The California Current Marine Bird Conservation Plan

Chapter 6

Predators, Competitors, Disease, and Human Interactions: "Top-Down" Control of Seabird Population Parameters and Population Dynamics

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Predators, Competitors, Disease, and Human Interactions: "Top-Down" Control of Seabird Population Parameters and Population Dynamics

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CHAPTER 6: PREDATORS, COMPETITORS, DISEASE, AND HUMAN INTERACTIONS: "TOP-DOWN" CONTROL OF SEABIRD POPULATION PARAMETERS AND POPULATION DYNAMICS

Marine birds in the Pacific are faced with many threats, on land and at sea, natural as well as anthropogenic in nature.

Natural threats include: ecological factors that limit population growth, large-scale climate change, disease, parasites, and marine biotoxins.

The most serious anthropogenic threats include loss or degradation of habitat, human disturbance, introduced species, oil and other marine pollution, contaminants, and fisheries interactions. Fisheries can impact seabirds, both directly and indirectly. Direct effects include entanglement in gear or hooking, leading to injury and/or drowning. Indirect effects may be caused by a reduction in seabird prey stocks, or by fisheries targeting adult/reproductive fish that might reduce the spawning population and cause a reduction in the juvenile fish that seabirds prey upon.

Other indirect effects may include disturbance to seabirds at colonies, oil contamination from vessels, and the introduction of debris into the marine environment.

In this section we discuss several "top-down" effects on seabird populations of the CCS, including predation, competition, disease, and fisheries.

6.1 PREDATORS

Predation at Sea

Predation on marine birds at sea is less commonly observed than land-based predation, as the wide distribution of birds at sea makes it difficult to make these rare observations. Inter-avian predation is not well described at sea, likely because predators, primarily large larids or raptors, have more difficulty capturing prey like small alcids on the ocean than on land. At sea, alcids can avoid gulls by diving, and are much more susceptible to predation on land where they are less maneuverable.

At sea, predation on North Pacific seabirds by marine mammals has been well described. For pinnipeds, documented records of predation include those of Northern Fur Seals on Rhinoceros Auklets, Marbled Murrelets, and Black-footed Albatross; Stellar-Sea Lions on Glaucous-winged Gulls; and California Sea Lions on Common Murres (see references in Long and Gilbert *(1)*). However, these observations are uncommon and seabird prey is often assumed to compose a minor portion of pinniped diet. Similar patterns for Killer (Orca) Whales have been observed, with observations of subadults rarely feeding on alcids. Quantitative diet analyses of Orcas in British Columbia and Washington suggest that seabirds are not a significant prey resource for this species *(2)*.

Predation on Land

Direct predation of adult seabirds at their breeding colonies in the California Current has been widely documented. Raptors, primarily Peregrine Falcons and to a lesser extent Bald Eagles and owls, are often observed preying on auks as they leave and arrive at several colonies, including Triangle Island (Centre for Wildlife Ecology, Simon Fraser University, unpublished data), Tatoosh Island *(3, 4),* Southeast Farallon Island (SEFI), and Ano Nuevo Island (PRBO unpublished data).

For Rhinoceros Auklets on Tatoosh Island and Ano Nuevo Island, Peregrine Falcon predation has been shown to have population level effects on the entire colony *(3)* (PRBO unpublished data). Predation of small auklets and storm petrels by larger gulls has also been well documented. On SEFI Western Gulls often prey on Cassin's Auklets and Ashy Storm-Petrels, and increases in gull numbers have mirrored decreases in these prey species throughout the last 3 decades *(5).* Burrowing Owls have also been observed to prey on Ashy Storm-Petrels on SEFI *(5).*

Predation on seabird eggs and chicks at breeding colonies is conducted by a large suite of predators, namely gulls, corvids, and rodents. In addition to preying on adult birds, large gulls will often take eggs and chicks of surface nesting seabirds *(6-8).*

Spear *(6)* found that many of the Western Gulls observed taking Common Murre and Brandt's Cormorants on SEFI were specializing in this prey resource.

Corvids, primarily Common Ravens, are also major predators of seabird eggs at certain coastal sites. Raven predation on some murre and cormorant colonies in central California has been shown to reduce productivity *(8)*(PRBO unpublished data). As corvid populations in the western United States have increased dramatically in recent decades *(46),* it is possible that predation pressure on seabird eggs by corvids may increase in the future.

Native rodents, specifically deer mice *(Peromyscus sp.),* have been observed to prey on the eggs of crevice nesting seabird eggs of Rhinoceros Auklets, Xantus's Murrelets, and Ancient Murrelets at breeding colonies in the California Current *(9-11).* Blight *(9)* noted high egg predation by deer mice during egg neglect of parents during a year of low ocean productivity.

Large introduced mammals, rats and cats, have caused major damage to seabird colonies through predation on eggs, chicks, and adult crevice nesting seabirds. The issue of predation by introduced species is detailed in the Introduced Species section of this document (Chapter 7, section 7.3).

In addition to direct predation, indirect predation effects through disturbance events or interactions between suites of predators can also have great effects on seabirds at their breeding colonies in the California Current. On Tatoosh Island, for example, disturbance of breeding Common Murres by Bald Eagles has caused increased levels of egg and chick predation by large gulls *(4).* At coastal Common Murre colonies in central California, disturbance of breeding birds by Brown Pelicans has facilitated egg predation by Common Ravens and gulls *(8, 12).*

6.2 COMPETITORS

Seabirds often forage in multi-species feeding associations. These associations, or feeding flocks, create visual cues for food finding and make more prey accessible due to the differentiation of feeding methods *(13).* Specifically, pursuit divers often initiate these aggregations and allow them to persist by driving prey to the surface *(14, 15).*

However, while different individuals and species can facilitate foraging for each other, they also compete for food. Intra-specific food competition can have direct effects on seabird population dynamics and has been suggested to have greater influence than interspecific food competition *(16).* Lewis et al. *(47)* showed how Northern Gannets at large colonies in the U.K. must forage longer to find food than birds at small colonies. In addition, marine mammals in the California Current consume similar prey to seabirds in significant quantities *(48).*

Seabirds in the California Current also compete for nest sites. Cavity nesting alcids from the Farallon Islands compete for burrow and crevice sites, with larger species usurping nest sites, pithing eggs, and killing young of smaller Cassin's Auklets *(17).* As Common Murre populations expand in large colonies like those on the Farallon Islands, they outcompete Brandt's Cormorants and exclude them from nesting at high densities within murre colonies (PRBO unpublished data).

