POLAR BEAR (*Ursus maritimus*): Chukchi/Bering Seas Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Polar bears are circumpolar in their distribution in the northern hemisphere. They occur in several largely discrete stocks or populations (Harington 1968). Polar bear movements are extensive and individual activity areas are enormous (Garner *et al.* 1990, Amstrup *et al.* 2000). The parameters used by Dizon *et al.* (1992) to classify stocks based on the phylogeographic approach were considered in the determination of stock separation in Alaska. Several polar bear stocks are known to be shared between countries (Amstrup *et al.* 1986, Amstrup and DeMaster 1988). Lentfer hypothesized that in Alaska two stocks exist, the Southern Beaufort Sea (SBS) and the Chukchi/Bering seas (CBS), based upon: (a) variations in levels of heavy metal contaminants of organ tissues (Lentfer 1976, Lentfer and Galster 1987); (b) morphological characteristics (Manning 1971, Lentfer 1974, Wilson 1976); (c) physical oceanographic features which segregate the Chukchi Sea and Bering Sea stock from the Beaufort Sea stock (Lentfer 1974); and (d) movement information collected from mark and recapture studies of adult female bears (Lentfer 1974, 1983) (Figure 1). Information on contaminants (Woshner *et al.* 2001, Evans 2004a, Evans 2004b, Kannan *et al.* 2005, Smithwick *et al.* 2005, Verreault *et al.* 2005, Muir *et al.* 2006, Smithwick *et al.* 2006, Kannan *et al.* 2007, Rush *et al.* 2008) and movement data using satellite collars (Amstrup *et al.* 2004, Amstrup *et al.* 2005) continue to support the presence of these two stocks.

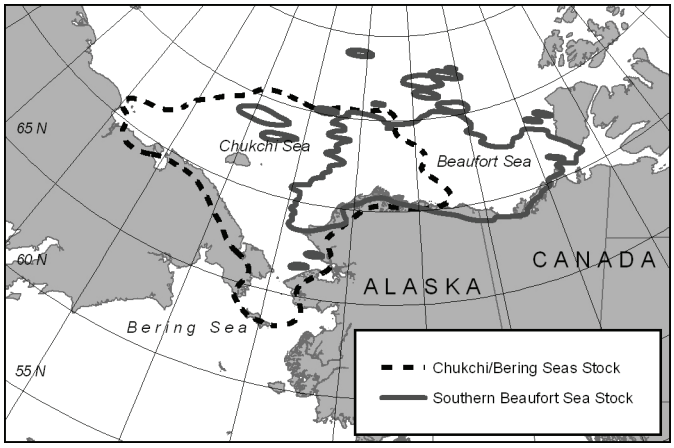

Figure 1. Map of the Southern Beaufort Sea and the Chukchi/Bering seas polar bear stocks.

The CBS population is widely distributed on the pack ice in the Chukchi Sea and northern Bering Sea and adjacent coastal areas in Alaska and Russia. The northeastern boundary of the Chukchi/Bering seas stock is near the Colville Delta in the central Beaufort Sea (Garner *et al.*1990, Amstrup 1995, Amstrup *et al.* 2005) and the western boundary is near Chauniskaya Bay in the Eastern Siberian Sea. The boundary between the Eastern Siberian Sea stock and the Chukchi Sea stock is designated based on movements of adult female polar bears captured in the Bering and Chukchi seas region. Female polar bears initially captured and radio collared on Wrangel Island exhibited no movement into the Eastern Siberian Sea, while female polar bears captured and radio collared in the Eastern Siberian Sea, exhibited only limited short term movement into the western Chukchi Sea (Garner *et al.* 1990). The Chukchi/Bering seas stock extends into the Bering Sea and its southern boundary is determined by the annual extent of pack ice (Garner *et al.* 1990). Adult female polar bears captured from the Southern Beaufort Sea stock may make seasonal movements into the Chukchi Sea in an area of overlap located between Point Hope and Colville Delta, centered near Point Lay (Garner *et al.* 1990, Garner *et al.* 1994, Amstrup 1995, Amstrup *et al.* 2002, Amstrup *et al.* 2005). Probabilistic distribution information for zones of overlap between the Chukchi/Bering seas and the Southern Beaufort Sea population exist (Amstrup *et al.* 2004, Amstrup *et al.* 2005). Telemetry data indicate that these bears, marked in the Beaufort Sea, spend about 25% of their time in the northeastern Chukchi Sea, whereas females captured in the Chukchi Sea spend only 6% of their time in the Beaufort Sea (Amstrup 1995). Average activity areas of females in the Chukchi/Bering seas from 1986–1988 (244,463 km^2, range 144,659–351,369 km^2) (Garner *et al.* 1990) were more extensive than the Beaufort Sea from 1983– 1985 (96,924 km^2, range 9,739–269,622 km^2) (Amstrup 1986) or from 1985–1995 (166,694 km^2, range 14,440–616,800 km^2) (Amstrup *et al.* 2000). Radio collared adult females spent a greater proportion of their time in the Russian region than in the American region (Garner *et al.* 1990). Historically polar bears ranged as far south as St. Matthew Island (Hanna 1920) and the Pribilof Islands (Ray 1971) in the Bering Sea.

Analysis of mitochondrial DNA indicates little differentiation of the Alaska polar bear stocks (Cronin *et al.* 1991, Scribner *et al.* 1997, Cronin *et al.* 2006). Using 16 highly variable micro-satellite loci, Paetkau *et al.* (1999) determined that polar bears throughout the arctic (19 populations) are genetically similar. Genetically, polar bears in the southern Beaufort Sea differed more from polar bears in the Chukchi/Bering seas than from polar bears in the northern Beaufort Sea (Paetkau *et al.* 1999).

