THE BERING SEA

A Biodiversity Assessment of Vertebrate Species

Center for Biological Diversity
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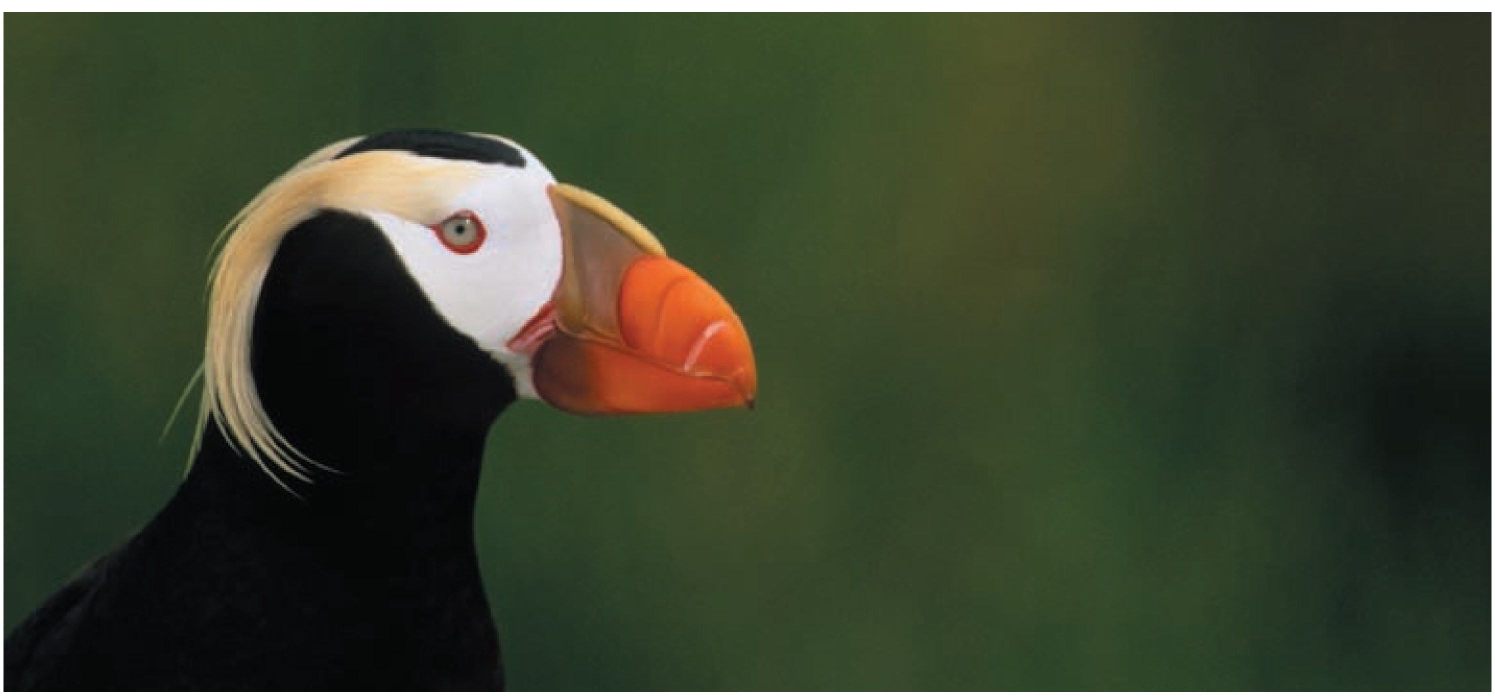
Cover photo: Male Pacific Walruses at haul out, Round Island Sanctuary
Photo, this page: Tufted Puffin
Both photos courtesy of: Kevin Schafer, kevinschafer.com



EXECUTIVE SUMMARY

In a comprehensive assessment of the status of and threats to Bering Sea vertebrate species, the Center for Biological Diversity reviewed nearly 500 references from published and grey literature, online databases, and other information. Based on this review, we determined that at least 549 vertebrate species live in the Bering Sea for all or part of the year, including 418 fish, 102 birds and 29 marine mammals. We classified species' status as non-imperiled, unknown or of conservation concern. Species of concern were further classified as critically imperiled, imperiled or vulnerable.

Of the 549 vertebrate species in the Bering Sea, we determined that 335 (61%) have an unknown status, 148 (27%) appear to be non-imperiled and 66 (12%) are of conservation concern. Of the species of concern, 52 (79%) are vulnerable, nine (13.6%) are imperiled, and five (7.6%) are critically imperiled. The fact that most species of concern in the Bering Sea are listed as vulnerable, and thus may not be at immediate risk of extinction, is cause for hope. For many of these species, positive reforms in management could forestall further decline.

Of the Bering Sea species of concern, 34 are birds, 21 are marine mammals and 11 are fish. Birds of concern include the critically imperiled Spoon-billed Sandpiper, Kittlitz's Murrelet and Short-tailed Albatross, and the imperiled Spectacled Eider, Steller's Eider, Common Eider and King Eider. Marine mammals of concern include the critically imperiled North Pacific Right Whale and Blue Whale, and the imperiled Steller's Sea Lion, Northern Sea Otter, Ringed Seal, Polar Bear and Pacific Walrus. All of the fish species of concern are listed as vulnerable, primarily due to the lack of detailed information on their status, including Sablefish, Softskin Slickhead, Greenland Turbot, Shortraker Rockfish, Rougheye Rockfish, Shortspine Thornyhead, Broadfin Thornyhead, Blue Lanternfish, Big Skate, Basking Shark and Big Mouth Manefish. Incidental to our search for information on Bering Sea vertebrate species, we also found information indicating six invertebrate species (five species of crab and one species of shrimp) are of concern, and have included these species in the report.

We identified potential threats to 22% of all studied Bering Sea species. Commercial fishing, either through direct exploitation, bycatch or competition, potentially impacts the greatest number of Bering Sea species (71), affecting 56% of all species for which we found threat information. Pollution potentially affects the second highest number of species (60, 48%), followed by ecological factors (35, 28%), hunting (26, 20%), global climate change (25, 20%), habitat destruction (25, 20%), human disturbance (21, 17%) and exotic species (21, 17%). These threats are resulting in the decline of a number of Bering Sea wildlife species, placing them at risk of extinction.

Bearded Seal pup
photo by USFWS

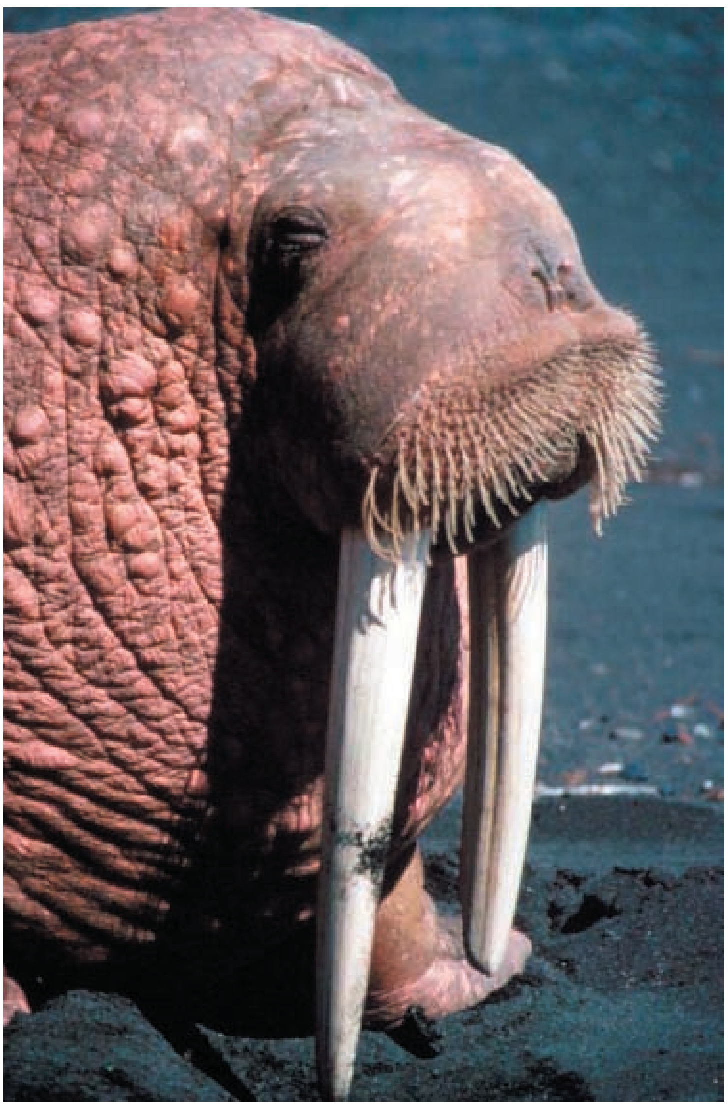
To alleviate these threats, we have the following recommendations:

– Protect the Kittlitz's Murrelet as endangered and the Polar Bear, Pacific Walrus, Northern Fur Seal and Ringed Seal as threatened under the Endangered Species Act, with sound critical habitat designations.

– Similar to conservation efforts for the Steller's Sea Lion, identify key foraging habitat for known declining species, such as the Northern Fur Seal and Harbor Seal, and prohibit or limit commercial fishing within those areas to ensure that prey abundance or density is not impacted.

– Establish international funding and cooperation to ensure enforcement of fishing regulations in Russian Federation Waters.

– Require the latest technology to avoid bycatch of marine mammals, seabirds, non-target fishes and other marine life.



– In the western Bering Sea, driftnets larger than 2.5 kilometers in length should be totally banned to bring Russia up to international and U.S. standards, while the eastern Bering is in need of further research and restrictions on bottom-trawling.

– In addition to the already established reserve centered on the Aleutian Islands and elsewhere, establish marine reserves to protect areas of high diversity – such as those containing deep-sea corals – from bottom trawling and other activities. This may require further surveys of the Bering Sea seafloor to determine reserve locations.

– The United States must ratify the Kyoto Protocol and reenter negotiations with other nations on the post-2012 commitment period, with a goal of reducing emissions by 80% below 1990 levels.

- Implement recommendations of the Shipping Safety Partnership to reduce the likelihood of oil spills and ensure timely clean-up of spills that do occur.

– For the benefit of Bering Sea seabirds, remove non-native foxes and rats from Bering Sea islands where they have been introduced.

– Enforce hunting restrictions in the Bering Sea, including ensuring that non-game species, such as eagles, are not hunted.

– Catalog all Bering Sea invertebrate species and identify those that are of concern based on abundance, trend or sensitivity to anthropogenic disturbance.

– Systematically identify a suite of indicator species to index changes in Bering Sea species and habitats related to anthropogenic activities, global climate change or other factors.

– Conduct experiments to identify and understand the key stressors of Bering Sea species and habitats to guide better conservation of Bering Sea wildlife.

– Increase fees on resource extractive industries in the Bering Sea – such as commercial fishing, oil and gas exploration, and shipping – in order to fund additional mitigation and research.

Pacific Walrus
photo by USFWS

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INTRODUCTION

During the height of the last Ice Age, the Bering Sea was a vast grassland that served as the gateway for people migrating from Asia to North America. Today, it is one of the most productive and diverse marine bodies in the world. Millions of seabirds representing more than 50 species, 19 species of whales and dolphins, 10 other marine mammal species, and more than 400 species of fish all make their home in the Bering Sea. From Polar Bears hunting on the sea ice to volcanic islands covered with seabirds, the Bering Sea is one of the world's last, best places for wildlife.

Despite cold winters and the remoteness of the Bering Sea, the productivity and richness of Bering Sea wildlife have drawn humans to the area for thousands of years. Following European exploration by the 1741 Bering Expedition, exploitation of wildlife in the Bering Sea began in earnest – driving two species, Steller's Sea Cow and Pallas's Cormorant, to extinction in a mere 30 years. Over the next 150 years, whaling and sealing for pelts, meat and oil drove one species after another to the brink of extinction. During the first half of the 20th century, whaling and sealing were largely phased out by international treaty and other laws, and a number of species subsequently recovered or are in the process of recovering.

Northern Fur Seals
photo by USFWS

Beginning in the 1950s, large-scale commercial fishing replaced whaling and sealing as a primary stressor on Bering Sea wildlife. Through the early 1970s, commercial fishing remained largely unregulated, and many stocks were overfished (NMFS 2000). In the eastern Bering Sea, overfishing has been largely controlled, despite the fact that nearly 50% of fish consumed in the United States come from the Bering Sea. Although sustainable for individual targeted stocks, commercial fishing still has many impacts on Bering Sea ecosystems through bycatch, habitat destruction, disposal of offal, and possible impacts on the prey-base of marine mammals (NAS 1996, NRC 2003).

The impacts of commercial fishing are compounded and confounded by natural fluctuations in the Bering Sea environment, which can be quite dramatic, and increasingly by the effects of global climate change caused by anthropogenic releases of greenhouse gases (ACIA 2004, PICES 2005). Climate change is likely a primary factor in unprecedented changes observed in the Bering Sea in recent decades. These include earlier breakup of summer sea ice, persistent warm waters, large blooms of marine algae called coccolithophorids, a large increase in the abundance of jellyfish (lasting from the early 1980s through 2000), and shifts in the abundance and distribution of fish and marine mammals (PICES 2005).