In addition, marine mammals, particularly California Sea Lions, can exclude gulls, cormorants, and oystercatchers from breeding when their haulout areas expand *(18).*

6.3 DISEASE AND TOXINS

Viral, bacterial, algal, and fungal diseases impact seabirds. The incidence of disease outbreaks may increase in the next decade, given the many stressors plaguing the physiologic functions and organ systems that maintain homeostasis and health in seabirds.

The causative agents of diseases are found naturally in the environment, but disease typically has not been prevalent thus far due to the balance and co-evolution between potential pathogens and their hosts *(49-50).* However, as perturbations occur with increasing frequency in the marine ecosystems inhabited by seabirds, disease-associated morbidity and mortality will likely become more prevalent as the "host-pathogen" balance sways in favor of the pathogens.

Changes in ecological health are beginning to result in the emergence of new infectious diseases affecting seabirds (e.g. West Nile Virus), the reemergence of historical diseases such as exotic Newcastle's disease, changes in the geographic range of disease distributions in Hawaiian avifauna (e.g., malaria), and pathogens altering their mechanisms of infecting seabirds, such as in botulism transmission in pelicans.
Source: (http://pacific.fws.gov/salton/saltn96.htm).

Because large segments of seabird populations congregate in small geographic zones annually for breeding or foraging purposes, they are at great risk of rapid and extensive disease transmission. This, coupled with the fact that many seabird species are typically wide ranging, suggests that seabirds may serve the role of sentinel species, the proverbial "canaries in the coal mine." The aforementioned characteristics make it likely that seabirds indicate the health and condition of the marine ecosystems.

The seabird sentinel species concept can be useful for providing an "early warning" system for emerging diseases and to monitor the course of disease-related activities requiring prevention, remediation, or control. Diseases that have historically impacted seabird populations in CA, OR, WA, AK, HI, and the Pacific Islands include: 1) bacterial diseases Salmonella, Chlamydia, Erysipelas, and Avian Cholera; 2) viral diseases Avian pox, Exotic New Castle disease, and Avian influenza; 3) fungal disease Aspergillosis; 4) parasitic disease Eustrongylidosis; and 5) biotoxins Domoic acid or Amnesic shellfish poisoning, Saxitoxin or Paralytic shellfish poisoning, and the Avian botulism toxin.

Large-scale mortality of hundreds to thousands of seabirds has historically occurred in the CCS region. According to information provided by the National Wildlife Health Center (NWHC), USGS, in Madison, WI, major mortality incidents have been caused by aspergillosis, botulism, and avian cholera, resulting in 2,360 seabird deaths in CA, OR, WA, AK, HI, and the Pacific islands between 1980 and1989. This number more than tripled to 7,908 between 1990 and 1999. Although not of great concern to populations of seabirds numbering in the tens of thousands or more, the number of cases seen by the NWHC is certainly a small percentage of the actual number of birds that die in the wild. Furthermore, the recent trend towards increased documented mortality due to disease may be cause for concern and indicative of environmental problems.

In a given decade, multiple mortality events occur and relatively few birds are recovered, because many die at sea, sink, or are scavenged if they wash ashore. Of those birds recovered, few are sent to the NWHC for diagnosis; of those sent to the lab, some are not fresh enough to conduct proper disease testing. In fact, over 10,000 birds analyzed at NWHC from 1980-1994 had no diagnosis; this was due, in part, to the condition of the received carcasses. Collectively, these factors systematically bias the number of reported deaths. This suggests that the numbers of seabird disease-associated deaths may actually be orders of magnitude larger than what is reported by the NWHC.

Another gap in information regarding disease-induced seabird mortality may be related to the manner in which much of seabird mortality data are collected, namely beached bird survey programs.

Many survey programs exist (i.e. Gulf of the Farallones National Marine Sanctuary Beach Watch Program, Monterey Bay Beachcombers, and Coastal Observation and Seabird Survey Team in Washington State), each of which documents seabird mortality along regularly surveyed stretches of coast. However, because these projects record low-level, typically background mortality rates, they do not routinely result in the same investigative response or public awareness as do large-scale die-off incidents. Thousands of dead seabirds are documented annually in beached bird surveys. Unfortunately, the cause of mortality for many of these birds is undetermined.

Additionally, in many cases mortality recorded in these surveys is not included in morbidity or mortality reports provided by the NWHC whenever they did not conduct diagnostic testing of the carcasses. Despite the best efforts of volunteers and trained beached bird survey staff, diagnoses remain undetermined for most beach-cast birds because many carcasses are decomposed or scavenged by the time they are observed on beaches.

Another common limiting factor in diagnosing diseases of seabirds is the lack of appropriate diagnostic techniques. While testing techniques have improved significantly in the past 20 years, some pathologies, such as that for domoic acid toxicosis, remain difficult to ascertain.

Finally, some morbidity or mortality incidents are handled by state or local agencies and biologists. If these agencies possess sufficient internal diagnostic capacity, they typically do not send samples to the NWHC. In these cases, diagnostic testing has been conducted and results are not added to the database maintained by USGS because the mortality incident was handled locally.

Despite data gaps that exist in documenting the extent of disease-associated seabird mortality in the United States, one fact remains indisputable; in the past 10 years, seabird disease-associated mortality has increased. Anthropogenic activities are undoubtedly playing a role in this increase in disease emergence amongst seabird populations.

While bacterial and viral diseases have been historically documented as sources of mass mortality of seabirds, biotoxins have only recently been recognized as a significant problem.

Biotoxins pose a great threat to seabirds when high levels produced during algal blooms accumulate in seabird prey (fish). Many scientists believe that biotoxins are becoming more prevalent as agricultural runoff, pollution, and nutrient loading create ecological conditions favoring algal blooms. Increased frequency and intensity of algal blooms can, in turn, lead to more biotoxin mortality incidents *(21).* The first documented Domoic acid (DA) associated mortality in California seabirds was in 1991 and killed hundreds to thousands of birds, primarily brown pelicans and Brandt's cormorants *(22).* A variety of other algal blooms have occured along the California coastline, most recently in 2002, including another DA toxicosis incident in which an estimated 1,000 California brown pelicans died in southern California and Mexico (F. Gress, pers. comm.).

A unique outbreak of botulism at the Salton Sea, California, has killed thousands of brown and white pelicans over the past four years. Typically, botulism outbreaks require that birds ingest biotoxins found in maggots that have eaten infected carcasses *(51).* In this recent outbreak, however, normal disease transmission did not occur. Instead, pelicans became infected while eating live fish *(Tilapia sp.).* This is the first recorded instance of botulism occurring through this transmission mode.

