DRAFT

STATUS ASSESSMENT IN RESPONSE TO A PETITION TO LIST POLAR BEARS AS A THREATENED SPECIES UNDER THE U.S. ENDANGERED SPECIES ACT

Prepared and Edited

By

Tentative list of contributors

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STATUS ASSESSMENT OF THE POLAR BEAR (*Ursus maritimus*)

I. Introduction to Polar Bear Status Assessment

On February 16, 2005, the Center for Biological Diversity (CBD) filed a petition with the U.S. Fish and Wildlife Service (Service) to list the polar bear (*Ursus maritimus*) as threatened throughout its range, pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). On July 5, 2005, Natural Resources Defense Council and Greenpeace, Inc. joined CBD as petitioners.

Section 4(b)(3)(A) of the Act requires that we make a finding on whether a petition to list a species presents substantial scientific or commercial information indicating that the petitioned action may be warranted. To the maximum extent practicable, this finding is to be made within 90 days of receipt of the petition, and the finding is to be published promptly in the *Federal Register*. On February 9, 2006, the Service published a positive 90-day finding in the *Federal Register* (meaning that we determined that the petition did present substantial scientific or commercial information that listing the polar bear under the Act may be warranted), and promptly initiated a status review of the species as required under the Act (71 FR 6745).

The purpose of the status review/assessment is to obtain, synthesize, and evaluate the best available scientific and commercial data on the status of the polar bear and threats thereto. Information in the status assessment is to form the basis for the next finding the Act requires the Service to make, the 12-month finding that the petitioned action is either: (1) warranted; (2) not warranted; or (3) warranted but precluded.

To ensure that the status review would be complete and based on the best available scientific and commercial information, we solicited information from the public on the status of the polar bear in two separate public comment periods announced in the *Federal Register* (71 FR 6745 and
71 FR 28653). The draft status assessment is being subjected to rigorous peer review in accordance with Office of Management and Budget and Service policy and guidelines. [Place holder for names and affiliations of peer reviewers]

Comment: Add dates of FR Notices

This document constitutes the Service's "Assessment of the Status of the Polar Bear (*Ursus maritimus*) in Response to a Petition to List the Species as Threatened under the Endangered Species Act." It is intended to be a detailed and comprehensive assessment of the status of knowledge of the species and threats thereto.

II. Population Ecology and Characteristics of Taxon

A. Taxonomy

Polar bears have a number of common names, among them are nanook, nanuq, ice bear, sea bear, isbjorn, white bears, and eisbär.

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Phipps (1774) first proposed and described the polar bear as a species distinct from other bears and provided a scientific name *Ursus maritimus*. A number of alternative namings followed: Pallas (1776) *Ursus marinus*: Shaw (1792) *Ursus polaris*; Knotterus-Meyer (1908) *Thallassarctos eogroenlandicus, Thalassarctos labrodorensis,* and *Thalassacrostos jenaensis.* Erdbrink (1953) and Thenius (1953) used *Ursus (Thalarctos) maritimus*, since interbreeding between grizzly/brown bears (*Ursus arctos*) and polar bears had been observed in zoos. Kurten (1964) examined the fossil evidence and suggested that polar bears originated from brown bears in Siberia during glacial ice advances of the mid-Pleistocene period. Recent genetic research has confirmed that polar bears evolved from brown bears (Shields and Kocher 1991, Cronin et al.

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Interechanging the use of grizzly and brown bear for U. arctos may become confusing for some. It might be worth explaining the situation in parentheses here or in a footnote. Also, it might be best to use just one name as much as possible, I would suggest using grizzly.

1991, and Talbot and Shields 1996). Kurten (1964) and Manning (1971) agreed that different populations of polar bears represent a single species. Kurten (1964) described the last Pleistocene occurrence of a subspecies, *Ursus maritimus tyrannus*, which was much larger than recent fossils. Harrington (1966), Manning (1971), and Wilson (1976) subsequently promoted the use of the name *Ursus maritimus*, that has been used since. The polar bear is usually considered a marine mammal since its primary habitat is the sea ice (Amstrup 2003), and it was included in those species covered under the Marine Mammal Protection Act of 1972.