Biological data show a disturbing downward trend in a number of Bering Sea wildlife species. The North Pacific Right Whale population numbers as few or fewer than

100 animals, and only one calf has been sighted this century (Rugh and Goddard 1998, Clapham et al. 1999, Perry et al. 1999, Tynan et al. 2001, Angliss and Lodge 2004, NMFS 2005). The Common Eider declined by 53% from 1976 to 1996 (Suydam et al. 2000), breeding Spectacled Eiders declined by 96% on the Yukon-Kuskokwim (YK) Delta (Stehn et al. 1993, FWS 2001a), and Aleutian Sea Otters suffered a 70% loss in their population from 1992 to 2000 (FWS 2005). Steller's Sea Lions declined 90% since the 1960s and continue to decline in the western Aleutians (Loughlin 2002, NRC 2003, Angliss and Lodge 2004). Northern Fur Seals on the Pribilof Islands have been declining since the 1970s, with numbers dropping by as much as 4-8% in recent years (Angliss and Lodge 2004). Numerous commercial fish species have also declined, including Yellowfin Sole, Alaska Plaice, Pacific Ocean Perch (which may have experienced some recovery in recent years), and Greenland Turbot, with the exact cause of these declines uncertain (Swartzman et al. 1992, Ianelli and Heifetz 1995, Wilderbuer and Zhang 1999, Spencer et al. 2004, Wilderbuer and Nichol 2004).

In the absence of a complete biodiversity assessment, it is impossible to gauge the level of impact to native species or adequately prioritize conservation efforts and scientific research at the national, regional or local levels. Substantial research and a modicum of protection have been provided for some of the marine mammals, a few of the seabirds, and the most important commercial fish species, but this information has never been analyzed to identify the primary species of concern in the Bering Sea or to determine the range of threats to these species. In conducting the first study to assess the conservation status of all known vertebrate species in the Bering Sea, we hope to alleviate this situation by calling attention to the full range of species of concern in the Bering Sea, highlighting species about which we lack sufficient information, and providing a scientific basis for improving conservation of the precious wildlife of the Bering Sea. Specifically, we:

1) Compiled as complete a list as possible of all Bering Sea vertebrate species.

2) Reviewed available literature on the taxonomy, range, status, threats and abundance of all Bering Sea vertebrate species, and identified species of conservation concern.

3) Identified key threats to vertebrate species in the Bering Sea.

4) Identified significant gaps in knowledge on the status of species.

We used this information to identify the proportion of Bering Sea species that are of conservation concern; determine whether taxonomic classification, commercial importance or other factors influence species' imperilment; identify the primary threats to Bering Sea biodiversity; identify key protections for species of concern in the Bering Sea; and determine whether adequate protection is afforded to species and their habitats in the Bering Sea.

Bar-Tailed Godwit
photo by USFWS

THE BERING SEA

Covering roughly 885,000 square miles, the Bering Sea is a semi-enclosed sea bordered on the east by Alaska, on the west by Russia, on the south by the Aleutian and Commander Islands, and on the north by the Bering Strait, which connects the Bering Sea to the Chukchi Sea.

The abundant and diverse animal life found in the Bering Sea is the pinnacle of a complex food-web supported by a mix of diverse habitats and productive, but fluctuating, ocean conditions that are found nowhere else in the world. Underlying the Bering Sea is a large continental shelf that occupies roughly half of the northern and eastern Bering Sea. The relatively shallow waters over the shelf are an important spawning area for many marine fish, such as Walleye Pollock, and support abundant benthic (bottom-dwelling) organisms that serve as prey for fish and marine mammals. Much of the shelf is covered by large expanses of sea ice during the winter. This ice provides important habitat for Polar Bears and other marine mammals. In the spring, blooms of algae, plankton and other organisms develop at the edge of the

retreating ice. Those organisms provide an important source of primary production in the Bering Sea and are frequented by a plethora of wildlife, including numerous species of seabirds.

South of the continental shelf lies the deeper water of the Aleutian Basin. Currents in the Basin bring to the surface cold, nutrient-rich water from lower in the water column in a process called upwelling. These currents also bring nutrient-rich water from the North Pacific into the Bering Sea through a series of passes through the Aleutian Islands. In particular, nutrient-rich water is carried to the outer portion of the continental shelf, making this an area of incredibly high fish abundance and a primary target for commercial fishing.

The many volcanic islands of the Bering Sea, including the Aleutian, Commander, Pribilof and others, form important habitat for nesting seabirds and breeding seals and sea lions. Rich cold-water coral reefs surrounding the islands are the foundation of a great diversity of ocean life. Coastal areas of the Bering Sea contain a number of estuaries that provide important habitat for many seabirds and fish. In particular, the YK Delta supports a large estuary where tens of thousands of seabirds, waterfowl and shorebirds nest and shelter. The combination of these diverse habitats explains the abundance and richness of the Bering Sea.

Polar Bear and cubs
photo by USFWS

Common Eiders
photo by USFWS

opposite page: the Bering Sea
map by Curtis Bradley, Center for Biological Diversity

1) Compile as complete a list as possible of all Bering Sea vertebrate species.

We compiled a complete list of known vertebrate species historically and currently present in the Bering Sea by searching natural history guides, taxonomic catalogues, historical accounts and other sources. Only species that occur in or are dependent on a marine environment were included. Accidental and exotic species were excluded, but migratory species that spend portions of the year in the Bering Sea were included. For species about which there were questions about their presence in the Bering Sea now or in the past, we carefully checked the literature and included only those species whose presence has been reliably documented.

The vast majority of the Bering Sea's biodiversity is found in the thousands of invertebrate species from multiple phyla. We did not collect information on these species because we did not have confidence that we would be able to document all of the species present or find meaningful information on their status. However, in our search for information on Bering Sea vertebrate species, we found information indicating that several invertebrate species are of conservation concern and have included information about these species. Cataloging the presence and status of Bering Sea invertebrates should be a high priority for scientific research.

2) Review available literature on the taxonomy, range, status, threats and abundance of all Bering Sea vertebrate species and identify species of conservation concern.

We extensively searched for information on the distribution, trend, status, threats to and habitat of Bering Sea species. For published literature, we searched biological abstracts on BIOSIS Database (Thomson Scientific, Stamford, Conn.), using the Latin name of the species as a primary search term, and collected all papers with information relevant to the above topics. We extended our search for information on the species by scanning bibliographies of all articles we obtained. This latter search included both published and grey literature.

Information from all papers was entered into a database of Bering Sea species, which included the species name and taxonomy, range, habitat type, population trend, primary threats, and management status (i.e., federal or state listing as a threatened or endangered species, etc.).

For range, we classified species as occurring in the Aleutian Islands, Aleutian Basin, eastern or western Bering Sea, or any combination of the above. We also included any specific information about their occurrence in the Bering Sea and whether they occurred outside the

Table 2. Classification of Bering Sea Imperiled Species.

Source	Critically Imperiled	Imperiled	Vulnerable
NatureServe	Critically Imperiled (G1)	Imperiled (G2)	Vulnerable (G3)
IUCN	Critically endangered	Endangered	Vulnerable
Federal ESA	Endangered	Threatened	Species of concern
Alaska	Endangered	Endangered	Species of concern
AK Audubon Society	N/A	N/A	Watchlist
Audubon Society	N/A	Red	Yellow
Am. Fisheries Society	Endangered	Threatened	Vulnerable

Table 1. Classifications used to identify species of conservation concern.

Source	Imperiled classifications
NatureServe	G1-3, S1-3 in either WA or BC
IUCN	Vulnerable, endangered, critically endangered
Federal ESA	Candidate, threatened, endangered
Alaska State	Species of concern, candidate, threatened, endangered
Russian Federation	Red Data Book
Alaska Audubon Society	PT=Population Trend, RA=Relative Abundance, BD=Breeding Distribution, ND=Non-breeding distribution, TB=Threats during Breeding Season, TN=Threats during non-breeding season.
National Audubon Society	Red, Yellow
American Fisheries Society	Vulnerable, threatened, endangered

Bering Sea. We classified habitat by depth, location and substrate, and included any specific information provided by individual studies. All population trend information (declining, stable, increasing) was noted in the database along with any information on the magnitude of trend, the methodology for determining trend, and the certainty of the trend.

To characterize abundance, we searched the literature for estimates of population numbers in the Bering Sea, but if only subjective descriptions of abundance, such as rare, common, ubiquitous or others were available, we included these in the database.

For information on status, we searched NatureServe's online species database, the International Union for Conservation of Nature's (IUCN's) Red List of threatened species, the U.S. Federal Register for documents on species listed under the Endangered Species Act, Alaska State's lists of endangered species, the Red Book of the Russian Federation, and lists of species of concern maintained by the American Fisheries Society and Audubon Society. Species were broadly classified as of conservation concern if they were recognized as being of concern, vulnerable, or worse by any of these sources (Table 1), if information in the literature showed them to be declining or rare, or if they are dependent on sea ice for their survival. We included the latter category due to the severity of threats to sea ice dependent species from global climate change.

Species were classified as critically imperiled, imperiled or vulnerable based on the corresponding classifications of the various organizations that rated the species status (Table 2). We adjusted classifications if newer information on trend or abundance indicated the species was faring better or worse, or if information suggested the species was faring better in the Bering Sea than other portions of its range.

Because many of the species of concern have ranges that extend outside the Bering Sea and in some cases we could not find information specific to the Bering Sea, we rated the reliability of our classifications of species of concern according to the quality of available information. Species were considered to be classified with a high reliability if one or more sources from the last ten years provided information on status, management or threats specific to the Bering Sea. Species were considered to have a medium reliability if one or more sources listed it as being of concern in the Bering Sea, but provide little or no additional information, or sources provided contradictory information on status. Finally, species were considered to have a low reliability if they were identified as being of concern rangewide, but not specifically within the Bering Sea, or if information was limited to only one source or was older than ten years.

To provide further detail about the area in which species are of concern, we also noted whether species were of concern in the eastern Bering Sea, including the Aleutian Islands, western Bering Sea, or rangewide, with the latter category indicating that we lacked information specific to the Bering Sea. We separated the eastern and western Bering Sea because of substantial differences in management between the U.S. and Russia, as well as physiographic differences between the two regions. In a number of cases, species listed as of concern in the eastern Bering Sea also occur in the western Bering Sea, but we lacked information on their status in this area.

Species for which we had no information on abundance, trend or status were classified as being of unknown status. Species that are rated in the literature or any of the above sources as common, abundant or otherwise secure were classified as being non-imperiled.

3) Identify key threats to imperiled species in the Bering Sea.

We searched the literature for information about threats to each imperiled species, and identified threats from commercial fishing, pollution, habitat destruction, global climate change, exotic species, direct human disturbance (e.g. hunting, boat collisions or nest distur-

bance), and ecological factors (low productivity, predation, climate extremes, etc.). Any information from the literature on the extent or impact of these threats on species' populations was added to the database.

Similar to above, we classified the reliability of available threat information based primarily on its applicability to the Bering Sea. Information on threats was considered to have a high reliability if a specific study demonstrated impacts from that threat in the Bering Sea. Information on threats was considered to have a medium reliability if a study or source identified a particular threat as potentially impacting a species in the Bering Sea, but provide little information on the degree of impact. Finally, information on threats was considered to have a low reliability if a particular threat was identified as being of concern for a species, but not specifically within the Bering Sea.

4) Identify significant gaps in knowledge on the status of species.

In compiling information on the presence and status of imperiled species in the Bering Sea, we identified significant information gaps, including specific taxonomic groups that have received little attention, and numerous species that require additional study in regards to all or some of the factors we researched (e.g. distribution, status, population trend, abundance and habitat). We will use this information to make specific recommendations for further research.

Polar Bear footprints
photo by David Isenberg

Humpback Whale
photo by USFWS

Opposite page: Polar Bear
photo by David Isenberg

WILDLIFE OF THE BERING SEA

We reviewed nearly 500 references and five databases concerning the distribution, habitat, threats to and status of Bering Sea species. Based on this exhaustive search, we identified a total of 549 vertebrate species in the Bering Sea, including 418 fish, 102 birds and 29 marine mammals.

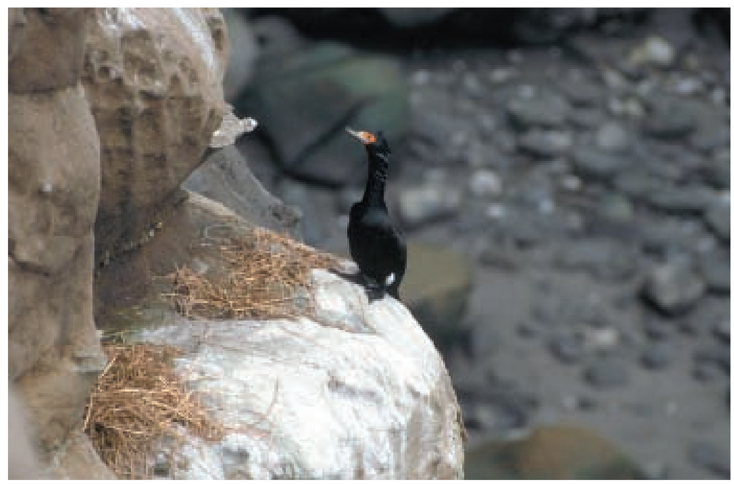
Fish biodiversity in the Bering Sea is high compared to other cold-water regions, containing nearly three times (2.7) more marine fish species than the Antarctic, more than twice the marine fish species of Greenland, and 62 more marine fish species than the United Kingdom (Froese and Pauly 2005). New fish species are being discovered at a rate of roughly three per week globally and as many as 5,000 species are believed yet to be discovered (O'Dor 2003). Concordantly, there are likely many new fish species to discover in the Bering Sea. Indeed, at least seven of the fish species were first recorded in the Bering Sea in the last 15 years (Balanov and Il'inskii 1992, Balanov and Fedorov 1996). The majority of fish species have received little study, indicated by the fact that we were only able to find information on status (9.6%), trend (10%), threats (5.7%) and abundance (14.8%) for a fraction of the species found in the Bering Sea.