This disease outbreak raises the question of whether environmental changes such as increased pollution or salinity levels at the Salton Sea have enabled a pathogen to evolve a new mode of transmission and infection; alternatively, it is possible that the host susceptibility to this disease has changed due to a compromised immune status in pelicans.

As more ecological perturbations occur in the marine environment, alterations in disease expression and changing relationships between hosts and infectious organisms are likely to occur. Such changes could be expressed in three ways: 1) diseases could spread to new species that are immunologically naïve, thereby establishing new host species; 2) diseases that currently coexist at low background levels in species could increase in pathogenicity in conjunction with declines in immunocompetence associated with increased environmental stressors; and 3) diseases that are geographically restricted could spread into different regions, thereby broadening their distribution. All of these situations have the potential to result in disease outbreaks and large-scale seabird mortality.

Another group of diseases of particular concern are the vector borne diseases, specifically arboviruses (diseases transmitted by mosquitoes or other arthropods). Theoretically, seabirds would be expected to be relatively safe from arboviruses since standing water sources required for mosquito reproduction are usually less common near seabird colonies, especially on off-shore rocks and islands where seabirds tend to nest. However, the prevalence of avian malaria and avian pox demonstrate that seabirds are susceptible to mosquito-borne diseases. Since it is unlikely that seabirds have much, if any, exposure to West Nile virus (WNV) to date, their immune systems are likely naïve, making them very susceptible to this newly emerging disease.

Mosquitoes do occur on many of the nearshore islands on which seabirds nest, and it is also possible that mainland mosquitoes could be transported to large offshore breeding colonies via storms or wind. Seabird responses when they become exposed to WNV are currently unknown; they may be immunocompetent, develop titers, and survive or, alternatively, succumb to this disease. To date, the most severely impacted species have been corvids and raptors although some marine species including pelicans, skimmers, herons, cormorants, and gulls have recently been shown to be susceptible to WNV (http://www.promedmail.org) raising concern for other species.

As WNV becomes established on the West Coast, mortality of some terrestrial avian species is almost certain, but the disease could also affect other colonial nesting seabirds. Inland nesting seabirds such as Marbled Murrelets *(Brachyramphus marmoratus)* may be at risk due to the high mosquito densities in terrestrial habitats.

Disease outbreaks in seabirds are most common and most devastating during the breeding season when high densities of birds at colonies facilitate pathogen transmission. Seabird diseases are transmitted through a variety of routes including fecal-oral, aerosol-inhalation, inoculation through trauma, bites, or scratches, and via vectors (i.e. arboviruses, tick-borne diseases).

Direct seabird morbidity or mortality secondarily through scavenging sick or freshly dead carcasses can also play a role in disease transmission. For those species of seabirds that congregate in closely associated groups or forage in flocks, the likelihood of disease transmission among individuals increases. This is exacerbated during the breeding season when adults can easily infect chicks.

Post-breeding dispersal movements of seabirds provide another mode by which diseases could be transported hundreds if not thousands of kilometers from their place of origin, thus potentially exposing large numbers of individuals from many different species. Diseases pose the greatest threat to small isolated populations of seabirds where the spread of a single disease at one colony could lead quite easily to a local island extinction and potential loss of genetic diversity.

The lack of available information about diseases and the immune status in free-ranging populations of seabirds emphasizes the need for collecting more baseline health information. Serological surveys for diseases in free-ranging seabird populations could greatly enhance our understanding of diseases that currently pose risks to populations and those diseases that birds have previously acquired immunity against.

The NWHC maintains an excellent national database of disease outbreaks and die-off incidents but dead birds are not always made available to the NWHC lab for diagnostics, thereby creating gaps in information. A single comprehensive national seabird disease morbidity and mortality database could incorporate information from local, regional, and national (already being conducted by NWHC) investigations and enhance efforts to better understand and document chronic seabird disease-associated mortality through collaborative efforts with beached bird survey groups.

Establishing better regional monitoring programs, coordinating epidemiological disease outbreak investigations, and initiating a seabird stranding network similar to the NMFS marine mammal stranding network would greatly assist seabird disease surveillance and documentation of emerging seabird pathogens that result in morbidity and mortality. Ultimately, this valuable information will assist resource managers in making important management decisions in an effort to balance seabird resources and other interests.

6.4 FISHERIES EFFECTS ON SEABIRDS

The California Current System (CCS), as a highly productive marine ecosystem, has a high abundance and diversity of marine mammals, sea turtles, seabirds, and fishers. This has resulted in encounters and conflicts between certain fisheries and marine wildlife, in some cases causing mortality of numerous marine animals, including seabirds.

Fisheries have existed for centuries, although only within the last few decades has there been growing awareness of the impact of fisheries on seabird populations. Direct injury or mortality by fishing activities is one of the most serious threats currently faced by seabirds that breed and feed within the CCS, and there is a high potential that this problem will intensify in the future as the demand for seafood increases with a growing human population.

Not only is it crucial to identify the existing problem areas and seek solutions to these conflicts, but it is also necessary to keep informed of developing or future fisheries that might impact seabirds, both directly as well as indirectly (see Chapters 5 and 7 for a description of indirect impacts on seabirds).

Seabirds that breed and feed in the CCS region are affected by commercial fisheries by several factors, including: (1) entanglement in deployed or discarded fishing gear, (2) competition for the same fish or invertebrate species (discussed in Chapter 5), and (3) changes in ecosystem structure produced by commercial fisheries activities due to biomass removal or habitat degradation *(23).*

Fisheries target a diverse group of species and use a variety of vessels and gear including pots, throw and dip nets, and harpoons that catch fish at a small scale. Purse seines, trawls, longlines, and drift gillnets target larger fish and at a correspondingly larger scale. Seabirds are killed incidentally in all oceans of the world in almost all gear types used by fisheries. Fishing activity within the U.S. portion of the CCS occurs within state waters (from the coastline to 3 miles from shore), and within federal waters (3-200 nautical miles offshore). Several fisheries also operate beyond the 200-nautical mile Exclusive Economic Zone (EEZ) and target highly migratory species such as tuna, swordfish, sharks, and billfish.

Direct seabird mortality, caused by entanglement in gear or hooking (leading to injury and/or drowning), can seriously jeopardize seabird populations. A select few fisheries pose a serious threat to certain seabird species (Table 6.1). Only eight of these 17 fisheries have ongoing observer programs.