While genetically similar, demographic and movement data of the CBS population, indicates a high degree of site fidelity, suggesting that the stocks should be managed separately (Amstrup 2000, Amstrup *et al.* 2000, Amstrup *et al.* 2001a, Amstrup *et al.* 2002, Amstrup *et al.* 2004, Amstrup *et al.* 2005).

Past management has consistently distinguished between the southern Beaufort Sea and the Chukchi/Bering seas stocks. The Inuvialuit of the Inuvialuit Game Council (IGC), Northwest Territories, and the Inupiat of the North Slope Borough (NSB), Alaska, polar bear management agreement for the Southern Beaufort Sea stock was based on stock boundaries described previously (Brower *et al.* 2002, Nageak *et al.* 1991, Treseder and Carpenter 1989) and reaffirmed by the information in this stock assessment report.

POPULATION SIZE

Polar bears typically occur at low densities throughout their circumpolar range (DeMaster and Stirling 1981). It has been difficult to obtain a reliable population estimate for this population due to the vast and inaccessible nature of the habitat, movement of bears across international boundaries, logistical constraints of conducting studies in Russian territory, and budget limitations (Amstrup and DeMaster 1988, Garner *et al.* 1992, Garner *et al.* 1998, Evans *et al.* 2003). The Chukchi Sea population is estimated to comprise 2,000 animals, based on extrapolation of aerial den surveys (Lunn *et al.* 2002). Estimates of the population have been derived from observations of dens and aerial surveys (Chelintsev 1977, Stishov 1991a, Stishov 1991b, Stishov *et al.* 1991); however, these estimates (see below) have wide confidence intervals and are considered to be of little value for management and cannot be used to evaluate status and trends for this population.

Minimum Population Estimate

A reliable population estimate for the Chukchi/Bering seas stock currently does not exist. Lentfer, in the Administrative Law Judge (ALJ) proceeding to waive the Marine Mammal Protection Act of 1972 (MMPA) moratorium on taking and return management to the State of Alaska (ALJ 1977), estimated the size of the Chukchi/Bering seas population stock (Wrangel Island to western Alaska) at 7,000, and Chapman estimated the Alaska population (both stocks) at 5,550 to 5,700 (ALJ 1977). Lentfer and Chapman's estimates (ALJ 1977), however, were not based on rigorous statistical analysis of population data and variance estimates could not be calculated. Amstrup *et al.* (1986) estimated densities (1976–129 km^2/bear, 1981–211 km^2/bear) based on mark and recapture of 266 polar bears near Cape Lisburne on the Chukchi Sea, but a population estimate for the Chukchi Sea was not developed at that time. An August 2000 aerial survey of polar bears in the Eastern Chukchi Sea resulted in density estimates of (0.00748 bear/km^2, or 147 km^2/bear, C.V. = 0.38) (Evans *et al.* 2003). A population estimate was not derived from this density since the study area included only a portion of the total area used by the population.

Amstrup and DeMaster (1988) estimated the Alaska population (both stocks) at 3,000 to 5,000 animals based on densities calculated previously by Amstrup *et al.* (1986). The area that the estimate applied to and the variance associated with the estimate were not provided for in the 1988 population estimate (Amstrup and DeMaster 1988). A crude population estimate for the Chukchi/Bering seas stock of 1,200 to 3,200 animals was derived by subtracting the Beaufort Sea population estimate of 1,800 animals (Amstrup 1995) from the total Alaska statewide estimate of 3,000 to 5,000 (Amstrup and DeMaster 1988). The IUCN Polar Bear Specialist Group (IUCN 2006) estimated this population to be approximately 2,000 animals based on extrapolation of multiple years of denning data for Wrangel Island, assuming that 10% of the population dens annually as adult females. However, confidence in this estimate is low due to the lack of current denning estimates and reliable data with measurable levels of precision (IUCN 2006). Nonetheless, an N_{MIN} of 2,000 is the best available information we have at this time.

Current Population Trend

Prior to the 20th century, when Alaska's polar bears were hunted primarily by Alaskan Natives, both stocks probably existed at near carrying capacity (K). The size of the Beaufort Sea stock declined substantially in the late 1960's and early 1970's (Amstrup *et al.* 1986) due to excessive sport harvest. Similar declines could have occurred in the Chukchi Sea, although there are no population data to support this assumption. Since passage of the MMPA, the southern Beaufort Sea population grew during the late 1970's and 1980's and then stabilized during the 1990's (Amstrup *et al.* 2001b). Based on demographic data 2001 to 2006, the overall population growth rate in the Southern Beaufort Sea population declined approximately 0.3% per year (Hunter *et al.* 2007). Until 1992 it is likely that the Chukchi/Bering seas stock mimicked the growth pattern and later stability of Southern Beaufort Sea stock, since both

stocks experienced similar management and harvest histories. However, since 1992 the CBS population has faced different stressors than the SBS population. These include increased harvest in Russia (150 – 250 bears/yr) (Kochnev 2006, Ovsyanikov 2006, Eduard Zdor personal communication) and greater loss of summer sea ice habitat from global warming (Overland and Wang 2007), which suggest that using the growth rate for the Southern Beaufort Sea may not be applicable. The status of the Chukchi/Bering seas stock was listed as data deficient (Aars *et al.* 2006) due to the lack of abundance estimates with measurable levels of precision. The population is believed to be declining and the status relative to historical levels is believed to be reduced based on harvest levels that were demonstrated to be unsustainable in the past.

