Marine Mammals of the Alaska Region

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Unit 21

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Photo above:
Humpback whale, Chatham Strait, Alaska.

INTRODUCTION

The Alaska Region has 42 stocks of 25 species of marine mammals. The U.S. Fish and Wildlife Service manages three of these species (sea otter, polar bear, and walrus), while the National Marine Fisheries Service (NMFS) manages the remaining cetacean and pinniped stocks. Fourteen of the 42 stocks in Alaska have been classified as strategic stocks, as defined by criteria provided in the 1994 Amendments to the Marine Mammal Protection Act (MMPA). These include northern fur seal, Cook Inlet beluga, and AT1 Transient killer whale (listed as depleted under the MMPA); sperm whale, western North Pacific and central North Pacific humpback whales, fin whale, North Pacific right whale, and bowhead whale (all listed as endangered under the Endangered Species Act [ESA] of 1973); Bering Sea, Gulf of Alaska, and Southeast Alaska harbor porpoise (abundance estimates are old and there is a lack of information about fisheries mortality); and western U.S. (listed as endangered under the ESA) and eastern U.S. stocks of Steller sea lion (listed as threatened under the ESA). In the Alaska Region, six stocks are believed to be increasing, two are stable or slightly increasing, three are stable, six are decreasing, and the abundance trends for the remaining 25 stocks are unknown.

Twenty-three stocks of marine mammals are subject to subsistence harvest in Alaska. While most marine mammal stocks are assessed under the authority of Section 117 of the MMPA, NMFS has determined that management of stocks subject to subsistence harvests without significant commercial takes should be developed through the co-management process described in Section 119 of

Table 21-1
Status of marine mammal stocks in the Alaska Region.

Species/stock	Minimum population estimate (N_{min})[1]	Potential biological removal level (PBR)[2]	Annual fisheries-caused mortality[3]	Annual subsistence mortality[4]	Total annual human-caused mortality[5]	Strategic status[6]	MMPA/ ESA status[7]	Trend[8]
Seals and sea lions								
Bearded seal (Alaska)	Unknown	Unknown	0.68	6,788	6,788.68	No		U
Harbor seal								
Bering Sea[9]	20,109	603	1.3	174.3	176.2	No		D
Gulf of Alaska[9]	44,453	1,334	24	795	820	No		D
Southeast Alaska[9]	108,670	3,260	0	1,092	1,094	No		U
Northern fur seal (eastern Pacific)	709,881	15,262	0.78	702	704	Yes	D	D
Ribbon seal (Alaska)	Unknown	Unknown	0.8	193	193.8	No		U
Ringed seal (Alaska)	Unknown	Unknown	0.71	9,567	9,567.71	No		U
Spotted seal (Alaska)	Unknown	Unknown	0.88	5,265	5,265.88	No		U
Steller sea lion								
Eastern U.S.	44,584	2,006	1.4	9	15.8	Yes	T	I
Western U.S.	38,988	234	24.6	198	223.6	Yes	E	S
Whales and porpoises								
Baird's beaked whale (Alaska)	Unknown	Unknown	0	0	0	No		U
Beluga whale								
Beaufort Sea	32,453	324	0	152	152	No		U
Bristol Bay	1,619	32	0	19	19	No		S/I
Cook Inlet[10]	264	Undet.	0	1	1	Yes	D	D
Eastern Bering Sea	14,898	298	0	209	209	No		U
Eastern Chukchi Sea	3,710	74	0	65	65	No		S
Bowhead whale (western Arctic)	9,472	95	0.2	46	46.2	Yes	E	I
Cuvier's beaked whale (Alaska)	Unknown	Unknown	0	0	0	No		U
Dall's porpoise (Alaska)[10]	Unknown	Undet.	29.9	0	29.9	No		U
Fin whale (northeast Pacific)	5,700	11.4	0	0	0	Yes	E	I
Gray whale (E. North Pacific)	17,752	417	6.7	122	130	No		I
Harbor porpoise								
Bering Sea	54,492	545	0.35	0	0.35	Yes		U
Gulf of Alaska	34,740	347	68	0	70	Yes		U
Southeast Alaska[11]	13,713	137	0	0	0	Yes		U
Humpback whale								
Central North Pacific	3,698	12.9	3.2	0	5	Yes	E	I
Western North Pacific	367	1.3	0.2	0	0.2	Yes	E	U
Killer whale								
E. North Pacific Northern resident	1,123	11.2	1.5	0	1.5	No		U
E. North Pacific transient	216	2.16	0	0	0	No		I
Gulf, Aleutian, Bering Sea transient	314	3.1	0.4	0	0.4	No		U
AT1 transient	7	0	0	0	0	Yes	D	D
West Coast transient	314	3.1	0	0	0	No		U
Minke whale (Alaska)	Unknown	Unknown	0.32	0	0.32	No		U
North Pacific right whale (E. North Pacific)	Unknown	Unknown	0	0	0	Yes	E	U

the MMPA. The process includes a sound research and management program to identify and address uncertainties concerning the stocks. At this time, the management of most of the stocks that are subject to subsistence harvest is being accomplished under co-management agreements.