Fisheries that pose the greatest risk for direct seabird mortality in the CCS region include those using set and drift gillnets, and pelagic and demersal longlines.

***Table 6.1** – Fisheries that operate in the CCS that have* documented *seabird bycatch and presence (Y)/absence (N) of an observer program associated with each fishery (the years in operation are in parentheses).*

FISHERY	SEABIRD SPECIES DOCUMENTED	OBSERVER PROGRAM
CA angel shark/halibut set gillnet	COMU, CORM SP, LOON SP, GREBE SP, ALCID SP	Y (1990-1994)
CA other species, large mesh set gillnet	CORM SPP.	Y (1983-1989)
WA Puget Sound Region salmon drift gillnet	COMU, RHAU, PIGU, MAMU	Y (1990-1994)
CA/OR thresher shark/swordfish drift gillnet	NOFU, unidentified spp.	Y (1990-present)
U.S. West Coast (CA/OR/WA) pelagic longline	BFAL	Y
CA/OR/WA commercial passenger fishing vessel	BRPE, LETE, MAMU, cormorant spp.	Y (short-term programs)
CA/OR/WA groundfish trawl		Y (2001-present)
Baja California sardine/anchovy seine net	BVSH, XAMU, CRMU	N
Baja California lobster and crab trap	BRAC, PECO, DCCO	N
Baja California gillnet for finfish and shrimp	BRAC, PECO, DCCO, XAMU, CRMU, CAAU, BVSH	N
Baja California longline	MAFR, BRPE, DCCO, BRAC, PECO, LAAL	N
Canada Halibut/Sablefish longline	BFAL, NOFU	Y (1999-present)
BC - Longline (ZN)	BFAL	Y (1999-present)
BC - Trawl - Midwater	STSH	Y (started 02/03)
BC - Scedule II Dogfish	gull spp.	Y (started 1999)
Vancouver salmon test fishery	COMU	
BC - Gillnet	PALO, COLO, SOSH, PECO, BRCO, COMU, RHAU, MAMU, PIGU, CAAU	Y (1995 - present)

Species abbreviations: ***ALCID SPP,*** *alcid species;* ***BFAL,*** *Black-footed Albatross;* ***BRCO,*** *Brandt's Cormorant;* ***BRPE,*** *Brown Pelican;* ***BVSH,*** *Black-vented Shearwater;* ***CAAU,*** *Cassin's Auklet;* ***COLO,*** *Common Loon;* ***COMU,*** *Common Murre;* ***CORM SPP,*** *cormorant species;* ***CRMU,*** *Craveri's Murrelet;* ***DCCO,*** *Double-crested Cormorant;* ***GREBE SPP,*** *grebe species;* ***GULL SPP,*** *gull species;* ***LAAL,*** *Laysoan Albatross;* ***LETE,*** *Least Tern;* ***LOON SPP,*** *loon species;* ***MAFR,*** *Magnificent Frigatebird;* ***MAMU,*** *Marbled Murrelet;* ***NOFU,*** *Northern Fulmar;* ***PALO,*** *Pacific Loon;* ***PECO,*** *Pelagic Cormorant;* ***PIGU,*** *Pigeon Guillemot;* ***RHAU,*** *Rhinoceros Auklet;* ***SOSH,*** *Sooty Shearwater;* ***STSH,*** *Short-tailed Shearwater;* ***XAMU,*** *Xantus's Murrelet.*

Although there are few fisheries that account for most of the seabird mortality, these can severely impact the health of some seabird populations. Additionally, there are 12 other fisheries that have a high potential of seabird mortality because of the type of gear used and the location of the fishery (Table 6.2), and few of these have ongoing observer programs.

***Table 6.2** – Fisheries that operate in the CCS that have potential seabird bycatch.*

FISHERY	TARGET SPECIES	OBSERVER PROGRAM
WA/OR lower Columbia River salmon drift gillnet	salmon	Y (1980s, 1990-93)
CA emerging tuna with surface drift net	tuna	Y (1999)
WA Willapa Bay salmon drift gillnet	salmon	Y (1980s, 1990-93)
WA Grays Harbor salmon drift gillnet	salmon	Y (1980s, 1990-93)
WA/OR gillnet	various species	N
OR blue shark surface longline	blue shark	N
OR swordfish surface longline	swordfish	N
WA/OR North Pacific halibut longline/set line	halibut	N
CA/OR/WA groundfish, bottomfish longline/set line	groundfish, bottomfish	N
CA shark/bonito longline/set line	shark, bonito	N
CA/OR/WA salmon troll	salmon	N
CA longline	pelagics	N

Another direct effect is seabird mortality or injury from lost or discarded nets or other fishing gear. Lost nets, such as drift gillnets, can travel long distances, affecting birds over vast regions.

Monofilament poses a serious threat to seabirds. This material is difficult to see, and is almost indestructible. Many birds are often seen on beaches with monofilament around their legs, wings, or head. Even though this may not cause immediate mortality, severe injuries may develop from the monofilament cutting into the flesh and becoming infected, and may impede with foraging or other behavior (mating).

Hooks are often associated with the monofilament. Fishermen in both commercial and recreational hook and line fisheries frequently cut the line after a bird has taken the bait and hooked itself, leaving the hook in the bird with trailing monofilament line. Hooks can become embedded in the mouth or in body parts. This type of injury usually results in the death of the bird affected.

In California, Brown Pelicans are one of the primary species affected. During 2002, at least 150 pelicans were affected by hooks or line entanglement at the Santa Cruz City Pier, resulting in the death of many of these rescued birds *(24)*.

