PACIFIC WALRUS (*Odobenus rosmarus divergens*): Alaska Stock

NOTE – April 2009: Analysis of data resulting from the 2006 walrus survey is ongoing. The estimate of Pacific walrus population size presented in this Stock Assessment Report has not been corrected for the number of walruses in the water or for areas not surveyed. USFWS therefore considers the estimates of Pacific walrus population size, N_{MIN}, and PBR presented in this Stock Assessment Report provisional and subject to change. Revision of this Stock Assessment Report will be undertaken when findings of the 2006 walrus survey are completed.

STOCK DEFINITION AND GEOGRAPHIC RANGE

The family Odobenidae is represented by a single modern species Odobenus rosmarus of which two subspecies are generally recognized: the Atlantic walrus (*O. r. rosmarus*) and the Pacific walrus (*O. r. divergens*). The two subspecies occur in geographically isolated populations. The Pacific walrus is the only stock occurring in U.S. waters and considered in this account.

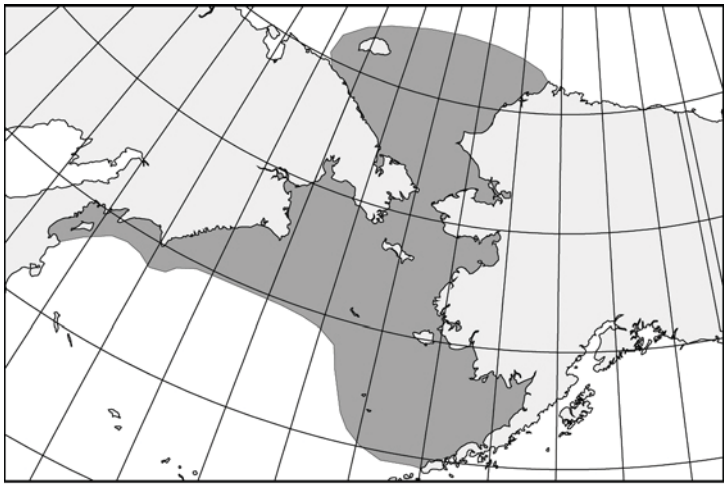

Figure 1. Approximate distribution of Pacific walrus in U.S. and Russian territorial waters (shaded area). The combined summer and winter distributions are depicted.

Pacific walrus range throughout the continental shelf waters of the Bering and Chukchi seas, occasionally moving into the East Siberian Sea and the Beaufort Sea (Figure 1). During the summer months most of the population migrates into the Chukchi Sea; however, several thousand animals, primarily adult males, congregate near coastal haulouts in the Gulf of Anadyr, Bering Strait region, and in Bristol Bay. During the late winter breeding season walrus are found in two major concentration areas of the Bering Sea where open leads, polynyas, or thin ice occur (Fay et al. 1984). While the specific location of these groups varies annually and seasonally depending upon the extent of the sea ice, generally one group ranges from the Gulf of Anadyr into a region southwest of St. Lawrence Island, and a second group is found in the southeastern Bering Sea from south of Nunivak Island into northwestern Bristol Bay.

Pacific walrus are currently managed as a single panmictic population; however, stock structure has not been thoroughly investigated. Scribner et al. (1997) found no difference in mitochondrial and nuclear DNA among walrus sampled shortly after the breeding season from four areas of the Bering Sea (Gulf of Anadyr, Koryak Coast, southeast Bering Sea, and St. Lawrence Island). More recently, Jay et al. (2008) found indications of stock structure based on differences in the ratio of trace elements in the teeth of walruses sampled in January and February from two breeding areas (southeast Bering Sea and St. Lawrence Island). Further research on stock structure of Pacific walruses is needed.

