Marine Bird Resources

Seabirds are a diverse assortment of bird species that inhabit salt or brackish water environments for most of their annual cycle, but this is no clear definition. Some seabird species (such as the double-crested cormorant) have populations that are both saltwater or freshwater year-round (even with populations spending part of their annual cycles in both environments). Other types of waterbirds found on salt water also include the classic waterfowl (ducks, geese, coots, and shorebirds) as well as those that live on sandy beaches and in coastal marshy areas or that nest in arctic tundra or inland lakes and marshes (such as loons, grebes, wading birds, and even the well-known seaducks). Loons and grebes are, in fact, unique in many ways. They may be encountered during their non-breeding seasons foraging and living miles at sea; yet, they nest inland in fresh water habitats. This discussion is, however, limited to those species of birds that have breeding populations on offshore islands, coastal rocks, headlands, and certain coastal old-growth forests and are part of the neritic (shallow marine waters less than 200m deep) and pelagic food webs. Our California seabird avifauna can also be further divided into resident (breeding) and non-resident (non-breeding) species. Birds in various ecological categories are very different in how they affect or are affected by the natural environment and human-related events offshore from our coast.

There are 29 species of seabirds (according to our definition) that breed in the state of California. Point Conception is generally considered a major area of transition between characteristically temperate (such as those found in the Gulf of Alaska and Washington) and subtropical seabirds (such as those found in the Gulf of California). North of Point Conception, marine waters are dominated by cold, nutrient-rich water upwelled along the coast. Waters south of Punta Eugenia, Baja California, are generally subtropical. Between is an area of transition that varies in marine climate depending on the temporal extent and timing of upwelling. For example, well-known El Niño conditions often extend warmer waters northward, while the opposite conditions known as La Niña often move relatively colder waters more southward. Ecologically, (and including both breeders and non-breeders) this makes California's marine birds among the most interesting and taxonomically diverse (for the amount of coastline and area of open ocean) in the Northern Hemisphere.

In California, many of our breeding seabirds, such as common murres, Brandt's cormorants, and Cassin's auklets (all primarily northern species) are concentrated at national wildlife refuges, for example, at the Farallon Islands (off San Francisco) and Castle Rock (near Crescent City). The Farallones are the most important single seabird-breeding site in California; these islands are monitored and studied each year by the Point Reyes Bird Observatory and U. S. Fish and Wildlife Service. Large seabird populations there are associated with a high availability of suitable and protected nesting habitat, coupled with strong and productive upwelling systems that provide for large prey resources in the same general area.

Many other species are concentrated on the Channel Islands, located south of Point Conception in the Southern California Bight. Most of these islands are within the Channel Islands National Park. The Channel Islands harbor important nesting colonies for some seabirds of northern affinity (such as Cassin's auklets), but also the state's entire nesting population of both brown pelicans (presently a recovering endangered species under the Endangered Species Act, ESA) and Xantus's murrelet (about to be proposed for endangered species listing; a petition has been recently submitted to the U.S. Fish and Wildlife Service for listing under the ESA). Both species have southern breeding distributions and also nest on islands off Baja California, but the brown pelican is of tropical affinity (origin), whereas the Xantus's murrelet is of subarctic affinity. Seabirds are monitored and studied each year in the Channel Islands by biologists from a number of government agencies, universities, and research groups (*e.g.*, University of California, Humboldt State University, U. S. Geological Survey, Channel Islands National Park, U.S. Minerals Management Service, California Department of Fish and Game, and California Institute of Environmental Studies).

Most of the remainder of important seabird breeding sites are protected by the National Park Service at Point Reyes National Seashore and by the U.S. Bureau of Land Management and State of California, which manage all offshore rocks as the new California Coastal National Monument. The marbled murrelet nests on public and private land, located within privately-owned forests.

