DRAFT REVISED PACIFIC WALRUS (*Odobenus rosmarus divergens*):

Alaska Stock

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 United States waters and considered in this account.

Pacific walruses 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, aggregate near coastal haulouts in the Gulf of Anadyr, Russia; Bering Strait, and Bristol Bay, Alaska. During the winter breeding season walruses are found in three concentration areas of the Bering Sea where open leads, polynyas, or thin ice occur (Fay *et al.* 1984, Garlich-Miller *et al.* 2011a). While the specific location of these groups varies annually and seasonally depending upon the extent of the sea ice, generally one group occurs near the Gulf of Anadyr, another south of St. Lawrence Island, and a third in the southeastern Bering Sea south of Nunivak Island into northwestern Bristol Bay. However, Pacific walruses are currently managed as a single panmictic population. Scribner *et al.* (1997) found no difference in mitochondrial and nuclear DNA among walruses 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).

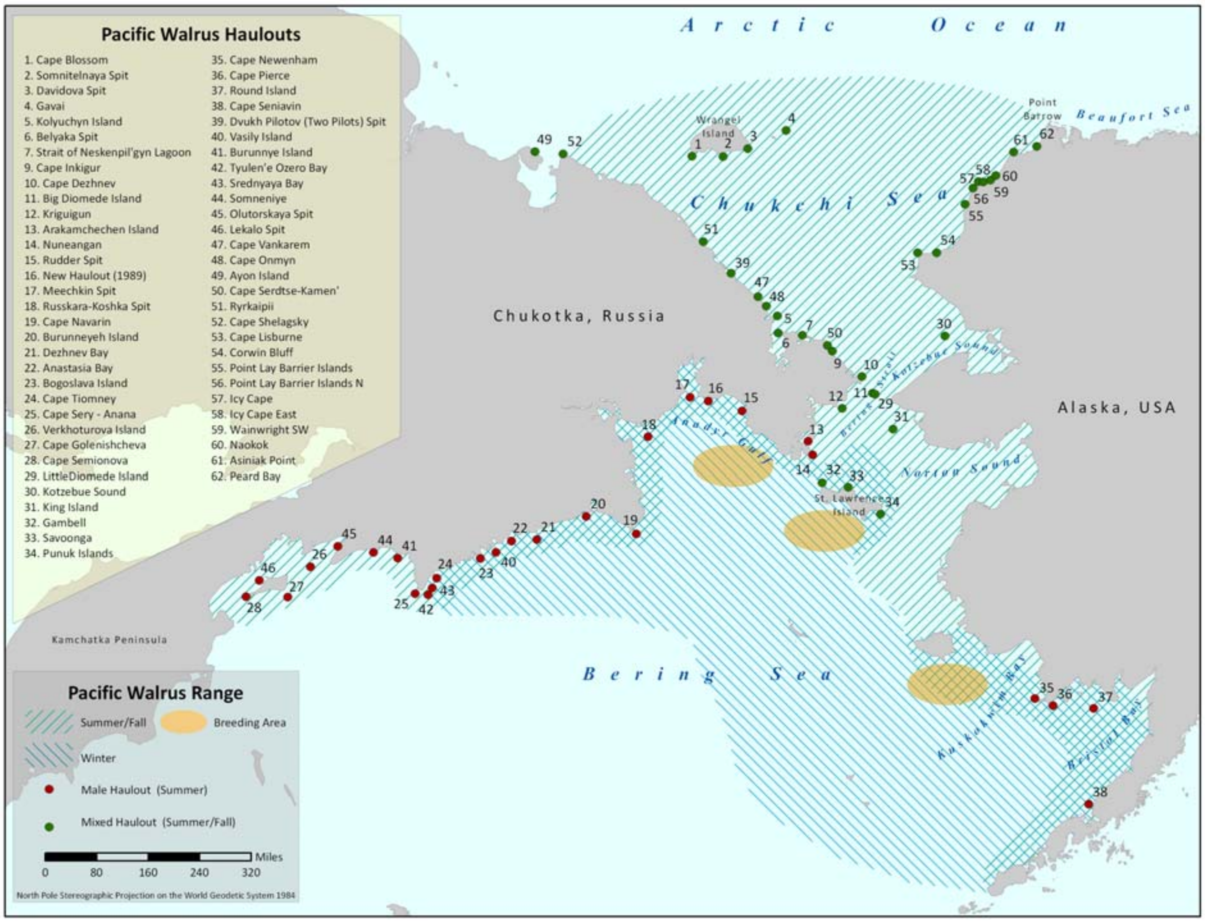

Figure 1. Seasonal distribution, breeding areas, and coastal haulouts of Pacific walruses in the Bering and Chukchi Seas. Modified from (Smith 2010).

Pacific walruses typically use sea-ice as a resting platform between feeding dives, as a birthing substrate, for shelter from storms, isolation from predators, and passive transportation (Fay 1982). Historically, the summer distribution of walruses in the Chukchi Sea occurred primarily on sea ice over the continental shelf from the Alaska to Chukotka coasts with large numbers of animals near Hanna Shoal in the United States and Wrangel Island in the Russian

Federation. A few animals would be observed utilizing haulouts along both the Alaska and Chukotka coasts, particularly in the fall. While the overall geographic range of Pacific walruses has not changed, over the past decade the number of walruses coming to shore along the coastline of the Chukchi Sea in both Alaska and Chukotka has increased from the hundreds to thousands to greater than 100,000 (Kavry *et al.* 2008, Garlich-Miller *et al.* 2011*a*, Jay *et al.* 2011). Additionally, adult female and young walruses are arriving at these coastal haulouts as much as a month earlier and staying at the coastal haulouts a week or two longer. In fall 2007, 2009, 2010, and 2011 large walrus aggregations (3,000-20,000) were observed along the Alaska coast (Garlich-Miller *et al*. 2011*a*). This increased use of coastal haulouts is a function of the loss of summer sea ice over the continental shelf (Garlich-Miller *et al.* 2011*a*). Summer sea-ice extent in the Chukchi Sea has decreased by about 12% per decade (NSIDC 2012); retreating off the shallow continental shelf and remaining only over deep Arctic Ocean waters where walruses cannot reach the benthos to feed. Declines in Chukchi Sea ice extent, duration, and thickness are projected to continue in a linear fashion into the foreseeable future (Douglas 2010).