Table 21-1 presents a summary of the status of stocks for the marine mammals in the Alaska region. Important population parameters for the stocks and their status under protected species laws are included. These include stock identification, minimum population estimates (N_{min}), potential biological removal levels (PBR), current human-related mortality (divided into fisheries-related, subsistence, and other removals), population status, and current population trend. A narrative for selected stocks follows.

Table 21-1
Continued from previous page.

Species/stock	Minimum population estimate (N_{min})[1]	Potential biological removal level (PBR)[2]	Annual fisheries-caused mortality[3]	Annual subsistence mortality[4]	Total annual human-caused mortality[5]	Strategic status[6]	MMPA/ ESA status[7]	Trend[8]
Pacific white-sided dolphin (N. Pacific)[10]	Unknown	Undet.	0	0	0	No		U
Sperm whale (North Pacific)	Unknown	Unknown	0.5	0	0.5	Yes	E	U
Stejneger's beaked whale (Alaska)	Unknown	Unknown	0	0	0	No		U
Other marine mammals[12]								
Polar bear								
Alaska: Chukchi & Bering Seas	Unknown	Unknown	0	44.8	44.8	No		U
Alaska: Southern Beaufort Sea[13]	1,973	88	0	32.2	54.8	No		S
Sea otter[9]								
South Central Alaska	13,955	1,396	0	297	297	No		S/I
Southeast Alaska	9,266	927	0	301	301	No		U
Southwest Alaska	33,203	830	0.2	97	99.4	No		D
Walrus (Alaska)	Unknown	Unknown	1.2	5,789	5,794	No		U

[1]A conservative estimate of abundance used to estimate PBR; provides reasonable assurance that the stock size is equal to or greater than the estimate.

[2]The maximum number of animals, not including natural mortalities, that may be removed from a stock while allowing that stock to reach or stay at its optimum sustainable population level (50–100% of its carrying capacity); calculated as the product of N_{min}, one-half of R_{max} (the maximum productivity rate), and F_r (the recovery factor).

[3]An estimate of the total number of annual mortalities and serious injuries (likely to result in death) caused by commercial fisheries.

[4]An estimate of the total number of annual mortalities and serious injuries (likely to result in death) caused by subsistence hunting.

[5]An estimate of the total number of annual mortalities and serious injuries (likely to result in death) caused by humans; includes other removals, such as ship strikes, strandings, orphaned animals collected for public display, mortalities associated with research activities, take by foreign countries, and mortalities associated with activities authorized through incidental take regulations.

[6]As defined in the Marine Mammal Protection Act (MMPA) Amendments of 1994, any marine mammal stock 1) for which the level of direct human-caused mortality exceeds the PBR level; 2) which is declining and likely to be listed as threatened under the Endangered Species Act (ESA); or 3) which is listed as threatened or endangered under the ESA or as depleted under the MMPA.

[7]As defined in the MMPA, any species that is listed as threatened (T) or endangered (E) under the ESA is also considered to be a depleted (D) stock.

[8]Trends: I=increasing; S/I=stable/increasing; S=stable; D=decreasing; U=unknown.

[9]Recent changes in the abundance estimates do not indicate a major population increase. Instead, these increases are due to new analytical methods that take environmental covariates into account and thus provide an improved estimate of harbor seal abundance.

[10]Undetermined PBR indicates data are available to calculate a PBR level, but a determination has been made that calculating a PBR level using those data is inappropriate.

[11]No or minimal take reported by fisheries observers; however, observer coverage was minimal or nonexistent.

[12]These species are under the jurisdiction of the U.S. Fish and Wildlife Service, and are not included in the stock status tables of the National Overview.

[13]The PBR level for the Southern Beaufort Sea stock of polar bears assumes a bias of 2 males for every 1 female in the harvest; no more than 30 females may be harvested annually.

STELLER SEA LION: EASTERN AND WESTERN U.S. STOCKS

Stock Definition and Geographic Range

Steller sea lions occur along the North Pacific rim from northern Japan to California, with historic centers of abundance and distribution in the Gulf of Alaska and Aleutian Islands. The current center of abundance has shifted eastward


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Steller sea lion rookery at Seal Rock in Prince William Sound, Alaska.