The marbled murrelet, in fact, is one of the most unique and interesting breeding seabirds off central and northern California. It is a small seabird that nests inland on the branches of coastal, old-growth coniferous trees, often over a hundred feet above the ground. This little bird species, listed as threatened under the Endangered Species Act, is very likely to be still declining (our table lists it as unknown) because of the loss of its nesting habitat due to logging and mortality caused by oil spills and, previously, gillnet fishing. Fortunately, because of conservation measures, there has been no known mortality in gillnets for the past 15 or so years, so there is cause for optimism.

Usually by the end of summer (after the upwelling period), the California Current system experiences an immigration,

Table 1. Seabirds which breed off the California coast, their distributional status relative to areas north (Alaska) and south (Baja California) of California, the approximate sizes of their breeding populations in 1989-1991, and their probable status in the early 2000s (X indicates presence, 0 indicates absence).

1989-91 Distribution in: Common Name (Scientific Name)	Alaska	California[1]	Baja Calif.	Estimated CA Breeding Pop. in the early 2000s [2]	Current Status in CA
Forked-tailed storm-petrel *(Oceanodroma furcata)*	X	X	0	300	Unknown
Leach's storm-petrel *(Oceanodroma leucorhoa)*	X	X	X	18,300	Declining
Ashy storm-petrel [3] *(Oceanodroma homochroa)*	0	X	0	<10,000	Declining
Black storm-petrel *(Oceanodroma melania)*	0	X	0	150	Unknown
Brown pelican [3] *(Pelecanus occidentalis)*	0	X	X	9,000	Stable
Double-crested cormorant *(Phalacrocorax auritus)*	X	X	X	1,900	Stable/Increasing
Brandt's cormorant *(Phalacrocorax penicillatus)*	0	X	X	64,200	Stable/Increasing
Pelagic cormorant *(Phalacrocorax pelagicus)*	X	X	0	15,900	Stable/Increasing
Western gull *(Larus occidentalis)*	0	X	0	51,000	Increasing
Common murre *(Uria aalge)*	X	X	0	363,200	Stable/Increasing
Pigeon guillemot *(Cepphus columba)*	X	X	0	14,700	Stable
Marbled murrelet [3] *(Brachyramphus marmoratus)*	X	X	0	<10,000	Declining
Xantus's murrelet [3] *(Synthliboramphus hypoleucus)*	0	X	X	<10,000	Stable/Declining
Cassin's auklet *(Ptychoramphus aleuticus)*	X	X	X	131,200	Declining
Rhinoceros auklet *(Cerorhinca monocerata)*	X	X	0	400	Increasing
Tufted puffin *(Fratercula cirrhata)*	X	X	0	250	Stable/Declining
Number species in common	10	-	7		
Total breeding species	28 (30)	16 (29)	14 (22)		

[1] Some species that breed in Alaska or Baja California are not listed above because they do not usually breed along the California coast; these species usually occur only as visitors, but in many cases can occur in very large numbers. Species in this category include white pelicans, black skimmers, at least four other species of gulls (Heerman's, laughing, ring-billed, and California), and seven species of terns (elegant, royal, Caspian, Forster's, gull-billed, least, black); numbers in parentheses indicate such additions for each area.

[2] Indicates numbers of individuals.

[3] Updated since 1991.

Note: The estimated total Alaskan breeding seabird population is about 40,200,000 compared to about 700,000 for California. These numbers represent approximate mean levels throughout the 1980s. Ten to 40 percent should be added to include non-breeders and immatures, a proportion that varies from year to year and species to species. Four species (common murre, Brandt's cormorant, Cassin's auklet, and western gull) comprise almost 90 percent of the total number of breeders. Population numbers given in this column are from the most recent statewide breeding surveys (see Carter et al. 1992).