POPULATION SIZE

The size of the Pacific walrus population has never been known with certainty. Based on large sustained harvests in the 18th and 19th centuries, Fay (1982) speculated that the pre-exploitation population was represented by a minimum of 200,000 animals. Since that time, population size is believed to have fluctuated markedly in response to varying levels of human exploitation (Fay et al. 1989). Large-scale commercial harvests reduced the population to an estimated 50,000-100,000 animals in the mid-1950s (Fay et al. 1997). The population is believed to have increased rapidly in size during the 1960s and 1970s in response to reductions in hunting pressure (Fay et al. 1989).

Between 1975 and 1990, visual aerial surveys were carried out by the United States and Russia at 5-year intervals, producing population estimates ranging from 201,039 to 234,020 animals (Table 1). The estimates generated from these surveys are considered minimum values that are not suitable for detecting trends in population size (Hills and Gilbert 1994, Gilbert et al. 1992). Efforts to survey the Pacific walrus population were suspended after 1990 due to

Table 1. Aerial survey estimates of Pacific walrus population, 1975-1990. Differences in survey design and methods preclude describing trends in population size.

Year	Population Estimate	References
1975	221,350	Estes and Gilbert 1978, Estes and Gol'tsev 1984
1980	246,360	Johnson *et al.* 1982, Fedoseev 1984
1985	234,020	Gilbert 1986, 1989a, 1989b; Fedoseev and Razlivalov 1986
1990	201,039	Gilbert *et al.* 1992

unresolved problems with survey methods that produced population estimates with unknown bias and unknown or large variances that severely limited their utility (Gilbert et al. 1992, Gilbert 1999).

An international workshop on walrus survey methods, hosted by the U.S. Fish and Wildlife Service (USFWS) and U.S. Geological Survey (USGS) in 2000, concluded that it would not be possible to obtain a population estimate with adequate precision for tracking trends using the existing visual methodology and any feasible amount of survey effort (Garlich-Miller and Jay 2000). Workshop participants recommended investing in research on walrus distribution and haul-out patterns, and exploring new survey tools, including remote sensing systems and development of satellite transmitters, prior to conducting another aerial survey. Remote sensing systems were viewed as having great potential to address many of the shortcomings of visual aerial surveys by sampling larger areas per unit of time (Burn et al. 2006), objectively detecting and quantifying walruses (Udevitz et al. 2001), and reducing observer error (Burn et al. 2006).

Four years of field study by the USFWS and Russian partners led to the development of a survey method that uses thermal imaging systems to reliably detect walrus groups hauled out on sea ice (Burn et al. 2006, Udevitz et al. 2008). At the same time, the USGS developed satellite transmitters that record information on haul-out status of individual walrus, which can be used to estimate the proportion of the population in the water. This allows correction of an estimate of walrus numbers on ice to account for walrus in the water that cannot be detected in thermal imagery. These technological advances led to a joint U.S.-Russia aerial survey in March and April of 2006 to estimate the size of the Pacific walrus population across its spring range (Speckman et al. 2009).

Analysis of data collected during the 2006 walrus survey is ongoing. The first step, estimating the number of walrus hauled out on sea ice within the area surveyed, has been completed. The study area was defined as potential walrus habitat, e.g., the area of Bering Sea north of the pack ice edge over waters less than 200 m deep (Fay and Burns 1988). During the course of the survey, the size of the study area ranged from about 576,000 km2 to 742,000 km2 and averaged about 660,000 km2. Logistical problems and poor weather limited the U.S. and Russian teams to survey blocks with a total combined area of 318,204 km2. The total number of Pacific walrus hauled out on sea ice within the surveyed area was estimated to be about 21,610 individuals, with a 95% confidence interval of 8,453 to 45,439 individuals and a CV of 0.44 (Speckman et al. 2009).

As this number does not account for areas that were not surveyed, some of which are known to have had walrus present, this estimate is negatively biased to an unknown degree. Analysis of haulout data collected in 2006 is also not complete. Once this dataset is fully analyzed, a correction factor for the proportion of the population in the water will be developed, leading to a final estimate of Pacific walrus population size within the surveyed area. The estimate of population size presented here is considered low by the USFWS and is subject to change when analysis of the 2006 walrus survey data has been completed.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this population is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842 * [\ln(1+[CV(N)^2]^{1/2})$. This gives an N_{MIN} for the Pacific walrus population of 15,164 walrus. This value is considered low by the USFWS and will be refined when a final population estimate resulting from the 2006 walrus survey has been completed.