Gillnets and Seine Nets

Both set and drift gillnets pose a serious threat to seabirds (Fig. 6.1), the use of which has resulted in the incidental catch of numerous seabirds of various species. The majority of the seabirds affected are diving and surface-seizing species, of the family Alcidae *(25),* although cormorants are also commonly caught *(26).*

One seabird species that has been severely impacted by fishing activities in central California is the Common Murre *(Uria aalge).* Populations of this species declined 53% between 1980 and 1986, due to oil spill and gillnet mortalities *(27);* populations continued to have high gillnet mortality in the 1990s *(26, 28).*

One of the most serious cases of seabird mortality associated with a specific fishery occurred with the North Pacific high seas drift gillnet fishery. It is estimated that more than 500,000 seabirds were killed by this fishery in 1990 *(29, 30).* Although the species most affected by this fishery were the Sooty Shearwater *(Puffinus griseus)* and the Short-tailed Shearwater *(P. tenuirostris),* up to 23 species have been taken in the Japanese salmon drift gillnet fishery *(31),* including large numbers of Black-footed Albatross *(Phoebastria nigripes)* and Laysan Albatross *(Diomedea immutabilis) (30).* The Japanese squid driftnet fishery reported a bycatch of almost 10,000 Black-footed and Laysan Albatross in 1990 alone *(52).* As a result of this, the use of drift gillnets was banned in 1992 *(29, 32, 33).*

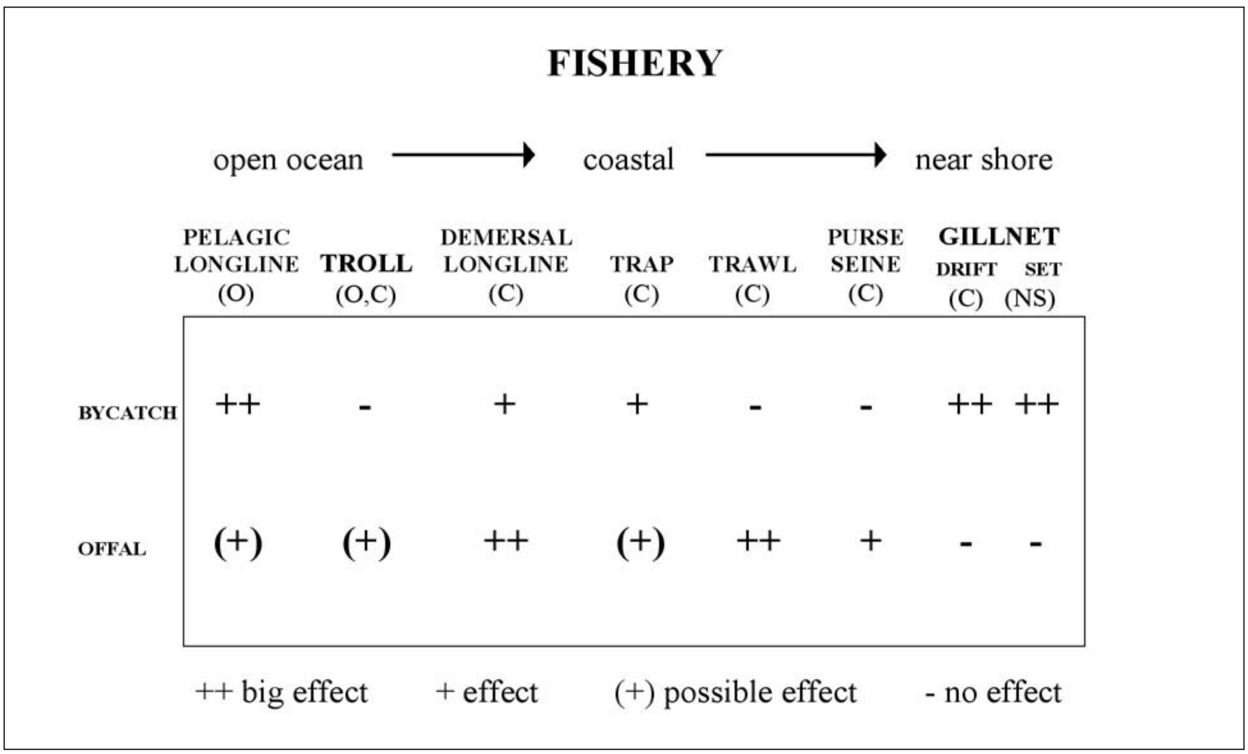

***Fig. 6.1** – Seabird interactions with different types of fishing gear (from Parrish et al. 2002).*

Longlines

Longlining, which targets mainly tuna and swordfish, is a more cost-effective method of catching large fish, but many seabirds are also caught in the process *(34, 35).* Longline fishing has increased rapidly in the Pacific because of the ban on high seas drift netting in the early 1990s and an increasing demand for tuna, swordfish, and shark. As a result of increased fishing pressure on pelagic species, such as tuna, billfish, and oceanic sharks, the Pacific Fisheries Management Council has banned pelagic longline fishing within the U.S. EEZ zone. However, longlining outside of the EEZ still poses a significant threat for seabirds within the CCS region.

Longline fisheries affect between 40 and 60 species of seabirds globally, most of which are procellariiformes, and particularly albatross *(34).* Albatross are surface-feeding birds, and bycatch occurs most often when birds are feeding actively in the vicinity of longline vessels, especially those targeting swordfish. Fishing for this species requires the use of bait that is set at more shallow depths (between 5-60 m), resulting in a line that is more buoyant than that for tuna, with slower sinking rates *(35).*

California and Washington

Large mesh gillnets (both set and drift gillnets greater than 3.5 inches [8.9 cm]) are known to incidentally take seabirds *(26, 28).* In California, the angel shark/halibut set gillnet (8.5 in mesh) has documented seabird bycatch for at least 7 species, including alcids, cormorants, and loons *(28)* (Table 6.1). The thresher shark/swordfish drift gillnet fishery has documented bycatch of Northern Fulmar *(Fulmarus glacialis),* although these numbers have been relatively small *(26).*

Between 1979-1987, the set gillnet fisheries caused the mortality of at least 75,000 Common Murres and undocumented numbers of cormorants, Pigeon Guillemots, and non-nesting grebes, loons, and Sooty Shearwaters in nearshore areas of Monterey Bay, Gulf of the Farallones, and Bodega Bay, before regulations moved the fishery offshore and instituted area closures *(36, 37).* In 1997, the Central California set gillnet fishery was re-examined when local monitoring efforts detected an estimated 1,000 to 3,000 stranded Common Murres annually south of Monterey Bay *(28).* Gillnet efforts had increased substantially between 1994-1998 and had shifted inshore in the bay *(28),* prompting new gillnet fisheries closures in 2000 (California Fish and Game Code Section 8664.5). In the Southern California Bight, gillnetting has killed smaller numbers of seabirds, particularly cormorants, between 1983-1994 *(38).*

In the drift gillnet salmon fisheries in Washington, Common Murres were the most abundant alcid killed, although other species included Rhinoceros Auklet *(Cerorhinca monocerata),* Pigeon Guillemot *(Cepphus columba),* and the federal and state listed Marbled Murrelet *(Brachyramphus marmoratus) (39),* (Table 6.1).