emigration, and reshuffling of certain species of seabirds from the north, south, and within California. The abundance and diversity of seabirds increases immensely at this time. One of the most abundant seabird species in the world, the sooty shearwater, comes through California waters by the hundreds of thousands, mostly from New Zealand breeding colonies. Similarly, thousands of pink-footed and Bullar's shearwaters visit from Chile and New Zealand, respectively. During the summer and late fall, large numbers of black-footed and smaller numbers of Laysan albatrosses visit from their Hawaii nesting colonies. Occasionally, southern seabirds, such as boobies, red-billed tropicbirds, and magnificent frigatebirds, will provide the highlight of an offshore birding trip. Usually, beginning in July, several species arrive from the Gulf of California, Mexico, dispersing northward along the California coast; these include black-vented shearwaters, least storm-petrels, Heermann's gulls, elegant terns, and many more brown pelicans than nest in California. Especially during late fall and winter, we witness the arrival of northern seabirds, such as northern fulmars, horned puffins (plus other species of the "alcid" family), black-legged kittiwakes, and other species. Such diversity and abundance certainly adds to the overall richness and ecological value of California's total marine avian resources.

Table 2. Scientific names of birds mentioned in text but not included in Table 1.

Albatrosses	Family Diomedeidae
Black-legged kittiwake	*Rissa tridactyla*
Black skimmer	*Rynchops niger*
Black tern	*Childonias niger*
Black-vented shearwater	*Puffinus opisthomelas*
Boobies	*Sula sp.*
Bullar's shearwater	*Puffinus bullari*
California gull	*Larus californicus*
California least tern	*Sterna antillarum*
Caspian tern	*Sterna caspia*
Elegant tern	*Thalasseus elegans*
Forster's tern	*Sterna forsteri*
Gull-billed tern	*Sterna nilotica*
Heermann's gull	*Larus heermanni*
Horned puffin	*Fratercula corniculata*
Least storm-petrel	*Oceanodroma microsoma*
Magnificent frigatebird	*Fregata magnificens*
Northern fulmar	*Fulmarus glacialis*
Pink-footed shearwater	*Puffinus creatopus*
Red-billed tropicbird	*Phaethon aethereus*
Ringed-bill gull	*Larus delawarensis*
Royal tern	*Sterna maxima*
Sooty shearwater	*Puffinus griseus*

History and Utilization

Seabirds are the most conspicuous and familiar elements of marine communities and are a source of pleasure and enjoyment for people at sea or along the coast. They are unique and important biotic elements of marine ecosystems and in the practical sense are a good indicator of the general health of coastal offshore environments, yet people working or recreating at sea often know little about them. Although often omitted from marine resource reference works, seabirds require management and protection, just as other elements of marine ecosystems do.

Seabirds are prominent elements in the biodiversity of marine ecosystems. They perform what ecologist Paul Ehrlich calls ecological services, such as nutrient cycling and scavenging of biological waste materials and debris from waters and beaches. They often guide fishermen to fish. They are a pleasure to watch, and consequently, contribute significantly to eco-tourism. A small industry of offshore nature cruises has, in fact, developed in many ports along the California coast. Healthy seabird populations give us the justified feeling that all is well at sea, and a missing, sick, or oiled bird tells us that it might not be.

Like most marine wildlife, marine birds have historically suffered severe and relentless exploitations by man. In California this was especially true at the Farallon and other islands during and after the gold rush (from 1850 to about 1900), where common murres were heavily exploited for their eggs. There was no regulation of take and the murre populations declined severely. Numbers had declined by an order of magnitude by the 1900s, and only a few thousand individuals were left by the 1930s. The Farallon Islands murre population did not recover for several decades and even now is far below numbers of the 1800s. Exploitation of seabirds or seabird products is neither a local or recent phenomenon. Recall the ancient, managed harvest of guano by the Incas of Peru, or the harvest of guano for manufacturing gunpowder by the imperialistic navies of Europe in the 16th-18th centuries. Empires were won or lost over control of seabird islands. Early sailors and explorers often utilized seabirds or their eggs for food, driving some species to extinction. In general, however, there has been little success worldwide in utilizing seabirds for sustainable food or other product sources. The few exceptions include guano harvests in

Peru, harvest of eider down from seaducks in Iceland, and muttonbird (shearwater) harvests for food in New Zealand. There has been no successful sustainable harvest of seabirds or seabird products in California or along the West Coast. Since the early days of exploitation, management has usually involved putting the nesting islands into a protection system. This is the case for all islands off California.

