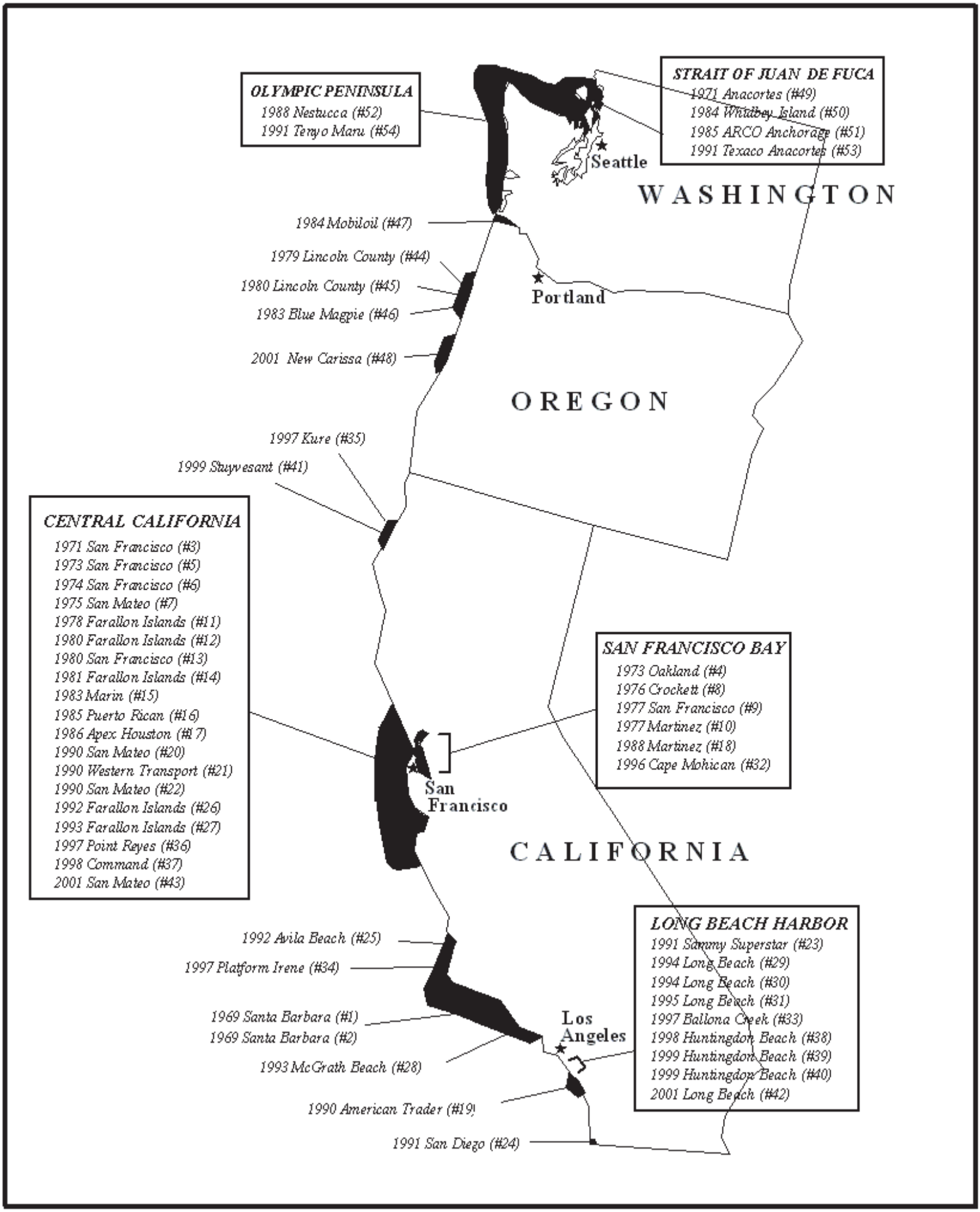


Figure 6. Oil Spills off California, Oregon, and Washington (updated from USFWS 1997; see Carter 2003, McShane et al. 2004).



the dumping of bilges and slops after or before entering major oil ports.[123] 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.[124] 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. 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, Brown Pelican) have also been recovered, in relatively high numbers, after certain spills.[125] 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.[126] 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, but 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

[123]Hampton *et al.* 2003a

[124]Hampton *et al.* 2003b

[125]Carter 2003, McShane et al. 2004

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

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.[127] Common Murre population declines in central California in the 1980's were linked to mortality from the 1984 *Puerto Rican* and 1986 *Apex Houston* oil spills, as well as to mortality from gillnet fishing.[128] In Washington, the Common Murre population failed to recover from declines in the early 1980's and mortality from the 1988 *Nestucca* and 1991 *Tenyo Maru* oil spills were identified as contributing factors.[129] 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 and this mortality likely contributed to population declines.[130] Oil pollution is a serious concern for localized endemics such as Xantus's Murrelets, a species whose key breeding colonies occur near shipping lanes and offshore oil platforms.[131]

Oil spills occur throughout the central Pacific but have been poorly documented. Oiled seabirds have been noted at the breeding colonies, but seabird injuries have been assessed for only two spills (*Hana* 1987 and *Tesoro* 1998) and population models to estimate total mortality have not been implemented to date. There have been major spills where seabird injuries were not examined: 1) 10 million gallons of crude oil, *Irene's Challenge,* north of Lisianski, 1977; 2) 31.2 million gallons of crude oil, *Hawaiian Patriot,* west of Kauai, 1977; 3) an estimated one

[127]Nur and Sydeman 1999

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

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

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

[131]Carter *et al.* 2000

million gallons that leaked over a two-year period from a power plant on Guam, early 1990's.[132]

In contrast to the well-developed oil spill response and seabird injury assessment programs in California and Washington, Hawaii and USPI have relatively small or non-existent programs. Nevertheless, a large volume of oil is transported by oil tanker to Oahu and vessel traffic is high.[133] 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 a 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

Four major sources of contaminants are present in the Region: 1) industrial and mining operations (both historic and current); 2) agriculture, runoff of pesticides, sediment, and nutrients; 3) urban, runoff and sewage outfalls; and, 4) military bases.