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 has fluctuated markedly in response to varying levels of human exploitation (Fay *et al*. 1989). Large-scale commercial harvests reduced the population to 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 five-year intervals, producing mean population estimates ranging from 201,039 to 234,020 animals with 95% confidence intervals that include zero (Table 1). The estimates generated from these surveys are considered minimum values and because of the large associated variances they are not suitable for detecting population trends (Hills and Gilbert 1994, Gilbert *et al.* 1992). Further, these earlier figures largely underestimate the population since they were not adjusted for walruses in the water, a proportion of the population that may be as high as 65 to 87 percent (Born and Knutsen 1997, Gjertz *et al*. 2001, Jay *et al*. 2001, Born *et al*. 2005, Acquarone *et al*. 2006, Lydersen *et al*. 2008) or the underestimation of walruses on ice or land. Efforts to survey the Pacific walrus population were suspended after 1990 due to unresolved problems with survey methods, which 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 in 2000 concluded that it would not be possible to obtain a population estimate with adequate precision for tracking trends using the existing aerial survey methods and any feasible amount of survey effort (Garlich-Miller and Jay 2000). Two major problems were identified: (1) accurately counting walruses in large groups, and (2) accounting for walruses in the water that were not available to be counted. Remote sensing systems were viewed as having great potential to address the first problem (Udevitz *et al.*

2001) as well as being able to sample larger areas per unit of time (Burn *et al*. 2006). To address the second problem U.S. Geological Survey (USGS) scientists developed satellite transmitters

Table 1. Point estimates (95% confidence interval) of Pacific walrus population size, 1975-2006 from cooperative United States – Russian aerial surveys and original references.

Year	Population Estimate	References
1975	221,350 (–20,000-480,000)[a]	Gol'tsev 1976, Estes and Gilbert 1978, Estes and Gol'tsev 1984
1980	246,360 (–20,000-540,000)[a]	Johnson *et al.* 1982, Fedoseev 1984
1985	234,020 (–20,000-510,000)[a]	Gilbert 1986, 1989a, 1989b; Fedoseev and Razlivalov 1986
1990	201,039 (–19,000-460,000)[a]	Gilbert *et al.* 1992
2006	129,000 (55,000-507,000)	Speckman *et al*. 2011

[a]95% confidence intervals are from Figure 1 in Hills and Gilbert (1994).

that recorded the haul-out status (in water or out) of individual walruses, which was used to estimate the proportion of animals in the water and correct walrus counts (Udevitz *et al.* 2009). These technological advances led to a joint United States-Russian Federation survey in March and April of 2006. This survey effort was timed to occur when the Pacific walrus population hauls out on sea ice habitats across the continental shelf of the Bering Sea in order to capture as much of the population as possible.

The goal of the 2006 survey was to estimate the size of the Pacific walrus population (Speckman *et al.* 2011). However, some areas known to be important to walruses were not surveyed in 2006 because of poor weather and therefore the 2006 estimate is also considered to be an underestimate. The number of Pacific walruses within the area surveyed in 2006 was estimated at 129,000 with a 95% confidence interval of 55,000 to 507,000 (Speckman *et al.* 2011).

Minimum Population Estimate

Under section 3(27) of the Marine Mammal Protection Act (MMPA), a “minimum population estimate” is defined as “an estimate of the number of animals in a stock that is based on the best available scientific information on abundance, incorporating the precision and variability associated with such information and provides reasonable assurance that the stock size is equal to or greater than the estimate.” The estimate derived from the joint United States-Russian Federation survey conducted in March and April 2006 (Speckman *et al*. 2011) represents the minimum population estimate for the Pacific walrus. Because the 2006 survey used the most advanced technologies developed to address the problems identified in earlier aerial survey methods and was timed to capture as much of the population as possible (see above discussion under **POPULATION SIZE**), the survey’s estimate of 129,000 individuals, with a 95% confidence interval of 55,000 to 507,000 (Speckman *et al*. 2011), constitutes the best available scientific information on the size of the Pacific walrus population, taking into account the precision and variability associated with such estimates on abundance. The estimate from the 2006 survey is also negatively biased (Speckman *et al*. 2011), which provides reasonable assurance that the walrus size is greater.

Current Population Trend

The 2006 estimate is lower than previous estimates of Pacific walrus population size (Table 1) and is known to be biased low to an unknown degree (Garlich-Miller *et al.* 2011*a*). However, estimates of population size from 1975 to the present (Table 1) are not directly comparable (Fay *et al.* 1997, Gilbert 1999) because of differences in survey methods, timing of surveys, and segments of the population surveyed. Therefore, while these estimates do not provide a good basis for inference with respect to population trends, there is other evidence supporting the hypothesis that the Pacific walrus population has declined from a peak in the late 1970s and 1980s.

Walrus researchers in the 1970s and 1980s were concerned that the population had reached or exceeded carrying capacity, and predicted that density-dependent mechanisms would begin to cause a decrease in population size (Fay and Stoker 1982b, Fay *et al*. 1986, Sease 1986, Fay *et al*. 1989). Estimates of demographic parameters from the late 1970s and 1980s support the idea that population growth was slowing (Fay and Stoker 1982a, Fay *et al*. 1986, Fay *et al*. 1989). Garlich-Miller *et al*. (2006) found that the median age of first reproduction for female walruses decreased in the 1990s, which is consistent with a reduction in density-dependent pressures. In addition, data on calf/cow ratios collected from harvested animals is consistent with a population peak in the late 1970s (i.e., low estimates in the late 1970s and 1980s) and subsequent population decline, and indicates that the population is currently below carrying capacity (MacCracken 2012).