After World War II, California's abundant seabird populations began to suffer from new problems. For example, populations were depleted as a result of offshore chemical pollutant discharges from industries in southern California. Most recently, populations have declined as a result of excessive mortality from entanglement in commercial gillnets. Bird populations in central and southern California may have declined because of excessive sardine fishing. Most species of seabirds feed on or near the surface, schooling species that are also sought in commercial fisheries. The well-known decline of sardines off Monterey is thought to have had deleterious effects on some species of seabirds. It is not well known, however, how long it takes to bring about a population decline of seabirds from prey depletion. Some species are able to switch effectively to other prey species, but often there are no other appropriate prey species to switch to. Since the 1950s, large oil spills and chronic waste oil discharges (such as slops and oily bilge waste-water) have become increasingly more frequent, and large numbers of seabirds have been killed. An outstanding example of seabird losses by oil spills is the "Point Reyes Tar Ball Incident" in which it is estimated that 10,000 to 20,000 seabirds died. Although acute oiling of seabirds from large oil spills receives a great deal more attention, chronic oil fouling of the offshore environment might cause the most damage to seabirds and other marine wildlife. Rehabilitation (washing and captive care) of oiled birds has so far not been very successful. Most birds die before rehabilitation can be attempted and many birds that receive care die anyway either before or after their release. It is not likely that most birds surviving rehabilitation will go on to breed. Thus, prevention of both oil spills and chronic oiling is the best solution. And, in stepping-up prevention activities, California has changed several factors to reduce the incidence and spread of spills: oil spill response schemes in all harbors, ship traffic control systems in all large ports, heavy fines of perpetrators of spills, and double-hulls required of all new tankers. In 1994, a multi-million dollar, statewide oil-spill rehabilitation network was initiated by the Office of Spill Prevention and Response, California Department of Fish and Game and Oiled Wildlife Care Network, University of California, Davis, to provide the immediate capability to clean oiled marine wildlife and to conduct research to improve rehabilitation techniques and survival success. Rehabilitation of individuals affected by diseases such as botulism or individuals that have been hooked or otherwise injured by fishing gear have proven to be much more successful. Unfortunately, funds to implement strategies to prevent birds from contacting oil during the spill response, such as wildlife hazing programs, have received limited support.

Adult Western Gull, *Larus occidentalis*
Credit: Paul Gorenzel, UC Davis

Population restoration and maintenance of populations into the future are ultimate goals of wildlife managers. Historically, most seabird conservation and management measures have been through protection of critical nesting, feeding, and roosting areas from human exploitation and disturbance, eradication of small populations of introduced predators, protection and recovery of prey species, and reduction of contaminants (*e.g.*, DDT and PCB compounds). Now, however, more proactive efforts are being utilized. For example, planned eradication of a large population of rats on Anacapa Island (by the Island Conservation and Ecology Group working with the Channel Islands National Park, USFWS, NOAA, and CDFG) will hopefully allow re-establishment of large populations of formerly-abundant crevice-nesting seabird populations. In another example, old-growth redwood forests have been preserved because of their importance as nesting habitat for marbled murrelets. Seabird recolonization is being achieved through social attraction techniques (using decoys, mirror boxes, and taped calls) to restore breeding

populations of common murres along the central California coast. Using these methods, breeding-age individuals were attracted to Devil's Slide Rock in San Mateo County, the site of a previously extirpated breeding colony. Since the project was initiated in 1996 (by the USFWS, Humboldt State University, and National Audubon Society), a small breeding colony soon established itself and increased each year to over 100 pairs in 2001. Proactive restoration and conservation efforts will undoubtedly expand in the future.