Contaminants that pose the greatest 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 are regulated and monitored, and the effects on seabirds are summarized in Table 7.

All of the organic and halogenated pollutants are "persistent organic pollutants" (POPs), because they are generally found as complex mixtures in sediments and in fat of exposed animals.[134] Newer persistent contaminant threats include brominated compounds. "Emerging" contaminant threats include endocrine disrupting chemicals (alkylphenols, estrogenic hormones, pesticides, and industrial chemicals), pharmaceuticals released from non-point sources and public operated waste-water treatment works. The extent of regional exposure and persistence of many of these compounds is unknown as the USGS has only recently begun to monitor these chemicals.[135]

[132]USFWS 1996

[133]Demarest and Elliot 1997

[134]Lipnick et al 2000

[135]Kolpin et al 2002

Table 7. Summary of Adverse Effects of Contaminants on Seabirds.

CHEMICAL	ADVERSE EFFECTS
Dioxins and coplanar PCBs	Developmental malformations, crossed beaks, brain asymmetry, immune suppression, altered reproductive behavior
Other POPs	
PBDE	developmental neurotoxicity
PAHs	mutagen (rare in birds), immune suppression
Phthalates	hormone disruption, developmental malformations
Sulfones	immune suppression, reproductive effects?
Pesticides	
DDT/DDE	eggshell thinning, other abnormalities
Other organochlorines	acute toxicity, reproductive failure
Organophosphates	Cholinesterase inhibition, acute toxicity
Pyrethroids	fish toxicity, unknown effects on birds
Herbicedes	hormone disruption, immune suppression
Fungicides	hormone disruption, immune suppression
Industrial chemicals	
Alkylphenols	hormone disruption
Phthalates	hormone disruption
Bisphenol	hormone disruption
Pharmaceuticals	
Hormones	hormone disruption
Antibiotics	immune suppression
Metals and trace minerals	
Arsenic	teratogen, carcinogen
Cadmium	reproductive toxicant
Chromium	mutagen, teratogen
Copper	growth depression, reproductive toxicant
Lead	developmental neurotoxicity, anemia
Mercury	developmental neurotoxicity
Selenium	developmental malformations
Petroleum hydrocarbons	
Oil spills	fouling, immune suppression
PAHs	mutagen (rare in birds), immune suppression

The "traditional" organochlorine POPs (pesticides, PCBs, and dioxins) are generally fat soluble, and have become biomagnified through the food web, exposing benthic invertebrates, fish, seabirds and marine mammals. Wide ranging top predators such as large seabirds and marine mammals have an increased exposure risk; the ecological magnification of POPs results in moderate to high exposure of top predators, with adverse reproductive consequences, including eggshell thinning, developmental malformations and mortality of embryos and juveniles, and immune suppression leading to increased disease susceptibility. Global transport of POPs results in diffuse deposition and they appear in the surface microlayer of the oceans, where surface feeding seabirds such as storm-petrels and albatross become exposed at measurable levels.[136]

Endocrine disruptors have recently been grouped together as a class of contaminants, but several have been persistent pollutants for decades.[137] The persistent endocrine disruptors include DDT, dioxins, tributyl tin (TBT), and PCBs. All are now regulated or banned. Most of the "emerging" chemicals do not bioaccumulate as do the POPs and some metals. Effects are confined to localized "hot spots", such as estuaries, or adjacent to outfalls of major industrial areas. The effects of these chemicals on food webs are unknown.

The diverse effects of contaminants on marine systems (*e.g.,* nutrient inputs, algal blooms, eutrophication, sedimentation, and specific invertebrate effects) all contribute to reduced ecological health, including reduced plankton and fish populations.[138] These indirect effects may be reflected in reduced reproductive success and other stresses to seabird populations. Effects may seem minor compared to global events such as El Niño or global warming, but ecological changes caused by contaminants may exacerbate the adverse effects of these events.[139]

SUMMARY OF CONTAMINANTS BY STATE

California The major sites of contamination in California that pose an exposure risk to seabirds, (primarily from food web bioaccumulation) are: Los Angles Harbor (historical DDT

[136]Fry, 1994, Cross et al 1987, Kucklick et al 1994, Hardy et al 1987, Ludwig et al 2001

[137]National Research Council 1999, Dawson 2000

[138]Long et al 1995, Horner et al 1997

[139]Scott et al 1975, Veit et al 1996, Sydeman et al 2001, Thompson et al 2000

contamination from Montrose Chemical Company and PCB contamination from industrial sources), Palos Verdes Shelf (Montrose DDT and White's Point Outfall), Santa Monica Bay (Montrose DDT plus PCBs), Monterey Bay (agricultural discharge and residual DDE from the Salinas River), and San Francisco Bay (historical mercury from the 19th century gold rush, DDT from agriculture and two Superfund sites,[140] metals and PCBs from industrial and military sites, selenium from industry and agriculture). Although contamination is centered in these specific areas, effects are widespread due to diffusion in the marine environment and uptake into the food web. Non-point source contamination of the river discharge from San Francisco Bay produces a diffuse plume of agricultural runoff and nutrients that pose a minimal contaminant risk, but appear to provide nutrients for toxic algal blooms that have affected both seabirds and marine mammals in recent years. Minor local sites of chemical contamination elsewhere in California include a mercury discharge into Tomales Bay, pulp mill discharges into and around Humboldt Bay, and agricultural runoff of pesticides into the Smith River estuary.