MAXIMUM NET PRODUCTIVITY RATES

Polar bears are long lived, mature at a relatively old age, have an extended breeding interval, and have small litters (Lentfer *et al.* 1980, DeMaster and Stirling 1981). Population/stock specific data to estimate R_{MAX} are not available for the Chukchi/Bering seas polar bear stock. The Southern Beaufort Sea is one of four polar bear populations with long-term data sets and as it overlaps with the Chukchi/Bering seas stock using the default value for R_{MAX} for the Southern Beaufort Sea seems reasonable as it is based on empirical data. Survival rates for the Southern Beaufort Sea stock (Regehr *et al.* 2006), which can be used in a Leslie matrix model, suggest that under optimal conditions and in the absence of human perturbations the population could increase at a rate of between 4 and 6%. Amstrup (1995) projected an annual intrinsic growth rate (including natural mortality but not human-caused mortality) of 6.03% for the Southern Beaufort Sea stock using a Leslie type matrix of recapture data. Since the Chukchi/Bering seas area is one of the most productive areas in the Arctic using the 6.03% for the Chukchi/Bering seas polar bear stock seems reasonable.

POTENTIAL BIOLOGICAL REMOVAL (PBR)

Under the 1994 reauthorized MMPA, the potential biological removal (PBR) level is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $(N_{MIN})(½\ R_{MAX})(F_R)$. Wade and Angliss (1997) recommend a default recovery factor (F_R) of 0.5 for a threatened population or when the status of a population is unknown. We used 0.5 as the recovery factor since reliable population estimates to assess population trends are not available. In the following calculation: $(N_{MIN})(½\ R_{MAX})(F_r)$ = PBR (Wade and Angliss 1997) the minimum population estimate, N_{MIN} was 2,000; the maximum rate of increase R_{MAX} was 6.03%; and the recovery factor F_R was 0.50. Therefore, the PBR level for the Chukchi/Bering seas stock is 30 bears per year. However, confidence in these numbers is low due to dated and extrapolated population information and, therefore, the PBR value has little utility for management purposes.

ANNUAL HUMAN CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Polar bear stocks in Alaska have no direct interaction with commercial fisheries activities. Consequently, the total fishery mortality and serious injury rate for the Chukchi/Bering seas stock is zero.

Alaska Native Subsistence Harvest

Historically, polar bears have been killed for subsistence, handicrafts, and recreation. Based on records of skins shipped from Alaska for 1925–53, the estimated annual statewide harvest averaged 120 bears, taken primarily by Native hunters. Recreational hunting by non-native sports hunters using aircraft was common from 1951–72, increasing statewide annual harvest to 150 during 1951–60 and to 260 during 1960–72 (Amstrup *et al.* 1986, Schliebe *et al.* 1995). Hunting by non-Natives has been prohibited since 1973 when provisions of the MMPA went into effect. This reduced the mean annual statewide harvest for both populations to 98 during 1980–2007 (SD=40; range 48–242) (USFWS unpublished data). The annual harvest from the Chukchi/Bering seas stock was 92/year in the 1980s, 49/year in the 1990s, and 43/year in the 2000s. More recently, the 2003−2007 average Alaska harvest for the Chukchi/Bering seas stock in Alaska was 37 and the sex ratio was 66M:34F.

Under the MMPA, an exemption was made for Alaska Natives living in coastal communities to allow them to hunt polar bears for subsistence and making of handicrafts provided that the hunt was not done in a wasteful manner. Recently, harvest levels by Alaska Natives from the Chukchi/Bering seas stock have been declining (Figure 2). The sex ratio of known-sex bears harvested since 1980 has remained relatively consistent at 66% males and 34% females (Schliebe *et al.* 2006).

The number of unreported kills in Alaska since 1980 to the present time is approximately 7% based on: (a) tagging information; (b) interviews with local hunters; and (c) law enforcement investigations. No user agreement, similar to that between the Inuvialuit and Inupiat for the Beaufort Sea stock, exists for the Bering/Chukchi stock. Harvest levels are not limited at this time.

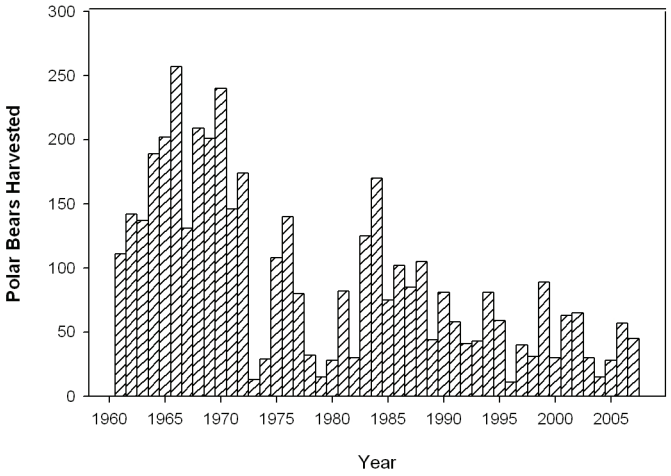

Figure 2. Annual Alaska polar bear harvest from the Chukchi/Bering Seas stock, 1961-2007.