The current working hypothesis, based on the available data, is that commercial and subsistence harvests prior to the 1960s limited the population; adoption of harvest quotas in the 1960s resulted in a population increase until the carrying capacity (about 300,000; according to Fay *et al.* (1997)) was reached in the 1970-1980s and productivity began to decline. The subsequent lack of harvest quotas in the United States beginning in 1979 and the reduced productivity levels resulted in another population decline, and the population is once again limited primarily by subsistence harvest. Garlich-Miller *et al*. (2011*a*) predicted that changing sea ice dynamics will result in further population declines in the future, but could not specify the magnitude or rate of decline. Given the suite of challenges associated with walrus aerial surveys, many of which cannot be overcome (e.g., poor weather, extensive area, estimate imprecision), it is clear that new approaches to evaluate population status and trend need to be explored. The Service is developing a project to test the feasibility of genetic mark-recapture methods to estimate population size and trend. In addition, the successful development of a repeatable, unbiased, and precise estimate of population size greatly facilitates harvest management (USFWS 1994).

MAXIMUM NET PRODUCTIVITY RATES

Estimates of net productivity rates for walrus populations have ranged from 3 to 13% per year with most estimates between 5 and 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%, which we use as the maximum net productivity rate in this assessment. Empirical estimates of age-specific survival rates for free ranging walruses are not available.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) of a marine mammal stock is defined in the MMPA as the maximum number of animals, not including natural mortalities that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimal sustainable population. The PBR is the product of the following factors: (A) the minimum population estimate of the stock, (B) one-half the maximum theoretical or estimated net productivity rate of the stock at a small population size, and (C) a recovery factor between 0.1 and 1.0 (MMPA §3(20)). Mathematically, PBR = N_{MIN} x 0.5 R_{MAX} x F_R; where N_{MIN} is minimum populations size, R_{MAX} the net productivity rate, and F_R a recovery factor. The F_R for the Pacific walrus is 0.5 (NMFS 2005) because the population is a candidate for listing under the U.S. Endangered Species Act of 1973, as amended (ESA) (USFWS 2011). R_{MAX} is estimated as 0.08 (Chivers 1999). Therefore, for the Pacific walrus population:

$$N_{MIN} = 129,000$$

$$R_{MAX} = 0.08$$

$$F_R = 0.5$$

$$PBR = (129,000 \text{ x } [0.5*0.08]*0.5) = 2,580$$

HUMAN CAUSED MORTALITY AND SERIOUS INJURY

Human Caused Mortalities

Subsistence Harvest

Over the past 60 years the Pacific walrus population has sustained estimated annual harvest removals ranging from 3,184 to 16,127 animals (mean = 6,440; Figure 2). Harvest levels since 2006 are 5 to 68% lower than this long-term average. It is not known whether recent reductions in harvest levels reflect changes in walrus abundance or hunting opportunities, but hunters consistently state that more frequent and severe storms are affecting hunting effort (EWC 2003, Oozeva *et al.* 2004). Other factors affecting harvest levels include: 1) the cessation of Russian commercial walrus harvests after 1990; and 2) changes in political, economic, and social conditions of subsistence hunters in Alaska and Chukotka.

The U.S. Fish and Wildlife Service (USFWS) uses the average annual harvest over the past five years as an estimate of current harvest levels in the United States and Russia. Total U.S. annual harvest is estimated using data collected by direct observation in selected communities and through the statewide regulatory Marking, Tagging, and Reporting Program. The two sources of data are combined to calculate annual reporting compliance and to correct for any unreported harvest. Total U.S. subsistence harvest is estimated as the sum of reported and