Since seabirds are visibly affected when people misuse marine resources, the well-being of our seabird populations can tell us a great deal about the health of our oceans. Potential effects on seabirds from future development are often examined to help evaluate overall projected effects on the marine environment. Such activities include increased levels of offshore oil extraction and transport, mining of other ocean resources, development of other forms of energy, use of new fishing techniques, fish farming and fish ranching at sea, and new marine product development and exploitation. Additionally, "ecotourism," a rapidly growing industry, can itself lead to unregulated intrusion onto islands that are important as nesting sites for seabird populations. There is already a long history of disappearance of seabird colonies on islands visited too frequently by unsupervised tourists. Global warming may also have detrimental effects on fish resources and, ultimately, seabirds. This may be seen in the form of population declines, changes in behavior, and/or shifts in distribution. Often predictive models, based on current research, will be necessary to more adequately predict what changes might be expected from long-term and radical changes in environmental conditions due to global warming.

The heavy fines and natural resource damage assessments that can be imposed on polluters, as well as recognition of the importance of seabirds as environmental indicators and of the effects that human activities can have on them, has led to a surge of activity and interest in seabird conservation and management. In addition to many governmental agencies that are concerned or charged with seabird conservation, there are at least five "seabird groups" that are composed of interested professionals worldwide who have become organized to study, help conserve these important elements of marine wildlife, as well as to educate the general public as to the value of seabirds in the California area. The Pacific Seabird Group focuses on the Pacific Coast from Baja California to Washington, plus Alaska, Hawaii, British Columbia, other parts of Mexico, and Japan. In California, state and federal governmental agencies, sport and commercial fishermen, seabird biologists, and marine bird conservationists are beginning to work together, guided in part by the California Marine Life Protection Act, to help study, conserve, and manage marine wildlife. Trust funds established from natural resource damage assessments resulting from oil spills such as the *Apex Houston*, the *American Trader*, and the *Commend* oil spills has already resulted in major new initiatives for seabird conservation; restoration funds of about $12.5 million have been committed to these efforts. And for the first time, significant marine bird protection zones (mainly for nesting areas) are being considered along with marine reserves, which address primarily fishery resources.

Seabird Ecology

Almost all important adaptations in body form and behavior of seabirds reflect specialization for either breeding or feeding. Methods of marine bird feeding depend on types of foods and where these foods are found in the water column. Seabirds, therefore, are influenced by the environmental factors that influence the marine environment. During the breeding season, seabirds are confined to feeding within range of their nesting islands. In addition to providing suitable habitat, nesting islands must be free of predators and disturbances. Outside the breeding season, when not constrained to tending offspring, many seabird species are highly mobile and can move long distances to find food while some species may remain in areas of abundant and predictable food supplies, just like fishermen. At sea, distribution of seabirds is heavily influenced by physical oceanographic processes. For example, plankton feeders will be found where ocean currents favor growth and accumulation of planktonic species. Such areas, in turn, provide food for shoals of species such as northern anchovy, Pacific sardine, herring, mackerel, or juvenile demersal fishes such as rockfishes. These midwater and epipelagic fish in turn are preyed upon by fish-feeding seabirds.

Juvenille Western Gull, *Larus occidentalis*
Credit: Paul Gorenzel, UC Davis

Some seabirds feed at the surface and others fly or paddle underwater to extend their reach lower into the water column. Some California species can dive to a depth of 330 feet. Water clarity influences which type of feeding method will be most successful. For example, clear, tropical waters typically best support species that catch fish by plunge-diving (boobies and pelicans). In contrast, northern waters are usually too turbid for aerial plungers to see prey, but are better suited to underwater swimmers or flyers (like the murres, auklets, and cormorants).