Other Removals

Russia prohibited all hunting of polar bears in 1956 in response to perceived population declines caused by over-harvest. In Russia, only a small number of animals, less than 3–5 per year, were removed for placement in zoos prior to 1986 (Uspenski 1986) and a few were killed in defense of life. No bears were taken for zoos or circuses from 1993 to 1995 (Belikov 1998). The occurrence of increased takes of problem bears in Chukotka was acknowledged in 1992, and Belikov (1993) estimated that up to 10 problem bears were killed annually in all of the Russian Arctic. Increased illegal hunting of polar bears in the Russian Arctic was also recognized to have begun in 1992. While the magnitude of the illegal harvest in Russia from the Chukchi/Bering seas stock is unquantified, reports indicate that a substantial number of bears, 150–250/yr (Kochnev 2006), or alternatively 120–150/yr (Eduard Zdor pers. comm.), are being harvested. Combining the reported Chukotka harvest with the documented Alaska harvest indicates that up to 200 bears may have been harvested from this population in many years. Harvest levels similar to these are believed to have caused population depletion by the early 1970s. Belikov *et al.* (2006) indicated that the current level of poaching in Russia poses a serious threat to the population. No serious injuries, other than the mortalities discussed here, have been reported for the Chukchi/Bering seas stock.

No orphaned cubs from the Alaskan Chukchi/Bering seas stock were placed in zoos since 2002. Illegal harvest has not been detected in Alaska. Oil and gas exploration in the Bering/Chukchi region of Alaska, began again in 2006, primarily during the open water season has resulted in minimal interaction with polar bears; there was no evidence of mortality or serious injury.

STATUS OF STOCK

Polar bears in the Chukchi/Bering seas stock are currently classified as depleted under the MMPA and listed as threatened under the U.S. Endangered Species Act of 1973 (ESA) as amended. Reliable estimates of the minimum population, PBR level, and human-caused mortality or serious injury in Chukotka are currently not available

The ongoing level of the subsistence hunting in western Alaska and Chukotka is a concern. There is no incidental mortality or serious injury of polar bear in any U.S. commercial fishery. The primary concerns for this population are habitat loss resulting from climate change, potential over-harvest, human activities including industrial activities occurring within the near-shore environment, and potential effects of contaminants on nutritionally stressed populations. The Chukchi/Bering seas polar bear stock is designated as a strategic stock because the population is listed as threatened under the ESA.

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. Polar bears from Chukchi/Bering seas stock seasonally use the shallow, productive, ice-covered waters of the eastern Chukchi Sea for feeding, breeding, and movements. The Fish and Wildlife Service (USFWS) works to monitor and mitigate potential impacts of oil and gas activities on polar bears through incidental take regulations (ITR) as authorized under the Marine Mammal Protection Act. Activities operating under these regulations must adopt measures to: ensure that the total of such incidental taking of polar bears remains 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

Polar bears evolved over thousands of years to life in a sea ice environment. They depend on the sea ice-dominated ecosystem to support essential life functions. Sea ice provides a platform for hunting and feeding, for seeking mates and breeding, for movement to terrestrial maternity denning areas and occasionally for maternity denning, for resting, and for long-distance movements. The sea ice ecosystem supports ringed seals, the primary prey for polar bears, and other marine mammals that are also part of their prey base.

Sea ice is rapidly diminishing throughout the Arctic and large declines in optimal polar bear habitat have occurred in the Southern Beaufort and Chukchi Seas between the two time periods, 1985–1995 and 1996–2006 (Durner et al 2009). In addition, it is predicted that the greatest declines in 21st century optimal polar bear habitat will occur in Chukchi and Southern Beaufort Seas (Durner *et al.* 2009a). Patterns of increased temperatures, earlier onset of and longer melting periods, later onset of freeze-up, increased rain-on-snow events, and potential reductions in snowfall are occurring. In addition, positive feedback systems (i.e., the sea-ice albedo feedback mechanism) and naturally occurring events, such as warm water intrusion into the Arctic and changing atmospheric wind patterns, can operate to amplify the effects of these phenomena. As a result, there is fragmentation of sea ice, a dramatic increase in the extent of open water areas seasonally, reduction in the extent and area of sea ice in all seasons, retraction of sea ice away from productive continental shelf areas throughout the polar basin, reduction of the amount of heavier and more stable multi-year ice, and declining thickness and quality of shore-fast ice (Parkinson et al 1999, Rothrock *et al.* 1999, Comiso 2003, Fowler *et al.* 2004, Lindsay and Zhang 2005, Holland *et al.* 2006, Comiso 2006, Serreze *et al.* 2007, Stroeve *et al.* 2008).

The Chukchi/Bering seas and the Southern Beaufort Sea population stocks are currently experiencing the initial effects of changes in sea ice conditions (Rode *et al.* 2007, Regehr *et al.* 2007, Hunter *et al.* 2007). These populations are vulnerable to large-scale dramatic seasonal fluctuations in ice movements, decreased abundance and access to prey, and increased energetic costs of hunting. The USFWS is working on measures to protect polar bears and their habitat.

Subsistence Harvest

Past differences in management regimes between the United States and Russia have made coordination of studies on the shared Alaska-Chukotka polar bear population difficult. In the former Soviet Union, hunting of polar bears was banned nationwide in 1956. Recently, Russia's ability to enforce that ban has been difficult due to logistical and financial constraints. In Alaska, subsistence hunting of polar bears by Alaska Natives is currently unrestricted under section 101(b) of the MMPA provided that the take is for subsistence purposes or creating authentic articles of Alaska Native handicrafts and conducted in a non-wasteful manner. While several joint research and management projects have been successfully undertaken in the past between the United States and Russia, today comparable efforts are either no longer occurring or are unilateral in scope.