The Bering Sea contains a wide range of habitats for fish, from intertidal, where there is a diversity of sculpin and snailfish; to shallow- and moderate-depth waters over the continental shelf, where there is a diverse and abundant fauna of halibut, flounder, sole, and other bottom-dwelling fish; and finally, to mesopelagic and deep water habitats, where a number of species of lanternfish and other poorly-known species occur. In combination with this diversity of habitat, the productivity of the Bering Sea supports a super abundance of fish, numbering in the tens of billions of individuals. Common species include Walleye Pollock, which comprises the largest commercial catch; five species of Pacific salmon; three species of shark, with the Salmon Shark being common; and many bottom-dwelling fish, such as Alaska Plaice, Dover Sole and Pacific Halibut.

The relatively pristine islands and coasts of the Bering Sea support an extraordinary abundance of seabirds, shorebirds and waterfowl, including at least 40 to 50 million breeding birds and another 30 million birds in migration. Of the 102 birds in the Bering Sea, we identified 51 seabirds (petrels, cormorants, shearwaters, albatross, auklets, puffins, fulmar, gulls, murres, murrelets, eiders, loons and others), 31 shorebirds (plovers, sandpipers, etc.), 15 waterfowl (geese and ducks), and five raptors (Peale's Peregrine Falcon, Steller's Sea Eagle, White-tailed Eagle, Northern Bald Eagle and Osprey). Two Bering Sea seabirds, Pallas's Cormorant and Bering Canada Goose, are extinct.

The Pribilof, Aleutian and other islands are particularly important for breeding seabirds; for example, the Pribilofs and Aleutians support Least Auklet colonies likely numbering over 6 million birds. On the coast, the YK Delta is an important nesting area for many bird species, including the endangered Steller's and Spectacled Eiders, as well as Common Eiders, Cackling Canada Geese, Red-throated Loons and many others. Millions of shorebirds use the islands and coasts of the Bering Sea as important stopover habitat en route between breeding grounds in the high Arctic and wintering grounds in North, Central and South America. Overall, birds have received more study than fish. We found status information for 100%, trend information for 42.7%, threat information for 60.2%, and abundance information for 92.2% of Bering Sea birds.

The 29 marine mammals in the Bering Sea include 18 whales, nine seals and sea lions, the Sea Otter, and the Polar Bear. One Bering Sea marine mammal, the Steller's Sea Cow, is extinct. Of the 18 whales, 10 are toothed whales – including the Orca, Beluga, two species of beaked whale, two dolphins and two porpoises – and eight baleen whales, which represent three-quarters of all baleen whales found on the planet. A number of the seal and sea lion species have populations of more than 100,000 individuals – in some cases well over this figure – and form large mating colonies on Bering Sea islands or coasts. The whales tend to be less abundant, but a small number of species likely have populations over 100,000 individuals (e.g., Dall's Porpoise). We were able to find status information for 100%, trend information for 42.9%, threat information for 100%, and abundance information for 92.9% of all Bering Sea marine mammals.



top: Black Oystercatcher
photo by USFWS

bottom: Red-Faced Cormorant
photo by USFWS

Steller's Sea Lions
photo by USFWS

Red-Legged Kittiwake

Found nowhere else in the world, Red-legged Kittiwakes breed in the Bering Sea on the Pribilof and Commander Islands, as well as Buldir Island and Bogoslof Island, with 96% of the population breeding on St. George Island in the Pribilofs. As the name implies, this small gull is characterized by its distinctive red legs. The Kittiwake nests on cliffs and travels to deep water at night to forage on fish by dipping, surface seizing, or plunge diving (Hatch et al. 1993). Compared to its close relative, the Black-legged Kittiwake, the Red-legged Kittiwake is more specialized in its feeding habits, primarily targeting Lanternfish as well as juvenile Walleye Pollock.

The Red-legged Kittiwake's narrow breeding distribution, top position on the food chain, and colonial nesting habits are all characteristics that make it vulnerable to decline (Byrd et al. 1997). Accounts from the late 1800s and early 1900s suggest the Kittiwake formerly had a larger breeding range in the Bering Sea, including a number of islands in the Aleutians where it no longer breeds, such as the Near Islands, and Aku and Sanak Islands (Hatch et al. 1993). Reports also suggest that Red-legged Kittiwakes were formerly more abundant in relation to Black-legged Kittiwakes on St. Paul and other islands.

In recent decades, a number of Red-legged Kittiwake populations have declined (Hatch et al. 1993, Byrd et al. 1997, Dragoo et al. 2004). From the 1970s to the 1990s, Red-legged Kittiwakes declined by as much as 50% on the Pribilofs, where the majority of the population occurs. Similar to marine mammals, the cause of decline is not immediately apparent. During the 1980s, Red-legged Kittiwake breeding colonies consistently produced low numbers of young, and it is believed this may be because adults are not obtaining enough food to successfully reproduce (Hatch et al. 1993, Hunt et al. 1996b, Byrd et al. 1997).

Like the declines themselves, the causes for food limitation in Kittiwakes and other seabirds have been difficult to determine. Byrd et al. (1997) concluded that "the disruption of marine food webs by fisheries is not well understood, but the removal of a large biomass of fish in the commercial harvest may adversely affect Red-

Red-Legged Kittiwake feeding chick
photo by USFWS

legged Kittiwakes." Others, however, point out that most of the Kittiwake's primary prey species are not commercially fished, or as in the case of Walleye Pollock, are fished after the age at which they are utilized by the seabird (Springer 1993).

Hunt et al. (1996) note that both Capelin and young Pollock declined around the Pribilofs between the 1970s and 1980s, and the proportion of fatty fishes, such as Lanternfish, Capelin and Sandlance, declined in the diets of both species of Kittiwakes after the late 1970s. It is unknown if declines in fatty fishes in seabird diets were caused by real changes in the abundance of these fish or if changes in fish distribution made them less available. One hypothesis is that warm sea surface temperatures after the late 1970s caused some fish species to be less available at the surface where Kittiwakes forage (Springer 1993, Hunt et al 1996), pointing to global climate change or regime shifts as potential threats to the Red-legged Kittiwake.

Recent surveys found some improvement in Kittiwake populations on the Pribilofs, with surveys in 2002 generally showing greater numbers of birds (Moore and Boyd 2002, Dragoo et al. 2004). Although there are still fewer Red-legged Kittiwakes than observed in the 1970s, improvement in population numbers result in no significant population trend in the St. George Island population

(Dragoo et al. 2004). However, on St. Paul Island, the population has significantly declined by 2.6% per year, and in 2005, Red-legged Kittiwake reproduction largely failed on St. George Island (Dragoo et al. 2004, Thomson 2005), suggesting there is still cause for concern for this unique Bering Sea species.

At this point, all that can be said with certainty is that Red-legged Kittiwakes have declined in portions of their range (e.g. the Pribilof Islands) and that these declines likely relate to the broad-scale changes occurring in the Bering Sea as a whole – which in themselves likely result from a combination of anthropogenic climate change, natural variability, historic exploitation and current widespread commercial fishing.

Red-Legged Kittiwake colony
photo by USFWS

SPECIES OF CONCERN IN THE BERING SEA

Identifying species of concern serves to call attention to their plight and thereby encourage conservation. It also identifies species that are sensitive to changes in the environment from both anthropogenic and natural causes and can thus serve as bellwethers of changes on our shared planet. Indeed, increasing evidence indicates that the Bering Sea is undergoing unprecedented changes, and the status of Bering Sea species is key to measuring and understanding these changes.

Of the 549 vertebrate species in the Bering Sea, we determined that 335 (61%) have an unknown status, 148 (27%) appear to be non-imperiled, and 66 (12%) are of conservation concern. Of the species of concern, 52 (78.8%) are vulnerable, nine (13.6%) are imperiled, and five (7.6%) are critically imperiled. We also identified six invertebrate species that are of conservation concern, all of which are considered vulnerable. The fact that most species of conservation concern in the Bering Sea are listed as vulnerable, and thus may not be at immediate risk of extinction, is cause for hope. For many of these species, positive changes in management could forestall further decline.

Of Bering Sea species of concern, 34 are birds, 21 are marine mammals, 11 are fish, and six are invertebrate species (Figure 1). The bias of the list towards birds and marine mammals reflects the greater visibility of these species and resulting attention they have received. Similarly, the fish and invertebrates on the list are mostly commercial species. Fortunately, in many cases, birds, marine mammals, commercial fish and invertebrates are at the top of the food chain, and thus to some extent, reflect impacts to the habitats and ecosystems of the Bering Sea as a whole.

The list of Bering Sea species of concern reflects the long and varied history of wildlife exploitation in the Sea. Commercial exploitation began in earnest following the discovery of large populations of whales and fur-bearing mammals by the 1741-1742 expedition of the Sea by

Russia's Commander Bering, who died on the voyage. The drive for pelts, meat and blubber decimated populations of many species, including the Steller's Sea Cow, which was driven extinct by as early as 1768 – fewer than 20 years after its discovery by Europeans. Other species, such as the Northern Sea Otter, North Pacific Right Whale, Northern Fur Seal and many others, were driven to near extinction by the beginning of the 20th century. By all accounts, wildlife exploitation in the 1800s was wanton and wasteful. Hunters of the Steller's Sea Cow, for example, were known to spear individuals in the shallows in the hope that animals would later die and drift to shore (Anderson 1995).

Controls on exploitation were first attempted within U.S. territorial waters in the mid-1800s, but were not effective until the U.S., Russia, Japan and other nations signed the Northern Fur Seal Treaty of 1911, prohibiting sealing at sea. Following the treaty's enactment, seal, sea lion and otter populations began to recover. Whaling continued until the creation of the International Whaling Commission in 1947, and to a lesser degree into the 1960s – both illegally and under the guise of scientific research. Whale populations are in the process of recovery, but 11 species remain of concern due to the residual impacts of historic whaling and existing threats from oil spills and other pollution, entanglement in fishing nets, collisions with boats, and potential for future oil and gas development (Appendix).

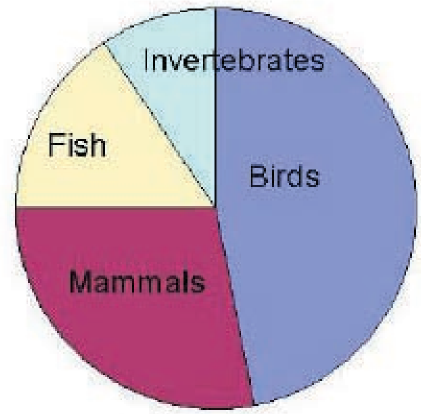


Figure 1: Bering Sea imperiled species by classification.

Today, imperilment of Bering Sea species reflects the more varied and complex problems of our increasingly global, populous and technology-dependent society. Although sealing and whaling have largely ceased, exploitation of wildlife continues in the form of industrial commercial fishing – a potential factor in the imperilment of the Northern Fur Seal, Steller's Sea Lion and other species (Appendix). Impacts from commercial fishing are increasingly compounded by global climate change, pollution, exotic species and other factors. Many of the species we found to be imperiled are dependent on sea

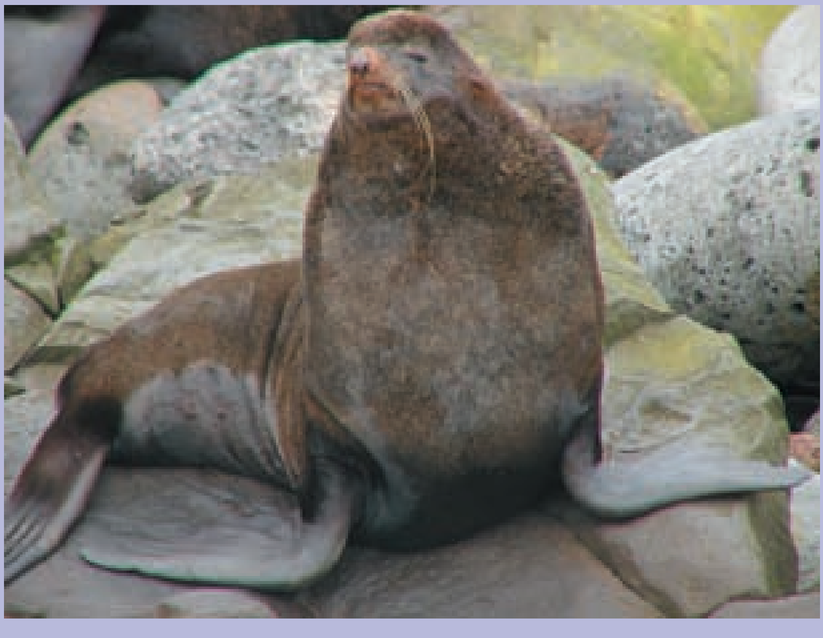
On thin ice. Global warming has serious consequences for the Polar Bear.
photo by Pete Spruance

Northern Fur Seal

Like other eared seals in the family Otaridae, Northern Fur Seals have small earflaps, and by propping themselves up on their front flippers, they can move quite quickly on land. The majority of Northern Fur Seals breed in the Bering Sea, with, until recent declines, 74% of the world's population breeding on the Pribilof Islands and the majority of the remaining population breeding on the Commander Islands (Reeves et al. 1992, Angliss and Lodge 2003). Interestingly, a small disjunct population breeds on San Miguel Island in Southern California, suggesting a much larger breeding distribution during the Pleistocene. During the non-breeding season, Northern Fur Seals are found throughout the North Pacific south to California. The occurrence of the vast majority of breeding in the Bering Sea highlights its importance to the survival of this seal.