The risk to seabirds from exposure to persistent organic chemicals (*e.g.,* DDT, PCB) in California has been reduced over the past 30 years, due to bans on the use and manufacture of these chemicals. However, hotspots of contamination remain in the Southern California Bight and San Francisco Bay, and these hotspots are near some of the largest concentrations of nesting seabirds in the state (*e.g.,* the Channel Islands and the Farallon Islands). DDT contamination of the Southern California Bight still causes eggshell thinning in some species (*e.g.,* pelicans, cormorants, gulls, and storm-petrels). Likewise, eggs of some Double-crested Cormorants and terns in San Francisco Bay contain PCB concentrations above adverse effect levels. Exposure risk to mercury, selenium, and other pollutants associated with agriculture, industry, and urban development may actually have increased or remained constant over the past 30 years. Updated assessments are needed for the majority of seabird species and specifically for those species that demonstrated eggshell thinning in 1992 due to DDT contamination associated with the Montrose case.

[140] United Heckathorn Superfund Site in Richmond (DDT)

Oregon Seabird colonies on small offshore islands have shown very little impact from chemical contaminants. Coos Bay estuary remains contaminated from shipyard operations, and is in the process of superfund site cleanup. The major estuary of concern in Oregon is the Columbia River, where large colonies of Double-crested Cormorants and Caspian Terns are found. Cormorant monitoring during the 1990s showed significant adverse effects from pulp mill effluent and metals; egg mortality may be as high as 23%. Contaminant discharge from pulp mills is being regulated, with conversion of mills to non-chlorine bleaches, but some discharge of black-liquor[141] will continue indefinitely.

Washington The sediments of Commencement and Elliott Bays remain highly contaminated, and continue to pose risks to breeding seabirds, especially gulls and Pigeon Guillemots using inner harbors as nesting sites. Cleanup of naval bases and industrial sites continues at several sites in Puget Sound.

Hawaii Hawaii has contaminant issues on many islands, stemming from historic and ongoing military operations. Laysan and Black-footed Albatross at Midway Island 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 lowered fledging success in these areas. Localized contamination has occurred on Laysan Island and Tern Island, but risk to seabird populations currently appears low. A portion of the Red-tailed Tropicbird colony on Johnston Atoll is at risk from dioxin exposure from contaminated soil left-over from military operations but the population, as a whole, is healthy. Some PCB contamination occurs on outer islands at Johnston Atoll, with possible exposure risk for shearwaters, but this risk appears to be low. Organochlorine concentrations in Laysan and Black-footed Albatross are at least an order of magnitude higher than levels in southern albatrosses and PCB and DDT concentrations were similar to those in Great Lakes fish eating bird which suffered embryo deformities and mortality.[142] 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

[141]Define black-liquour

[142]Guruge et al 2001

Albatross at Midway.[143] Marine debris remains a high exposure hazard throughout the Northwestern Hawaiian Chain, with many albatross chicks dying of impaction due to ingestion of plastics.

DISEASE

The colonial behavior of seabirds would presumably make them highly susceptible to epizootic[144] 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 (viral) in free-ranging wild birds have occurred in Double-crested Cormorants in Canada and the U.S.[145] 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 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, but 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), their immune systems are naive to these types of viral infections, potentially making them 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.[146]

[143]Ludwig et al 1997

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

[145]Friend and Franson, 1999

[146]Feare, 1976

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.[147] 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.[148] Mortalities of chicks, especially during fledging, is a common phenomenon in a wide variety of seabirds.[149] 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.

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 food and, in some cases, cultural purposes for thousands of years. In Oregon, village sites and seasonal camps were located near seabird colonies and on offshore islands. Radiocarbon dating of

[147]Work *et al.*, 1993

[148]Bayer *et al.*, 1991

[149]Piatt and Van Pelt, 1997

material from various Oregon sites have indicated that coastal rocks and islands were used by native peoples for thousands of years for food gathering.[150] In Hawaii, 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 being diked, drained, dredged, or dammed for agricultural and hydroelectric development. 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 more detailed discussion.)

Much of the development in Hawaii and 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. The Save Our Shearwaters Program that was initiated on Kauai in the 1970's has rescued more than 30,000 Newell's Shearwater fledgelings that would otherwise have perished because of this coastal development. Powerlines are another problem in areas where they transect flyways between the colonies and the ocean.[151]

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 WWII; disturbance from the military activities affected non-target rocks used by seabirds, some of which were bombed by mistake.[152] Farallon de Medinilla, CNMI and Kaula Rock, HI are still actively bombed. Scheduled maintenance at remote sites that support seabird colonies, that could potentially be conducted during the nonbreeding season, 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.

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

[151]Harrison 1990

[152]Speich 1985

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.

MANAGEMENT ISSUES

APPLICATION OF THE MIGRATORY BIRD TREATY ACT TO THE HIGH SEAS

While all terrestrial migratory birds are afforded full protection under the Migratory Bird Treaty Act (MBTA), seabirds have not been afforded similar protections beyond state (3 nm) or U.S. (12 nm) territorial limits. This is despite the Act's express goal of protecting these species throughout their ranges and four bilateral treaties calling for similar protections. Commercial fishing operations incidentally kill large numbers of seabirds. Currently, the Service has no legal authority on the high seas to protect migratory birds beyond our territorial limits. Application of the MBTA to U.S. citizens and citizens on board U.S. flagged vessels anywhere within the U.S. 200-mile EEZ and on the high seas would enable the Service to enforce regulations and better manage seabirds on the high seas. Extension of the MBTA to the high seas would enable the Service to work more effectively with industry, the public, and other regulatory agencies to conserve seabirds.

ENDANGERED SPECIES MANAGEMENT CONFLICTS

Today, with so many species and ecosystems facing tremendous challenges, conflicts sometimes arise between conservation management for seabirds and endangered species. One example in this Region is management of endangered salmonids and Caspian Terns in the Columbia River estuary. There is considerable pressure to resolve these conflicts through management but the relationships between endangered species recovery and predators, including seabirds, is complex and not well understood. Conservation of endangered species in highly altered landscapes presents unique challenges to resource managers.

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. These inventories were generally coordinated at the state, island, or archipelago scale, although the initial inventories of the west coast states (California, Oregon, Washington) during the 1970s and early 1980s were part of a larger effort to provide a complete inventory of seabird nesting colonies along the continental west coast including Alaska. 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 Refuge Complex level or they have been associated with specific projects such as oil spill monitoring. 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 compilation of existing population information rather than new survey data.