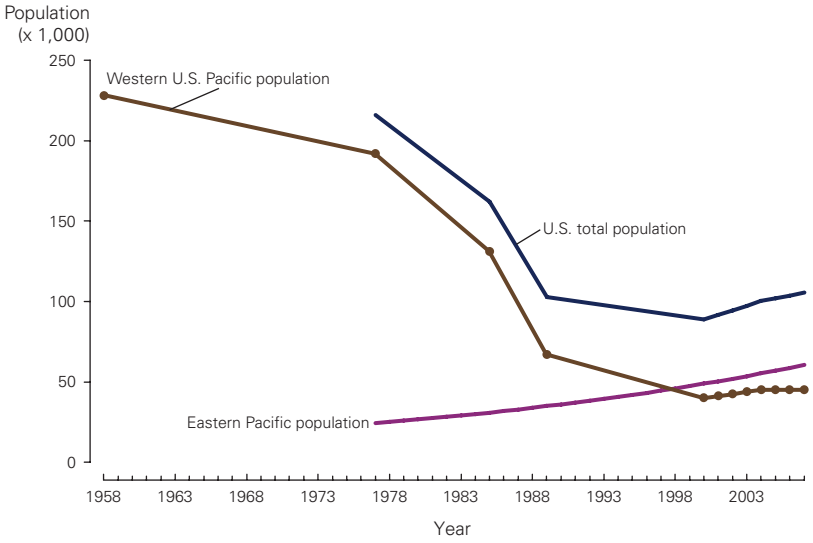

Figure 21-1

Estimated population size of Steller sea lions (adults, juveniles, and pups) of the two stocks off the United States and Canada, 1958–2007. Numbers from 1977–2007 for the Eastern U.S. stock represent a 3.1% annual growth, based on an average count of 52,000 from the 2002 survey (midpoint of 46,000–58,000; Pitcher et al., 2007). Points from 1958–1989 for the Western U.S. stock represent individual surveys. Numbers from 2000–04 show 2.9% annual growth, with numbers stable at 45,000 between 2004–07 (Fritz and Stinchcomb, 2005; NMFS, 2008).

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Steller sea lions hauled out to rest, sleep, and socialize on Shakun Rock, Alaska.

to Southeast Alaska and British Columbia because of proportional declines in the western portion of the range. The species is not known to migrate, but individuals disperse widely outside of the breeding season (late May–early July), potentially intermixing with animals from other areas. Two separate stocks of Steller sea lions are recognized within U.S. waters: an eastern U.S. stock, which includes animals east of Cape Suckling, Alaska (144°W), and in Canada; and a western U.S. stock, which includes animals from Cape Suckling westward.

Population Size and Current Trends

Western U.S. stock: The western U.S. stock is distributed across the western Gulf of Alaska, the Aleutian Islands, and the U.S. portion of the Bering Sea. The most recent population estimate for this stock is 38,988 Steller sea lions, based on aerial surveys of non-pups in 2004 and aerial and ground surveys of pups in 2004 and 2005. This estimate has not been corrected for animals not seen during the surveys (i.e. in the water or out of the survey area), so it should be considered a minimum population size. The first reported trend counts of Steller sea lions in Alaska during 1956–60 indicated that there were at least 140,000 sea lions in the Gulf of Alaska and Aleutian Islands. Subsequent surveys indicated a major population decrease, first detected in the eastern Aleutian Islands in the mid 1970's, spreading eastward to the Kodiak Island area during the late 1970's and early 1980's, and then westward to the central and western Aleutian Islands during the early and mid 1980's. The greatest declines since the 1970's occurred in the eastern Aleutian Islands and western Gulf of Alaska, but declines also occurred in the central Gulf of Alaska and central Aleutian Islands. More recently, counts of Steller sea lions at trend sites for the western U.S. Pacific stock showed a 3.1% average annual decline from 1991 to 2004. During 2000–04, counts increased 5.5%, the first region-wide increase for the western stock since standardized surveys began in the 1970's. Surveys conducted in 2006 and 2007 did not encompass the entire western U.S. stock; as a result, abundance trends for the western U.S. stock as a whole through 2007 are not available. However, available data for sub-areas indicate that the western U.S. stock remained largely unchanged between 2004 and 2007 throughout much of its range in Alaska (Cape St. Elias to Tanaga Island, 145°–178° W).

Eastern U.S. stock: The Steller sea lion eastern U.S. stock covers Southeast Alaska, British Columbia, Washington, Oregon, and California. The current minimum population estimate is 44,584 animals (uncorrected) based on aerial surveys in 2002–05. Trend counts for the eastern U.S. stock indicate a growth rate of about 3.1% since the 1970's (Figure 21-1). Counts of adult and juvenile sea lions in Oregon have shown a gradual increase from 1,486 in 1976 to 4,169 in 2002. Counts in California declined by over 50%, from 5,000–7,000 in 1927–47 to 1,500–2,000 during 1980–2004. Limited information suggests that counts in northern California appear to be stable, while in central California, a steady decline in ground counts at Año Nuevo started around 1970, resulting in an 85% reduction in the breeding population by 1987 and a 5% annual decline in pup counts since 1990. Overall, counts of non-pups in California and Oregon have been relatively stable since the 1980's. In Southeast Alaska, counts of non-pups at trend sites increased by 56% between 1979 and 2002. During 1979–2005, counts of pups on the three largest rookeries in Southeast Alaska increased by 148%. In British Columbia, counts of non-pups increased at a rate of 3.2% annually during 1971–2002.

Stock Status

The PBR has been estimated at 234 animals for the western U.S. stock of Steller sea lions and 2,006 for the eastern U.S. stock. The estimated annual level of total human-caused mortality and serious injury was 223.6 animals for the western U.S. stock and 15.8 animals for the eastern U.S. stock. Although the annual human-caused mortality and serious injury does not exceed the PBR level, both stocks of Steller sea lions are classified as strategic stocks under the MMPA because the western U.S. stock is listed as endangered and the eastern U.S. stock is listed as threatened under the ESA.

Issues

The unprecedented decline in the western U.S. stock of Steller sea lion caused a change in the ESA listing status of the stock from threatened to endangered in 1997. The population decline documented in 1990, when it was first listed as threatened, continued until at least 2000. Increasing annual counts of Steller sea lions at census sites since 2000 suggest a change in trend over portions of the range, but data are insufficient to confirm that the decline has stopped. Many theories, including overfishing of sea lion prey species, environmental change, disease, and increased killer whale predation have been suggested as possible causes, but it is not clear what factor or factors are the most important causes of the decline. However, predation by killer whales, environmental variability, and competition for fish, perhaps with commercial fisheries, have been identified as potentially high threats to recovery.