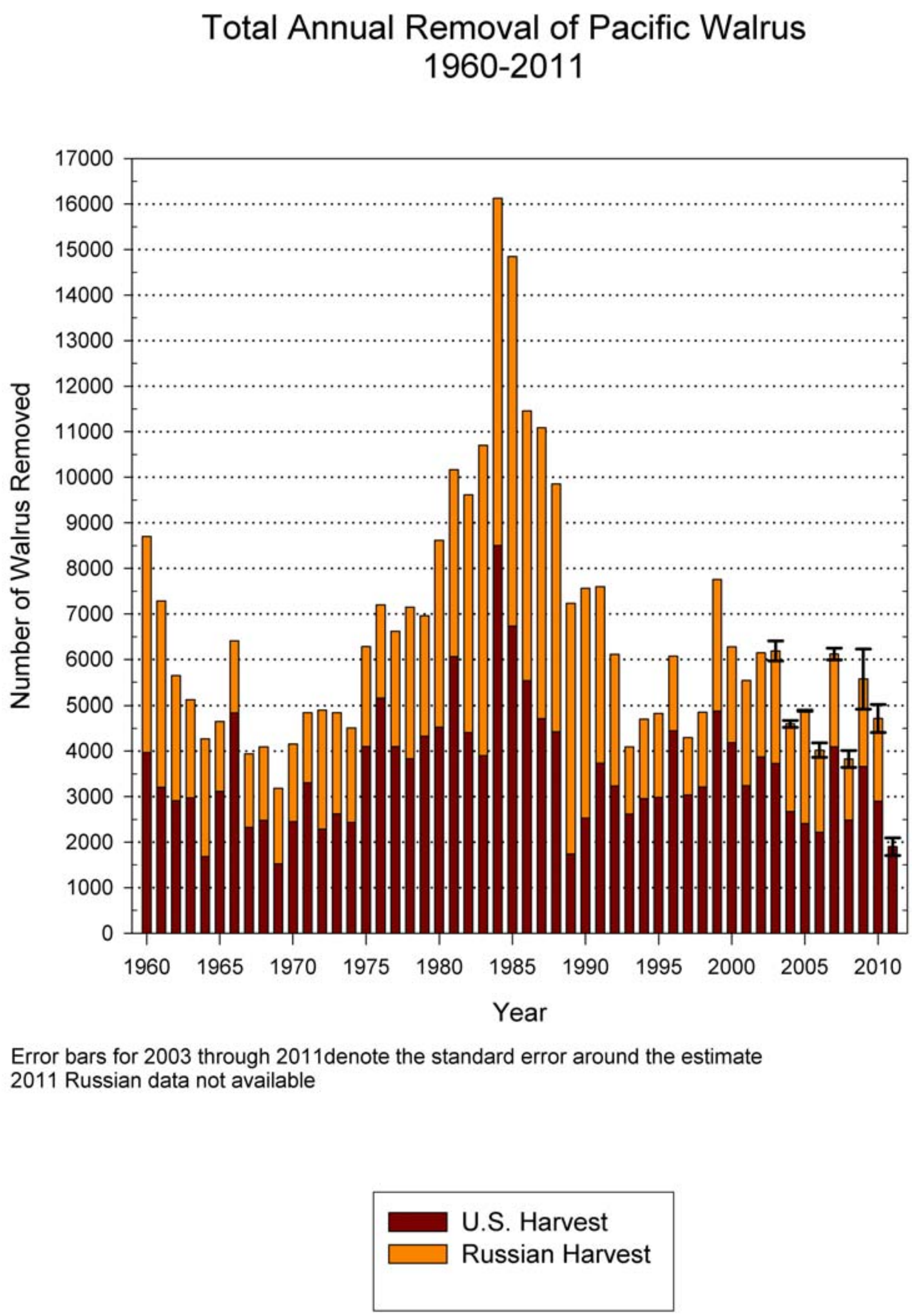

Figure 2. Total annual harvest removals for the Pacific walrus population from 1960 to 2008.

estimated unreported harvests. Harvest estimates in Russia were collected through both an observer program and a reporting program instituted by the Russian Federation.

Using data collected between 1952 and 1972, Fay *et al*. (1994) estimated that 42% of walruses that were shot at were lost after being hit. All walruses that have been shot with a firearm are either killed immediately or assumed to be mortally wounded; however, they are often not retrievable if they die in the water because they sink and wounded animals can escape (Fay *et al.* 1994). We recognize that hunting equipment and techniques have improved since Fay *et al.* (1994) published their estimate; however, that estimate is still the best available. We therefore multiply the estimated harvest by 1.42 to adjust for walruses shot but not retrieved (i.e., struck and lost), resulting in a more accurate estimate of total number of walruses harvested.

Harvest mortality levels from 2006 to 2010 are estimated at 3,828-6,119 walruses per year (Table 2). The sex-ratio of the reported U.S. walrus harvest over this time period was 1.3:1 males to females. The sex-ratio of the reported Russian walrus harvest was 3.1:1 males to females based on harvest information collected by ChukotTINRO from 1999-2009 (Kochnev 2010).

Impacts of climate change on future subsistence harvests of walruses are difficult to predict (Holversrud 2008). Changes in walrus distribution, abundance, and health; sea ice characteristics and distribution; length and timing of the hunting season; and weather and sea state during the hunting season can all influence hunting success. Recent harvests are lower than historic levels and more frequent storms during the traditional hunting season, which limit

Table 2. Mean (standard error) harvest of Pacific walruses, 2006-2010. Russian harvest information was provided by ChukotTINRO and the Russian Agricultural Department. United States harvest information was collected by the U.S. Fish and Wildlife Service, and adjusted for unreported walruses using a mark-recapture method. Total harvest includes a struck and lost factor of 42% (Fay *et al*. 1994).

Year	Total harvest	United States harvest	Russian harvest
2006	4,022(157)	1,286(91)	1,047
2007	6,119(127)	2,376(74)	1,173
2008	3,828(185)	1,442(107)	778
2009	5,547(654)	2,123(379)	1,110
2010	4,716(308)	1,682(178)	1,053
Five year mean	4,852(346)	1,782(200)	1,032(67)

hunting opportunities, appear to be a contributing factor. Holversrud (2008) predicted that climate change would result in a decline in the subsistence harvest of marine mammals. Garlich-Miller *et al*. (2011*a*) predicted that walrus harvest levels would remain relatively stable. Since 2006, the estimated total removal of walruses has fluctuated from year to year by an average of 3%, but is highly variable (e.g., 2006 to 2007, a 52% increase; and 2007 to 2008, a 60% decline). Hunters will likely be able to adapt to changing hunting conditions and although fewer walruses are currently being harvested overall, more walruses are being harvested earlier in the spring and earlier in the winter than during the previous 20 years. Harvest levels must be assessed within the context of the best available information on walrus population size, weather and climate, and political, economic, and social conditions of subsistence hunters in Alaska and Chukotka. Garlich-Miller *et al*. (2011*a*) assumed that summer sea ice loss will result in a reduced walrus population over time and that subsistence harvests could become unsustainable if not reduced in concert with any decline in the population. The recent adoption of trip limit ordinances by the Native Villages of Gambell and Savoonga and the acquisition of a Tribal Wildlife Grant to ensure administration of those ordinances is a significant positive development in this arena.

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 the walrus 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 United States and Russian Federation. Achieving this management goal will require continued investments in co-management relationships, harvest monitoring programs, international coordination, and research.

Fisheries Related Mortalities and Injuries

A complete list of fisheries and marine mammal interactions is published annually by the National Oceanic and Atmospheric Administration (NOAA)-Fisheries, the most recent of which was published on November 29, 2011 (NOAA 2011). Pacific walruses occasionally interact with trawl and longline gear of groundfish fisheries. No data are available on incidental catch of walruses 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 of marine mammals incidental to these operations. Overall, 13 fisheries, with observers, operate in Alaska within the range of the

Pacific walrus in the Bering Sea, and could potentially interact with them.

Mortalities

Incidental mortality during 2006-2010 was observed in only one fishery, the Bering Sea/Aleutian Island flatfish non-pelagic trawl (Table 3); which, according to NOAA-Fisheries is a Category II Commercial Fishery with an estimated 34 vessels and/or persons participating. Observer coverage for this fishery averaged 88% during 2006-2010. The mean number of observed mortalities was one walrus per year, with a range of zero to three (Table 3). The total estimated annual fishery-related incidental mortality in Alaska was two walruses per year. We consider fishery related mortality to be insignificant.

Table 3. Summary of incidental mortality of Pacific walruses in the Bering Sea/Aleutian Islands flatfish trawl fishery from 2005-2010 and estimated mean annual mortality. Data provided by the National Marine Fisheries Service.

Year	Observer coverage (%)	Observed mortality	Estimated mortality	95% CI
2006	68	2	3	1 – 6
2007	72	1	3	1 – 5
2008	100	1	1	0.6 – 1.4
2009	100	0	0	
2010	100	2	2	1 – 3
Five year mean(SE[a])	88(7)	1(0.4)	2(0.6)	

[a]standard error.