The bilateral "Agreement between the United States and the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population (Agreement)" was signed by the governments of the United States and the Russian Federation on October 16, 2000, with subsequent advice and consent provided by the U.S. Senate. Among other provisions the Agreement recognizes the needs of Native people to harvest polar bears for subsistence purposes and includes provisions for developing sustainable harvest limits, allocation of the harvest between jurisdictions, and compliance and enforcement. Each jurisdiction is entitled to up to one-half of a harvest limit to be determined by a future the joint Commission. The Agreement reiterates requirements of the 1973 multi-lateral agreement and includes restrictions on harvesting denning bears, females with cubs, or cubs less than one year old, and prohibitions on the use of aircraft, large motorized vessels, and snares or poison for hunting polar bears.

On January 12, 2007, President Bush signed into law H.R. 5946, the "Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006." This Act includes Title X implementing the Agreement. This action allows for the establishment of the commission and development of enforceable harvest management agreements. The Russian Federation and the United States have completed documents necessary to implement the Agreement within Russia and the United States. The USFWS is currently developing recommendations for the Bilateral Commission that will direct research and establish sustainable and enforceable harvest limits needed to address current potential population declines due to over-harvest of the population.

CITATIONS

Aars, J., N.J. Lunn, and A.E. Derocher. eds. 2006. Polar bears: proceedings of the 14th working meeting of the IUCN/SSC Polar Bear Specialist Group, 20-24 June, Seattle, Washington, USA. IUCN, Gland, Switzerland. 189 pp.

Administrative Law Judge. 1977. Environmental Impact Statement: Consideration of a waiver of the moratorium and return of management of certain marine mammals to the State of Alaska. 2 Volumes.

Amstrup, S.C. 1986. Research on polar bears in Alaska, 1983-1985. pp. 85-115. In Proceedings of the Ninth Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Edmonton, Canada. IUCN, Gland, Switzerland, and Cambridge, U.K. 152 pp.

Amstrup, S.C. 1995. Movements, distribution, and population dynamics of polar bears in the Beaufort Sea. Ph.D. Dissertation. University of Alaska Fairbanks. Fairbanks, Alaska, 299 pp.

Amstrup, S.C. 2000. Polar Bear. In The Natural History of an Oil Field: Development and Biota. Edited by J.C. Truett and S.R. Johnson. Academic Press, Inc., New York, New York, USA pp. 133-157.

Amstrup, S.C., and D.P. DeMaster. 1988. Polar bear, *Ursus maritimus*. Pages 39-45 in J.W. Lentfer, ed. Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations. Marine Mammal Commission, Washington, D.C.

Amstrup, S.C., I. Stirling, and J.W. Lentfer. 1986. Past and present status of polar bears in Alaska. Wildlife Society Bulletin. 14:241-254.

Amstrup, S.C., G. Durner, I. Stirling, N.J. Lunn, and F. Messier. 2000. Movements and distribution of polar bears in the Beaufort Sea. Canadian Journal of Zoology. 78:948-966.

Amstrup, S.C., G.M. Durner, T.L. McDonald, D.M. Mulcahy, and G.W. Garner. 2001a. Comparing movement patterns of satellite-tagged male and female polar bears. Canadian Journal of Zoology. 79:2147-2158.

Amstrup, S.C., T.L. McDonald, and I. Stirling. 2001b. Polar bears in the Beaufort Sea: A 30-year mark-recapture case history. Journal of Agricultural, Biological, and Environmental Statistics Vol.(2): 221-234.

Amstrup, S.C., G. M. Durner, A. S. Fischbach, K. Simac, and G. Weston-York. 2002. Polar Bear Research in the Beaufort Sea. pp. 109-125. In N. Lunn, E. W. Born, and S. Schliebe (eds). Proceedings of the Thirteenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Nuuk, Greenland. IUCN, Gland, Switzerland, and Cambridge, U.K. vii + 153 pp.

Amstrup, S.C., T.L. McDonald, and G.M. Durner. 2004. Using satellite radiotelemetry data to delineate and manage wildlife populations. Wildlife Society Bulletin. 32:661-679.

Amstrup, S.C., G.M. Durner, I. Stirling, and T.L. McDonald. 2005. Allocating harvests among polar bear stocks in the Beaufort Sea. Arctic. 58:247-259.

Belikov, S.E. 1993. Status of polar bear populations in the Russian Arctic 1993. pp. 115-121. In Ø. Wiig, G.W. Garner (eds.), Proceedings of the Eleventh Working Meeting of the IUCN/SSC Polar Bear Specialist Group. IUCN, Gland, Switzerland, and Cambridge, U.K. v + 192 pp.

Belikov, S.E. 1998. Research and management of polar bear populations in the Russian Arctic. pp. 113-114. In A.E. Derocher, G. Garner, N. Lunn, and Ø. Wiig (eds). Proceedings of the Twelfth Working Meeting of the IUCN/SSC Polar Bear Specialist Group. 3-7 February, 1997. Oslo, Norway. IUCN, Gland, Switzerland, and Cambridge, U.K. v + 159 pp.

Belikov, S.E., A.N. Boltunov, N.G. Ovsianikov, G.I. Belchanskiy, and A.A. Kochnev. 2006. Polar bear management and research in Russia 2000-2004. pp. 153-155. In J. Aars, N.J. Lunn, and A.E. Derocher (eds.), Proceeding of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 20-24 June 2005, Seattle, Washington, U.S.A. IUCN, Gland, Switzerland, and Cambridge, U.K.