The Region does not have a centralized data management system. Seabird data derived from these programs are managed/stored at the Refuges, although several Refuges (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. The Service is in the process of developing a Biological Data Management System for NWRs.

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 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*.[153] The Service and MMS funded another complete seabird inventory of California in 1989-1991 and a draft report was produced *Breeding Populations of Seabirds in California, 1989-1991* [154] but the report was not finalized. The Service also commissioned an inventory of Oregon seabird colonies, conducted in 1979. A draft colony catalog was produced *Oregon Seabird Colony Catalog*, but never published. Oregon Coast NWR Complex completed another inventory in 1988.[155] In Washington, Speich and Wahl (1989) compiled information from numerous sources to complete the *Catalog of Washington Seabird Colonies*; colonies had been surveyed between 1978 - 1982.

Migratory Birds and Habitat Programs is working with Refuge 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 compiled for Alaska, Russia, and other north Pacific Rim states/nations. A *Catalog of Oregon Seabird Colonies* will be released in 2004. Compilation and computerization of data to update the *Catalog of California Seabird Colonies* is underway, after which data for Washington colonies will be computerized. These efforts are being coordinated with USFWS Region 7 (Alaska), other federal and state land management agencies. Ultimately, up to date, colony catalog information with mapping

[153]Sowls *et al.* 1980

[154]Carter *et al.* 1992

[155]Varoujean and Pitman 1980, USFWS in prep.

capabilities will be available on the web.

Surveys of the central Pacific Islands were conducted during the 1960s as part of the Department of Defense-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 Hawaii and the USPI was not compiled. In 1975, a formal agreement among the Service, NMFS, and Hawaii Department of Land and 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 USFWS research scientists and Refuge and state biologists working on the main Hawaiian Islands to prepare a *Draft Atlas of Hawaii Seabird Colonies*.[156] A final Atlas or Colony Catalog was never published but summaries of the data were presented in publications.[157] These data and subsequent population data will be incorporated into the seabird colony catalog GIS databases.

The Service commissioned a study (1975-1976) to document the status of wildlife and wildlife habitats of American Samoa, including seabirds.[158] The status and conservation of seabirds in the Mariana Islands was synthesized and reported by Commonwealth biologists from data collected during the period 1979 - 1988.[159] 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 Atoll since 1982 and inventories of all nesting seabirds are available for this atoll.[160] A Refuge 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.[161] Access to Howland, Baker, and Jarvis islands is extremely difficult and costly, and surveys have been conducted

[156]USFWS 1983

[157]Harrison *et al.* 1982, Harrison 1990

[158]Amerson *et al.* 1982

[159]Reichel 1991

[160]USFWS unpubl. data

[161]Depkin 2003

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 were not designed to detect small changes in the size of breeding populations and they 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 Refuge- 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 were conducted sporadically until 1993 when annual surveys began. All major colonies are photographed during each survey and the photographs are labeled and archived. Washington is the only state where all colonies are counted annually (USFWS unpubl. data, Washington Maritime NWR), but <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. USFWS sponsored a synthesis of Common Murre data from the 1970s through 1995 summarized

in *Biology and Conservation of the Common Murre in California, Oregon, Washington, and British Columbia. Volume 1: Natural History and Population Trends*.[162]

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. 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; in Puget Sound and the Straits of Juan de Fuca, cormorant colonies have been monitored annually, on NWR islands only, since 1983.[163]

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. 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 USFWS and PRBO Conservation Science (formerly Point Reyes Bird Observatory) has resulted in long-term databases, since 1971, on 11 seabird species: 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.[164] Under the USFWS-PRBO cooperative agreement, annual estimates of breeding population size and reproductive success are provided based on studies of permanent study plots, and burrows, crevices or nest boxes; detailed protocols have been established for this monitoring and are available from PRBO.

[162]Manuawal *et al.* 2001

[163]USFWS unpubl. data, Carter *et al.* 1995, Wilson 1991

[164]Ainley and Boekelheide 1990

Coastal gulls and terns are monitored on Refuge lands at San Diego, San Francisco, and Humboldt bays, CA. At San Francisco Bay, seabird colonies on Refuge lands 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 Refuge lands, but monitoring of colonies on non-Refuge 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.[165]

The Service, in conjunction with the states, federal agencies (including the military), and other researchers, annually monitor populations of species listed under ESA, *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.

Hawaii and Pacific Islands Seabird population 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 once per year. Monitoring efforts are concentrated at four NWR locations: Tern Island (French Frigate Shoals), Laysan Island, and Midway Atoll NWRs in the northwestern Hawaiian Islands and Johnston Atoll NWR, in the central Pacific. Year-round USFWS staffing of Palmyra NWR started in 2002 and the establishment of a research station run by 7 academic institutions and museums planned for 2005 will increase the probability that comprehensive monitoring of Palmyra seabirds will continue. Permanent Service staff have been stationed at Tern Island and Midway Atoll since 1979 and 1992, respectively. A field camp has been staffed year-round at Laysan Island 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, estimated by sampling every year at Laysan and counted annually at French Frigate Shoals NWRs. High levels of albatross mortality in North Pacific longline fisheries led to close scrutiny of these population data by the Service, other regulatory

[165]Roby *et al.* 2001

agencies, and conservation organizations. Consequently, the Service and USGS are collaborating to design a more detailed albatross monitoring program with standardized protocols for determining albatross population trends and adult survival.

At Tern Island 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 documentation of breeding populations started in 1989.

Detailed Demographic Monitoring

Washington Maritime NWR 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 Island NWR.

The most intensive demographic studies for seabirds occurs at Farallon NWR where PRBO studies 7 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 provides 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 dynamics models to estimate rates of population growth/decline and evaluate population viability. In addition, PRBO studies the diet of 6 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 made. PRBO's research emphasizes the effects of climate variability and change on seabird population biology and foraging ecology.