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B. General description

Polar bears are characterized by large body size and a stocky form. Polar bears have a longer neck and proportionally smaller head than other members of the bear family, and are missing the distinct shoulder hump common to grizzly bears. Fur color varies between white, yellow, grey, or almost brown, and is affected by oxidation, i.e. exposure to the air, light conditions, and soiling or staining due to contact with fats obtained from prey items. The nose, lips, and skin of polar bears are black. (Demaster and Stirling 1981, Amstrup 2003)

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Polar bears are the largest of the living bear species (DeMaster and Stirling 1981). Polar bears exhibit sexual dimorphism with female body length and skull size being considerably smaller and body mass considerably less than that of males (Derocher et al. 2005). Adult males have been recorded weighing 654 kg (1440 pounds) (Kolenosky et al. 1992), with some individuals too large for the weighing equipment, estimated at 800 kg (1760 pounds) (DeMaster and Stirling 1981). Adult females weigh 181 to 317 kg (400-700 pounds). Adult males range in length from 2.4 to 3.4m (8-11 feet) and adult females range in length from 1.8 to 2.4m (6-8 feet) (FWS 1998; Stirling, 1998). Manning (1971) described a cline in body size of polar bears extending from Spitzbergen, where bears are the smallest, to the Bering Strait, where they are the largest. Presumably the general cline in body size is similar across the Russian high arctic.

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C. Ecological Adaptations

Polar bears are believed to have originated from a group of grizzly bears which became isolated during the glacial periods of the mid-Pleistocene approximately 250,000 years ago (Kurten 1964). Only in portions of northern Canada and northern Alaska do the ranges of polar bears and grizzly bears overlap. Cross breeding of grizzly bears and polar bears in captivity have dproduce reproductively viable offspring (Gray 1972). The first documented case of cross breeding in the wild was reported in the spring of 2006. A sport hunter in the Canadian southern Beaufort Sea region harvested a hybrid and genetic testing by Wildlife Genetics International (May 2006) confirmed breeding between a polar bear female and grizzly bear male had occurred.

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Evolutionary adaptations by polar bears to life on sea ice include: a white pelage with water repellent guard hairs and dense under-fur; a short furred snout; small ears; teeth specialized for a carnivorous rather than an omnivorous diet; and feet with hair on the bottoms (FWS 1998; Stirling 1998). Polar bears have large, paddle-like feet (Stirling 1998) that probably assist in swimming and also help to disperse weight and avoid breaking through when walking on thin ice (Stirling 1998). Polar bear claws are shorter and more strongly curved than those of grizzly bears, and larger and heavier than those of black bears, and appear to be well adapted to traveling over blocks of ice and snow and to securely gripping prey animals (Amstrup 2003). Polar bear teeth have evolved significantly from those of their grizzly bear ancestor (Amstrup 2003). Their teeth are better suited to grab prey and eat fat from the meat and hide and less well suited for grinding grasses or other vegetation (Amstrup 2003).

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Polar bears are well adapted for thermoregulation in the extreme cold conditions of the Arctic. Normal body temperature of a resting polar bear is 37°C (98.6° F), quite similar to other mammals (Best 1982; Stirling 1998). Additionally a combination of fur and hide properties, and up to 11 centimeters (4.5 in.) of blubber all serve as excellent insulators and operate to maintain body temperature and metabolic rate at near normal levels even at environmental temperatures of -37° C (-34° F) (Stirling 1998 H), however, polar bears are susceptible to overheating (Best 1982 Stirling 1998).

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Polar bears radiate heat from their muzzle, nose, ears, footpads, and insides of the thighs, and also, apparently, from blood vessels in the shoulder region which lie only a few millimeters under the skin (Stirling 1998). Polar bears can also cool off by swimming, since water conducts heat about 20 times more efficiently than air (Stirling 1998). For young cubs, however, swimming may be dangerous if it chills their body too much (Stirling 1998). Bears also conserve body temperature by curling into a ball when exposed to extremely cold, windy weather, or sprawl out to keep cool on warm days (Stirling 1998). Bears in warm areas like Hudson Bay also move very little in the summer in order to stay cool and conserve energy (Stirling 1998).

Unlike other species of bears, where both sexes may hibernate, only pregnant female polar bears hibernate through the winter (Stirling 1998; Amstrup 2000). This is specialized winter dormancy with a slightly depressed heart rate and temperature, during which time the bear does not feed and lives off its accumulated fat stores (Stirling 1998; Amstrup 2003).

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Male and female polar bears can also enter a state termed "walking hibernation" at any time of year when food supplies are scarce, a trait not found in any other bear species (Stirling and Øritsland 1995; Stirling 1998; Amstrup 2003). During walking hibernation the bear's metabolism is similar to that of hibernation and facilitates significant energy conservation (Stirling and Øritsland 1995; Amstrup 2003). Both sexes and all age groups may use temporary dens ("shelters") during periods with inclement weather and winter darkness (REFERENCE

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D. Distribution

Polar bears evolved to take advantage of the Arctic sea-ice environment and are distributed throughout most ice-covered seas of the Northern Hemisphere. Their range is limited to areas where the sea is ice covered for much of the year; however, polar bears are not evenly distributed throughout areas of ice coverage. They are most abundant near shore and in other areas where currents and ocean upwellings increase productivity and serve to keep the ice cover from becoming too solidified in winter (Stirling and Smith 1975; Stirling et al. 1981; Amstrup and

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DeMaster1988; Stirling 1990; Stirling and Øritsland 1995; Stirling and Lunn 1997; Amstrup et al. 2000).