Brower, C.D., A. Carpenter, M. Branigan, W. Calvert, T. Evans, A.S. Fischbach, J. Nagy, S. Schliebe, and I. Stirling. 2002. The polar bear management agreement for the Southern Beaufort Sea: An evaluation of the first ten years of a unique conservation agreement. Arctic 56:362-372.

Chelintsev, N.G. 1977. Determination of the absolute number of dens based on the selective counts. Pp. 66-85, In Uspenski, S.M. (ed.). The polar bear and its conservation in the Soviet Arctic. Moscow, Central Laboratory on Nature Conservation. (in Russian with English summary).

Comiso, J.C. 2003. Warming trends in the Arctic from clear sky satellite observations. Journal of Climate 16:3498-3510.

Comiso, J.C. 2006. Arctic warming signals from satellite observations, Weather 61(3):70-76.

Cronin, M.A., S.C. Amstrup, G.W. Garner, and E.R. Vyse. 1991. Interspecific and intraspecific mitochondrial DNA variation in North American bears (Ursus). Canadian Journal of Zoology. 69:12:2985-2992.

Cronin, M.A., S.C. Amstrup, K.T. Scribner. 2006. Microsatellite DNA and mitochondrial DNA variation in polar bears (*Ursus maritimus*) in the Beaufort and Chukchi seas, Alaska. Canadian Journal of Zoology 84:655-660.

DeMaster, D.P., and I. Stirling. 1981. *Ursus maritimus*. Mammalian Species: 1-7.

Dizon, A.E., C. Lockyer, W.F. Perrin, D.P. DeMaster, and J. Sisson. 1992. Rethinking the stock concept: a phylogeographic approach. Conservation Biology 6:24-36.

Durner, G.M., D.C. Douglas, R.M. Nielson, S.C. Amstrup, T.L. McDonald, I. Stirling, M. Mauritzen, E.W. Born, Ø. Wiig, E. DeWeaver. M.C. Serreze, S.E. Belikov, M.M. Holland, J. Maslanik, J. Aars, D.C. Bailey, and A.E. Derocher. 2009. Predicting 21st century polar bear habitat distribution from global climate models. Ecological Monographs 79(1): 25-58.

Evans, T.J. 2004a. Concentrations of selected essential and non-essential elements in adult male polar bears (*Ursus maritimus*) from Alaska. U.S. Fish and Wildlife Service Technical Report. MMM 04-02. 68pp.

Evans, T. J. 2004b. PCBs and chlorinated pesticides in adult male polar bears (*Ursus maritimus*) from Alaska. U.S. Fish and Wildlife Service Technical Report. MMM 04-01. 61pp

Evans, T.F., A.S. Fischbach, S. Schliebe, B. Manley, S. Kalxdorff, and G. York. 2003. Polar bear aerial survey in the Eastern Chukchi Sea: A Pilot Study. Arctic 56(4):359-366.

Fowler, C., W.J. Emery and J. Maslanik. 2004. Satellite-derived evolution of Arctic sea ice age: October 1978 to March 2003. Geoscience and Remote Sensing Letters, IEEE, Volume 1, Issue 2, April 2004. pp.71–74.

Garner, G.W., S.T. Knick, and D.C. Douglas. 1990. Seasonal movements of adult female polar bears in the Bering and Chukchi seas. International Conference on Bear Research and Management 8:219-226.

Garner, G.W., L.L. McDonald, D.S. Robson, D.P. Young Jr., and S.M. Arthur. 1992. Literature review: population estimation methodologies applicable to the estimation of abundance of polar bears. Internal Report, U.S.F.W.S. 102 pp.

Garner, G.W., S.E. Belikov, M.S. Stishov, V.G. Barnes, and S.A. Arthur. 1994. Dispersal patterns of maternal polar bears from the denning concentration on Wrangel Island. International Conference on Bear Research and Management 9(1):401-410.

Garner, G.W., M.S. Stishov, Ø. Wiig, A. Boltunov, G.I. Belchansky, D.C. Douglas, L.L. McDonald, D.M. Mulcahy, and S. Schliebe. 1998. Polar bear research in western Alaska, eastern and western Russia 1993-1996. pp. 125-129. In A.E. Derocher, G. Garner, N. Lunn, and Ø. Wiig (eds.), Proceedings of the Twelfth Working Meeting of the IUCN/SSC Polar Bear Specialist Group. 3-7 February, 1997. Oslo, Norway. IUCN, Gland, Switzerland, and Cambridge, U.K. v + 159 pp.

Hanna, G.D. 1920. Mammals of the St. Matthew Islands, Bering sea. Journal of Mammalogy 1:118-122.

Harington, C.R. 1968. Denning habits of the polar bear (*Ursus maritimus* Phipps). Canadian Wildlife Service Report, Series 5. 33 pp.

Holland, M., C.M. Bitz, and B. Tremblay. 2006. Future abrupt reductions in summer Arctic sea ice. Geophysical Research Letters 33 L25503: doi 10.1029/200661028024: 1-5.

Hunter, C.M., H. Caswell, M.C. Runge, E.V. Regehr, S.A. Amstrup, and I. Stirling. 2007. Polar bears in the Southern Beaufort Sea II: Demography and population growth in relation to sea ice conditions. U.S. Geological Survey, Alaska Science Center, Administrative Report. 46 pp.

IUCN. 2006. Status of the polar bear. pp. 33-56 in J. Aars J., N.J. Lunn, and A.E. Derocher (eds.), Proceedings of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Seattle, United States. IUCN, Gland, Switzerland, and Cambridge, U.K.