There is a long history of harvest of Northern Fur Seals for their pelts. The genus name for Northern Fur Seals, Callorhinus, literally means "beautiful skin" in Greek. Beginning in the late 1700s, Northern Fur Seals were taken directly from their rookeries on the Pribilof Islands. This practice remained largely unregulated until 1847, when harvest was limited to several thousand males, and the population subsequently began increasing (Reeves et al. 1992). However, this increase was offset by intensive commercial sealing at sea. By 1909, the population in the Pribilofs had declined to 300,000 seals (Reeves et al. 1992). Responding to these declines, the United States, Russia, Japan and Canada signed the Northern Fur Seal Treaty in 1911 prohibiting killing of seals at sea. Combined with a U.S. prohibition of harvest on the Pribilofs between 1912-1917, the new regulation led to sharp population increases, with the Pribilof herd reaching 2.5 million animals by the late 1950s (Reeves et al. 1992).

Based on the flawed idea that a female harvest would lead to a compensatory increase in productivity, the U.S. government sanctioned harvest of 300,000 female Northern Fur Seals in the Pribilofs from 1956 to 1968. At the same time, Russia allowed killing of large numbers of males on the Commander Islands – a practice that was not tightly regulated until 1973-1978 (Boltnev 1996). Both of these harvests led to renewed population declines. Following cessation of these practices, the population again began to increase, with the Alaska population reaching 1.25 million in 1974 (Angliss and Lodge 2003).



Since the late 1970s, Northern Fur Seals have again declined, with latest estimates placing the Alaskan herd under 900,000 animals (Angliss and Lodge 2003). These declines led the National Marine Fisheries Service to list the population as a depleted species under the Marine Mammal Protection Act in 1988. Unlike the past, recent declines in Northern Fur Seal populations do not correspond with a substantial harvest, and thus the cause of declines has been difficult to determine. Initially it was believed that declines were caused primarily by mortality from entanglement in fishing nets – particularly the high seas driftnet fishery, which resulted in mortality of roughly 5,200 animals in 1991 (Fowler 1984, Angliss and Lodge 2003). However, driftnet fishing ceased in 1992 and declines have persisted (Angliss and Lodge 2003).

In the absence of substantial incidental mortality from commercial fisheries, possible causes of continued Northern Fur Seal declines are food limitation related to commercial fishing and climatic shifts that have favored the less nutritious Walleye Pollock at the expense of more nutritious prey such as Herring and Capelin (Trites 1992, Rosen and Trites 2000, NMFS 2000). Declines in prey abundance and availability and shifts in prey composition are believed to be factors in similar declines of Steller's Sea Lions and Harbor Seals (Castellini 1993, NMFS 2000). Another factor in declines is believed to be development on the Pribilof Islands, leading to pollution and human disturbance (Angliss and Lodge 2003). The fact that continued declines in Northern Fur Seal and other pinniped populations are potentially related to a combination of overfishing, climate change and habitat loss highlights the complexity and interconnectedness of Bering Sea ecosystems and the need for further international regulations.

Northern Fur Seal
photo by Pete Spruance

ice or cold-ocean conditions, including the Polar Bear, Pacific Walrus, Greenland Turbot and others. Many of the imperiled species of the Bering Sea, including the three species of eagle, sea otters and others, are also high on the food chain, which exposes them to persistent organic pollutants (POPs) (Appendix).

Overall, commercial fishing potentially threatens the greatest number of imperiled species (38), followed by pollution (33), global climate change (17), habitat loss (17, outside the Bering Sea in some cases), direct human disturbance (boat collisions, nest disturbance, etc.) (13), and exotic species (6). Hunting impacts 19 imperiled species, but is managed to limit population impacts for many species. Even with this management, however, hunting can be a threat to species with very small populations or when restrictions are poorly enforced. In total, these threats not only impact those species we have identified as imperiled, but also many other Bering Sea wildlife species.

King Eider
photo by USFWS

We identified threats to 22% of all Bering Sea vertebrate species. Our search of available literature, databases and other sources found information on threats to individual species of varying reliability. For many species, we found specific studies of a particular threat's impact on species in the Bering Sea. For others, available sources inferred threats based on a range of factors, including direct observation of the species being impacted by a threat (e.g., commercial fishing, oil spills, boat collisions, net entanglement, etc.), likely impacts to the species' habitat, or impacts to the species from a particular threat in another region. We did not initially exclude any threats identified in the literature or attempt to prioritize threats by the extent of impact on species' populations. However, for a number of species, we found studies that identified individual threats as those most likely to impact populations now or in the future, and have considered this information in the following discussion of individual threats.

As with imperiled species, commercial fishing – either through direct exploitation, bycatch or competition – potentially impacts the greatest number of Bering Sea species (71), affecting 56% of all species for which we found threat information. Pollution affects the second-highest number of species (60, 48%), followed by ecological factors (35, 28%), hunting (26, 20%), global climate change (25, 20%), habitat destruction (25, 20%), human disturbance (21, 17%) and exotic species (21, 17%).

Commercial Fishing

Commercial fishing in the Bering Sea harms wildlife through overfishing, bycatch, competition for prey, and seafloor habitat destruction caused by dragging of nets. Although exploitation of fisheries in the Bering Sea began in the late 1800s, it was not until the advent of modern trawling gear and other technology in the 1950s that large-scale commercial fishing began (NMFS 2000). From 1954 to 1974, fishing was dominated by fleets from Japan and the Soviet Union, and is believed to have taken 22 million metric tons (mt) of groundfish (NMFS 2000). This fishing was largely unregulated, resulting in overfishing of one species after another.

Male Walruses
photo by Kevin Schafer, www.kevinschafer.com

For example, NMFS (2001) concluded:

> "From 1964 to the mid-1970s, the fishing power of these fleets created a pattern of overfishing one species before shifting to another species. This pattern was reflected in a progression of increasing catch, followed by steep declines as abundance fell off, followed by another increase in catch as the fleet targeted another species or new fishing grounds."

Among the fish species believed to have been overfished are the Yellowfin Sole and Pacific Ocean Perch, which have yet to completely recover (NMFS 2000).

In the early 1970s, the United States began to set controls on fishing, culminating in the passage of the Magnuson-Stevens Fisheries Conservation and Management Act (MSFCMA) in 1976. The MSFCMA required limits on fishing to ensure that stocks were not overfished and established regional fishery councils to develop management plans to ensure this occurred. All waters of the U.S. "exclusive economic zone" (EEZ), which extends 200 nautical miles (nm) from the coast and the Aleutian Islands, are covered by the MSFCMA.

Despite these new regulations, fishing remained high through the 1980s, resulting in overfishing of some stocks. In 1985, foreign fisheries began operating in the central Bering Sea outside the U.S. and Russia EEZs, in an area commonly referred to as "the Donut Hole," primarily for Walleye Pollock. As a result of this fishing, catches of Pollock were nearly 5 million tons in 1988. The Pollock catch began to decline in the late 1980s, indicating the fishery was crashing in the area, and in 1992, fishing was prohibited in the Donut Hole by convention (Wespestad 1993, Bulatov 1995, Bailey et al. 2000). To date, the Pollock fishery in the Donut Hole has never reached the population targets that would allow reopening of the fishery.

Most stocks in the eastern and central Bering Sea and Aleutian Islands are not currently overfished (Plan Team 2004). However, overfishing may be a continuing problem in waters of the western Bering Sea governed by the

Maritime National Wildlife Refuge
photo by Kevin Schafer, www.kevinschafer.com

Russian Federation, where corruption and insufficient resources for enforcement are resulting in fishing well over targets (Pautzke 1997). Furthermore, even where properly managed, commercial fishing has impacts to Bering Sea ecosystems (e.g. NMFS 2000 and 2001, Enticknap 2002, NAS 1996, NRC 2003).

Bycatch from commercial fishing impacts a wide diversity of species, from non-target fish and invertebrates that are discarded, to marine mammals that are entangled in nets. Although fishing nets trap hundreds of thousands of tons of fish and other organisms every year in the Bering Sea, the full impacts of bycatch have not been quantified for most organisms, excluding marine mammals, some seabirds, and other commercial fish. The impacts of bycatch on marine mammals have been much reduced since the cessation of the high seas drift gillnet fishery in 1992. This fishery resulted in the annual mortality of thousands of Steller's Sea Lions, Northern Fur Seals, seabirds, and other species. Since its cessation, bycatch for marine mammals has generally been small enough to avoid population impacts (Hill and DeMaster 1999). For species like the North Pacific Right Whale, however, entanglement and mortality of even a small number of whales would be serious, making bycatch a continuing concern for some species. Success in reducing bycatch for marine mammals needs to be carried over to the plethora of other species impacted by incidental entanglement and death in nets.

Commercial fishing may also be a factor in the decline of some Bering Sea marine mammals because it competes with them for prey. Although it is widely acknowledged that a number of species have been declining in the Bering Sea and that food limitation is a factor in these declines (Pitcher 1990, Trites 1992, Castellini 1993, Springer 1993, Merrick et al. 1997, Rosen and Trites 2000), the role of commercial fishing in food limitation has been controversial. A number of scientists have argued that the declines are more likely caused by a shift to warmer waters in the late 1970s and a subsequent increase in Walleye Pollock at the expense of other cold-water species, such as Capelin and Herring, that may provide greater nutritional value for marine mammals and seabirds (e.g. Alverson 1992, Rosen and Trites 2000, Hunt et al. 2002). Others have noted that com-

Greenland Turbot

Like other flatfish, the Greenland Turbot, or Greenland Halibut, has both eyes on one side of its head and dwells on the seafloor, where it buries itself in sand to avoid predation. The Turbot is a widely distributed species with a circumpolar distribution. In the North Pacific, the Turbot occurs from the Chukchi and Beaufort Seas to California, but is only abundant in the Bering Sea and Gulf of Alaska.

The wide distribution of the Turbot probably protects it from extinction as a species in the near-term. In the eastern Bering Sea and Aleutian Islands, however, the Greenland Turbot is known to have been declining since the late 1970s (Swartzman et al. 1992, Ianelli et al. 2004). For example, Ianelli et al. (2004) concluded that "the stock appears to be on a continuing decline," and that further declines are anticipated based on estimates of the age composition of the stock. As with other species, the exact causes of these declines are difficult to determine and probably include a combination of factors, particularly global climate change and commercial fishing.

Commercial catches of Greenland Turbot in the eastern Bering Sea and Aleutian Islands peaked between 1972 and 1976 at 63,000 to 72,000 tons annually (Ianelli et al. 2004). Following passage of the MFCMA, catches remained relatively high at 48,000 to 57,000 tons through 1983, but thereafter declined to 7,000 tons annually, mostly as bycatch because of poor recruitment (Ianelli et al. 2004). In response to indications of continued decline, the "acceptable biological catch" in U.S. waters was further reduced in 2004 to 3,930 tons (Ianelli et al. 2004). At least in U.S. waters, this catch level is probably not sufficient to cause continued declines based on estimates of total biomass of Turbot.

The beginning of observed Turbot declines correspond to the observed shift in the Bering Sea from a primarily cool arctic climate regime to a warmer more maritime climate (PICES 2005), suggesting that warmer waters may be responsible. If this is the case and predictions for global climate change are correct, then like many other coldwater species, the Greenland Turbot's status may continue to deteriorate in the Bering Sea. Whether the Turbot will find suitable waters further north remains an open question.

Humpback Whale
photo by USFWS

Greenland Turbot
drawing by H.L. Todd, provided courtesy of NOAA Fisheries

mercial fisheries target larger fish than those targeted by seabirds or marine mammals and actually remove a major predator (Walleye Pollock) of forage-sized fish (e.g. Springer 1993). Finally, some scientists believe that increased predation from Orcas related to loss of other prey, such as large whales, may be a factor in the decline of the Steller's Sea Lion, Northern Fur Seal and others (NRC 2003).

In 2000, the National Marine Fisheries Service (NMFS) evaluated the impacts of commercial fishing on the endangered Steller's Sea Lion and concluded that although direct evidence was lacking, commercial fishing likely does impact the Sea Lion through local depletion of prey and dispersal of fish schools (NMFS 2000). These impacts were believed to jeopardize the Sea Lion's continued existence, and measures to reduce impacts were instituted, including closing all commercial fishing within 66% of the Sea Lion's critical habitat and within 3 nm of all major rookeries and haulouts; closing the Pacific Cod, Walleye Pollock and Atka Mackeral fisheries November 1 - January 20; and dispersing fishing in remaining Sea Lion critical habitat more evenly over the year to avoid local prey depletions during critical Sea Lion periods (NMFS 2000). In 2003, NMFS again reviewed the likely impacts of commercial fishing on the Sea Lion and concluded that mitigation measures were effective at reducing overlap between commercial fishing and Sea Lion foraging, avoiding jeopardy to the Steller's Sea Lion and modification of its critical habitat (NMFS 2003).

Responding to the mitigation measures put in place by NMFS, the National Research Council (NRC) was asked to determine the most likely cause(s) of the Steller's Sea Lion's decline (NRC 2003). NRC (2003) identified multiple possible factors in the decline of the Sea Lion and broadly classified these factors as either bottom-up, which includes nutritional stress related to either climate change or depletion of prey from commercial fishing, or top-down, which includes predation, fisheries mortality, harvest and illegal shooting. Ultimately, NRC concluded that recent declines since the 1990s were unlikely to be caused solely by bottom-up factors based on a lack of evidence to support either lack of prey or nutritional stress in Sea Lions. However, in making this conclusion,

Horned Puffins, Pribilof Islands
photo by Kevin Schafer, www.kevinschafer.com

North Pacific Right Whale

Considered the world's most endangered large whale, the North Pacific Right Whale hangs by a thread. Today, there are fewer than 100 Right Whales in the eastern Bering Sea with no more than 24 seen at any given time, and only 17 individual whales identified over the past 10 years (NMFS 2005). A separate stock occurring in the western Pacific in the Sea of Okhotsk is faring slightly better with a population somewhere in the low- to mid-hundreds. North Pacific Right Whale numbers are perilously small despite nearly 40 years of protection from whaling, and reflect the Right Whale's low reproductive capacity and ongoing threats. Indeed, only one calf has been positively sighted in the Eastern Pacific in decades (Angliss and Lodge 2004).