Current Population Trend

The trend in size of the Pacific walrus population is not known. Precision of the on-ice estimate resulting from the 2006 walrus survey was lower than expected, and likely too low for accurate detection of trends in population size (Speckman et al. 2009). Differences in methodology, timing of the survey, and segment of the population sampled between the 2006 survey and earlier surveys will preclude direct comparison of results. Trends in abundance will be examined in more detail once all aspects of the analysis of the 2006 survey data have been completed.

MAXIMUM NET PRODUCTIVITY RATES

Estimates of net productivity rates for walrus populations have ranged from 3-13% per year with most estimates falling between 5-10% (Chapskii 1936, Mansfield 1959, Krylov 1965, 1968, Fedoseev and Gol'tsev 1969, Sease 1986, DeMaster 1984, Sease and Chapman 1988, Fay et al. 1997).

Chivers (1999) developed an individual age-based model of the Pacific walrus population using published estimates of survival and reproduction. The model yielded a maximum population growth rate (R_{MAX}) of 8%. This estimate remains theoretical because age-specific survival rates for free ranging walrus are poorly known.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) of a marine mammal stock is defined in the Marine Mammal Protection Act (MMPA) as the product of the minimum population estimate (N_{MIN}), one-half the maximum theoretical net productivity rate (R_{MAX}), and a recovery factor (F_R): PBR = N_{MIN} x 0.5 R_{MAX} x F_R. The recovery factor (F_R) for the Pacific walrus is 1.0 (Wade and Angliss 1997) as population levels are not known to be in decline. R_{MAX} is estimated as 0.08 (Chivers 1999). Therefore, for the Pacific walrus population, PBR = 607 walrus (15,164 x 0.5 (0.08) x 1.0). This value is considered low by the USFWS and will be refined when a final population estimate resulting from the 2006 walrus survey has been completed.

ANNUAL HUMAN CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

A complete list of fisheries and marine mammal interactions is published annually by NOAA-Fisheries, the most recent of which was published on December 1, 2008 (73 FR 73032). Pacific walrus occasionally interact with trawl and longline gear of groundfish fisheries. No data are available on incidental catch of walrus in fisheries operating in Russian waters, although trawl and longline fisheries are known to operate there. In Alaska each year, fishery observers monitor a percentage of commercial fisheries and report injury and mortality to marine mammals incidental to these operations. Overall, 13 observed fisheries operate in Alaska within the range of the Pacific walrus in the Bering Sea, and could potentially interact with them. Incidental mortality during the 5-year period 2002-2006 was recorded only for one fishery, the Bering Sea/Aleutian Island flatfish trawl fishery (non-pelagic; Table 2), which according to NOAA-Fisheries' List of Fisheries is a Category II Commercial Fishery with an estimated 34 vessels and/or persons participating in the fishery. No incidental injury was recorded during this time period; therefore, annual serious injury is estimated to be zero. Observer coverage for this fishery averaged 64.7% during 2002-2006. The mean number of observed mortalities was 1.8 walrus per year, with a range of 0 to 3 (Table 2). The total estimated

Table 2. Summary of incidental mortality of Pacific walrus due to commercial fisheries from 2002-2006 and estimated mean annual mortality. All mortalities occurred in the Bering Sea/Aleutian Islands flatfish trawl fishery. Fisheries observer data provided by NMFS. NE = no estimate made because no take was recorded.

Fishery	Year	Data type	Observer coverage (%)	Observed mortality (in given years)	Estimated mortality (in given years)	95% CI
Bering Sea/Aleutian Islands flatfish trawl	2002	obs data	58.4	2	3.3	1.4 – 7.5
	2003		64.1	0	NE	NE
	2004		64.3	2	3.1	1.4 – 6.8
	2005		68.3	3	4.1	2.3 – 7.31
	2006		67.8	2	2.8	1.4 – 5.9
Mean	2002-2006	obs data	64.7	1.8	2.66 CV = 0.39	1.83 – 3.86

annual fishery-related incidental mortality in Alaska was 2.66 walrus per year (CV = 0.39). We consider fishery mortality insignificant.