Injuries

No incidental injury was observed during this time period; therefore, annual serious injury is estimated to be zero.

Other Removals

Between 2006 and 2011, satellite transmitters were affixed to 348 walruses, and collections of skin and blubber samples with biopsy darts were attempted from 183 walruses. No mortalities or serious injuries were directly associated with those research activities. However, in 2011, walruses at the Point Lay, Alaska haulout cleared the beach as USGS researchers, ferried by local guides, boated past resulting in the death of one calf (Jay 2012).

Up to 52 orphaned walrus calves were captured in Russia and placed on public display between 2006 and 2010. Based on this information, about 10 (standard error = 8) walruses per year were removed from the wild due to other human activities.

Total Estimated Human-Caused Mortality and Serious Injury

The average (standard error) total annual human-caused mortality or removal is 4,864 (346) walruses (2 due to fisheries interactions, 4,852 due to harvest, and 10 due to other human activities). There is no evidence that levels of human-caused serious injury are significant at this point.

Mortalities at coastal haulouts are due to several natural sources (poor condition, old age, injuries, predation, etc.) and occur at all haulouts at an unknown background level. Mortalities due to human caused stampedes also occur but are hard to quantify – most events are observed after the fact (Fay and Kelley 1980, Fischbach *et al.* 2009), some may go undetected, and carcasses can be redistributed during storms and consumed by predators. In 2007, more than 3,200 haulout mortalities were attributed to disturbance events along the Russian coast, but none were noted in Alaska. In 2008, few haulout mortalities were observed (0 in the United States, 165 in Russia) as remnant ice in the Chukchi Sea allowed walruses to stay offshore. In 2009, 131 calves were apparently trampled in a disturbance event at Icy Cape, Alaska (Fischbach *et al.* 2009) and another 53 were reported from other locations in Alaska with 453 counted in Russia.

In 2010, 680 carcasses were counted at four haulouts in Russia and less than 200 were observed at Point Lay, Alaska. In 2011, 376 carcasses were counted in Russia and about 100 carcasses were found at the Point Lay haulout. Apparently, haulout management programs in Russia and the United States, beginning in 2009 and 2010, respectively, have been successful in reducing disturbance related mortalities compared to the extreme event in 2007.

STATUS OF STOCK

Pacific walrus are not designated as depleted under the MMPA; however, we have determined that listing the Pacific walrus as endangered or threatened under the ESA is warranted, but precluded by higher priority listing actions (USFWS 2011). Based on the best available information, the estimated incidental mortality and serious injury related to commercial fisheries (two walruses per year) is less than one percent of PBR and therefore can be considered insignificant and approaching a zero mortality and serious injury rate. However, the total human-caused removals exceed the PBR of 2,580. Therefore, the Pacific walrus is classified as a strategic stock.

EMERGING CONSERVATION ISSUES

A status review for the Pacific walrus was completed in 2011 in response to the ESA listing petition (Garlich-Miller *et al.* 2011*a*, available at: http://alaska.fws.gov/fisheries/mmm/walrus/pdf/review_2011.pdf). That review provides a comprehensive analysis of the stressors currently affecting the Pacific walrus population and how they may develop out to 2099. The major findings of that analysis have been incorporated into this document in the appropriate sections. Readers should refer to Garlich-Miller *et al.*

(2011*a*) for additional information on topics not covered by this stock assessment report.

Chukchi Coast Haulout Use

Over the past decade, the number of walruses coming to shore in summer and fall along the coastline of the Chukchi Sea in both Alaska and Russia has increased (Kavry *et al.* 2008, Garlich-Miller *et al.* 2011*a*) coincident with the earlier and more extensive melting of sea ice. In fall 2007, 2009, 2010, and 2011, large aggregations of females and young (about 3,000-30,000) were observed along the Alaska coast. An area of concern is the amount of walrus prey within the foraging range of coastal haulouts (Garlich-Miller *et al*. 2011*a*). As more walruses use coastal haulouts more frequently and for longer periods each year, prey populations could be depleted. Malnourished walruses have been reported from Chukotka (Ovsyanikov *et al*. 2008, A.A. Kochnev personal communication) and they are also regularly observed in Alaska (Garlich-Miller *et al.* 2011a); however, the majority of walruses observed at fall haulouts in Alaska in 2010 and 2011 were in good physical condition.

Ocean Acidification

The effect of ocean acidification (OA) on walrus prey is another issue of concern because lower pH levels can interfere with invertebrate shell formation and erode existing shells. No information is available about potential impacts on specific walrus prey species. Uncertainty regarding the general effects of ocean acidification has been summarized by the National Research Council (2010:1): "The major changes in ocean chemistry caused by increasing atmospheric CO_2 are well understood and can be precisely calculated, despite some uncertainty resulting from biological feedback processes. However, the direct biological effects of ocean acidification are less certain and will vary among organisms, with some coping well and others not at all." Consequently, although we recognize that effects to calcifying organisms that are important prey items for Pacific walruses may occur in the foreseeable future from ocean acidification, we do not know which species may be able to adapt and thrive, which may decline, or the ability of the walrus to depend on alternative prey items. The prey base of walrus includes over 100 taxa of benthic invertebrates from all major phyla (Sheffield and Grebmeier 2009). Although walruses are highly adapted for obtaining bivalves, they also have the potential to switch to other prey items if bivalves and other calcifying invertebrate populations decline. Whether other prey items would fulfill walrus nutritional needs over their life span is unknown (Sheffield and Grebmeier 2009), and there also is uncertainty about the extent to which other suitable non-bivalve prey might be available, due to uncertainty about the effects of ocean acidification and the effects of ocean warming.

Subsistence Harvest

Recent subsistence harvests are lower than historic levels due to a faster spring migration and more frequent severe storms that have limited hunting opportunities during the spring migration (Kapsch *et al.* 2010). Garlich-Miller *et al.* (2011*a*) predicted that walrus harvest levels would remain relatively stable as hunters adapt to changing hunting conditions, but that summer sea ice loss will result in a reduced walrus population over time, and therefore subsistence harvests could become unsustainable if not reduced similarly. The USFWS, in cooperation with the Russian Federation, has a comprehensive harvest monitoring program in place that provides detailed information on harvest trends and characteristics. We will continue to cooperatively monitor harvest levels into the future, a key component to maintaining a sustainable harvest.