Over most of their range, polar bears remain on the sea-ice year-round or spend only short periods on land. They occur throughout the East Siberian, Laptev, and Kara Seas of Russia and the Barents Sea of northern Europe. They are found in FramFrams Strait and east coast of , the Greenland, Denmarks Strait, the Davis Strait, Baffin Bay, Kane Basin, as well as through most of the Canadian Arctic archipelago, and in the Chukchi and Beaufort Seas north and west of Alaska. In most areas, pregnant females come ashore in the fall to create a den in snow drifts in which to give birth. Following emergence from these maternal dens female polar bears will return to the sea ice as soon as their cubs are able. In some areas, notably the Beaufort and to a limited extent the Chukchi Seas of the polar basin, females may den and give birth to their young on shorefast ice ordrifting pack ice (Amstrup and Gardner 1994).

The distribution of polar bears in most areas varies with the seasonal extent of sea-ice cover and availability of prey. In Alaska in the winter, sea-ice may extend 400 km south of the Bering Strait, and polar bears will extend their range to the southernmost extreme of the ice (Ray 1971). Sea-ice disappears from the Bering Sea and is greatly reduced in the Chukchi Sea in the summer, and polar bears occupying these areas may migrate as much as 1000 km to stay with the pack ice (Garner et al. 1990, 1994). Throughout the polar basin, during the summer polar bears generally concentrate along the ice edge or into the adjacent persistent pack ice. Significant northerly and southerly movements appear to be dependent on seasonal melting and refreezing of ice (Amstrup et al. 2000). In other areas, for example, Hudson Bay, James Bay, Davis Strait, Baffin Bay, and portions of the Canadian High Arctic, when the sea-ice melts polar bears are forced onto land for up to several months while they wait for winter and new ice to form (Jonkel et al. 1976; Schweinsburg 1979; Prevett and Kolenosky 1982; Schweinsburg and Lee 1982; Ferguson et al. 1997; Lunn et al. 1997).

Ddistribution patterns for some populations during the open water and early fall seasons have changed in recent years. In the Beaufort Sea, greater numbers of polar bears (up to 200

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individuals) are being found on shore during this period than at any previous time (Schliebe et al. in prep). The exact reason(s) for the change in distribution are uncertain and may involve a number of factors, although a statistically significant positive relationship exists between the number of bears using the coast and the distance the pack ice is from shore--. Radio telemetry data in the sSouthern Beaufort Sea indicate that polar bears are shifting their activity areas during the summer and fall (Durner et al. in prep), apparently in response to ice that is retreating farther from shore than it has in previous years. Gleason and Monnett (in prep.) analyzed fall bowhead whale aerial survey data collected from 1979 to 2005 and observed an easterly and northerly shift in distribution of polar bears in the Alaska Beaufort Sea, apparently in response to changing ice conditions. Durner et al. (in prep.) also noted a significant trend of increased use of land and water habitats by polar bears during the later period of the aerial surveys.

In Baffin Bay, Davis Strait, wWestern Hudson Bay and other areas of Canada, Inuit hunters are reporting an increase in the numbers of bears present on land (Dowsley and Taylor, 2006a 2006b). In many instances, the hunters believe this is a result of increased population size. In an extensively studied polar bear population with a long time series of capture data in wWestern Hudson Bay; however, data analysis indicates that this population has in fact edfrom 1,194 bears in 1987 to 935 bears in 2004declining and the distribution pattern appears to be changing (Regehr et al. in prep). Distribution changes in response to recently recorded extreme ice retractions in areas such as the Chukchi Sea and other populations are undoubtedly occurring, yet remain unquantified by telemetry or aerial survey data.

The Polar Bear Specialist Group (PBSG) has classified 19 polar bear populations (Fig. 1) for the purposes of management. Scientists have defined these populations worldwide based on decades of intensive scientific studies of patterns in spatial segregation determined by telemetry data, survey and reconnaissance, marking and tagging studies, and traditional knowledge (Stirling and Taylor 1999, Lunn et al. 2002). Each of the 19 populations is considered to be discrete based on behavioral and ecological factors. Furthermore, genetic variation among polar bear populations is correlated with these movement data, reinforcing the appropriateness of the population designations (Paetkau et al. 1999; Amstrup 2003). There is considerable overlap in areas

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occupied by members of these populations, and boundaries separating the populations have been adjusted as new data were collected. re is some uncertainty about the discreetness ofThe the central polar basin population because radiotelemetry data suggest bears occurring deep in the polar basin are simply occasional visitors from adjacent areas.