Management actions implemented by NMFS since 1990 to reduce interactions between humans and Steller sea lions include setting no-entry buffer zones around rookeries, a prohibition on groundfish trawling within 10–20 nautical miles of certain rookeries, and the spatial and temporal allocation of Gulf of Alaska walleye pollock catch. More recent modifications began in 1999 and continued into 2002, including reductions in fishery removals of Atka mackerel in areas designated as Steller sea lion critical habitat; further temporal and spatial dispersion of the pollock, cod, and mackerel fisheries; and expansion of the number and extent of protective zones around sea lion rookeries and haul-outs.

Figure 21-2
Distribution of eastern North Pacific right whales during the 1800's (yellow area) and sightings of right whales reported between 1979 and 2005 (red stars), as determined by whaling catch and sighting records. The blue box shows the location of focused right whale surveys in 1997–2000, 2002, and 2004.

Area-specific management measures including restrictions and closures designed to reduce direct and indirect interactions between Steller sea lions and the groundfish fisheries were developed by a committee formed from the fishing industry, the Alaska community, environmental groups, and NMFS. A revised Recovery Plan for both stocks of Steller sea lion was released in March 2008 (NMFS, 2008).

EASTERN NORTH PACIFIC RIGHT WHALE

Stock Definition and Geographic Range

In April 2008, North Pacific right whales were listed as endangered under the Endangered Species Act as a separate species from North Atlantic right whales. Two stocks are found in the North Pacific: one in the Sea of Okhotsk and the other in the eastern North Pacific (Brownell et al., 2001). Migratory patterns of the North Pacific stocks are unknown, although researchers believe that the whales spend summers on high-latitude feeding grounds and migrate to more temperate waters during the winter (Clapham et al., 2004). Calving areas for these stocks are unknown. Recent sightings of eastern North Pacific right whales (Figure 21-2) have been reported as far south as Baja California, Mexico, as

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Right whale sighted in the Bering Sea, Alaska, in September 2004.

far west as Hawaii in the central North Pacific, and as far north as the sub-Arctic waters of the Bering Sea in the summer (Brownell et al., 2001). Aerial and vessel surveys for right whales have occurred in a portion of Bristol Bay in the eastern Bering Sea where whales have been observed each summer since 1996 (Figure 21-2; LeDuc et al., 2001; Wade et al., 2006; National Marine Fisheries Service, unpublished data[1]). Right whale calls obtained from yearlong deployments of autonomous recorders confirmed their presence in this region from late May to early November (Munger et al., 2003).

Commercial whaling records indicate that right whales historically ranged across the entire North Pacific north of 35°N and occasionally as far south as 20°N (Brownell et al., 2001). In the eastern North Pacific, commercial whalers focused on concentrations of animals found in the Gulf of Alaska, eastern Aleutian Islands, and Bering Sea (Shelden et al., 2005), though whales were observed and killed as far south as the Hawaiian Islands (Figure 21-2). Right whales are large, slow-swimming, and float when killed, making them an easy and profitable species for whalers. By the time the modern whale fishery (with harpoon cannons and steam-powered catcher boats) began in the late 1800's, right whales were rarely encountered in the North Pacific.

[1]National Marine Fisheries Service, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Population Size and Current Trend

The pre-exploitation size of this stock exceeded 11,000 animals and was perhaps twice that number (Scarff, 2001). Estimates of current abundance range from 100 to 500 for the entire North Pacific; however, no quantitative data exist to confirm these estimates (Brownell et al., 2001). The few sightings reported in the eastern North Pacific since the late 1960's were primarily sightings of single whales or small groups of 4–6 animals (Brownell et al., 2001). At this time, it is not possible to produce a reliable estimate of minimum abundance or population trend for this stock. The portion of the eastern North Pacific stock found during summer in the Bering Sea has been studied since 1997 and as of 2004, a total of 23 individuals have been identified from genotyping of biopsy samples (16 males and 7 females; Wade et al., 2006). This includes two male calves accompanied by females that shared at least one allele for each microsatellite marker, as well as sharing a mitochondrial haplotype (Wade et al., 2006). In 2004, the number of females detected in this region rose from one whale biopsied in 2002 to seven, including the female from 2002 (Wade et al., 2006). There is some suggestion of site fidelity among right whales found in the Bering Sea. Of the whales observed between 1997 and 2004, at least five were photographed and five were biopsied over multiple years. This mark-recapture success rate is consistent with a very small population size (Brownell et al., 2001). Dedicated ship-based surveys conducted in the Bering Sea in August 2007 using line-transect methods and passive acoustic monitoring failed to find a single right whale. Additional and considerably expanded effort (shipboard, aerial, acoustic, and oceanographic) is planned for July and August 2008.