Right Whales feed on zooplankton (small marine animals) by filtering them from water using stiff plates that are called baleen and grow from their upper jaw. Despite their small prey, Right Whales can be 60 feet long and weigh 100 tons. Their large size, in combination with slow speed, tendency to congregate in coastal areas, and the fact that they float when killed, made Right Whales an ideal target for early whalers beginning in the 1800s (NMFS 2005). By 1900, Right Whales were already severely depleted.

Protection for Right Whales was first established in 1935 when a League of Nations agreement was signed. Unfortunately, neither Russia nor Japan was a signatory to this agreement. and both continued to kill Right Whales. Following creation of the International Whaling Commission in 1947, killing of Right Whales was limited to a small number for "scientific purposes." The Soviet Union, however, is known to have illegally killed 372 Right Whales in the eastern Bering Sea from 1963 to 1967 (NMFS 2005).

The Right Whale is protected from whaling today, but it faces new threats. In particular, the Right Whale is threatened by boat collisions, entanglement in fishing nets, reductions in prey potentially related to climate change, and pollution. Given the tiny population of the Right Whale, even limited mortality related to these factors could impact its survival. After a petition and lawsuit from the Center for Biological Diversity, the National Marine Fisheries Service proposed to designate critical habitat for the Right Whale in the southeastern Bering Sea and northwestern Gulf of Alaska, where Right Whales have been consistently spotted in the last 10 years. This designation should help control harmful activity within areas where Right Whales still occur.

NRC also concluded that there were multiple avenues for commercial fishing to impact the species and it could not be ruled out as a substantial factor in the decline of the Steller's Sea Lion:

> "Although most evidence indicates that groundfish fisheries are not causing a range-wide depletion of food resources necessary to sustain the current western population of sea lions, there is insufficient evidence to fully exclude fisheries as a contributing factor to the continuing decline. In some areas, fisheries may compete with sea lions for localized fish stocks, increase incidental mortality due to gear entanglement and associated injuries, disturb animals on haulouts, increase exposure to natural predators through attraction to fish catches, and provide motivation for continued illegal shooting of animals to mitigate lost catches and damaged fishing gear. Moreover, fisheries are one of the few human influences on the Steller sea lion's environment and hence are subject to regulation under the ESA. Therefore, restriction of fishing operations in sea lion habitat remains a reasonable response to the continuing decline of the endangered western population."

Given NRC's conclusions about the likelihood of impacts from fisheries and the reasonableness of mitigation measures, as well as NMFS's conclusion that mitigation measures are effective, similar analyses and mitigation measures should be taken for other species known to be declining, such as Northern Fur Seals and Harbor Seals.

Aleutian Sea Otter

Prior to extensive killing for their furs, Aleutian Sea Otters were widespread around the Pacific Rim from northern Japan to central Baja California. Sea Otters were discovered in large numbers by the Bering expedition in 1741 and 1742, sparking a rush for otter fur. By the end of 1900, the Sea Otter was reduced to just 13 remnant populations and as few as only 1,000-2,000 individuals (FWS 2005). Signing of the Northern Fur Seal Treaty in 1911 ended fur hunting of Sea Otters, by which time they were so reduced they had lost their commercial value anyway.

Sea Otters are a member of the Mustelidae family, which also includes river otters, mink and the Pine Marten. Instead of a layer of blubber like seals and sea lions, Sea Otters are kept warm by the densest fur of any mammal, with 100,000 hairs per square centimeter (Kenyon 1969). They eat sea urchins, octopuses, mussels, clams and fish and have fur pouches under their arms where they stash food. After 70 years of population recovery, Sea Otters in the Aleutians and other parts of southwest Alaska are once again experiencing a decline.

At the cessation of Sea Otter hunting, six of the 13 remnant populations were found in southwest Alaska. By the 1980s, these populations had expanded to occupy all of the species' former habitat in the region, and there were as many as 74,000 Otters in the Aleutians (FWS 2005). However, surveys in 1992 and 2000 found population declines of as much as 17% per year, with some populations declining by more than 90% overall (FWS 2005). The entire Aleutian population may have declined to less than 4,000 individuals (FWS 2005). In response to the survey results, leading Sea Otter researchers concluded:

> "These data chronicle one of the most widespread and precipitous population declines for a mammalian carnivore in recorded history" (Doroff et al. 2003).

Like declines in Northern Fur Seals, Steller's Sea Lions and Harbor Seals, the cause(s) of Sea Otter decline are not immediately obvious. The leading hypothesis is that declines in seal and sea lion populations, which are the favored prey of Orcas, has caused a shift in the diet of

these large predators to Sea Otters. Estes et al. (1998) found that adult mortality was a primary factor in Sea Otter declines and that Orca predation was the principle factor in this mortality. This suggests that the key to reversing the Sea Otter's slide towards extinction is to recover other marine mammal populations and the Bering Sea ecosystems on which they depend. Other proximate causes of the Otter's population decline potentially include oils spills, habitat loss, disease and pollution, with Aleutian Sea Otters having high levels of organochlorine pollutants in tissue samples.

Sea Otters are considered a keystone species because their presence maintains kelp forests that provide habitat for a wide diversity of species. Sea Otters prey extensively on sea urchins, which in turn feed on kelp. Without Sea Otters, urchins overpopulate and kelp forests disappear, ultimately resulting in declines of a host of fish and other animals. Indeed, Anderson (1995) speculated that hunting of Sea Otters for their pelts may have contributed to the extinction of the Steller's Sea Cow, which also likely fed on kelp.

In response to the Otter's sharp decline and a petition from the Center for Biological Diversity, the U.S. Fish and Wildlife Service listed the "Southwest Alaska Distinct Population Segment" of the Sea Otter as a threatened species under the Endangered Species Act in 2005. Such protection will lead to greater funding for research on the Sea Otter, further elucidate the causes of decline, and increase protection of its habitat.

Sea Otter
Photo by USFWS

Finally, commercial fishing harms Bering Sea biodiversity by dragging enormous trawl nets across the seafloor, disturbing benthic animals and destroying their habitat. Bottom trawling involves dragging large nets across the seafloor, weighted with chains, steel beams or other equipment. Bottom trawls were banned from the Bering Sea pollock fishery in 1999, but the majority of the fishery uses pelagic trawls, which are known to often contact the seafloor (Enticknap 2002). Roughly 27% of the trawl catch in the Bering Sea and Aleutian Islands comes from bottom trawl gear (NMFS 2001). From 1998 to 2000 alone, an estimated 53,931 km^2 in the Bering Sea and 10,201 km^2 in the Aleutians Islands were swept by bottom trawlers (NRC 2002).

Although poorly chronicled, trawling likely impacts hundreds of Bering Sea species, including Blue and Red King Crabs, Snow Crabs, Tanner Crabs, and other crab species that are important commercial species in their own right but have experienced population crashes (Otto 1986, Stevens et al. 1994, NAS 1996, Merkouris et al. 1997). Furthermore, trawling is known to impact cold-water corals and sponges, which besides being exceedingly beautiful,

Rock Sandpiper
photo by USFWS

also provide habitat for many species, such as rockfish, Pacific Cod, and Walleye Pollock (Witherall and Coon 2000). Recognizing the destructiveness of bottom trawling to deep sea corals and the importance of habitat provided by corals for fish and other species, a large area surrounding the Aleutian Islands, where large coral colonies were known to exist, was closed to such trawling in February 2005. Other areas in the Bering Sea need to be surveyed for deep sea corals, and bottom-trawling should be similarly banned.

Global Climate Change

Global climate change caused by anthropogenic increases in carbon dioxide and other greenhouse gases is expected to have disproportionate impacts on arctic ecosystems, including the Bering Sea, with rises in temperature already apparent. In the last 50 years, the Bering Sea's average annual temperatures have increased by 0.5°C (1°F) and winter temperatures have increased by 3-5°C (6-9°F)(ACIA 2004). These temperature increases are causing changes in Bering Sea ecosystems, with sea ice melting earlier in the summer and forming later in the fall. Overall in the Arctic, summer sea ice has declined by 15-20% (ACIA 2004). A recent report prepared by dozens of scientists evaluating the impacts of global climate change on the Arctic concluded:

> "In the Bering Sea, rapid climate change is already apparent and its impacts significant" (ACIA 2004).

By 2090, average annual temperatures are predicted to rise another 3-4°C and winter temperatures are predicted to rise 4-7°C. Sea ice is expected to decrease by another 10-50% with the near total loss of summer sea ice (ACIA 2004). These changes will have disastrous consequences for Bering Sea species that are dependent on or use ice or areas adjacent to ice, including the Polar Bear, Pacific Walrus, Ringed Seal, Spotted Seal, Bearded Seal, Kittlitz's Murrelet, Dovekie, Beluga Whale and many others (ACIA 2004).

Beginning in 1977, the Bering Sea underwent a shift from a primarily cool, arctic climate to a warmer, more maritime climate (PICES 2005). This shift was consis-

tent with a pattern of warm and cool periods alternating every two to three decades known as the "Pacific Decadal Oscillation." However, unlike previous shifts, the Bering Sea did not return to cooler conditions concurrent with a shift to cooler waters further south. Based on this observation, PICES (2005) concluded:

> "We hypothesize that the overall climate change occurring in the Arctic, as indicated by warmer atmospheric and oceanic temperatures and loss of 15% of sea ice and tundra area over the previous two decades, is making the Bering Sea less sensitive to the intrinsic climate variability of the North Pacific. Indeed, when the waters off the west coast of the continental United States shifted to cooler conditions after 1998, the subarctic did not change (Victoria pattern), in contrast to three earlier PDO shifts in the twentieth century. Thus we project that the Bering Sea will more likely continue on its current warm trajectory, with biomes transitioning northward, allowing pollock a larger domain at the expense of cold and ice-adapted species."

As noted by PICES (2005), the shift to warm waters beginning in 1977 resulted in the increase of Walleye Pollock, but it also resulted in the decline of coldwater species, such as Greenland Turbot, Artic Cod, Snow Crab and many others (Swartzman et al. 1992, PICES 2005). In combination with the increasing decline of sea ice, warm water temperatures related to global climate change are likely to result in the extirpation of many coldwater species from the Bering Sea and the Arctic as a whole. Loss of species from the Bering Sea is likely to accelerate as the climate warms further.

A Malaysian cargo ship, broken in half and spewing oil into the Bering Sea, December 2004
Photo by Unalaska Community Broadcasting, KIAL AM

Pollution

Given the remoteness of the Bering Sea from major population centers, agriculture, or industry, one would not expect pollution to be a serious problem in the Sea. However, a number of studies have found elevated levels of contaminants in wildlife of the Bering Sea, including polychlorinated biphenyls (PCBs) and other persistent organic pollutants (POPs) (e.g., Estes et al. 1997), and heavy metals, such as lead, cadmium, selenium and mercury (Henny et al. 1995, Grand et al. 1998, Zhang et al. 2001, Stout et al. 2002). Pollutants enter the Bering Sea and the Arctic as a whole from atmospheric transport and ocean currents (Brunstrom and Halldin 2000). There are also local sources of pollution, including oil exploration, shipping traffic with the potential for oil spills, military activities, and lead shot (Estes et al. 1997, NMFS 2000, Stout et al. 2002). For example, the naval

Bearded Seal
Photo by David S. Isenberg

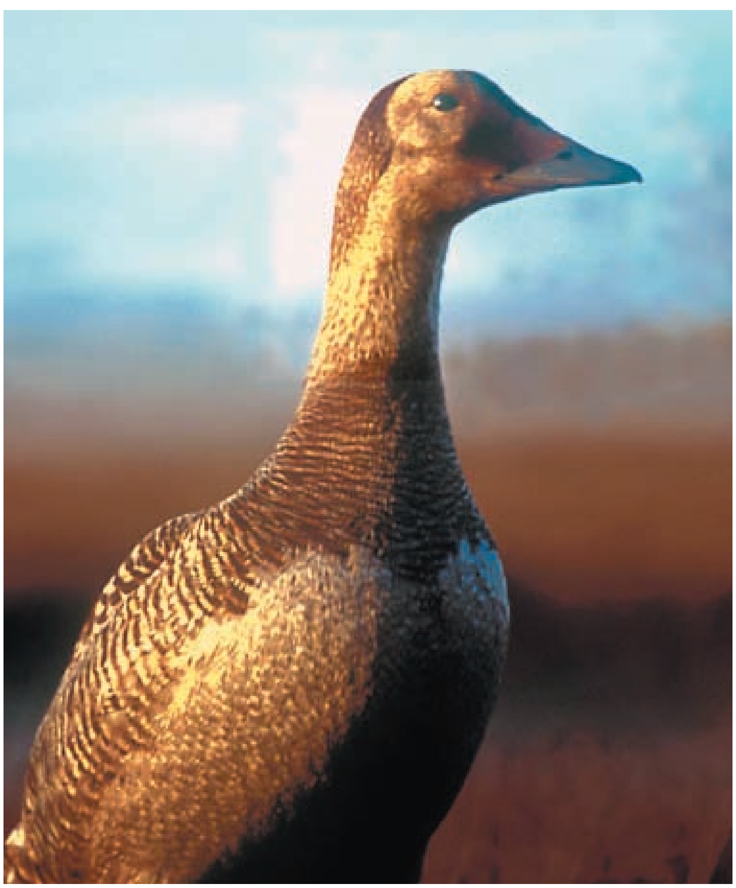
air station on Adak Island in the Aleutians is a source of PCBs and other pollutants (NMFS 2000).