Kannan, K., S.H. Yun, and T.J. Evans. 2005. Chlorinated, brominated, and perfluorinated contaminants in livers of polar bears from Alaska. Environmental Science and Technology. 39:9057-9063.

Kannan, K., T. Agusa, T.J. Evans, and S. Tanabe. 2007. Trace element concentrations in livers of polar bears from tow population in northern and western Alaska. Archives of Environmental Contaminants and Toxicology 53:473-482.

Kochnev, A.A. 2006. Research on polar bear autumn aggregations on Chukotka, 1989-2004. pp. 157-166. In J. Aars, N.J. Lunn, and A.E. Derocher (eds.) Proceeding of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 20-24 June 2005, Seattle, Washington, U.S.A. IUCN, Gland, Switzerland, and Cambridge, U.K.

Lentfer, J.W. 1974. Discreteness of Alaskan polar bear populations. Proceedings of the International Congress of Game Biologists 11:323-329.

Lentfer, J.W. 1976. Environmental contaminants and parasites in polar bears. Alaska Department of Fish and Game, Pittman-Robertson Project Report. W-17-4 and W-17-5. 22 pp.

Lentfer, J.W. 1983. Alaskan polar bear movements from mark and recovery. Arctic 36:282-288.

Lentfer, J.W., and W.A. Galster. 1987. Mercury in polar bears from Alaska. Journal of Wildlife Diseases 23:338-341.
Lentfer, J.W., R.J. Hensel, J.R. Gilbert, and F.E. Sorensen. 1980. Population characteristics of Alaskan polar bears. International Conference on Bear Research and Management 3: 109-115.
Lindsay, R.W., and J. Zhang. 2005. The thinning of the Arctic sea ice, 1988-2003: have we passed a tipping point? J. Climate 18:4879-4894.
Lunn, N.J., S. Schliebe, and E.W. Born, eds. 2002. Polar bears: Proceedings of the 13th working meeting of the IUCN/SSC Polar Bear Specialist Group. IUCN, Gland, Switzerland, and Cambridge, U.K. vii +153pp.
Manning, T.H. 1971. Geographical variation in the polar bear *Ursus maritimus* Phipps. Canadian Wildlife Service Report Series No. 13. 27 pp.
Muir, D.C.G., S. Backus, A.E. Derocher, R. Dietz, T.J. Evans, G.W. Gabrielsen, J. Nagy, R.J. Norstrom, C. Sonne, I. Stirling, M.K. Taylor, and R.J. Letcher. 2006. Brominated flame retardants in polar bears (*Ursus maritimus*) from Alaska, the Canadian Arctic, East Greenland and Svalbard. Environmental Science and Technology 40(2):449-455.
Nageak, B.P., C.D.N. Brower, and S.L. Schliebe. 1991. Polar bear management in the southern Beaufort Sea: An Agreement between the Inuvialuit Game Council and the North Slope Borough Fish and Game Committee. In Transactions of North American Wildlife and Natural Resources Conference 56:337-343.
Ovsyanikov, N.G. 2006. Research and conservation of polar bears on Wrangel Island. Pp. 167-171, In J. Aars, N.J. Lunn, and A.E. Derocher (eds.), Proceeding of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 20-24 June 2005, Seattle, Washington, U.S.A. IUCN, Gland, Switzerland, and Cambridge, U.K.
Overland, J.E., and M. Wang. 2007. Future regional Arctic sea ice declines. Geophysical Research Letters 34: L17705.
Paetkau, D., S.C. Amstrup, E.W. Born, W. Calvert, A.E. Derocher, G.W. Garner, F. Messier, I. Stirling, M.K. Taylor, Ø. Wiig, and C. Strobeck. 1999. Genetic Structure of the world's polar bear populations. Molecular Ecology 8:1571-1584.
Parkinson, C.L., D.J. Cavalieri, P. Gloersen, H.J. Zwally, and J.C. Comiso. 1999. Arctic sea ice extents, areas, and trends, 1978-1996. Journal of Geophysical Research 104(C9):20837-20856.
Ray, C.E. 1971. Polar bear and mammoth on the Pribilof Islands. Arctic 24:9-19.
Regehr, E.V., S.C. Amstrup, and I. Stirling. 2006. Polar bear population status in the Southern Beaufort Sea. Report Series 2006-1337, U.S. Department of the Interior, U.S. Geological Survey, Anchorage, Alaska. 55 pp.
Regehr, E.V., C.M. Hunter, H. Caswell, S.C. Amstrup, and I. Stirling. 2007. Polar bears in the Southern Beaufort Sea I: Survival and breeding in relation to sea ice conditions, 2001-2006. U.S. Geological Survey, Alaska Science Center, Administrative Report. 45 pp.
Rode, K.D., S.C. Amstrup, and E.V. Regehr. 2007. Polar Bears in the southern Beaufort Sea III: stature, mass, and cub recruitment in relationship to time and sea ice extent between 1982 and 2006. U.S. Dept. of the Interior, U.S. Geological Survey Administrative Report, Reston, Virginia. 28 pp.
Rothrock, D.A., Y. Yu, and G.A. Maykut. 1999. Thinning of the Arctic sea-ice cover, Geophysical Research Letters 26:3469-3472.
Rush, S.A., K. Borga, R. Dietz, E.W. Born, C. Sonne, T. Evans, D.C.G. Muir, R.L. Letcher, R.J. Norstrom, and A.T. Fisk. 2008. Geographic Distribution of selected elements in the livers of polar bears from Greenland, Canada, and the United States. Environmental Pollution 153 (3): 618-626.
Schliebe, S.L., S.C. Amstrup, and G.W. Garner. 1995. The status of polar bear in Alaska, 1993. Pp. 125-139, In Ø. Wiig, G.W. Garner (eds.), Proceedings of the Eleventh Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Copenhagen, Denmark. IUCN, Gland, Switzerland, and Cambridge, UK. v + 192 pp.
Schliebe, S., T.J. Evans, S. Miller, C. Perham, J. Wilder, and L.J. Lierheimer. 2006. Polar bear management in Alaska 2000-2004. Pp. 63-76, In J. Aars, N.J. Lunn, and A.E. Derocher (eds.), Proceeding of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 20-24 June 2005, Seattle, Washington, U.S.A. IUCN, Gland, Switzerland, and Cambridge, U.K.
Scribner, K.T., G.W. Garner, S.C. Amstrup, and M.A. Cronin. 1997. Population genetic studies of the polar bear (*Ursus maritimus*): a summary of available data and interpretation of results. Pp. 185-196, In Dizon, S., J. Chivers, and W. Perrin (eds.), Molecular genetics of marine mammals, incorporating the proceedings of a workshop on the analysis of genetic data to address problems of stock identity as related to management of marine mammals. Spec. Pub. #3 of the Society of Marine Mammalogy.
Serreze, M.C., M.M. Holland, and J. Stroeve. 2007. Perspectives on the Arctic's shrinking sea-ice cover. Science 315: 1533-1536.