In the coastal drift gillnet fishery of Washington, Melvin et al. *(25)* demonstrated that there was a significant reduction in seabird bycatch (up to 70-75%), of mainly Common Murres and Rhinoceros Auklets, when visual (visible mesh panels) and acoustic alerts (pingers) were used in this fishery.

Regulatory difficulties exist with the fishery in the shared waters of Canada, Washington, and the Treaty Tribes because of these three governing entities. Within Washington, both state and tribal governments manage the fishery. Each of these governments enforces different regulations, with tribal regulations being less strict than those of the state. The tribal government does not enforce a length limit for gillnets and set nets from shore *(29).* Furthermore, the Washington Treaty Tribes argue that they are not bound by the Migratory Bird Treaty Act, and are therefore "allowed" bycatch in their fisheries.

Largely due to the high mortality resulting from swordfish longline fishing in Hawaii, this fishery has been closed, since December 27, 1999[1]. As a result of this closure, a recently emerging fishery of concern, particularly for albatross mortality, is the U.S. West Coast Pelagic Longline Fishery which occurs outside the 200 nm EEZ (K. Rivera, pers. comm.).

This California-based longline fishery, mostly composed of Vietnamese vessels, will be managed under the Highly Migratory Species Fisheries Management Plan. The vessels that operate within this fishery will be required to have High Seas Compliance Act permits from the National Marine Fisheries Service, as well as a state license if operating out of California *(40).* Current regulations do not require observers aboard these vessels.

An emerging fishery that may pose a risk for seabirds in the CCS is the California tuna fishery, where surface drift nets are being used (6-7 in mesh size; Table 6.2). This fishery, which began in 1999, uses nets that were formerly used for catching sea bass and were set at the bottom. The current fishery uses these nets at the surface, where the potential for seabird bycatch is very high *(41).*

Baja California

Seabird mortality in gillnets is not well documented in Baja California (Q. García, pers. comm.). However, the species that have been recorded killed in gillnets off the Baja California peninsula include Brandt's and Double-crested Cormorants, Brown Pelicans, Common Loons *(Gavia immer),* Pacific Loons *(Gavia pacifica),* and Western Grebes *(Aechmophorous occidentalis)(37).* As diving species, Black-vented Shearwaters, Xantus's Murrelets, Craveri's Murrelets, and Cassin's Auklets are at high risk *(42).*

In Baja California gillnets are legal fishing gear and are used for a variety of small-schooling fish species including: mullet, sea bass, sierra mackerel, corvina, and shrimp inside coastal lagoons. The average net length used by fishermen in the region is 60 to 100 m. Because most of these fish species are unregulated and the catch is used primarily for local consumption, there is little data on the numbers of gillnets or fishing effort for the Baja California peninsula, and therefore no information on seabird bycatch. However, this type of nets does result in bycatch of large numbers of alcids off the western U.S. and it is highly probable that there is considerable bycatch of seabirds off Baja California.

Long gillnets are used to catch sharks, tuna, and billfish in waters more than 50 nautical miles from shore. These nets can be up to 2,000 m long and 36 m high with a minimum mesh size allowed of 457 mm. This fishery takes place year-round, mostly around the Revillagigedo Archipelago. No records of mortality rates of seabirds on offshore gillnet fishing gear are available. If bycatch occurs, it is most likely to affect albatrosses, shearwaters, pelicans, frigatebirds, and cormorants. Since the mid-1980s, a coastal gillnet fishery has developed and expanded along the western coast of Baja California with potential impacts on diving species *(29, 42).*

The Mexican tuna fishery fleet, which uses seine nets, is the most important tuna fleet in the Eastern Tropical Pacific. Tuna is the second most important fishery in Mexico, in terms of weight landed after the sardine fishery, and the second in the value of the weight landed, after the shrimp. This fishery takes place in offshore waters inside the EEZ of Mexico. Vessels are sophisticated technologically and have capacities ranging from 150 to 1,300 metric tons. This fishery has long been known to have high levels of marine mammal bycatch. However, there is no estimate of the seabird bycatch, although it is believed to be small.

In Baja California, pelagic sharks, tuna, and sailfish are caught using longlines. The maximum length allowed is 85,000 m, with 1,500 hooks per line; in practice, longlines in this region are usually shorter with fewer hooks, frequently set at depths of 100m. The size of the pelagic long liner fleet size operating off the Baja California Peninsula is small, 15 boats in 1996. However, because of the length of the longlines and the large number of hooks deployed by each vessel, even a small fleet can cause significant seabird mortality. In this region, the fishery poses a danger to albatrosses, pelicans, cormorants, and frigatebirds, primarily during the hook baiting and deployment phase. This fishery takes place all year, mostly around the Revillagigedo Archipelago and off the southern Gulf of California. No data on actual seabird bycatch numbers are available for this fishery.

Canada

The two species that are most commonly found in gillnets in British Columbia are Common Murres and Rhinoceros Auklets (43). Other species also found in gillnets include loons (both Pacific and Common), Sooty Shearwaters, Pelgic and Brandt's Cormorants, Pigeon Guillemots, Marbled Murrelets, and Cassin's Auklets. The DFO manages a salmon test fishery off Vancouver Island, which is carried out in September and October every year since 1995. This test fishery regularly kills Common Murres in its seine and gillnets *(43).*

In British Columbia, longline fishing for halibut and sablefish has a high documented bycatch of Blackfooted Albatross, and the second highest rate for this species in the Pacific Halibut fishery *(44).*

6.5 RESEARCH AND MONITORING RECOMMENDATIONS

Bycatch and other Fisheries Interactions:

1. Foster communication with agencies involved in fisheries management to keep informed of potential or emerging fisheries that may affect seabird bycatch in the CCS.
2. Use population dynamics models to estimate and evaluate the potential impacts of fisheries bycatch on seabird populations.
3. Identify current or potential impacts of aquaculture (e.g., salmon farming) on seabirds, including change in predator-prey interactions and competition.
4. Identify the spatial and temporal overlap between seabird foraging "hotspots" and fisheries in the CCS.
5. Collate and distribute information regarding seabird species that are affected by fisheries bycatch.
6. Investigate how international fisheries affect seabirds of the CCS.
7. Model population decline of seabird species (e.g., Sooty Shearwaters, Black footed Albatross) in relation to both bycatch and climate/ecosystem change.
8. Identify areas of high boat traffic that have potential or actual conflicts with seabirds at-sea.
9. Continue, or begin, population monitoring programs of seabird species that are impacted or have the potential for being impacted by fisheries.
10. Conduct studies on foraging ranges and diet of seabirds (e.g., Short-tailed, Black-footed, and Laysan albatross) which are often victims of bycatch.
11. Assess each fishery in U.S. Pacific waters for seabird bycatch. Design mitigation measures that are fisheries- and species-specific to minimize or eliminate bycatch.