In Hawaii and the USPI, the most intensive population monitoring is conducted at Tern Island, French Frigate Shoals NWR, where populations of all 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 the 2 albatross species, 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, and 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 demographic analysis of banding data that USGS is conducting, will form a basis for a status assessment for the these two species of conservation concern.

STATUS ASSESSMENTS AND SPECIAL SURVEYS

In addition to long-term monitoring, special surveys and assessments are designed specifically for threatened/endangered species and seabirds of conservation concern.[166]

In 1995, the Service helped fund 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 a population viability analysis for Xantus's Murrelets and Ashy Storm-Petrels, conducted by PRBO. Both species are on the Birds of Conservation Concern 2002 lists.[167] 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,

[166]USFWS 2002

[167]USFWS 2002

Caspian Terns are closely monitored at colonies in the Columbia River estuary by USGS. The Service coordinated a status assessment of Caspian Terns in 2001 and conducted a review of Caspian Tern nesting habitat in the Region, to assess the feasibility of management opportunities.[168] The Service developed a Cooperative Agreement with Mexico (CICESE/Pronatura) and coordinated a range-wide survey of Western Gull-billed Terns during 2003 to provide baseline data for a status assessment of this rare tern.[169]

Contaminants Monitoring

Several of the largest seabird colonies are located on islands with active or historic military bases or where military activities have occurred in the past and contaminants are an issue at some of these locations. Pacific Remote Islands NWR Complex has an active research and monitoring program directed at compiling 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 Island, French Frigate Shoals. 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 clean-up proposal for lead contamination of Midway Atoll has been approved.

MANAGEMENT

To date, the Service's management has focused primarily on acquisition and protection of breeding habitat; limiting or eliminating threats; and environmental education and outreach.

Habitat Protection and Restoration

Many of the major seabird colonies in the Region are protected by the Service, other federal agencies, territorial governments, or the states as National Wildlife Refuges, national and state parks, national monuments, 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

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

[169]Palacios and Mellink 2003, Molina 2003

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 to give presentations on the effects of low level "fly-overs" on seabirds and provide guidelines that the Coast Guard can follow 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. 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 not necessary on most of the NWRs. Exceptions include the low inshore islands in bays and estuaries. The San Diego Bay NWR Complex is in process for completion of a Comprehensive Conservation Plan for Sweetwater Marsh and South San Diego Bay. All habitat management and restoration alternatives in the plan include proposals for seabird nest site enhancements that include expansion of existing sites, creation of new nesting areas, and substrate enhancements of existing sites. Projects already underway include annual vegetation management at nesting areas and the installation of clean coarse sand on the tops of the existing levees within the solar salt evaporation ponds in 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 Hawaii, extensive projects have been conducted at Midway Atoll NWR, Johnston Atoll, and Kilauea Pt. NWR to restore native vegetation.

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 Refuges. 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 has 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. Service activities with respect to oil spills and contaminants are ongoing and not covered here in detail.

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 Refuge 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, school children 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.

OUTREACH AND EDUCATION

Service personnel throughout the Region provide information on seabirds for tourists, community members, and students in grades K-12. Slide 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 run by San Francisco Bay NWR to educate K-5 students about the hazards that face seabirds. In San Diego, the Service is working with the San Diego Zoo to incorporate migratory bird information into the Dr. Zoolittle program.

GOALS and OBJECTIVES

Goals and objectives are grouped under the broad categories

- Inventory and Monitoring
- Management
- Research
- Education and Outreach
- Planning and Coordination

The lead USFWS program/division and the proposed implementation schedule (if known) are indicated after each objective. All inventory, monitoring, and management objectives are considered high priority (unless otherwise indicated). Research, outreach, planning and coordination objectives are ranked according to priority.[1]

INVENTORY AND MONITORING

A 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 seabird colonies at long-term intervals (*e.g.,* 10 years) to provide baseline information and document large-scale changes, and, 2) intensive quantitative monitoring of specific demographic parameters for a select group of seabird species ("indicator" or "focal" species) at short-term intervals (*e.g.,* annual, biennial) at specific locations throughout the Region. The development and implementation of this program will need to be coordinated with other agencies and organizations that manage seabird colonies in the Region (*e.g.,* NPS, BLM, states, Tribes, and NGOs). Emphasis will be placed on Birds of Conservation Concern.[2] Threatened and endangered species will be inventoried and monitored in accordance with respective recovery plans. All monitoring and inventory goals and objectives are high priority, unless otherwise noted.

[1]Priority Ranks: I = High Priority; II = Secondary Priority

[2]Kushlan et al. 2002

GOAL 1. DESIGN AND IMPLEMENT AN INVENTORY PROGRAM FOR BREEDING SEABIRDS THROUGHOUT THE REGION AND MAKE THIS INFORMATION AVAILABLE TO STAKEHOLDERS AND THE PUBLIC.

Inventories - Inventories provide a snapshot of seabird distribution and abundance throughout the Region. While these large-scale inventories typically do not lend themselves to detailed statistical analysis, they provide landscape-scale information on the distribution and abundance for all breeding seabirds in the Region. In collaboration with other nations and other agencies/organizations that manage seabird colonies, these inventories can provide population-level information. Standardization is essential to allow for the combination and comparison of data.