While nesting, seabirds are largely bound to nest contents that requires protection from predators. The breeding season is the period of time it takes from courtship, nest-building, and egg-laying to the point of fledging, when young leave the nest or become independent. During breeding seabirds are strongly influenced by local food supplies (*i.e.,* prey available within the feeding range of nesting birds), which are dependent upon oceanographic and meteorological conditions. Reproductive success is influenced by the biomass, availability, and consistency of local food supplies. For instance, when El Niño weather patterns associated with reduced productivity occur, seabirds reproduce poorly or not at all because prey resources are less abundant and available. Decadal alteration of marine climate can also be important, for example, the warm, nutrient-depleted period that existed during the late 1800s and again in the last decades of the 1900s.

Since offshore islands with nearby, stable food supplies are in short supply for nesting seabirds in California, such birds are almost always found concentrated into tightly-packed nesting colonies, with different species usually segregated onto different kinds of micro-habitat. As a consequence, nesting colonies are vulnerable to destruction by mammalian predators such as foxes, raccoons, mink, and cats. Therefore, nesting islands must be free from both terrestrial predators and human disturbance to provide seabirds with successful nesting opportunities. Evolutionary development on islands lacking terrestrial predators has left many seabirds with no defenses against predators, except to abandon their colonies. Undisturbed roosting and loafing sites are also critical to seabirds. Tourism and introductions of rats, cats, dogs, pigs, goats, and other feral animals has repeatedly led to extermination of seabirds from islands that were formerly predator-free.

Brown Pelican, *Pelecanus occidentalis*
Credit: Paul Gorenzel, UC Davis

Management and Conservation

Traditionally (up until about 1990), responsible government agencies had expressed almost no interest in funding basic seabird conservation research. Official listing under various categories and laws (the most outstanding being both state and federal "endangered" species acts) forced agencies to expend some limited funds on such species as brown pelicans, least terns, and marbled murrelets. Impending offshore oil development prompted some federal agencies to begin basic surveys of marine birds and mammals at sea and on the California coastline. Recent damage assessments guided by the Oil Pollution Act of 1990 have stimulated new directions in seabird conservation and management. It is ironic that mainly because of impending threats to seabirds by various forms of oceanic pollution (Outer Continental Shelf developments and marine contaminants), only then have seabirds begun to receive adequate research and conservation attention. Relative to other categories of marine resources, however, marine wildlife research and conservation still has to be considered as minimal. Interestingly, the non-game program of the California Department of Fish and Game (under the leadership of Howard Leach) pioneered on a national basis, investigations of seabird resources in California. Also in the early-1970s, a non-profit research organization, the Point Reyes Bird Observatory, initiated important research on the Farallon Islands.

Many federal and state agencies are now involved in the management and conservation of marine birds, and many statutory and regulatory provisions contribute to their protection. In addition, California has one of the finest systems of sanctuaries and refuges for seabirds in the world, although coordination among the many agencies and organizations involved has proven to be challenging. However, our coastal wetlands now comprise only a small percentage of their former extent, and these habitats are critical to many species of seabirds. Offshore waters are becoming increasingly occupied and utilized by people, yet many offshore islands and rocks are as close to their natural states as one might reasonably expect in our modern world.

Nonetheless, some of California's seabirds have been designated as threatened or endangered (*e.g.,* California least tern, California brown pelican, and marbled murrelet),

and others may already warrant such designations (*e.g.*, Xantus's murrelet and ashy storm-petrel). Brown pelicans may eventually be downlisted and delisted as an endangered species because its populations have shown strong recovery and are now self-sustaining; among seabirds this is one of the few true success stories of marine bird conservation in recent times.