Disease, Parasites, and Biotoxins:

1. Identify the main seabird diseases, parasites, and biotoxins responsible for seabird mortality events and model their effects on seabird population dynamics.
2. Conduct surveys for diseases present in adult seabirds, fledglings and juveniles to evaluate how diseases are affecting different age classes of seabirds.
3. Develop a standardized collection protocol for unusual mortality events for both live and dead birds.
4. Develop a seabird stranding network (similar to the Marine Mammal Stranding Network) to facilitate pathological and toxicological sampling.
5. Develop collaborations with the USGS – Wildlife Health Laboratory and local agency and university partners to facilitate necropsies and pathological examinations during seabird mortality events.
6. Coordinate dispersal of dead seabirds for research and specimen archival.
7. Establish an archival freezer for future use studies of seabird genetics, pathology, parasitology, etc.
8. Determine whether parasite loads, disease prevalence, or pathogen prevalence is greater in habitats that are more fragmented, more disturbed, and/or more polluted.
9. Evaluate breeding success in relation to contaminants and potential pathogens.
10. Evaluate environmental conditions associated with harmful algal blooms (HABs) and determine whether agricultural run-off and coastal development is contributing to this problem.
11. Conduct research on HABs and the physiological and pathological effects on seabirds.
12. Determine prevalence of West Nile Virus in seabirds and evaluate potential mortality from spread of this disease.
13. Test for prevalence of the following diseases in seabirds in the CCS: New Castle's, St. Louis, Western Encephalitus viruses.

6.6 Conservation and Management Recommendations

6.6 CONSERVATION AND MANAGEMENT RECOMMENDATIONS

Fishing Interactions and Marine Ecosystem Protection

1. Managers need to be aware of emerging fisheries that could potentially impact seabird bycatch and take action before they become a problem.
2. Examine krill fishing moratoriums in California National Marine Sanctuaries (NMS) and work to establish a CCS-wide ban on krill fishing.
3. Ban fishing for forage species around important seabird breeding colonies and foraging areas.
4. Despite the obvious value of Observer Programs and the necessity of these programs for documenting impacts of fisheries on seabirds and other marine animals, there are few Observer Programs for Pacific fisheries. Fisheries that have a high potential for seabird bycatch need to be identified, and funding secured for observer coverage for these fisheries.
5. Resolution is needed for conflict between tribal gillnet fishing in Washington State and seabird bycatch.
6. Work with appropriate agencies to develop solutions for studying and lessening, as needed, interactions between seabirds and aquaculture.
7. Establish a network of Marine Protected Areas for seabird foraging "hotspots" in the CCS.

Disease, Parasites, Marine biotoxins:

1. Establish a national and international database of seabird morbidity and mortality events of both natural and anthropogenic causes.

CHAPTER 6 LITERATURE CITED

1. Long, D. and L. Gilbert, 1997. California Sea Lion predation on chicks of the Common Murre. *Journal of Field Ornithology* 68: 152-154.

2. Ford, J.K.B., et al., 1998. Dietary specializations in two sympatric populations of killer whales *(Orcinus orca)* in coastal British Columbia and adjacent waters. *Canadian Journal of Zoology* 76: 1456-1471.

3. Paine, R.T., et. al., 1990. Direct and indirect effects of peregrine falcon predation on seabird abundance. *The Auk* 107: 1-9.

4. Parrish, J.K., et. al., 2001. Direct and indirect effects: interactions between bald eagles and common murres. *Ecological Applications* 11: 1858-1869.

5. Sydeman, W.J., et. al., 1998. *Status and trends of the Ashy Storm Petrel on southeast Farallon Island, California, based upon capture-recapture analyses*. Unpublished report. PRBO Conservation Science, Stinson Beach, CA.

6. Spear, L.B., 1993. Dynamics and effect of western gulls feeding in a colony of guillemots and Brandt's Cormorants. *Journal of Animal Ecology* 62: 399-414.

7. Parrish, J. K. and L. Edelstein-Keshet, 1999. Complexity, pattern, and evolutionary trade-offs in animal aggregation. *Science* 284: 99-101.

8. Thayer, J. A., et al., 1999. Attendance and effects of disturbance on coastal Common Murre colonies at Point Reyes, California. *Waterbirds* 22: 130-139.

9. Blight, L., et. al., 1999. Predation on Rhinoceros Auklet eggs by a native population of Peromyscus. *Condor* 101: 871-876.

10. Murray, K.G., 1980. *Predation by Deer Mice on Xantus' Murrelet Eggs on Santa Barbara Island, California*. M.Sc. Thesis, California State University, Northridge, CA.

11. Gaston, A.J., 1992. Annual survival of breeding Cassin's Auklet in the Queen Charolette Islands, British Columbia. *Condor* 94: 1019-1021.

12. McChesney, G. J., et al., 2004. *Restoration of Common Murre Colonies in Central California: Annual Report 2003*. Unpublished Report, U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge, Newark, CA.

13. Camphuysen, C.J. and A. Webb, 1999. Multi-species feeding associations in North Sea seabirds: jointly exploiting a patchy environment. *Ardea* 87: 177-198.

14. Mills, K.L., 1998. Multispecies seabird feeding flocks in the Galapagos Islands. *Condor* 100: 277-285.

15. Ostrand, W.D., et. al., 1998. Evaluation of radio-tracking and strip transect methods for determining foraging ranges of Black Legged Kittiwakes. *Condor* 100: 709-718.

16. Birkhead, T.R. and R.W. Furness, 1984. Regulation of seabird populations. *In Behavioral Ecology Ecological Consequences of Adaptive Behavior.* The 25th Symposium of the British Ecological Society. Blackwell Scientific Publications, London.

17. Wallace, G.E., et al., 1992. Interspecific nest-site competition among cavity-nesting alcids on Southeast Farallon Island, California. *Colonial Waterbirds* 15: 241-244.

18. Ainley, D.G. and R.J. Boekelheide (eds.), 1990. *Seabirds of the Farallon Islands*. Stanford University Press, Palo Alto, CA.