Objective 1. a. Prepare and implement a seabird colony inventory plan and techniques manual to outline a comprehensive strategy and standardized protocols for data collection to inventory Region 1 seabird species and habitats.

i. The plan will be developed in cooperation with USGS and contain standard operating procedures (SOPs) for inventory of each species, or species group. Separate plans/techniques manuals will be developed for CCS and Pacific Islands ecosystems.
   (1) California Current Seabirds [MBHP/NWR/USGS; 2005]
   (2) Pacific Island Seabirds [MBHP/NWR/USGS; 2006]

Objective 1. b. Disseminate inventory information in electronic and printed formats using standardized GIS databases developed in coordination with USFWS Region 7.

i. Finalize and publish the Oregon Seabird Colony Catalog. [MBHP/NWR; 2004]

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

iii. Compile and distribute Hawaii and USPI Seabird Colony Catalog information. [NWR/AES/MBHP; Hawaii 2006, Pacific Islands 2007]

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

Objective 1. c. Extract, compile, computerize, and disseminate survey data contained in USFWS files. Enter these data into standardized GIS databases

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, I, 200X]

Objective 1. d. Develop an interactive web interface with GIS mapping capabilities in coordination with NBII, USGS, Region 7, and the Beringian Seabird Colony Catalog to provide access and seamless integration with other North Pacific seabird colony data.

i. Develop a data management system whereby USFWS personnel can enter new data and extract tabular and mapped information via the web or desktop platforms. [MBHP, I, 2005]

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

GOAL 2. DESIGN AND IMPLEMENT A SEABIRD MONITORING PROGRAM TO DETERMINE AND TRACK POPULATION TRENDS OF BREEDING SEABIRDS.

Monitoring - Whereas regional inventories (Goal 1) will provide broad-scale information on the distribution and abundance of breeding seabirds, more intensive monitoring of focal species at specific colony sites is needed to provide detailed, time series data by which the Service can track and assess trends in population size and other demographic parameters (*e.g.,* productivity, adult survival). Monitoring will be based on repeated sampling and data collection will be designed to allow rigorous statistical analysis. Factors that will be considered in selecting focal species include: foraging guild, conservation status, importance of Regional population with respect to global population, vulnerability to known or impending threats, response to environmental variability, and accessibility.

Objective 2. a. Prepare and implement a plan and techniques manual that outlines a comprehensive strategy for monitoring seabird populations and demographic parameters and provides standard operating procedures for data collection, analysis, and reporting.

i. Manuals will include rationale for species and parameter selection, minimum change to be detected for each parameter, standardized protocols for data collection and analysis, and thresholds for action outlined in detail. Focal species, monitoring locations, and survey protocols will all be delineated. USFWS biologists and managers will work with USGS and seabird scientists to develop this plan and techniques manual. Separate manuals will be prepared for California Current System birds and Pacific Islands seabirds. Implementation will include a feedback loop, whereby monitoring is evaluated for sufficiency in meeting objectives and protocols will be adapted accordingly.
   (1) California Current Seabirds [MBHP/NWR/USGS; 2005]
   (2) Pacific Island Seabirds [MBHP/NWR/USGS; 2006]

Objective 2. b. Develop a Data Management System for data storage and retrieval, archiving photographs and maps, and cataloging raw data and reports to ensure that these data are accessible for analysis and interpretation.

i. Coordinate with ongoing efforts towards a Biological Data Management System for National Wildlife Refuges, the Pacific Seabird Group Monitoring Database, and NBII. [MBHP/NWR; 2004]

ii. Submit summarized data entered to the Pacific Seabird Group Monitoring Database which will provide a mechanism for data dissemination to the public. [MBHP/NWR; 2004]

Objective 2. c. 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; annual]

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

MANAGEMENT

The Service has trust resource responsibilities for the conservation of seabirds as well as site specific management responsibilities associated with the NWRS. All management goals and objectives are high priority, unless otherwise noted. Habitat protection, habitat restoration, and alleviation of threats are the primary focus of management activities. Control and eradication of invasive plants are included under the habitat goal (GOAL 3) rather than the invasive species goal (GOAL 4).

GOAL 3. HABITAT MANAGEMENT - MAINTAIN, PROTECT AND ENHANCE SEABIRD HABITATS (BREEDING, ROOSTING, FORAGING, MIGRATING AND WINTERING) IN SUFFICIENT QUANTITY AND QUALITY TO MEET SEABIRD NEEDS.

Objective 3. a. Identify important breeding, roosting, and foraging habitats throughout the Region.

i. Maintain updated list of all seabird breeding locations with ownership/protection information in the Seabird Colony Catalog Database. [MBHP/NWR/AES; ongoing]

ii. Modify the Seabird Colony Catalog Database to include information on important roosting sites. [MBHP/NWR/AES; 2005]

iii. Coordinate with other state and federal agencies, conservation organizations, researchers, and other stakeholders in the identification and protection of important foraging habitats. [MBHP/NWR/AES; 2004]

Objective 3. b. Protect important sites identified in Objective 3.a. that currently are not protected through acquisition, easement, overlay NWR, special designation (*e.g.,* marine protected area), regulation, etc. Key nesting and roosting sites include areas such as tern nesting habitat in southern California (*e.g.,* Port of Los Angeles and Santa Ana River mouth), working with the Tribes on a cooperative management plan to protect seabirds at Chief's Island, OR; working with Department of Defense to protect important seabird colonies on military bases (e.g., Wake Atoll). [AES/NWR/MBHP; ongoing]

Objective 3. c. Protect seabird habitats on and off NWR lands from adverse human impacts such as disturbance through regulation, buffer zones, seasonal closures, restricted access, public outreach, enforcement, etc. Coordinate with other federal, state, and tribal agencies.

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

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

Objective 3. d. Habitat Restoration - Restore lost or degraded seabird habitats. Many of these projects require ongoing management activities and are not limited to a specific time period. Dates and schedules refer to the date of initiation. Specific projects include but are not limited to:

i. Remove or ameliorate hazards to seabirds at nesting and roosting sites such as the concrete containment at SE Farallon Island; unnecessary buildings and other structures (*e.g.,* light poles, unused and active power lines) at Midway and Johnston Atolls NWRs. [NWR; ongoing]

ii. Work internally and with partners to restore native habitat that has been lost or degraded at important seabird sites such as Midway Atoll NWR, HI, and San Nicolas Is, CA (coordinate with DOD). [AES/NWR/MBHP; ongoing]

iii. Restore, protect, and maintain sandy beach and dune habitats in central and southern California, historically used by nesting terns and skimmers *e.g.,* sites in south San Diego Bay, Bolsa Chica Restoration Project. Many of these projects require ongoing habitat management to maintain early successional habitat preferred by coastal tern species. [AES/NWR/MBHP; ongoing]

iv. Eradicate or control invasive vegetation that degrades seabird nesting or roosting habitat *e.g.,* golden crown-beard and bufflegrass in the northwestern Hawaiian Islands; Ironwood at Midway Atoll NWR; and, New Zealand spinach and cheeseweed at Farallon NWR. [NWR/AES/MBHP; ongoing]

GOAL 4. ERADICATE OR CONTROL INTRODUCED PREDATORS AND OTHER INVASIVE SPECIES THAT HAVE NEGATIVE IMPACTS ON SEABIRD POPULATIONS.