Stock Status

The North Pacific right whale is listed as endangered under the ESA, and is therefore designated as depleted under the MMPA, and the eastern North Pacific stock is classified as an MMPA strategic stock. The abundance of this stock is considered to represent only a small fraction of its pre-commercial whaling abundance (i.e. the stock is well below its Optimum Sustainable Population [OSP] size), but

reliable estimates of minimum population size and PBR are not available. Between 1835 and 1909, an estimated 15,374 right whales were taken from the North Pacific by American-registered whaling vessels, with most of those animals taken prior to 1875. Total whaling mortality may have been in the range of 26,500–37,000 animals when including struck-but-lost whales and non-American whalers (Scarff, 2001). In addition, 28 right whales were killed between 1911 and 1938 in waters off Alaska and British Columbia, Canada (Reeves et al., 1985). A prohibition on the catching of right whales established in 1935 provided some protection for the species until the U.S.S.R. began widespread illegal whaling in the post-war period. Soviet pelagic whalers illegally killed at least 372 right whales in Alaskan waters from 1963 to 1967, which severely depleted what remained of the slowly recovering North Pacific right whale population and may explain why little recovery has been observed to date (Brownell et al., 2001).

The current estimates of annual human-caused mortality and serious injury appear to be minimal for this stock. Although gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October 1989, no other incidental takes of right whales are known to have occurred in the North Pacific (Brownell et al., 2001). Evidence of entanglements or ship strikes (such as scarring) has not been observed in photographs taken for identification purposes (W. Perryman, personal communication[2]). Any right whale mortality incidental to the commercial fisheries would be considered significant.

Issues

Because of the critically small size of the eastern North Pacific right whale stock, determining seasonal distribution and habitat use is imperative to adequately manage this stock. Some studies on the distribution of the species have already been conducted. Short- and long-term passive acoustic monitoring have been used during dedicated surveys to locate right whales and to determine length of habitat occupation, respectively. Deployment of autonomous acoustic recorders to detect right whale calls year-round was initiated in the southeastern Bering Sea and Gulf of Alaska in 2000 (Munger et al., 2003; Mellinger et al., 2004; Moore et al., 2006). Results of these acoustic data collected from 2000 to 2006 indicate that at least a few right whales continue to occupy middle-shelf habitats in the southeastern Bering Sea from late May through November, and in one year as late as December (Munger, 2007). Acoustic recorders deployed along the Bering Sea slope in April 2004, which marked the first attempt to monitor this region for right whales over the course of a year, detected right whale calls south of the Pribilof Islands on only one day in June 2005 (Munger, 2007). Right whale calls have also been recorded in August and September from instruments deployed in the Gulf of Alaska in the vicinity of the 1998 (Waite et al., 2003), 2004 (K. Hough, personal communication[3]), and 2005 (P. Wade, personal communication[4]) sightings near Kodiak Island, as well as waters southwest of there (ca. 53°N, 157°W) in a region where right whales have not been encountered since the 19th century (Mellinger et al., 2004). Funding for deployments in 2007 was not available, but deployments in the Bering Sea are planned for 2008.

Data are also needed to provide reliable estimates of abundance, or at least to establish the minimum population size. Genetic analysis and photo-identification are techniques that have been used successfully to determine population abundance, viability, movement patterns, and survival in other cetacean populations. For example, mark-recapture analyses of photographs taken in the North Atlantic has led to a minimum population estimate of 291 right whales (Waring et al., 2002). Furthermore, genetic analysis of North Atlantic right whales suggests that inbreeding depression is slowing the recovery of this stock, compared to South Atlantic right whales which exhibit greater genetic diversity (NMFS, 2002). Further analysis of the photographs and genetic samples obtained thus far may provide preliminary estimates of abundance and viability.

[2]W. Perryman, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA 92037.

[3]K. Hough, NOAA, 1801 Fairview Avenue E, Seattle, WA 98102.

[4]P. Wade, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

HARBOR SEALS

Stock Definition and Geographic Range

Harbor seals are distributed continuously along the Alaskan coast from southernmost Southeast Alaska, throughout the Gulf of Alaska and Aleutian Islands, and as far north as Cape Newenham and the Pribilof Islands in the Bering Sea. They haul out on offshore rocks and reefs, nearshore beaches and tidal flats, and drifting ice calved from glaciers in glacial fjords. Harbor seals are generally non-migratory, with local movements associated with such factors as tides, weather, season, food availability, and reproduction (Scheffer and Slipp, 1944; Fisher, 1952; Bigg, 1969, 1981). Individual seals seem to have a very small home range, rarely moving more that 200 km from a central haul-out site (Lowry et al., 2001), though some long-distance movements of tagged animals have been recorded (Pitcher and McAllister 1981; Lowry et al., 2001; Small et al., 2001). The stock structure of Alaskan harbor seals is unclear and much research, including mitochondrial DNA studies, is underway (O'Corry-Crowe et al., 2003). Currently three stocks (or management units) are recognized by NMFS: 1) Southeast Alaska, 2) Gulf of Alaska (including the Aleutian Islands), and 3) Bering Sea.

Population Size and Current Trend

The population size of harbor seals in Alaska is estimated using aerial surveys to count seals during their annual molt (August–September), the time of year when the largest number of seals are hauled out on land and visible to observers. The state is divided into five survey regions for census purposes: 1) southern Southeast Alaska (from the Canadian border to Frederick Sound); 2) northern Southeast Alaska (Frederick Sound to Kayak Island); 3) Gulf of Alaska (from Prince William Sound to the Shumigan Islands); 4) the Aleutian Islands; and 5) the north side of the Alaska Peninsula, including Bristol Bay. One region is surveyed each year, and the entire state is surveyed on a 5-year cycle.