19. Wanless, S., et. al., 1997. Modeling environmental and energetic effects on feeding performance and distribution of shags *(Phalacrocorax aristotelis)*: integrating telemetry, geographical information systems, and modeling techniques. *ICES Journal of Marine Science* 54: 524-544.

20. Bodkin, J.L. and R.J. Jameson, 1991. Patterns of seabird and marine mammal carcass deposition along the central California coast, 1980-1986. *Canadian Journal of Zoology* 69: 1149-1155.

21. Scholin, C.A., et al., 2000. Mortality of sea lions along the central California coast linked to a toxic diatom bloom. *Nature* 403: 80-84.

22. Work, T.M., et al., 1993. *Domoic acid intoxication of brown pelicans and cormorants in Santa Cruz, California.*, in *Toxic phytoplankton blooms in the sea*, T.J. Smayda and Y. Shimizu (Eds.). Elsevier, London.

23. Furness, R.W. and P. Monaghan, 1987. *Seabird Ecology*. Chapman and Hall. New York, NY.

24. Rojek, N., 2002. *Preliminary draft squid Fisheries Management Plan*. California Department of Fish and Game, La Jolla, CA.

25. Melvin, E.F., et. al., 1999. Novel tools to reduce seabird bycatch in coastal gillnet fisheries. *Conservation Biology* 13: 1386-1397.

26. Julian, F. and M. Beeson, 1998. Estimates of marine mammal, turtle, and seabird mortality for two California fisheries: 1990-1995. *Fisheries Bulletin* 96: 271-284.

27. Takekawa, J.E., H.R. Carter, and T.E. Harvey, 1990. Decline of the Common Murre in central California, 1980-1986. *Studies in Avian Biology* 14: 149-163.

28. Forney, K.A., et. al., 2001. Central California gillnet effort and bycatch of sensitive species, 1990-98. *In Seabird Bycatch: Trends, Roadblocks, and Solutions.*, E.F. Melvin and J.K. Parrish (eds.). University of Alaska Sea Grant. Fairbanks, AK.

29., 37. DeGange, A.R., et al., 1993. Losses of seabirds in gillnets in the North Pacific. *In The Status, Ecology, and Conservation of Marine Birds of the North Pacific.* K. Vermeer, et al. (eds.). Ottawa, ON, Canada.

30. Ogi, H., et al., 1993. The mortality of seabirds by driftnet fisheries in the North Pacific. *The North Pacific Commission Bulletin* 53: 499-518.

31. Jones, L.L. and A.R. DeGrange, 1988. Interactions between seabirds and fisheries in the North Pacific Ocean. *In Seabirds and other marine Vertebrates: Competition, Predation, and other Interactions.* J. Burger (ed.). Columbia University Press, New York, NY.

32. Northridge, S.P., 1991. *Driftnet fisheries and their impacts on non-target species: a worldwide review.* FAO Fisheries Technical Paper 320: 1-115.

33. Johnson, D.H., et. al., 1993. Incidental catch of marine birds in the North Pacific high seas driftnet fisheries in 1990. *International North Pacific Bulletin* 53: 473-483.

34. Brothers, N.P., et. al., 1999. The incidental catch of seabirds by longline fisheries: worldwide review and technical guidelines for mitigation. *In FAO Fisheries Circular*. Rome.

35. Cousins, K.L., et. al., 2000. Managing pelagic longline-albatross interactions in the North Pacific Ocean. *In Albatross and Petrel Mortality from Longline Fishing International Workshop, Honolulu, Hawaii, USA, 11-12 May 2000*. J. Cooper (ed.).

36. Manuwal, D.A., et al., 2001. *Biology and conservation of the Common Murre in California, Oregon, Washington, and British Columbia.* US Department of the Interior, US Geological Survey. Washington, D.C.

38. Carter, H.R., et al., 1990 (draft). *Survey of seabird colonies of northern and central California in 1989*. U. S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center. Dixon, California.

39. Melvin, E.F., et. al., 1997. *Seabird bycatch reduction: new tools for Puget Sound drift gillnet salmon fisheries: 1996 sockeye and 1995 chum non-treaty salmon test fisheries.* Final report to the Washington Sea Grant Program, Seattle, WA.

40. URS Corporation and NOAA/NMFS, 2001. *Final Environmental Impact Statement - Fishery Management Plan, Pelagic Fisheries of the Western Pacific Region.* National Oceanic and Atmospheric Administration and National Marine Fisheries Service. Honolulu, HI.

41. Forney, K.A., et al., 2000. *U.S. Pacific Marine Mammal Stock Assessments: 2000.* U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-300.

42. Everett, W.T. and D.W. Anderson, 1991. *Status and conservation of the breeding seabirds on offshore Pacific Islands of Baja California and the Gulf of California.* ICBP Technical Publication. 11: p. 115-139.

43. Hipfner, J.M., et. al., 2002. *Pacific and Yukon Regional Seabird Conservation Plan.* Canadian Wildlife Service. Ottawa, ON, Canada.

44. Hipfner, J.M., et. al., 2001. Food supply and the consequences of egg size in the Thick-Billed Murre. *Condor* 103: 240-247.

45. Hamer, K.C. and J.K. Hill, 1993. Variation and regulation of meal size and feeding frequency in Cory's shearwater *(Calonectris diomedea). Journal of Animal Ecology* 62: 441-450.

46. Marzluff, JM, et al., 1994. *Captive propagation and reintroduction of social birds.* Annual Report. Sustainable Ecosystems Institute, Meridian, ID.

47. Lewis, S., et. Al., 2001. Evidence of intra-specific competition for food in a pelagic seabird. *Nature* 412: 816-819.

48. Olesiuk, P.F., 1993. Annual prey consumption by harbor seals (*Phoca vitulina*) in the Strait of Georgia, British Columbia. *Fisheries Bulletin* 91: 491.

49. Kaleta, E.F., 1990. Herpes viruses of free-living and pet birds. *In A laboratory manual for the isolation and identification of avian pathogens.* American Association of Avian Pathologists.

50. Choe, J.C. and K.C. Kim, 1987. Community structure of arthropod ectoparasites on Alaskan seabirds. *Canadian Journal Zoology* 65: 2998-3005.

51. Smith, L.D., 1977. *Botulism: the organism, its toxins, the disease.* Charles C. Thomas. Springfield, Illinois.

52. Yatsu, A., et. Al., 1993. Outline of the Japanese squid driftnet fishery with notes on the by-catch. *International North Pacific Fisheries Commission Bulletin 53*: 5–24.