A more complete list of invasive species problems in the Region are contained in Appendix 9. Most control and eradication projects are multi-year undertakings and the schedule refers to the date of initiation.

Objective 4. a. Work with NWRs, state and federal agencies, and other partners at the local, regional, and national levels to eradicate or control introduced species that negatively affect seabirds. If broad-scale control or eradication programs are not feasible then work with partners at a more localized scale to control cats, dogs, pigs, rats, mongooses, foxes, cattle, and other non-native species in the vicinity of seabird colonies through such actions as fencing. Top priority projects include the following (See Appendix 9 for a more complete list):

i. Eradicate rats at Palmyra Atoll (NWR/TNC), Wake Atoll (DOD), and San Miguel Is, CA. (NPS). [NWR/AES/MBHP; pending funding or cooperators schedule]

ii. Work with partners to eradicate cats at Wake Atoll (DOD), San Clemente Is, CA (DOD), and San Miguel Is, CA.(NPS). [AES/MBHP/NWR; cooperators schedule]

iii. Control domestic, feral, and introduced species such as cats, dogs, rats, red foxes, and opossum near coastal seabird colonies throughout the Region. [NWR/AES; ongoing]

iv. Control cats, rats, mongoose, Cattle Egrets, and Barn Owls in Hawaii where they negatively affect seabird populations, especially in Newell's Shearwater and Hawaiian Petrel colonies. [AES/NWR; ongoing]

v. Fence and remove feral ungulates from forest habitats of Hawaii's NWRs to restore habitat for petrels, shearwaters, and other native species [NWR/AES; ongoing]

vi. Work with USPI territorial and commonwealth governments, to reduce impacts of introduced ungulates on seabird habitats. [NWR/AES; cooperators schedule]

Objective 4. b. Support efforts by partners at the international level to control or eradicate introduced species that negatively affect seabirds. Emphasis on Birds of Conservation Concern and shared seabird resources. Projects include, but are not limited to: [MBHP/AES/NWR; ongoing]

i. Control or eradicate introduced species, especially predators, at seabird colonies in the Gulf of California and along the Pacific coast of Mexico. Emphasis on protecting colonies of species such as Laysan Albatross, Black-vented Shearwaters, Gull-billed Terns, Xantus's and Craveri's Murrelets.

ii. Control or eradicate introduced species at seabird colonies throughout Oceania and other Pacific Rim countries. Emphasis on protecting colonies of species such as albatrosses; Phoenix Petrels; Polynesian, Tristram's and Band-rumped Storm-Petrels; and Lesser Frigatebirds.

iii. Control or eradicate introduced species at seabird colonies in Canada. Emphasis on shared species such as Ancient Murrelets.

Objective 4. c. Support research to determine the effects of invasive species (especially invertebrates) on seabirds and their habitats. And research into new technologies to eradicate or control these species. Implement these programs upon completion of the research. Projects include, but are not limited to:

i. Research into the effects and control of introduced insects (*e.g.,* ants and scale insects at Rose Atoll and Palmyra NWRs where they are causing the destruction of the pu'avai forests; grasshoppers at Nihoa NWR where they defoliate the island during population eruptions; ants at all Hawaii and Pacific islands where they directly attack seabirds; mosquitoes at Midway and Palmyra atolls NWRs where they are vectors for diseases such as avian pox and potentially West Nile Virus). [Scale insects at Palmyra; 2004] [NWR/AES/MBHP; ongoing]

ii. Research into the control and eradication of invasive plant species such as golden-crown beard and methods to restore native habitat. [NWR/AES/MBHP; ongoing]

Objective 4. d. Develop operational programs including SOPs to prevent introductions of invasive species and to detect predator and invasive species "spills" at island colonies. Prepare Response Plans that outline actions and responsible parties in the event of an introduction.

i. Assess the need and, if deemed necessary, develop and implement SOPs for Service staff, researchers, and visitors regarding movement of personnel and gear to colony islands to limit the potential for new introductions of alien species. [NWR/AES; 2005]

ii. Conduct 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 5. WORK WITH OTHER AGENCIES, FISHERIES COUNCILS, INDUSTRY, RESEARCH SCIENTISTS, AND OTHER PARTNERS TO MINIMIZE THE NEGATIVE IMPACTS OF FISHERIES INTERACTIONS ON SEABIRD POPULATIONS

Authorization and regulation of fisheries are the responsibility of various federal and state agencies such as NMFS and state fish and wildlife/game agencies. The Service will work with these agencies 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. Determining the effects of fisheries interactions on seabird populations, requires coordination between all agencies (e.g., effects of fisheries bycatch). Many of the specifics regarding monitoring of seabird populations are covered in GOALS 1 and 2.