Subsistence Harvest

Over the past 47 years the Pacific walrus population has sustained estimated annual harvest removals ranging from 3,184 to 16,127 animals per year (mean: 6,713; Figure 2). Recent harvest levels are lower than the long-term average over this period. It is not known whether recent reductions in harvest levels reflect changes in walrus abundance or hunting effort. Factors affecting harvest levels include: 1) the cessation of Russian commercial walrus harvests after 1991; 2) changes in political, economic, and social conditions of subsistence hunters in Alaska and Chukotka; and 3) the effects of variable weather and ice conditions on hunting success.

Figure 2. Estimated subsistence harvest of Pacific walrus in the U.S.and Russia, 1960-2007. Years for which a range of harvest estimates exists are represented as the average of high and low values.

The USFWS uses the average annual harvest over the past five years as a representative estimate of current harvest levels in Alaska and Chukotka. Number harvested is multiplied by 0.72 to adjust for walruses wounded but not retrieved (struck and lost; Fay et al. 1994), yielding the estimated total number taken. Based on the best available data, all walruses that have been shot with a firearm are assumed to be mortally wounded (Fay et al 1994). Based on 2003-2007 harvest statistics, adjusted for animals mortally wounded but not retrieved, harvest mortality levels are estimated at 4,960 – 5,457 walrus per year (Table 3). The sex-ratio of the reported U.S. walrus harvest over this time period was 1.55:1 males to females. The sex-ratio of the reported Russian walrus harvest was 3.76:1 males to females based on harvest information collected by ChukotTINRO in 2003 and 2005 only.

Table 3. Estimated harvest of Pacific walrus, 2003-2007. Russian harvest information provided by Chukotka TINRO and the Russian Agricultural Dept. U.S. harvest information collected by the U.S. Fish and Wildlife Service, and adjusted for unreported walrus using the Mark Recapture method, which yields upper and lower harvest estimates. Number struck and lost is estimated using a 42% struck and lost rate from Fay et al. (1994).

Year	Estimated Total Number Taken	Number Harvested, U.S.	Number Harvested, Russia	Number Struck and Lost
2003	5,909 – 6,551	2,002 – 2,375	1,425	2,482 – 2,751
2004	4,429 – 4,858	1,451 – 1,700	1,118	1,860 – 2,040
2005	4,762 -5,037	1,292 – 1,451	1,470	2,000 – 2,115
2006	3,907 – 4,262	1,219 – 1,425	1,047	1,641 – 1,790
2007	5,789 – 6,571	2,185 – 2,638	1,173	2,432 – 2,760
Mean	**4,960 – 5,457**	**1,630 – 1,918**	**1,247**	**2,083 – 2,292**

Other Removals

Between 2003 and 2007, satellite transmitters were affixed by crossbow to 143 walrus (annual mean: 28.6), and collections of skin and blubber biopsy samples were attempted from 214 walrus (annual mean: 42.8). No mortalities or serious injuries were associated with these research activities. Four orphaned walrus calves were rescued from the wild and placed in public display between 2003 and 2007. Based on this information, an estimated 0.8 walrus per year were removed from the wild due to other human activities.

Total Estimated Human-Caused Mortality and Serious Injury

The total estimated annual human caused mortality or removal is calculated to be 4,963 - 5,460 walrus per year (2.66 attributed to fisheries interactions, 4,960 to 5,457 due to harvest, and 0.8 due to other human activities). There is insufficient information to accurately estimate human-caused serious injury, but there is no evidence that levels of human-caused serious injury are significant.