Oil and Gas Exploration

In 2008, the Minerals Management Service (now the Bureau of Ocean Energy Management) held an oil and gas lease sale for offshore blocks in the eastern Chukchi Sea. In

2009, 2010, and 2011 a number of seismic surveys were conducted in the lease sale area. Exploratory drilling is scheduled to begin in 2012. A significant portion 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 walruses and their dependent young. The Hanna Shoal area seems to be particularly attractive to walruses summering in the Chukchi Sea likely due to both high prey abundance and shallow waters. To date, exploration activities have been about 50-90 km southwest of Hanna Shoal, which is included in the lease sale area. The USFWS works to monitor and mitigate potential impacts of oil and gas activities on walruses 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. These regulations also specify monitoring requirements that provide a basis for evaluating potential impacts of current and future activities on marine mammals. The current ITRs expire in 2013 and the Alaska Oil and Gas Association (AOGA) petitioned the USFWS to renew those regulations for another five years. The USFWS will include a thorough analysis of the monitoring data collected in association with the current ITRs when responding to the AOGA petition.

The USFWS (2011) concluded that at current levels, oil and gas exploration posed a relatively minor threat to the Pacific walrus population. However, they noted that a large oil spill could significantly impact the population depending on timing, location, amount and type of oil, efficacy of response efforts, etc.

International Commercial Shipping

As summer sea ice melts earlier in the year and the open water extends further north, opportunities for commercial shipping through the arctic increase (Garlich-Miller *et al.* 2011*a*). Transits through Bering Strait increased by 423% in Russian waters and 7% in United States waters between 2009 and 2010 (M. Williams, pers. comm.), with the majority of transits (89%) in the United States. Shipping activities are currently outpacing regulatory efforts to define shipping channels, seasons of use, and mitigation measures to reduce ship strikes, etc. Commercial shipping is expected to increase in the future, but several scenarios are possible depending on economics and international regulatory efforts. Shipping is not currently impacting the Pacific walrus population and not expected to be a major source of mortality in the future.

Disease

During summer and fall 2011, about 130 ringed seals (*Pusa hispida*) were found on the beaches on northwest Alaska with skin lesions and hair loss suggestive of a viral infection. About 48% of those seals were found dead and the others were lethargic. During September 2011, 6% of the walruses at the Point Lay haulout had similar skin lesions, but were otherwise in good physical condition. The majority of affected walruses were subadults and some of those had healed lesions, indicating that the disorder is not necessarily fatal. However, a number of dead calves at the haulout had both skin lesions and signs of trampling trauma (Garlich-Miller *et al.* 2011*b*) and the ultimate cause of death is not known at this time.

In December 2011, the National Marine Science Fisheries (NMFS) declared the seal mortalities an unusual mortality event (UME) and included walrus in the UME, with USFWS concurrence, due to the similarities of the lesions. No causative agent has been identified and it’s not known if the same agent is infecting both species. The symptoms appear to be less severe in walruses than in ringed seals in terms of prevalence and mortalities. Sampling of Pacific walrus' tissues and comprehensive laboratory analyses is continuing as part of the UME investigation.

CITATIONS

Acquarone, M., E.W. Born, and J.R. Speakman. 2006. Field metabolic rates of walrus (*Odobenus rosmarus*) measured by doubly labeled water method. Aquatic Mammals 32: 363-369.

Born, E. W., M. Acquarone, L.Ø. Knutsen, and L. Toudal. 2005. Homing behaviour in an Atlantic walrus (*Odobenus rosmarus rosmarus*). Aquatic Mammals 31:23-33.

Born, E.W. and L.Ø. Knutsen. 1997. Haul-out and diving activity of male Atlantic walruses (*Odobenus rosmarus rosmarus*) in NE Greenland. Journal of Zoology 243:381-396.

Burn, D.M., M.A. Webber, and M.S. Udevitz. 2006. Application of airborne thermal imagery to surveys of Pacific walrus. Wildlife Society Bulletin 34:51-58.

Chapskii, K.K. 1936. The walrus of the Kara Sea. Results of an investigation of the life history, geographical distribution, and stock of walruses in the Kara Sea. Transactions of the Arctic Institute 67:1-124.

Chivers, S.J. 1999. Biological indices for monitoring population status of walruses evaluated with an individual-based model. Pages 239-247, *In* Garner, G.W., S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald, and D.G. Robertson (eds.), Marine Mammal Survey and Assessment Methods. A. A. Balkema, Rotterdam.

DeMaster, D.P. 1984. An analysis of a hypothetical population of walruses. Pages 77-80, *In* F.H. Fay and G.A. Fedoseev (eds.), Soviet American Cooperative Research on Marine

Mammals, vol. 1, Pinnipeds. NOAA, Technical Report, NMFS 12.

Douglas, D.C. 2010. Arctic sea ice decline: projected changes in timing and extent of sea ice in the Bering and Chukchi Seas. U.S. Geological Survey, Open-file Report 2010-1176, Reston, VA.

Estes, J.A., and J.R. Gilbert. 1978. Evaluation of an aerial survey of Pacific walruses (*Odobenus rosmarus divergens*). Journal of the Fisheries Research Board of Canada 35:1130-1140.

Estes, J.A., and V.N. Gol'tsev. 1984. Abundance and distribution of the Pacific walrus (*Odobenus rosmarus divergens*): results of the first Soviet American joint aerial survey, autumn 1975. Pages 67-76, *In* F.H. Fay and G.A. Fedoseev (eds.), Soviet American Cooperative Research on Marine Mammals, vol. 1, Pinnipeds. NOAA, Technical Report, NMFS 12.

EWC (Eskimo Walrus Commission). 2003. Conserving our culture through traditional management. Department of Natural Resources, Kawerak Inc., Nome, AK.

Fay, F.H. 1982. Ecology and biology of the Pacific walrus (*Odobenus rosmarus divergens*). North American Fauna 74. U.S. Fish and Wildlife Service, Washington, DC.

Fay, F.H. and B.P. Kelly. 1980. Mass natural mortality of walruses (*Odobenus rosmarus*) at St. Lawrence Island, Bering Sea, autumn 1978. Arctic 33:226-245.