Objective 5. a. Coordinate with Division of Migratory Bird Management (DMBM) and other Regions to develop a National Waterbird Bycatch Action Plan to implement Service policy to eliminate seabird bycatch in fisheries. [DMBM/MBHP; 2004]

Objective 5. 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 5. c. Provide technical assistance to Fisheries Councils, industry, fishers, federal and state agencies, Tribes, and other stakeholders in support of workable

solutions and rigorous scientific studies to develop new gear, fishing techniques, and/or mitigation measures to reduce and eventually 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. Hawaii 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

Objective 5. 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 5. e. Outreach to fishers regarding threats to seabirds and measures to minimize the problem *e.g.,* the dangers of long, trailing lengths of monofilament for birds caught in hook and line fisheries. [AES/MBHP; ongoing]

GOAL 6. OIL SPILLS - COLLECT AND PROVIDE TECHNICAL INFORMATION ON SEABIRD DISTRIBUTION AND ABUNDANCE THAT WILL INCREASE 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. Seabird populations and the environmental and anthropogenic factors that affect them need to be studied to assess the short- and long-term injuries from oil pollution. Implementation of a seabird monitoring program and development of websites to provide up-to-date information on the distribution and abundance of seabirds (proposed in GOALS 1 and 2) would assist response agencies in identifying

"resources at risk" and facilitate the development of appropriate response strategies. Long-term monitoring of demographic parameters are needed to assess impacts and evaluate the success of restoration projects.

Objective 6. 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; 200X]

Objective 6. b. Increase the protection of seabirds by increasing the Service's role in spill prevention and pre-spill planning activities, including development and revision of Area Contingency Plans, participation with the Coast Guard and other response agencies in Area Committees, and participation in spill drills. [AES/NWR; 2004]

Objective 6. c. Develop a list of seabird restoration projects that is continually updated, to provide the Trustees information on highest priority restoration projects. [AES/MBHP; 200X]

Objective 6. 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; 200X]

GOAL 7. CONTAMINANTS/HAZARDOUS SUBSTANCES - IDENTIFY PROBLEMS AND WORK WITH PARTNERS TO AMELIORATE THE EFFECTS AND CLEAN-UP CONTAMINATED SITES THAT NEGATIVELY IMPACT SEABIRDS.

Objective 7. a. Develop and implement a coordinated regional monitoring program for early detection of contaminant problems. Emphasis on birds of conservation concern and declining species. Program will include but not be limited to :

i. Periodic monitoring of contaminant levels in birds and eggs of nesting seabirds. [AES/NWR; 200X]

Objective 7. b. Identify, eliminate and/or neutralize contaminant sources at seabird colonies, important roost sites, and foraging areas. [AES/NWR; ongoing]

Objective 7. 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, I; 200X]

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 birds of conservation concern and species listed under ESA, 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 8. IDENTIFY AND SUPPORT RESEARCH THAT FURTHERS CONSERVATION OR ASSISTS IN THE MANAGEMENT OR MONITORING OF PACIFIC SEABIRDS.

Objective 8. 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, I; 2006]

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 Birds of Conservation Concern[3] *e.g.,* petrels, shearwaters, storm-petrels, and murrelets. [MBHP, I; 2006]

[3]USFWS 2002

Objective 8. 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, nesting habitat, foraging habitat, reproductive biology, population status, etc. Emphasis on birds of conservation concern.

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, I; Tristram's 2006; band-rumped 2007]

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, I; 200X]

iii. Conduct population viability analysis for birds of conservation concern [MBHP, I; 200X]

Objective 8. 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, I; 200X]

Objective 8. 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, II]

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 9. DEVELOP A COORDINATED PROGRAM TO EDUCATE THE PUBLIC ABOUT SEABIRD RESOURCES IN THE REGION, INCLUDING SEABIRD ECOLOGY, THREATS AND CONSERVATION ISSUES THAT AFFECT SEABIRD POPULATIONS.

Objective 9. a. Develop a K-12 curriculums on seabirds with specific chapters on the California Current System and tropical/subtropical island systems. [MBHP/NWR/AES, II]

Objective 9. b. Develop presentations about various aspects of seabird ecology, research, monitoring, threats, and other issues that can be distributed to Refuges and USFWS field offices. [MBHP/NWR/AES, II]

Objective 9. c. Develop a website dedicated to seabirds with links to current and recent investigations and monitoring. Include interactive teaching modules. [MBHP, I; 2005]

GOAL 10. INCREASE OPPORTUNITIES FOR THE PUBLIC TO VIEW AND EXPERIENCE SEABIRDS

Objective 10. 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. [NWR/AES/MBHP, I; ongoing]

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

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, II]

iv. Design an "Oceans of Wings" poster that celebrates seabirds world-wide. [MBHP, I; 2005]

Objective 10. 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, I; 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 11. COORDINATE WITH OTHER COUNTRIES, US 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 BIRDS OF CONSERVATION CONCERN AND SHARED RESOURCES.

Objective 11. a. Develop and implement seabird components of regional waterbird plans under the North American Waterbird Conservation Plan.

i. Foster the development of an international waterbird working group for the California Current System, to coordinate implementation of the regional waterbird and seabird plans. Continue involvement with the CCS Adaptive Seabird Management Plan to address seabird conservation in Bird Conservation Regions 5 and 32. [MBHP/NWR/AES, I; ongoing]

ii. Coordinate with partners in Hawaii and the Pacific Islands to develop and implement a Regional Waterbird Plan for BCRs 67 and 68. [MBHP/NWR/AES, I; 2005]

Objective 11. b. Participate in working groups, interagency teams, 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, I; 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. [AES/MBHP/NWR, I; ongoing]

iii. Provide input to USFWS 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, I; 2004]

iv. Establish contacts with ongoing seabird conservation efforts currently underway through groups such as BirdLife International, Audubon's Living Oceans, Wetlands International, etc. [MBHP, I; 2004]

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

Objective 11. c. Improve coordination on seabird monitoring and management issues within USFWS and with other agencies/land owners such as BLM, NPS, DOD, states, TNC, etc. Improve coordination with USGS and support increased focus on key seabird issues. [MBHP/NWR/AES, I; 2004]

Objective 11. d. Improve coordination with NOAA-Fisheries on shared monitoring, management, and conservation issues.

i. Involvement with 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, I; ongoing]

ii. Integrate USFWS activities with the developing NOAA-Fisheries efforts to expand Coast Watch program to develop a monitoring program for seabirds at sea.[get official terminology] [MBHP, I; 2004]

iii. Technical assistance for observer programs that monitor the bycatch of seabirds in commercial fisheries. [MBHP/NWR/AES, I; ongoing]