Because POPs and heavy metals tend to increase in concentration as they move up the food chain in a process known as bioaccumulation, contaminants are most likely to affect animals at the top of the food chain. And indeed, contaminants have been found in a number of top-level predators in the Bering Sea, including the Bald Eagle, Steller's Sea Lion, White-winged Scoter, four Eider species, Common Murre, Sea Otter, Polar Bear, and salmon (Prestrud and Stirling 1994, Henny et al. 1995, Grand et al. 1998, Stout et al. 2002).

For example, Estes et al. (1997) found that Bald Eagles and Sea Otters in the Aleutian Islands had elevated levels of dichlorodiphenyltrichloroethane (DDT) in tissue samples, and deduced that it was carried in the atmosphere from Asia. They based this on observations that DDT concentration declined from west to east and on a relatively high ratio of DDT to its metabolite DDE – implicating active use of the chemical, which currently occurs in Asia. In addition to DDT, they documented contamination by PCBs and other organochlorines (OCs) and speculated that their presence may relate to past military activities on the Aleutians. In some cases, concentrations of DDT were found to be sufficient to impact the health of eagles and otters, leading Estes et al. (1997) to conclude:

> "Detrimental impacts of OCs on these and other species in the Aleutian Islands are likely. Various marine birds and mammals are experiencing population declines in the western North Pacific/Bering Sea region and whereas changes in the abundance or quality of food is the proposed cause, this remains uncertain. Our findings indicate that elevated OC concentrations should be considered among the possible factors."

Likewise, elevated concentrations of several heavy metals have been observed in Bering Sea wildlife, including imperiled species. A recent study found elevated levels of lead, cadmium, copper and selenium in Common, King, Spectacled, and Steller's Eiders from Alaska to Russia (Stout et al. 2002). Stout et al. (2002) observed that "these elements were often high in Spectacled Eiders, a species that has suffered declines of nearly 90% in one of its primary nesting populations over the last 25 years," suggesting that "high levels of these



Female Spectacled Eider
Photo by USFWS

elements approach the upper tolerance level for some eiders." The Spectacled Eider is listed as a threatened species under the Endangered Species Act. Of the four metals, only lead has a local source, which is lead shot. Both the Spectacled and Steller's Eiders have sharply declined on the YK Delta, where hunting with lead shot is a common practice. It is unknown whether the other metals originate from anthropogenic or natural sources.

In the Bering Sea, contaminants have also been observed in salmon (mercury), the Polar Bear (OCs), White-winged Scoter (Selenium), and Common Murre (mercury) (Prestrud and Stirling 1994, Henny et al. 1995, Zhang et al. 2001). It is likely that many more Bering Sea species carry contaminants but have not been studied. As many of the pollutants originate outside the region, ensuring that Bering Sea wildlife is not further contaminated requires a concerted international effort.

Habitat Loss

There are several substantial sources of habitat destruction in the Bering Sea. As noted above, trawling by commercial fisheries, which involves dragging nets across the seafloor, results in the degradation and destruction of benthic habitats utilized by a plethora of Bering Sea animals. Other marine habitat loss is caused by oil and gas exploration. Many exploratory wells have been drilled in the Bering Sea, resulting in seafloor disturbance and potential for oil spills. To date, major oil production has not been initiated at most of these wells; but as the world's oil supplies diminish, pressure to develop the Bering Sea's oil potential may grow and further threaten its habitat and wildlife. Oil spills from shipping are an additional source of habitat loss in the Bering Sea, particularly in the Unimak Pass area, which is a major shipping route and an area where high numbers of Humpback Whales, Shearwaters and other species congregate to feed.

Exotic Species

The most devastating impact to Bering Sea wildlife from exotic species has been the introduction of Arctic Foxes and Norway Rats to the Aleutian and other islands of the Bering Sea, which historically lacked mammalian predators. The introduction of these predators has had devastating impacts on breeding birds of the Bering Sea. In particular, the Aleutian Canada Goose was driven to near extinction by the introduction of foxes to hundreds of Bering Sea islands beginning in the 1750s. By 1967, when the Goose was listed as an endangered species under the Endangered Species Act, it had been reduced to one island, where it was estimated that there

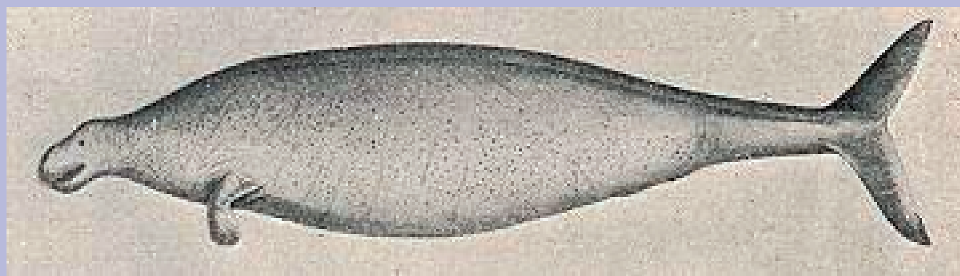
Male Spectacled Eider
Photo by USFWS

were only 200-300 birds (FWS 2001c). Prohibitions on hunting of the Aleutian Canada Goose and translocation to fox-free islands have resulted in recovery, and recent counts estimated 37,000 birds. The Goose was removed from the endangered species list in 2001 (FWS 2001c). Introduced foxes and rats, however, continue to impact many seabirds throughout the Bering Sea, including at least 22 species identified in the present study. Birds impacted by introduced predators include auklets, murres, puffins, kittiwakes and many others.

Human Disturbance

Human presence in the Bering Sea has the potential to disturb wildlife in a number of ways. Seabirds can be sensitive to human presence in their nesting colonies and will in some cases abandon nesting if disturbed. A number of the large whales are subject to mortality from boat collisions. This is a particular concern for the North Pacific Right Whale because its population is so small that any mortality is a potential threat (FWS 2005). Other whales threatened by collisions include the Sei Whale, Blue Whale, Fin Whale, Humpback Whale and Sperm Whale, all of which are listed as threatened or endangered under the Endangered Species Act. Finally, poaching of Bering Sea wildlife is a threat to a number of species that have small populations, including eagles, Spoon-billed Sandpipers, and the four species of Eiders. The remoteness of much of the Bering Sea in Russia and Alaska makes enforcement of hunting restrictions particularly difficult.

Extinct Species of the Bering Sea:
The Spectacled Cormorant, Steller's Sea Cow and Bering Canada Goose



Three Bering Sea species are known to have gone extinct in modern times – the Spectacled Cormorant, Steller's Sea Cow and Bering Canada Goose. All three species formerly occurred in the Commander Islands. The Sea Cow and Cormorant were first discovered by Europeans in 1741, when the Bering Expedition shipwrecked on Bering Island, then uninhabited and unnamed. Like many island species, the two were docile and unwary of humans, and thus became a source of food for the starving expedition crew. After surviving members of the crew, which did not include Vitus Bering, managed to construct a craft out of the wreckage of their ship and return to Russia, their reports of plentiful fur and meat led to a rush to exploit wildlife of the Bering Sea, culminating in the quick extinction of both the Cormorant and Sea Cow.

Little is known about Spectacled Cormorants beyond that they were large (12-14 pounds), nearly flightless seabirds that, like other cormorants, fed on fish (AGFD 1997). The Cormorant was driven extinct by fur traders, whalers and Aleut Natives brought to Bering Island by the Russian-American Company, who all harvested it for food. It was last seen around 1850, only 100 years after its discovery by Europeans (AGDF 1997).

The Steller's Sea Cow was the largest relative of the Manatee and Dugong, reaching lengths of 26 feet and weighing as much as eight tons. Like other Sirenians, the Sea Cow had a whale-like fluke. It also had thick bark-like skin. It is believed that the Sea Cow was unable to submerge and foraged exclusively in shallow waters.

Steller's Sea Cows were wantonly harvested for meat and leather. Although this exploitation certainly contributed to their extinction in 1868, a mere 27 years after their discovery by Europeans, Anderson (1995) suggests that elimination of Sea Otters by fur traders may have also contributed to their demise. The Sea Cow was known to feed primarily on kelp. Loss of Sea Otters has been shown to result in the loss of kelp forests because Otters prey on a key forager of kelp – the Sea Urchin.

The Bering Canada Goose, a small subspecies of the well-known Canada Goose that bred on Bering Island and wintered in Japan, managed to survive for longer either the Cormorant or Sea Cow, but a combination of hunting and introduction of rats to the Commander Islands eventually led to its demise. The Goose was last observed in Japan in 1929.

To ensure that more spectacular animals like the Spectacled Cormorant, Steller's Sea Cow and Bering Canada Goose are not similarly driven to extinction, it will not only require controls on exploitation in the Bering Sea, but will also require the nations of the world to reduce their emissions of greenhouse gases and other pollutants.

Polar Bear and cubs
photo by Pete Spruance

Steller's Sea Cow, now extinct
image from USFWS

As documented in this report, Bering Sea wildlife species are threatened by an array of complex problems, including commercial fishing, global climate change and pollution. These threats are striking in that action is required both in the Bering Sea itself and internationally if further species decline and extinction is to be avoided. Marine reserves are needed in the Bering Sea to protect areas from bottom trawling, ensure prey for marine mammals is not depleted, provide relief to species from bycatch, and ensure that species are able to complete their necessary life functions, including breeding and foraging. Protecting the Bering Sea will also require further international regulations and treaties limiting commercial fishing and the release of pollutants that contaminate the Arctic or cause global warming. An immediate step that can be taken to protect Bering Sea wildlife is to protect deserving species as threatened or endangered under the Endangered Species Act.

Crested Auklet making territorial call
photo by Kevin Schafer, www.kevinschafer.com

Listing Species Under the Endangered Species Act

Beyond regulation of individual fisheries, most conservation efforts to date have focused on protecting the Steller's Sea Lion, reflecting its listing as an endangered species under the Endangered Species Act with designated critical habitat. Commercial fishing has been prohibited within 66% of its critical habitat and sharply limited in the remainder to avoid local depletion of prey for the Sea Lion (NMFS 2000 and 2003).

A number of other species likely warrant and would benefit from listing under the Endangered Species Act. Of critically imperiled species, the Kittlitz's Murrelet is not currently protected by the Endangered Species Act. In response to a petition from the Center for Biological Diversity and other groups, the Murrelet was designated as a candidate for listing. Unfortunately, candidate status does not confer any protection for the Murrelet; often species are left to languish on the candidate list for years, allowing continued decline (Greenwald et al. 2005). The Murrelet should be listed as endangered, following the timelines specified in the Endangered Species Act, which allow two years for a species to be proposed and listed.

Of imperiled species, the Ringed Seal, Polar Bear, Pacific Walrus and Long-tailed Duck are not listed under the Act. Current numbers of Polar Bears, Ringed Seals and Pacific Walruses do not indicate immediate risk of extinction. Due to their dependence on sea ice, however, they are the most likely to be affected by global climate change. In regards to Ringed Seals, for example, ACIA (2004) concluded:

> "Ringed Seals are likely to be the most highly affected species of seal because all aspects of their lives are tied to sea ice. They require suffi-

cient snow cover to construct lairs and the sea ice must be stable enough in the spring to successfully rear young. Earlier ice breakup could result in premature separation of mothers and pups, leading to higher death rates among newborns."

Predictions for loss of sea ice in the Bering Sea and the Arctic as a whole suggest these species need the protections of the Endangered Species Act. Long-tailed Ducks have a large breeding distribution spread across much of the Canadian Arctic and a relatively large population, suggesting listing for the full species may not be warranted at this time.

Another imperiled species, the Southwest Alaska Distinct Population Segment of the Northern Sea Otter, was listed as a threatened species in August 2005. However, the U.S. Fish and Wildlife Service delayed designation of critical habitat for the species. We recommend critical habitat be designated for the Otter immediately. Based on continued and well-documented declines, we further recommend that the Northern Fur Seal, which is listed as vulnerable, be considered for listing as threatened under the Endangered Species Act.

Vulnerable species, such as the Red-legged Kittiwake, should be closely monitored for early detection of renewed or increased declines. They should also be the subject of research to determine the natural and anthropogenic factors most influential on population status. If declines are observed or populations are found to be threatened by particular factors, increased protection should be implemented.

As more research and understanding of Bering Sea species is developed, it is likely that other species will be found to need the greater protections of the Endangered Species Act, particularly if threats are not reduced. To this end, we have the following recommendations:

Steller's Sea Lion nursing pup
photo by USFWS

Commercial Fishing

Commercial fishing is already regulated by international treaties between the United States, Russia and Japan and within the U.S. EEZ by the MSFCMA. These regulations have resulted in the cessation of the Pollock fishery in the Donut Hole and have largely controlled overfishing of single species in the eastern Bering Sea and Aleutian Islands. However, problems with commercial fishing persist in the Bering Sea; namely, the potential for local prey depletions, bycatch, habitat destruction and overfishing in the western Bering Sea. To alleviate these problems, we recommend the following:

– Similar to conservation efforts for the Steller's Sea Lion, identify key foraging habitat for known declining species, such as the Northern Fur Seal and Harbor Seal, and prohibit or limit fishing within those areas to ensure that prey abundance or density is not impacted.

– Establish international funding and cooperation to ensure enforcement of fishing regulations in Russian Federation waters and the Bering Sea as a whole, potentially involving the U.S. Coast Guard.

– Require the latest technology to avoid bycatch of marine mammals, seabirds, non-target fishes, and other marine life.