Fay, F.H., B.P Kelly, P.H. Gehnrich, J.L. Sease, and A.A. Hoover. 1986. Modern populations, migrations, demography, trophics, and historical status of the Pacific walrus. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Outer Continental Shelf Environmental Impact Assessment Program, Final Reports of Principal Investigators 37:231-376. National Oceanic and Atmospheric Administration, National

Ocean Service, Anchorage, AK.

Fay, F.H., B.P. Kelly, and J.L. Sease. 1989. Managing the exploitation of Pacific walruses: a tragedy of delayed response and poor communication. Marine Mammal Science 5:1-16.

Fay, F.H., B.P. Kelly, P.H. Gehnrich, J.L. Sease, and A.A. Hoover. 1984. Modern populations, migrations, demography, trophics, and historical status of the Pacific Walrus, final report. Outer Continental Shelf Environmental Assessment Program, Institute of Marine Science, University of Alaska-Fairbanks, Fairbanks, AK.

Fay, F.H., J.J. Burns, S.W. Stoker, and J.S. Grundy. 1994. The struck-and-lost factor in Alaskan walrus harvests. Arctic 47:368-373.

Fay, F.H., L.L. Eberhardt, B.P. Kelly, J.J. Burns, and L.T. Quakenbush. 1997. Status of the Pacific walrus Population, 1950-1989. Marine Mammal Science 13:537-565.

Fay, F.H. and S.W. Stoker. 1982a. Analysis of reproductive organs and stomach contents from walruses taken in the Alaskan Native harvest, spring 1980. Final Report. U.S. Fish and Wildlife Service, Anchorage, AK.

Fay, F.H. and S.W. Stoker. 1982b. Reproductive success and feeding habits of walruses taken in the 1982 spring harvest, with comparisons from previous years. Eskimo Walrus Commission, Department of Natural Resources, Kawerak Inc., Nome, AK.

Fedoseev, G.A. 1984. Present status of the population of walruses (*Odobenus rosmarus*) in the eastern Arctic and Bering Sea. Pages 73-85, *In* V.E. Rodin, A.S. Perlov, A.A. Berzin, G.M. Gavrilov, A.I. Shevchenko, N.S. Fadeev, and E.B. Kucheriavenko (eds.), Marine Mammals of the Far East. TINRO, Vladivostok, Russian Federation.

Fedoseev, G.A., and V.N. Gol'tsev. 1969. Age-sex structure and reproductive capacity of the Pacific walrus population. Zoological Journal 48:407-413.

Fedoseev, G.A., and E.V. Razlivalov. 1986. The distribution and abundance of walruses in the eastern Arctic and Bering Sea in autumn 1985. VNIRO, Magadan Branch, Russian Federation.

Fischbach, T.A., D.H. Monson, and C.V. Jay. 2009. Enumeration of Pacific walrus carcasses on beaches of the Chukchi Sea in Alaska following a mortality event, September 2009. U.S. Geological Survey, Open-file Report 2009-1291, Reston, VA.

Garlich-Miller, J., and C.V. Jay. 2000. Proceedings of a workshop concerning walrus survey methods. U.S. Fish and Wildlife Service, Marine Mammals Management, Technical Report 00-2, Anchorage, AK.

Garlich-Miller, J.L., L.T. Quakenbush, and J.F. Bromaghin. 2006. Trends in age structure and productivity of Pacific walruses harvested in the Bering Strait region of Alaska, 1952-2002. Marine Mammal Science 22:880-896.

Garlich-Miller, J., J.G. MacCracken, J. Snyder, M.M. Myers, E. Lance, A. Matz, and J.W. Wilder. 2011*a*. Status of the Pacific walrus (*Odobenus rosmarus divergens*). U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, AK.

Garlich-Miller, J., W. Neakok, and R. Stimmelmayr. 2011*b*. Field report: walrus carcass survey, Point Lay, Alaska September 11-15, 2011. U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, AK.

Gilbert, J.R. 1986. Aerial survey of Pacific walruses in the Chukchi Sea, 1985. Mimeo Report.

Gilbert, J.R. 1989a. Aerial census of Pacific walruses in the Chukchi Sea, 1985. Marine Mammal Science 5:17-28.

Gilbert, J.R. 1989b. Errata: Correction to the variance of products, estimates of Pacific walrus populations. Marine Mammal Science 5:411-412.

Gilbert, J.R. 1999. Review of previous Pacific walrus surveys to develop improved survey designs. Pages 75-84, *In* Garner, G.W., S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald, and D.G. Robertson (eds.), Marine Mammal Survey and Assessment Methods. A. A. Balkema, Rotterdam.

Gilbert, J.R., G.A. Fedoseev, D. Seagars, E. Razlivalov, and A. LaChugin. 1992. Aerial census of Pacific walrus, 1990. U.S. Fish and Wildlife Service, Marine Mammals Management Technical Report 92-1, Anchorage, AK.

Gol'tsev, V.N. 1976. Aerial surveys of Pacific walruses in the Soviet sector during fall 1975. Procedural Report TINRO, Magadan, USSR (Russian Federation).

Gjertz, I., D. Griffiths, B.A. Krafft, C. Lydersen, and Ø Wiig. 2001. Diving and haul-out patterns of walruses *Odobenus rosmarus* on Svalbard. Polar Biology 24:314-319.

Hills, S. and J.R. Gilbert. 1994. Detecting Pacific walrus population trends with aerial survey—a review. Transactions North American Wildlife and Natural Resource Conference 59:201-210.

Hovelsrud, G.K., M. McKenna, and H.P. Huntington. 2008. Marine mammal harvests and other interactions with humans. Ecological Applications 18:S135-S147.

Jay, C.V. 2012. Annual report of 2011 activities under USFWS permit MA801652-6: Pacific walrus. U.S. Geological Survey, Alaska Science Center, Anchorage, AK.

Jay, C.V., B.G. Marcot, and D.C. Douglas. 2011. Projected status of the Pacific walrus (*Odobenus rosmarus divergens*) in the twenty-first century. Polar Biology 34:1065-1084.