To derive an accurate estimate of population size from these surveys, a method was developed to address the influence of external conditions on the number of seals hauled out on shore, and counted, during the surveys. Many factors influence the propensity of seals to haul out, including tides, weather, time of day, and date in the seals' annual life history cycle. A statistical model defining the relationship between these factors and the number of seals hauled out was developed for each survey region. Based on those models, the survey counts for each year were adjusted to the number of seals that would have been ashore during a hypothetical survey conducted under ideal conditions for hauling out (Boveng et al., 2003). In a separate analysis of radio-tagged seals, a similar statistical model was used to estimate the proportion of seals that were hauled out under those ideal conditions (Simpkins et al., 2003). The results from these two analyses were combined for each region to estimate the population size of harbor seals in Alaska.

Combining the most recent population estimates for the three Alaska stocks, the total population size of harbor seals in Alaska is estimated to be 180,017 (Table 21-2), based on surveys in 1996–2000 that had incomplete coverage of terrestrial sites in Prince William Sound and of glacial sites in the Gulf of Alaska and the Southeast Alaska regions. The population estimates for the Gulf of Alaska (45,975) and Southeast Alaska stocks (112,391) include survey estimates from glacial sites where seals haul out on ice calved from glaciers. These sites are difficult to survey using standard aerial survey techniques, and photogrammetric techniques are being developed and used to provide more accurate estimates of population sizes at glacial sites. Current estimates probably

Table 21-2
Population estimates for harbor seal stocks in Alaska.

Stock	Year	Population size (N)[1]	CV (N)[2]	N_{min}[3]
Gulf of Alaska		45,975	0.04	44,453
Aleutian Is. region	1999	9,993	0.06	
All other regions	1996	35,982	0.05	
Southeast Alaska		112,391	0.04	108,670
N. SE AK region	1997	32,454	0.06	
S. SE AK region	1998	79,937	0.05	
Bering Sea	2000	21,651	0.1	20,109
Total		180,017	0.03	

[1]Population sizes are based on survey data from the years indicated (Angliss and Outlaw, 2007).

[2]Coefficient of variation for the population estimates.

[3]Conservative estimate of abundance calculated based on each population estimate and its coefficient of variation (Wade and Angliss, 1997).

underestimate the actual number of seals at these sites. The Bering Sea stock is estimated at 21,651 seals.

Minimum population estimates (N_{min}) are calculated for management purposes based on each population estimate and its coefficient of variation (CV; Wade and Angliss, 1997). N_{min} is 44,453 for the Gulf of Alaska stock; 108,670 for the Southeast Alaska stock; and 19,907 for the Bering Sea stock (Table 21-1). Because the Pribilof Islands are not included in the aerial surveys used to estimate the population size of the Bering Sea stock, the maximum count of 202 seals from the Pribilof Islands in 1995 is added to the estimate for this stock (Jemison, 1996), and N_{min} becomes 20,109 harbor seals. The N_{min} estimates for the Gulf of Alaska and Southeast Alaska stocks may be underestimates because survey counts from the glacial sites within those regions are probably underestimated.

Population trends vary within and between the three stocks. Population abundance has declined substantially in some areas of the Gulf of Alaska since the 1970's (including up to an 85% decline from 1976–1988 at Tugidak Island, near Kodiak Island, which was formerly one of the largest harbor seal haul-out sites in the world). Recent trends vary geographically within the Gulf of Alaska. Harbor seal abundance is increasing in the Kodiak Island archipelago (6.6% annually during 1993–2001; Small et al., 2003) and Tugidak Island (7% annual increase during 1992–2001; Small, 1996; Withrow et al., 2002) and decreasing in Prince William Sound (–3.3% annually during 1990–99; VerHoef and Frost, 2003). Despite some positive signs of growth in some areas, the overall Gulf of Alaska stock size likely remains small compared to its size in the 1970's and 1980's.

Population trends in Southeast Alaska also vary geographically. Harbor seal abundance near Ketchikan has increased (5.6% annually during 1994–1998; Small et al., 2003), while seal populations near Sitka showed no detectable trend during 1995–2001 (Small et al., 2003), and seal abundance in Glacier Bay National Park showed a sharp decline of 63–75% from 1992 to 2002 (Mathews and Pendleton, 2006).

Harbor seal abundance in the Bering Sea is thought to have declined substantially between the 1970's and 1990's. Counts of harbor seals along the north side of the Alaska Peninsula in 1995 were less than 42% of the 1975 census, though the 1975 counts were not adjusted for the effects of covariates (environmental conditions, time of day, survey date, etc.; Withrow and Loughlin, 1996). The Bristol Bay population has remained stable since 1990. In recent years, the Bering Sea stock size seems to have stabilized (no detectable trend during 1998–2001; Small et al., 2003).


Dave Withrow, NMML/AFSC

Mother harbor seal and pup on an ice floe calved from the LeConte Glacier near Petersburg, Alaska. Many harbor seals in Alaska have their young on ice floes calved from tidewater glaciers, which provide a relatively safe location to pup and molt.