– In the western Bering Sea, driftnets larger than 2.5 kilometers in length should be totally banned to bring Russia up to international and U.S. standards, while the eastern Bering is in need of further research and restrictions on bottom-trawling.

– In addition to the already established reserve centered around the Aleutian Islands, establish marine reserves to protect areas of high diversity, such as those containing deep-sea corals, from bottom trawling and other activities. This may require further surveys of the Bering Sea seafloor to determine reserve locations.

Global Climate Change

International efforts to curb greenhouse gases presently hinge on the Kyoto Protocol, which was ratified by enough countries to enter into force in February 2005. Unfortunately, the United States – the world's largest producer of greenhouse gases – has elected to withdraw from the Kyoto Protocol. As a first step to addressing global warming, the United States must adopt the Kyoto Protocol. However, the committments for the Kyoto Protocol 's first reducton phase, which include average emission cuts among developed nations of 5.2% below 1990 levels, are far less than what scientists advise are necessary to mitigate the impacts of global warming. Thus, if we are to achieve sufficient reductions to mitigate the most severe impacts of global warming, the Protocol must serve as a starting point for much greater reductions in the second commitment period and beyond.

The European Council, which includes the heads of state of all European nations, has defined "dangerous" climate change as a rise in average global surface temperatures of 2˚C above the pre-industrial level. Because climate change is more severe in the Arctic, such a rise in temperature would still have dramatic consequences for the Bering Sea and other Arctic regions (ACIA 2004). However, even reaching this goal will require deep cuts in emissions. The current scientific consensus is that emissions must be reduced by at least 80% to mitigate the most severe impacts of climate change. Minimizing impacts to the Bering Sea from climate change will require emissions reductions of this magnitude, clearly a great challenge given the current position of the U.S. federal government. A top priority for conservation is to shift the position of the United States into line with other jurisdictions, such as the European Union and California, that have set appropriate emissions reductions targets.

Pollution

The presence of contaminants in the Bering Sea and the Arctic as a whole highlights the fact that pollution emissions create an international problem that crosses borders. As an international problem, reducing sources of pollution will require international solutions.

Emperor Goose and nest
photo by USFWS

Although the United States now prohibits the use of DDT, for example, it continues to appear in the Bering Sea from sources in Asia, indicating that prohibitions on one contaminant, one country at a time are unlikely to be effective. With these realities in mind, we recommend the following:

– The Stockholm Convention is an international treaty that calls for eliminating sources of persistent organic pollutants (POPs). Both the United States and Russian Federation are signatories to the Convention, but neither has ratified it to allow them to become parties. Ratification and enforcement of the Convention are a first step to addressing problems related to POPs.

– Lead shot is currently banned for waterfowl hunting in the United States. This ban needs to be extended to upland birds to ensure that lead shot does not continue to accumulate in places like the YK Delta. Lead shot bans need to be strictly enforced.

– The Naval Air Station on Adak Island, which is a Superfund site, and other military sites need to be immediately cleaned up so they are no longer a source of POPs and other pollution in the Bering Sea.

– Further oil exploration or development in the Bering Sea should be prohibited. In the eastern Bering Sea, there has been exploration and leasing for oil and gas development. To date, these leases have not been developed, but there are recent plans to drill oil in Bristol Bay. There has also been extensive exploration in the western Bering Sea and currently at least some oil is being extracted. Overall, little damage has been done in the Bering Sea from oil and gas exploration, and its impacts could be sharply limited before substantial economic investments have been made.

Emperor Goose with chicks. The mother's head is "stained" from iron in the waters in which she feeds.
photo by USFWS

– Implement the recommendations of the "Shipping Safety Partnership" (SSP) to prevent future oil spills and ensure that those that do occur are rapidly cleaned-up. The SSP is a consortium of Alaska Natives, commercial fishermen, conservationists, and scientists who are dedicated to ensuring that accidents like the grounding of the freighter Selendang Ayu on December 8, 2004 in the Aleutians, which resulted in the spill of 335,000 gallons of fuel, do not happen again. Their recommendations include among other things acquisition of a sufficiently powered rescue tug, construction of salvage tugs, a tracking system to detect disabled vessels before they run aground, and acquisition of lightering vessels, boom capacity, and other necessary spill recovery equipment.

Other Threats

Protection and recovery of many Bering Sea wildlife species could be facilitated by tackling a number of other problems. We recommend the following:

– For the benefit of Bering Sea seabirds, remove foxes and rats from Bering Sea islands where these species did not historically occur, as has already been accomplished on a number of islands (see Byrd and Williams 2002).

– Enforce hunting restrictions in the Bering Sea, including ensuring that non-game species, such as eagles, are not hunted.

Further Research

We were not able to find information on the status of or threats to the majority of Bering Sea vertebrate species, with 60.9% of species, primarily fish, having an unknown status. Even for those species that have received extensive study, basic questions about their status, relationship to a changing environment, and the impacts of anthropogenic activities remain unanswered. This lack of knowledge is greatly magnified for invertebrate species – the vast majority of which have received little attention. Given the long-history of wildlife exploitation in the Bering Sea, which continues today in the form of industrial scale commercial fishing, and the observed changes in the Bering Sea likely related in part to global climate change, it is important that we have a baseline of information on species' status to understand the impacts of our actions on wildlife of the Bering Sea.

To this end, we recommend the following:

– Catalog all Bering Sea invertebrate species and identify those that are of concern based on abundance, trend or sensitivity to anthropogenic disturbance.

– Systematically identify a suite of indicator species to index changes in Bering Sea species and habitats related to anthropogenic activities, global climate change and other factors.

– Determine the key stressors of Bering Sea species and habitats to guide better conservation of Bering Sea wildlife.

– Increase fees on extractive industries, such as commercial fishing, shipping, and oil and gas exploration, to fund research and mitigation.

Tatik Point, St. Lawrence Island, in the Bering Sea
photo by Kevin Schafer, www.kevinschafer.com

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Appendix

Imperiled Species of the Bering Sea

Species	Classification	Classification Sources	Classification Reliability	Area of Concern	Potential Threats	Threat Reliability	References
Kittlitz's Murrelet	Critically Imperiled	Declined (Springer et al. 1982, USFWS 2004); AK Audubon; NatureServe; IUCN; Redbook	High	Eastern and western Bering Sea	Global warming, fisheries mortality and oil spills	Medium	Ewins et al. 1993, Springer et al. 1993, Agler et al. 1998, Kendall and Agler 1998, Alaska Audubon 2002, NatureServe 2004, FWS 2004, Birdlife International 2005
Short-tailed Albatross	Critically Imperiled	Alaska; ESA; NatureServe; IUCN; Redbook	High	Eastern and western Bering Sea	Fisheries mortality, threats to breeding islands from volcanic eruption or other disturbance (outside of Bering Sea)	High	McDermond and Morgan 1993, USFWS 2000, NatureServe 2004, Birdlife International 2005, FWS 2005a
Spoon-billed Sandpiper	Critically Imperiled	IUCN; Redbook	Medium	Western Bering Sea	Habitat loss, pollution, hunting and human disturbance	Medium	Flint et al. 1998, Collar et al. 2001, Birdlife International 2005
North Pacific Right Whale	Critically Imperiled	AK Endangered; ESA; NatureServe; IUCN	High	Eastern Bering Sea	Historic whaling, ship collisions (slight chance in Unimak Pass), fisheries mortality (one entanglement observed in western Bering), potential for oil and gas development	High	Rugh and Goddard 1998, Clapham et al. 1999, Perry et al. 1999, Tynan et al. 2001, Angliss and Lodge 2004, NMFS 2005

Species	Classification	Classification Sources	Classification Reliability	Area of Concern	Potential Threats	Threat Reliability	References
Blue Whale	Critically Imperiled	ESA; NatureServe; IUCN; Redbook	High	Eastern and western Bering Sea	Historic whaling, ship collisions	Medium	Braham 1991, Clapham et al. 1999, Perry et al. 1999, IUCN 2004, NMFS 2000, NatureServe 2004, Plan Team 2004
Northern Sea Otter (SW AK DPS)	Critically Imperiled	AK Species of concern; ESA; NatureServe	High	Eastern Bering Sea	Predation, pollution	Medium	Estes 1990, Garshelis et al. 1990, Green and Brueggeman 1991, Reeves et al. 1992, Estes et al. 1997, Doroff et al. 2003, Angliss and Lodge 2004, NatureServe 2004
King Eider	Imperiled	Declined (Suydam et al. 2000); AK Audubon; NatureServe	High	Eastern Bering Sea	Pollution, ingestion of lead, oil spills, predation	High (pollution)	Suydam et al. 2000, Stout et al. 2002, NatureServe 2004
Spectacled Eider	Imperiled	Declined (Stehn et al. 1993): AK Species of conern; ESA; NatureServe	High	Eastern Bering Sea	Pollution, predation, oil and gas development	High (pollution)	Grand et al. 1993, Stehn et al. 1993, FWS 1993, Henny et al. 1995, FWS 2001a, Stout et al. 2002, Birdlife International 2005, NatureServe 2004
Steller's Eider	Imperiled	Declining (Henny et al. 1995, USFWS 1997, 2001); AK Species of concern; ESA; NatureServe	High	Eastern Bering Sea	Pollution, predation, oil and gas development	High (pollution)	Henny et al. 1995, FWS 1997, FWS 2001b, Stout et al. 2002, NatureServe 2004

Species	Classification	Classification Sources	Classification Reliability	Area of Concern	Potential Threats	Threat Reliability	References
Long-tailed Duck	Imperiled	Declined (Henny et al. 1995); AK Audubon; NatureServe	High	Eastern Bering Sea	Pollution, fisheries mortality, oil spills	Low	Henny et al. 1995, Alaska Audubon 2002, NatureServe 2004
Sperm Whale	Imperiled	ESA; NatureServe; IUCN	Low	Rangewide	Historic whaling	Low	Braham 1991, Zimmerman 1991, Meyers 1993, Perry et al. 1999, Whitehead 2000, IUCN 2004, NatureServe 2004
Sei Whale*	Imperiled	ESA; NatureServe; IUCN; Redbook	Low	Rangewide	Historic whaling, uncertain recovery	Low	Clapham et al. 1999, Perry et al. 1999, IUCN 2004, NatureServe 2004
Steller's Sea Lion	Imperiled	ESA; NatureServe; IUCN	High	Eastern Bering Sea	Reduced prey, predation, fisheries mortality	High	Reeves et al. 1992, Merrick et al. 1997, Hill and DeMaster 1999, Rosen and Trites 2000, Loughlin 2002, Barron et al. 2003, NRC 2000, Angliss and Lodge 2004, IUCN 2004, Plan Team 2004, Savinetsky et al. 2004, NatureServe 2004
Ringed Seal	Imperiled	Sea-ice dependent (Reeves et al. 1992, Angliss and Lodge 2004, ACIA 2004)	High	Eastern and western Bering Sea	Global warming/ice loss	Medium	Reeves et al. 1992, Simkins et al. 2003, ACIA 2004, Angliss and Lodge 2004, NatureServe 2004

Species	Classification	Classification Sources	Classification Reliability	Area of Concern	Potential Threats	Threat Reliability	References
Pacific Walrus	Imperiled	Sea-ice dependent (Reeves et al. 1992, Angliss and Lodge 2004, ACIA 2004)	High	Eastern and western Bering Sea	Global warming/ice loss	Medium	Reeves et al. 1992, Fay et al. 1997, Simkins et al. 2003, Angliss and Lodge 2004, NatureServe 2004
Polar Bear	Imperiled	NatureServe; IUCN; Prestrud and Sterling 1994; Redbook	High	Eastern and western Bering Sea	Global warming/ice loss	High	Prestrud and Stirling 1994, Brunstromm and Halldin 2000, ACIA 2004, Angliss and Lodge 2004, NatureServe 2004
Red-legged Kittiwake	Vulnerable	AK Audubon; NatureServe; IUCN; Redbook	High	Eastern Bering Sea	Food limitation	Medium	Springer et al. 1986, Climo 1993, Dragoo and Sundseth 1993, Hatch et al. 1993, Hunt et al. 1996b, Byrd et al. 1997, Alaska Audubon 2002, Dragoo et al. 2004, NatureServe 2004, Birdlife International 2005, Thomson 2005
Pribilof Rock Sandpiper	Vulnerable	AK Audubon; NatureServe	Low	Eastern Bering Sea	Oil spills	Low	Alaska Audubon 2002, Winker et al. 2002, Natureserve 2004
Kuril Rock Sandpiper	Vulnerable	Redbook	Low	Western Bering Sea	Lack of information	Low	Flint et al. 1989, Russian Federation Redbook

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Wandering Tattler	Vulnerable	AK Audubon	Low	Eastern Bering Sea	Lack of information	Low	Alaska Audubon 2002, NatureServe 2004, Birdlife International 2005
Whiskered Auklet	Vulnerable	AK Audubon; NatureServe	High	Eastern Bering Sea	Introduced species, oil spills	High (intro-duced species)	Gould et al. 1982, Bailey and Kaiser 1993, Springer et al. 1993, Natureserve 2004, Birdlife International 2005
Steller's Sea Eagle	Vulnerable	IUCN; Redbook	Medium	Western Bering Sea	Pollution, habitat destruction, overfishing	Low	FADR 2002, Collar et al. 2001, IUCN 2004, Birdlife International 2005, Russian Federation Redbook
White-tailed Eagle	Vulnerable	NatureServe; Redbook	Low	Western Bering Sea	Pollution, habitat destruction	Low	Flint et al. 1989, Natureserve 2004, Birdlife International 2005
Black Oyster-catcherr	Vulnerable	AK Audubon; National Audubon; NatureServe	Low	Eastern Bering Sea	Lack of Information	Low	Alaska Audubon 2002, National Audubon 2002, NatureServe 2004, Birdlife International 2005