Smithwick, M., J.W. Martin, S.A. Mabury, K. Solomon, C. Sonne, E.W. Born, R. Dietz, A.E. Derocher, R.L. Letcher, T.J. Evans, G.W. Gabrielsonm, J. Nagy, I. Stirling, and D.C.G. Muir. 2005. A circumpolar study of perfluoroalkyl contaminants in polar bears (*Ursus maritimus*). Environmental Science and Technology 39(15):5517-5523.

Smithwick, M.J., R.J. Norstrom, S.A. Maybury, K. Solomon, T.J. Evans, I. Stirling, M.K. Taylor, and D.C.G. Muir. 2006. Temporal trends of perfluoroalkyl contaminants in polar bears (*Ursus maritimus*) from two locations in the North American Arctic, 1972 -2002. Environmental Science and Technology. 40(4):1139-1143.

Stishov, M.S. 1991a. Results of aerial counts of the polar bear dens on the arctic coast of the extreme Northern Asia. Pp. 90-92, In Amstrup, S.C., and Wiig, Ø. (eds.), Polar Bears: Proceedings of the Tenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group. IUCN, Gland, Switzerland, and Cambridge, U.K.

Stishov, M.S. 1991b. Distribution and number of polar bear maternity dens on Wrangel and Herald islands, in 1985-1989, pp. 91-115 in Amerirkhavov, A.M. (ed.), Population and Communities of Mammals on Wrangel Island. Moscow, CNIL Glavokhhoty RSFSR. (in Russian).

Stishov, M.S., G.W. Garner, S.M. Arthur, and V.G.B. Barnes Jr. 1991. Distribution and relative abundance of maternal polar bear dens in the Chukotka Peninsula region, U.S.S.R. p. 67 in Abstracts, Ninth Biennial Conference on the Biology of the Marine Mammals, 5-9 December 1991, Chicago, Illinois, U.S.A.

Stroeve, J., M. Serreze, S. Drobot, S. Gearheard, M. Holland, J. Maslanik, W. Meier, and T. Scambos. 2008. Arctic Sea Ice Extent Plummets in 2007. EOS, Transactions, American Geophysical Union 89(2):13-14.

Treseder, L., and A. Carpenter. 1989. Polar bear management in the Southern Beaufort Sea. Info. N. 15(4):2-4.

USFWS. Unpublished data (polar bear harvest information). Available from: USFWS Marine Mammals Office, 1011 East Tudor Road, Anchorage, AK 99503.

Uspenski, S.M. 1986. Research and management of polar bear populations in the USSR, 1981-85. Pages 133-136 in Proceedings of the Ninth Working Meeting of the IUCN/SSC Polar Bear Specialist Group, IUCN, Gland, Switzerland, and Cambridge, U.K.

Verrault, J., D.C.G. Muir, R.J. Norstrom, I. Stirling, A.T. Fisk, G.W. Gabrielsen, A.E. Derocher, T.J. Evans, R. Dietz, C. Sonne, G.M. Sandala, W. Gebbink, F.F. Riget, E.W. Born, M.K. Taylor, J. Nagy, and R.J. Letcher. 2005. Chlorinated hydrocarbon contaminants and metabolites in polar bears (*Ursus maritimus*) from Alaska, Canada, East Greenland, and Svalbard: 1996-2002. The Science of the Total Environment 351-352:369-390.

Wade, P.R., and R. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report in the GAMMS Workshop, April 3-5, 1996, Seattle, WA. 93 pp.

Wilson, D.E. 1976. Cranial variation in polar bears. International Conference Bear Research and Management 3:447-453.

Woshner, V.M., T.M. O'Hara, G.R. Bratton, and V.R. Beasley. 2001. Concentrations and interactions of selected essential and non-essential elements in ringed seals and polar bears of Arctic Alaska. Journal of Wildlife Diseases. (37):711-721.

Zdor, Eduard. Personal Communication. Executive Director, Association of Traditional Marine Mammal Hunters of Chukotka.