Seabird populations have a number of characteristics in common, which make them susceptible to harm from environmental changes:

1) Resident seabirds concentrate their nesting efforts over several months at small areas, and they traditionally use the same nesting areas year after year.
2) Some seabirds (*e.g.,* pelicans, cormorants, and gulls) concentrate in roosts or resting sites. Night roosts provide protection from predators and disturbances and may have beneficial thermal characteristics. Day roosts are located closer to food supplies and may also have good plumage-drying properties, such as sunny, cold-wind protected surfaces.
3) Many seabirds depend on concentrated food supplies, often commercially valuable fisheries resources. Marine fisheries biologists are beginning to work with marine wildlife biologists to balance recreational and commercial fisheries with other wildlife needs.
4) Many seabirds tend to be long-lived with low annual reproductive rates. Thus, seabirds cannot usually recover very rapidly from large impacts on their populations.
5) Seabirds are often components of assemblages with interdependent elements, which means that they are closely allied to other species in their system. Disruption of one or more interacting elements may affect the entire assemblage in some way.

Seabird and Fisheries Interactions

Seabird-fisheries interactions have been categorized as follows: 1) direct competition, with negative population implications either for fish or seabird populations; 2) mutualism, where the interaction is beneficial, or commensalism, where there is neither benefit nor detriment to the interaction; and 3) physical injury, where birds are killed or injured by fishing activities, or bird activities affect operations or damage gear. Categories 1 and 3 describe conflicts in resource use that should be minimized. Extensive mortality of common murres and other seabirds in the 1980s and 1990s in gillnets has led to extensive fishing closures throughout most of California. Multi-species or ecosystem management instead of management that is single-species oriented may be the key to minimizing many conflicts. The management plan of the Pacific Fishery Management Council (PFMC) for northern anchovies was one of the first in the nation to consider the multiple uses of the anchovy resource, including prey for both seabirds and marine mammals and bait for sport fishermen. With recovering Pacific sardine populations (beginning in the late 1980s), the PFMC is revising its anchovy plan to include multi-species management of small pelagic fishes. Fishery management plans are beginning to include concepts such as forage reserves, multiple-needs, ecosystem balance, and thresholds of minimum resource abundance.

In recent years, there has been conflict between seabird needs for disturbance free nesting habitat and the market squid fishery in the Channel Islands. This fishery depends on the use of intense lighting during the night to attract squid. Much of the squid harvest occurs relatively close to the shorelines of islands where seabirds nest. As a result, smaller crevice-nesting nocturnal birds (*e.g.*, Xantus's murrelet and ashy storm-petrels) become highly vulnerable to predators (such as gulls and owls) while attending nest sites. These species are also attracted to light and can become disoriented and crash into the boats, potentially causing death or injury, or separating adults from their young on the water. Additionally, there is concern over the impacts of continuous light on the breeding success of diurnal species such as brown pelicans and cormorants. For these species, continuous light may affect hormonal levels, which in turn may alter behavioral patterns important in courtship, incubation, and chick care. Noise and disturbance generated from fishing activities may also affect breeding success of vulnerable species. Measures to resolve these conflicts are currently (in 2001) being considered and discussed by state and federal agencies together with seabird biologists and fishery managers, but at this time (summer of 2001) there are no assurances of a resolution.

Overall, the future of fishery-seabird interactions free of major conflicts is improving. For example, since gillnetting has been banned in many areas, some fishermen have switched to alternate fishing methods that do not harm seabirds. Situations are more difficult to control when commercial fishing occurs outside areas of state or federal jurisdiction, such as foreign waters where many of our migratory seabirds reside part of the year. Interactions between the recreational fisherman and marine wildlife also occur. While each individual interaction may involve only one angler and one bird (involving hook injuries, monofilament entanglements, and other injuries from handling and struggle), recreational fishermen as a group can have a significant impact on some seabird populations. In most instances the best management approach is still education.

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Because this report focuses on the status of marine fisheries, as required my the MLMA, the editors have had to limit the space devoted to birds. Since marine birds are an integral part of all the ecosystem divisions of this book we have included a comprehensive list of references.

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