STATUS OF STOCK

Pacific walrus are not designated as depleted under the MMPA, or listed as threatened or endangered under the Endangered Species Act of 1973 (ESA), as amended. In February 2008, the USFWS received a petition to list the Pacific walrus under the ESA. The 90-day finding on this petition will be made on or before September 10, 2009. Based on the best available data, the estimated incidental mortality and serious injury related to commercial fisheries (2.66 walrus per year) is less than 10% of the calculated PBR and therefore can be considered insignificant and approaching a zero mortality and serious injury rate. However, harvest levels exceed the provisional PBR based on a preliminary estimate of population size. Therefore, the Pacific walrus population is classified as strategic.

Conservation Issues and Habitat Concerns

Oil and Gas Exploration

In 2008, the Minerals Management Service held an oil and gas lease sale for offshore blocks in the eastern Chukchi Sea. A significant proportion of the Pacific walrus population migrates into the Chukchi Sea region each summer, and the shallow, productive, ice covered waters of the eastern Chukchi Sea are considered particularly important habitat for female walrus and their dependent young. The USFWS works to monitor and mitigate potential impacts of oil and gas activities on walrus and polar bears through incidental take regulations (ITR) as authorized under the MMPA. Activities operating under these regulations must adopt measures to: ensure that impacts to walruses remain negligible; minimize impacts to their habitat; and ensure no unmitigable adverse impact on their availability for Alaska Native subsistence use. ITR also specify monitoring requirements that provide a basis for evaluating potential impacts of current and future activities on marine mammals.

Climate Change

Impacts to walrus of changes in arctic and subarctic ice dynamics are not well understood. Walrus are dependent on sea ice as a substrate for birthing, nursing, and resting between foraging trips. Annual winter ice in the Bering Sea is predicted to decrease in extent by 40% by the year 2050 (Overland and Wang 2007). Summer sea-ice extent in the Chukchi Sea has decreased rapidly in recent years (Meier et al. 2007, Stroeve et al. 2008), retreating off the shallow continental shelf and over deep Arctic Ocean waters where walruses presumably can not feed. Declines in sea-ice extent, duration, and thickness are expected to continue (Overpeck et al. 2005, Maslanik et al. 2007, Stroeve et al. 2007).

Some impacts of the loss of summer sea ice on walrus have been documented. Over the past decade, the number of walrus coming to shore along the coastline of the Chukchi Sea in Russia has increased (Kavry et al. 2008). Female and young walrus are arriving earlier and staying longer at coastal haulouts as summer ice disappears. Numbers in the tens of thousands have been reported anecdotally from some haulouts in Chukotka (Kavry et al. 2008, A.A. Kochnev personal communication). In the fall of 2007, large walrus aggregations were also observed along the Alaska coast. The ability of the food supply within foraging range of coastal haulouts to support large numbers of walruses over the long term is unknown. Thin walrus that appear to be physiologically stressed have also been reported from Chukotka (Ovsyanikov et al. 2008, A.A. Kochnev personal communication). Walrus at dense coastal haulouts are vulnerable to disturbance, which can result in increased mortality from stampedes (Kavry et al. 2008). The USFWS will review all available information on the impacts of climate change on the Pacific walrus population when it considers the petition to list them under the ESA.

Subsistence Harvest

Impacts of climate change on subsistence harvests of walrus are also difficult to predict. Changes in walrus distribution, abundance, individual health, ice type, length and timing of the hunting season, and weather and sea state

during the hunting season, can all influence hunting success. Recent harvest levels are lower than historical levels but it is not clear if this represents reduced hunting effort. Harvest levels must be assessed within the context of the best available population estimate, which is still being developed.

Cooperative Agreements have been developed annually between the USFWS and the Eskimo Walrus Commission since 1997 to facilitate the participation of subsistence hunters in activities related to the conservation and management of walrus stocks in Alaska. This co-management process is on-going. Ensuring that harvest levels remain sustainable is a goal shared by subsistence hunters and resource managers in the U.S. and Russia. Achieving this management goal will require continued investments in co-management relationships, harvest monitoring programs, international coordination, and research.

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