Stock Status

Harbor seals are not listed as threatened or endangered under the ESA nor depleted under the MMPA. PBR levels were estimated for each stock based on N_{min}, maximum net productivity rate for harbor seals, and a recovery factor set at 0.5 for pinniped stocks of unknown status (Bering Sea and Gulf of Alaska) and 1.0 for stable or increasing stocks (Southeast Alaska; Wade and Angliss, 1997). A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Based on abundance and mortality data from the mid 1990's, the estimated annual level of total human-caused mortality is 820 for the Gulf of Alaska stock, 1,094 for the southeast Alaska stock, and 176.2 for the Bering Sea stock (Table 21-1). All

of these mortality levels are below estimated PBR levels for each stock, and none of the three stocks is currently defined as strategic. The status of the stocks relative to their OSP sizes is unknown.

Issues

The stock structure of harbor seals in Alaska likely will be revised in the near future. Genetics data, information about animal movements, and contrasting population trends within the current three stocks suggest that the stocks be further subdivided. Reviews of genetic and trend data are underway to determine the number of stocks, as well as the geographic boundaries between them (O'Corry-Crowe et al., 2003). As discussed above, subsistence harvest and fishery bycatch mortality levels appear to be sustainable, based on the current three stocks and data from the mid 1990's, though good fishery bycatch estimates are not available and revised stock assessments have been delayed pending new stock boundaries. If stocks are redefined, however, both harvest and bycatch numbers will need to be re-evaluated relative to the new stock boundaries.

Potential impacts of industrial activities are a concern in some regions. Exploration and development of oil reserves and the potential for oil spills during production or transport of oil are important issues, particularly in the aftermath of the Exxon Valdez oil spill in Prince William Sound, Alaska (e.g. Hoover-Miller et al., 2001). Potential impacts of the cruise ship industry on seals have recently become a concern, especially in glacial fjords that are popular tourist destinations (Jansen et al., 2003).

Captain Budd Christman, NOAA Corps

Male ribbon seal at the end of molt season on an ice floe in the Bering Sea.

ARCTIC ICE SEALS: BEARDED SEAL, RIBBON SEAL, RINGED SEAL, AND SPOTTED SEAL

Stock Definition and Geographic Range

Four species of phocid seals are commonly associated with sea ice in Alaska and are collectively known as Arctic ice seals: bearded seals, ribbon seals, ringed seals, and spotted seals. These seal species all haul out on sea ice to rest, give birth, and molt, and are therefore particularly sensitive to changes in the environment that affect the timing and extent of sea ice formation and breakup.

Bearded seals have a circumpolar distribution from approximately 45° to 85°N. In Alaska waters they are distributed over the shallow (less than 200 m) Continental Shelf of the Bering, Chukchi, and Beaufort Seas. Bearded seals generally prefer pack ice habitats with well-developed lead systems (Burns, 1981a). Some migrate through the Bering Strait from April to June and spend the summer along the ice edge in the Chukchi Sea, while others appear to remain in open water areas of the Bering and Chukchi Seas during this time.

Ribbon seals inhabit the North Pacific Ocean and southern parts of the Arctic Ocean. In Alaska waters, they range northward from Bristol Bay in the Bering Sea to the Chukchi and western Beaufort Seas. Ribbon seals are usually found in the loose ice of the ice front zone near the ice edge, and rarely along the coast or on fast ice (Burns, 1981b). From March to May they inhabit the Bering Sea ice front and are most abundant in the central and western Bering Sea. Little is known about ribbon seal distribution during the rest of the year. Some animals are thought to migrate north through the Bering Strait into the Chukchi Sea (Kelly, 1988), while others may remain in the central Bering Sea (Burns, 1981b).

Ringed seals have a circumpolar distribution from approximately 35°N to the North Pole. In Alaska waters, and depending on ice cover, they are found throughout the Beaufort, Chukchi, and Bering Seas as far south as Bristol Bay in the southern Bering Sea. Ringed seals prefer areas with high ice cover, either in fast ice along coastal areas, or in the interior ice pack, away from the ice edge (Burns et al., 1981). Because ringed seals are believed to remain associated with ice throughout the spring and summer, their seasonal distribution is constrained by the seasonal advance and retreat of sea ice in the Bering Sea.

Spotted seals are distributed along the Continental Shelf of the Beaufort, Chukchi, Bering, and Okhotsk Seas south to the northern Yellow Sea and western Sea of Japan. In Alaska waters, they are known to occur as far south as the Pribilof Islands, Bristol Bay, and the eastern Aleutian Islands. Spotted seals migrate south from the

Chukchi Sea through the Bering Strait in October and November ahead of the advancing sea ice, and overwinter in the Bering Sea in the pack ice over the Continental Shelf (Lowry et al., 1998, 2000). During spring, they are distributed mainly in the ice front (Burns et al., 1981) and move to coastal habitats after the sea ice retreats. Spotted seals are often mistaken for North Pacific harbor seals, as there is little morphological difference between the two species and their geographic ranges overlap in the southern Bering Sea. However, only the spotted seal is regularly associated with pack ice.

A lack of significant genetic, phenotypic, and population response data precludes subdividing the stocks of bearded, ribbon, ringed, and spotted seals. Therefore, in U.S. waters, only the Alaska stocks are recognized.