Jay, C.V., S.D. Farley, and G.W. Garner. 2001. Summer diving behavior of male walruses in Bristol Bay, Alaska. Marine Mammal Science 17:617-631.

Johnson, A., J. Burns, W. Dusenberry, and R. Jones. 1982. Aerial survey of Pacific walruses, 1980. U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, AK.

Kapsch, M.L., H. Eicken, and M. Robards. 2010. Sea ice distribution and ice use by indigenous walrus hunters on St. Lawrence Island. Pages 115-144, *In* I. Krupnik, C. Aporta, S. Gearheard, G.J. Laidler, and L.K. Holm, (eds.), SIKU: knowing our ice. Documenting Inuit sea-ice knowledge and use. Springer, Dordrecht.

Kavry, V.I., A.N. Boltunov, and V.V. Nikiforov. 2008. New coastal haulouts of walruses (*Odobenus rosmarus*) – response to the climate changes. Pages 248-251, *In* Collection of Scientific Papers from the Marine Mammals of the Holarctic V conference, Odessa, Ukraine, 14-18 October 2008.

Kochnev, A. 2010. Walrus harvest monitoring in Chukotka in 2009. Technical Report. Eskimo Walrus Commission, Department of Natural Resources, Kawerak Inc., Nome, AK.

Kochnev, A.A. Personal Communication. Head of Laboratory of Marine Mammals Study, ChukotTINRO, Pacific Research Institute of Fisheries and Oceanography, P.O. Box 29, Anadyr, Chukotka, 689000, Russian Federation.

Krylov, V.I. 1965. Determination of age, rate of growth, and analysis of the age structure of the catch of the Pacific walrus. Pages 210-211, *In* E.N. Pavlovskii, B.A. Zenkovich, S.E. Kleinenber, and K.K. Chapskii (eds.), Morskie Mlekopitaiushchie. Nauka, Moscow.

Krylov, V.I. 1968. On the present status of stocks of the Pacific walrus and prospects of their rational exploitation. Pages 189-204, *In* V.A. Arsen'ev and K.I. Panin (eds.), Lastonogie Severnoi Chasti Tikhogo Okeana. Pischevaya Promyshlennost', Moscow.

Lydersen, C., J. Aars, and K.M. Kovacs. 2008. Estimating the number of walruses in Svalbard from aerial surveys and behavioral data from satellite telemetry. Arctic 61:119-128.

MacCracken, J.G. 2012. Pacific walrus and climate change: observations and predictions. Ecology and Evolution, in press.

Mansfield, A.W. 1959. The walrus in the Canadian Arctic. Fisheries Research Board of Canada, Circular 2.

National Research Council. 2010. Ocean acidification: a national strategy to meet the challenges of a changing ocean. National Academies Press, Washington, DC.

NMFS (National Marine Fisheries Service). 2005. Revisions to Guidelines for Assessing Marine Mammals Stocks. Available at: http://www.nmfs.noaa.gov/pr/pdfs/sars/gamms2005.pdf.

NOAA (National Oceanic and Atmospheric Administration). 2011. List of fisheries 2012. *Federal Register* 76:73912-73953.

NSIDC (National Snow and Ice Data Center). 2012. Arctic sea ice new and analysis. University of Colorado, Boulder, CO. Available at: http://nsidc.org/arcticseaicenews/.

Oozeva, C., C. Noongwook, G. Noongwook, C. Alowa, and I. Krupnik. 2004. Watching ice and weather our way. Smithsonian Institution Press, Washington.

Ovsyanikov, N.G., I.E. Menyushina, and A.V. Bezrukov. 2008. Unusual Pacific walrus mortality at Wrangel Island in 2007. Pages 413-416, *In* Collection of Scientific Papers from the Marine Mammals of the Holarctic V conference, Odessa, Ukraine, 14-18 October 2008.

Scribner, K.T., S. Hills, S.R. Fain, and M.A. Cronin. 1997. Population genetics studies of the walrus (*Odobenus rosmarus*): a summary and interpretation of results and research needs. *In* A.E. Dizon, S.J. Chivers, and W.F. Perrin (eds.), Molecular Genetics of Marine Mammals. Marine Mammal Science, Special publication 3:173-184.

Sease, J.L. 1986. Historical status and population dynamics of the Pacific walrus. Thesis, University of Alaska-Fairbanks, Fairbanks, AK.

Sease, J.L., and D.G. Chapman. 1988. Pacific walrus (*Odobenus rosmarus divergens*). Pages 17-38, *In* J.W. Lentfer (eds.), Selected Marine Mammals of Alaska: species accounts with research and management recommendations. Marine Mammal Commission, NTIS PB88-178462, Washington, D.C.

Sheffield, G., and J.M. Grebmeier. 2009. Pacific walrus (*Odobenus rosmarus divergens*): differential prey digestion and diet. Marine Mammal Science 25:761-777.

Smith, M. A. 2010. Arctic Marine Synthesis: Atlas of the Chukchi and Beaufort Seas, Audubon Alaska and Oceana, Anchorage, AK.

Speckman, S.G., V.I. Chernook, D.M. Burn, M.S. Udevitz, A.A. Kochnev, C.V. Jay, A. Lisovsky, A.S. Fischbach, and R.B. Benter. 2011. Results and evaluation of a survey to estimated Pacific walrus population size, 2006. Marine Mammal Science 27:514-553.

Udevitz, M.S., J.R. Gilbert, and G.A. Fedoseev. 2001. Comparison of method used to estimate numbers of walruses on sea ice. Marine Mammal Science 17:601-616.

Udevitz, M.S., C.V. Jay, A.S. Fischbach, and J.L. Garlich-Miller. 2009. Modeling haul-out behavior of walruses in Bering Sea ice. Canadian Journal of Zoology 87:1111-1128.

USFWS (U.S. Fish and Wildlife Service). 1994. Conservation plan for the Pacific walrus in Alaska. U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, AK.

USFWS (U.S. Fish and Wildlife Service). 2011. Threatened and endangered plants and animals. 12-month finding for listing the Pacific Walrus (*Odobenus rosmarus divergens*). *Federal Register* 76:7634-7679.

Williams, M. 2010. Personal Communication. World Wildlife Federation.