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Red-throated Loon	Vulnerable	Declining (Groves et al. 1996); AK Audubon; NatureServe	High	Eastern Bering Sea	Habitat destruction, pollution, fisheries mortality	Low	Peterson et al. 1991, Groves et al. 1996, Birdlife International 2005, NatureServe 2004
Yellow-billed Loon	Vulnerable	National Audubon; NatureServe; Redbook	Low	Eastern and Western Bering Sea	Oil and gas development	Low	National Audubon 2002, NatureServe 2004, Birdlife International 2005
Bar-tailed Godwit	Vulnerable	National Audubon; NatureServe; U.S. Shoreird Conservation Plan: Species of High Concern	Medium	Eastern and potentially western Bering Sea	Hunting during migration in Asia, intrinsic vulnerability related to small population size.	Medium (Intrinsic vulnerability)	National Audubon 2002, NatureServe 2004, Birdlife International 2005
Emperor Goose	Vulnerable	AK and National Audubon; NatureServe; IUCN	High	Eastern and Western Bering Sea	Oil pollution, global warming, hunting	Medium	NAS 1996, Alaska Audubon 2002, National Audubon 2002, Natureserve 2004, Birdlife International 2005
Harlequin Duck	Vulnerable	Declined (Harlequin Duck Working Group. 1993); NatureServe	Medium	Eastern Bering Sea	Oil spills, habitat destruction (outside Bering Sea)	Low	NatureServe 2004, Birdlife International 2005

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Aleutian Canada Goose	Vulnerable	AK Audubon; AK Species of concern; NatureServe; Redbook	High	Eastern Bering Sea	Habitat destruction, disease, introduced species.	High (Introduced species)	Mowbray et al. 2002, Springer and Lowe 1998
Long-billed Murrelet	Vulnerable	IUCN; Redbook	Medium	Western Bering Sea	Habitat destruction, pollution	Medium	Childress and Rothe 1990, Byrd et al. 1994, FWS 2001, IUCN 2004, Natureserve 2004, Birdlife International 2005
Marbled Murrelet	Vulnerable	Potentially declin-ing (Mendenhall 1992, Springer et al. 1982, Mendenhall 1992, Piatt and Naslund 1995, Birdlife International 2005), AK Audubon, NatureServe, Birdlife Internation	High	Eastern Bering Sea	Lack of information, logging from southeast Alaska south.	Low	Mendenhall 1992, Ewins et al. 1993, Piatt and Ford 1993, Springer et al. 1993, Pitocchelli et al. 1995, Nelson 1997, Piatt 1998, Natureserve 2004, IUCN 2004, Birdlife International 2005
Dovekie	Vulnerable	Small Disjunct Population; NatureServe	High	Eastern Bering Sea	Lack of information	Low	Gould et al. 1982, Natureserve 2004, Wiese and Robertson 2004, Birdlife International 2005

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Peale's Peregrine Falcon	Vulnerable	AK Audubon, NatureServe; Redbook	Low	Eastern and western Bering Sea	Organochlorine pollutants	Low	White et al. 1990, Estes et al. 1997, Millsap et al. 1998, Alaska Audubon 2002, Natureserve 2004
Common Eider	Vulnerable	Declined (Suydam et al. 2000); AK Audubon; NatureServe	High	Eastern Bering Sea	Reduced prey, ingestion of lead	High (pollution)	Robertson and Gilchrist 1998, Suydam et al. 2000, Petersen and Flint 2002, Stout et al. 2002, NatureServe 2004, Birdlife International 2005
Black Scoter	Vulnerable	AK Audubon; NatureServe	Medium	Eastern Bering Sea	Pollution, hunting	High (pollution)	Gould et al. 1982, Henny et al. 1995, Alaska Audubon 2002, Natureserve 2004, Birdlife International 2005
White-winged Scoter	Vulnerable	Declines recorded in Alaska (Henny et al. 1995); NatureServe	Medium	Eastern Bering Sea	Habitat degradation, pollution	High (pollution)	Gould et al. 1982, Henny et al. 1995, Krements et al. 1997
Surf Scoter	Vulnerable	Declines recorded in Alaska (Hodge et al. in press, in Henny et al. 1995); NatureServe	Medium	Eastern Bering Sea	Habitat degradation, pollution	High (pollution)	Henny et al. 1995, Natureserve 2004, Birdlife International 2005

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Red-faced Cormorant	Vulnerable	AK Audubon; National Audubon; NatureServe	Low	Eastern Bering Sea	Lack of information	Low	Siegel-Causey and Litvinenko 1993, Natureserve 2004, Birdlife International 2005
Pacific Golden Plover	Vulnerable	AK Audubon	Low	Eastern Bering Sea	Lack of information	Low	Alaska Audubon 2002, Natureserve 2004, Birdlife International 2005
Bufflehead	Vulnerable	Documented declines of 42% in Alaska (Henny et al. 1995); NatureServe	Low	Eastern Bering Sea	Unknown	Low	Henny et al. 1995, Natureserve 2004, Birdlife International 2005
Common Goldeneye	Vulnerable	Declined (Henny et al. 1995); NatureServe	Low	Eastern Bering Sea	Unknown	Low	Henny et al. 1995, Rose 1996, Natureserve 2004, Birdlife International 2005
Humpback Whale	Vulnerable	Alaska Endangered; ESA; NatureServe; IUCN; Redbook	Medium	Eastern and western Bering Sea	Historic Whaling, fisheries mortality, ship collisions, Noise	Medium	Meyers 1993, Braham 1991, Clapham et al. 1999, Gerber and DeMaster 1999, Perry et al. 1999, NMFS 2000, IUCN 2004, NatureServe 2004, Plan Team 2004

Species	Classification	Classification Sources	Classification Reliability	Area of Concern	Potential Threats	Threat Reliability	References
Bowhead Whale	Vulnerable	Alaska; NatureServe; ESA; MMPA	High	Eastern and western Bering Sea	Historic whaling, global warming,, ship collisions	Medium	Braham 1991, Meyers 1993, Clapham et al. 1999, Zimmerman 1991; NMFS 2000, Boyce 2002; Angliss and Lodge 2004; IUCN 2004, NatureServe 2004
Fin Whale	Vulnerable	ESA, NatureServe, IUCN; Redbook	Medium	Eastern and western Bering Sea	Historic whaling	Medium	Braham 1991, Zimmerman 1991, Meyers 1993, Perry et al. 1999, Clapham et al. 1999, Gregr and Trites 2001, Angliss and Lodge 2004, IUCN 2004, Plan Team 2004, NatureServe 2004, Tynan 2004
Minke Whale	Vulnerable	IUCN	Low	Eastern and western Bering Sea	Slight fisheries mortality	Low	Frost and Burns 1982, Wada and Numachi 1991, Zimmerman 1991, Meyers 1993, Angliss and Lodge 2004, IUCN 2004, Plan Team 2004, Natureserve 2004
Harbor Porpoise	Vulnerable	NatureServe; IUCN; Redbook	Low	Eastern and western Bering Sea	Fisheries mortality	Low	Angliss and Lodge 2004, IUCN 2004, Natureserve 2004

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Beluga Whale	Vulnerable	AK Species of concern; NatureServe; IUCN	Low	Eastern Bering Sea	Harvest	Low	Frost and Burns 1982, Angliss and Lodge 2004, IUCN 2004, NatureServe 2004
Stejneger's Beaked Whale	Vulnerable	NatureServe; Russian Federation; Redbook	Low	Eastern and western Bering Sea	Fisheries mortality	Low	Houston 1990, Zimmerman 1991, Angliss and Lodge 2004, IUCN 2004, NatureServe 2004
Ribbon Seal	Vulnerable	Sea-ice dependent (Reeves et al. 1992, Angliss and Lodge 2004, ACIA 2004)	High	Eastern and Western Bering Sea	Global warming	Medium	Reeves et al. 1992, Simkins et al. 2003; Angliss and Lodge 2004, NatureServe 2004
Bearded Seal	Vulnerable	Sea-ice dependent (Reeves et al. 1992, Angliss and Lodge 2004, ACIA 2004)	High	Eastern and Western Bering Sea	Global warming	Medium	Reeves et al. 1992, Simkins et al. 2003, Angliss and Lodge 2004, NatureServe 2004
Spotted Seal	Vulnerable	Sea-ice dependent (Reeves et al. 1992, Angliss and Lodge 2004, ACIA 2004)	High	Eastern and Western Bering Sea	Global warming	Medium	Reeves et al. 1992, Rugh and Sheldon 1997, Lowry et al. 2000, Simkins et al. 2003; Angliss and Lodge 2004, NatureServe 2004

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Northern Fur Seal	Vulnerable	Declined (Trites 1992, Livingston 1989, Hill and DeMaster 1999, Loughlin 2002, Fowler 1984); NatureServe, IUCN, MMPA	High	Eastern Bering Sea	Food limitation, fisheries mortality, predation	Medium	Fowler 1984, Livingston 1989, Reeves et al. 1992, Trites 1992, Buckland et al. 1993, Boltnev 1996, NAS 1996, Baird and Hanson 1997, Hill and DeMaster 1999, Loughlin 2002, Angliss and Lodge 2004, Plan Team 2004, IUCN 2004, Natureserve 2004
Harbor Seal	Vulnerable	Declined (Pitcher 1990, Hill and DeMaster 1999, Loughlin 2002); AK Species of concern, NatureServe	High	Eastern Bering Sea	Food limitation, fisheries mortality, predation	Medium	Pitcher 1990, Reeves et al. 1992, Loughlin 2002, Angliss and Lodge 2004, NatureServe 2004, Plan Team 2004
Shortspine Thornyhead	Vulnerable	IUCN	Low	Eastern and western Bering Sea	Potential overfishing in western Bering Sea.	Medium	Tokranov and Novikov 1997, Stepian et al. 2000, IUCN 2004, Reuter and Spencer 2004
Broadfin Thornyhead	Vulnerable	Declined (Natsume et al. 2001)	High	Eastern and western Bering Sea	Potential overfishing in western Bering Sea	Medium	Stepian et al. 2000, IUCN 2004, Reuter and Spencer 2004

Species	Classification	Classification Sources	Classification Reliability	Area of Concern	Potential Threats	Threat Reliability	References
Sablefish	Vulnerable	Decline (Bakkala et al. 1990, Sigler et al. 2005)	High	Eastern Bering Sea	Recent declines in response to fishing and variable recruitment	High	Allen and Smith 1988, Bakkala et al. 1990, Hanselman et al. 2005, Sigler et al. 2005
Rougheye Rockfish	Vulnerable	Decline (Spencer and Reuter 2004)	High	Eastern Bering Sea	Fisheries mortality	Low	Krieger and Ito 1998, Spencer and Reuter 2004
Shortraker Rockfish	Vulnerable	Decline (Spencer and Reuter 2004)	High	Eastern Bering Sea	Fisheries mortality	Low	Krieger and Ito 1998, Spencer and Reuter 2004
Basking Shark	Vulnerable	AFS; IUCN	Low	Rangewide	Overfishing	Low	Musick et al. 2000, IUCN 2004
Big Skate	Vulnerable	AFS; IUCN	Low	Rangewide	Fisheries mortality	Low	Musick et al. 2000, IUCN 2004
Greenland Turbot	Vulnerable	Declined (Swartzman et al. 1992, Bakkala et al. 1990, Lowe 1994, Ianelli et al. 2004)	High	Eastern Bering Sea	Climate change, target of commercial fishery	Low	Bakkala et al. 1990, Swartzman et al. 1992, Lowe 1994, Ianelli et al. 2004
Softskin slickhead	Vulnerable	Rare (Balanov and Il'inskii 1992)	Low	Western Bering Sea	Lack of information	Low	Balanov and Il'inskii 1992
Blue lantern-fish	Vulnerable	Rare (Balanov and Il'inskii 1992)	Low	Western Bering Sea	Lack of information	Low	Balanov and Il'inskii 1992

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Bigmouth manefish	Vulnerable	Rare (Balanov and Il'inskii 1992)	Low	Western Bering Sea	Lack of information	Low	Balanov and Il'inskii 1992
Red King Crab	Vulnerable	Declined (Otto 1986, Stevens et al. 1994, Plan Team 2004)	High	Eastern Bering Sea	Overharvest	High	Otto 1986, Stevens et al. 1994, Zheng and Kruse 2002, Plan Team 2004
Blue King Crab	Vulnerable	Declined (Otto 1996, Plan Team 2004)	Medium	Eastern Bering Sea	Overharvest	Medium	Otto 1986, Stevens et al. 1994, Pereladov and Miljutin 2002, Plan Team 2004
Hair Crab	Vulnerable	Declined (Stevens et al. 1994, NAS 1996, Stevens et al. 2002, Overland et al. 2005	High	Eastern Bering Sea	Overharvest	Low	Stevens et al. 1994, Overland et al. 2005
Snow Crab	Vulnerable	Declined (NAS 1996, Stevens et al 1994, Plan Team 2004)	High	Eastern Bering Sea	Overharvest	High	Stevens et al. 1994, NAS 1996, Merkouris et al. 1997, Selin 1998, Rosenkranz 2002, Plan Team 2004
Pink Shrimp	Vulnerable	Declined (Dungan et al. 1988; NAS 1996)	High	Eastern Bering Sea	Overharvest	Medium	Dungan et al. 1988, NAS 1996

*Uncommon in the Bering Sea

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A Russian translation of this report is available.

Back cover photo: Polar Bear
Photo, this page: Male and female Spectacled Eiders in flight
Both photos courtesy of USFWS

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