National Marine Mammal Laboratory

A juvenile ribbon seal with the NOAA Ship *Oscar Dyson* seen in the background. The *Dyson*, the first of four technologically advanced survey vessels being added to the NOAA fleet, was in the Bering Sea conducting research on ice seal breeding ecology as part of the National Marine Mammal Laboratory's Polar Ecosystems Program.

Population Size and Current Trend

Reliable estimates for the current minimum population size, abundance, and trend of the Alaska stocks of bearded, ribbon, ringed, and spotted seals are unavailable. However, crude estimates are available from the historical literature. Early estimates of the Bering–Chukchi Sea population of bearded seals range from 250,000 to 300,000 (Burns, 1981a). Burns (1981b) estimated the worldwide population of ribbon seals at 240,000 in the mid 1970's, with an estimate of 90,000–100,000 for the Bering Sea. A similarly rough estimate for the number of ringed seals in Alaska is 3.3–3.6 million (Frost et al., 1988), based on aerial surveys conducted in the Chukchi and Beaufort Seas during 1985–87. A more accurate estimate of the density of bearded seals in the Chukchi Sea, based on aerial surveys and haul-out behavior studies conducted in 1999 and 2000, resulted in an average density of 0.07 seals/km^2 and 0.14 seals/km^2, respectively, with consistently high densities along the coast to the south of Kivalina (Bengtson et al., 2005). The same surveys produced ringed seal abundance estimates, corrected for seals in the water, of 252,488 and 208,857 for 1999 and 2000, respectively. Similar surveys, flown in 1996–99 in the Alaska Beaufort Sea, produced observed ringed seal densities of 0.81–1.17 km^2, resulting in an estimate of 18,000 seals hauled out in the surveyed area of the Beaufort Sea. Combining this estimate with the average abundance estimate of 230,673 from the Chukchi Sea (Bengtson et al., 2005) gives a total of approximately 249,000 ringed seals. This total is a minimum population estimate, as it does not include the whole geographic range of the ringed seal stock.

The worldwide population of spotted seals was estimated to be 335,000–450,000, with an estimate for the Bering Sea of 200,000–450,000 (Burns, 1973). Aerial surveys conducted in 1992–93 produced a maximum count of 4,145 spotted seals hauled out on the ice in the Bering Sea in spring and along the western Alaska coast during summer (Rugh et al., 1995). The proportion of time that spotted seals haul out averages about 6.8% (CV = 8.85; Lowry et al., 1994); applying this correction factor to the maximum count of 4,145 results in an estimate of 59,214 seals.

Stock Status

Bearded, ribbon, ringed, and spotted seals are not listed as threatened or endangered under the ESA, nor as depleted under the MMPA. Current and reliable estimates of the minimum population size, total abundance, PBR, and human-caused injury or mortality are not available. Because current information is insufficient to evaluate whether subsistence hunting is adversely affecting these stocks, and because of minimal evidence of interactions with U.S. fisheries, the Alaska stocks

Lisa Hiruki-Raring, NMML/AFSC

Ringed seal near Kotzebue, Alaska, instrumented with a satellite-linked time–depth recorder to evaluate the amount of time that seals spend basking on the surface of the ice.

of bearded, ribbon, ringed, and spotted seals are not classified as strategic stocks.

Issues

Arctic ice seals are a critical component of the Alaska Native subsistence harvest. All four species are hunted for subsistence purposes, but bearded and ringed seals in particular are targeted, with an average of 6,788 and 9,567 taken each year, respectively (ADFG, 2000a,b). There is significant annual variation in harvest numbers; however, the effect of the subsistence hunt on ice seal populations cannot be assessed, because there are no current and reliable population dynamics and ecological data for any of the four species of Arctic ice seals. Abundance, population discreteness, annual survival, and reproductive rates (together with information on food habits, seasonal movements, distribution, and habitat requirements for breeding, foraging, and molting) are all unknown, but are essential to making sound management and conservation decisions. Current knowledge of vital rates in all four species of Arctic ice seals is insufficient to allow for the timely detection of changes in population trends. Without reliable estimates of the abundance of these species, PBR levels cannot be calculated and any impacts of human activities on the populations cannot be assessed.

Ecological data are particularly important with regard to the effect of global climate change and the resulting changes to Arctic ice habitats. A reduction or change in ice cover would directly affect the survival of all four species of ice seals, since they depend on seasonal ice for breeding and haul-out substrate. Evidence indicates that the Arctic climate is changing significantly and that one result of the change is a reduction in the extent of sea ice in at least some regions of the Arctic (ACIA, 2004; Johannessen et al., 2004). All four species of ice seals will be vulnerable to reductions in sea ice, as they are dependent on sea ice for at least part of their life history. There are insufficient data to make reliable predictions on the effects of Arctic climate change on ice seal populations.

Oil and gas exploration and development overlaps with both the summer and winter ranges of ringed seals in the Alaska Beaufort Sea. There has been concern that oil and gas exploration could result in changes in ringed seal distribution. However, aerial surveys conducted for 3 years both before and after industry activities indicate that local seal densities in the spring were not significantly different after industry activity (Moulton et al., 2002).

The effects of interactions with commercial fisheries (both direct, such as entanglement in nets, and indirect, such as competition for food resources) are not well known. However, given that there is little overlap between the distribution of commercial fisheries and the distribution of Arctic ice seals, it is possible that commercial fishery impacts may be minor.

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