E. Movements and Home Ranges

Data from telemetry studies show that polar bear movements are not random, nor do they followwith the ocean currents as previously thought (Pedersen 1945). Mmovement data come almost exclusively from only adult female polar bears because male anatomy (their neck is larger than their skull) will not accommodate radio collars. The movements of seven male polar bears surgically implanted with transmitters in 1996 and 1997 were compared to movements of 104 females between 1985 and 1995 (Amstrup et al. 2001). Males and females had similar activity areas on a monthly basis, however males traveled farther each month. Annual activity areas of females varied from year to year, howevermost femaleshad an area of overlap each year, that are used over multiple years(Amstrup et al. 2000). Activity areas combinedcompiled over multiyear periods could be considered as home ranges. The smaller activity areas used within the larger home ranges vary annuallyyear possibly due to sea-ice habitat quality, which also varies annually (Stirling and Smith 1975; Ferguson et al. 1997, 1998, 2000a, 2000b; DeMaster et al. 1980; Amstrup et al. 2000, Taylor et al. 2001,).

In Alaska, radio-collared polar bears are closely associated with pack ice. In the Chukchi and Beaufort Sea areas of Alaska and northwestern Canada, only 7% of the polar bear locations obtained were on land (Amstrup et al. 2000; Amstrup, USGS, unpublished data). The majority of the land locations were locations with bears occupying maternal dens during the winter. A similar pattern has been reported for East Greenland (Wiig et al. 2003). In the absence of ice during the summer season some populations of polar bears in eastern Canada and Hudson Bay have developed a strategy of remaining on land for protracted periods of time until ice again forms and provides a platform for traveling and huntingthem to move to sea.

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The areal extent of home ranges and the annual movements within home ranges varies among spopulation. Most Canada populations are bounded and constricted by land masses of the high Arctic aArchipelago, whereas populations in Russia, Alaska, and Greenland are only bounded on the southern periphery by land masses or in the case of the Chukchi or Barents seas populations, by the southerly maximal position of pack ice. Consequently, the size of home ranges can generally be determined by geographical land mass boundaries.

Activity areas have not been determined for many of the populations. In the Beaufort Sea, annual activity areas for individually monitored female bears averaged 149,000 km^2 and ranged from 13,000 km^2 to 597,000 km^2 (Amstrup et al. 2000). The mean activity area in the Chukchi Sea, characterized by highly dynamic ice conditions, was 244,463 km^2 (Garner et al. 1990). The average annual distance moved by Chukchi Sea female bears was 5,542 km. Schweinsburg and Lee (1982) reported smaller activity areas of <23,000 km^2 in the Canadian Arctic Archipelago. Spring movements averaged 14.1 km/day to the north at a time when ice was advancing 15.5 km/day in the opposite direction (Garner et al. 1990). Huge annual home ranges of individual bears and movement in the dynamic pack ice often against the direction of the movement of the pack ice have also been reported for polar bears in East Greenland (Born et al. 1997, Wiig et al. 2003). Ferguson et al. (1999) also reported large-scale movements for polar bears in highly dynamic sea-ice conditions of Davis Strait and Baffin Bay, and smaller movements for bears in the interior of the Canadian Arctic Archipelago. The mobility of polar bears appears to be directly related to variability in ice dynamics in specific areas (Garner et al. 1990, 1994; Gloersen et al. 1992; Messier et al. 1992).

In regard to the timing of movements, Messier et al. (1992) reported that peak movement rates of polar bears in Viscount Melville Sound in the Canadian High Arctic aArchipelago occurred from May to July. Ferguson et al. (2001) reported high movement rates in spring and summer in the High Arctic, and Messier et al. (1992) reported increasing mobility from January through spring in the Canadian Arctic. In contrast, (Amstrup et al. 2000) reported that polar bears in the Beaufort Sea were most mobile in winter and early summer. The lower level of winter

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movement of bears of Viscount Melville Sound result from the presence of multiyear ice year-round (Gloersen et al. 1992), and foraging opportunities are restricted to particular areas which bears key to quickly. Also, lower rates of movement may indicate an energy conservation mode invoked when food is scarce (Amstrup et al. 2000).

The high variability of summer and autumn ice could affect seal hunting opportunities. This unpredictability may require longer movements and larger activity areas during seasons of freeze-up and break-up. Patterns of movement to the north and south appeared to be correlated with general patterns of ice formation and melting. (Stirling 1990; Amstrup et al. 2000; Wiig et al. 2003).

Between May and August, the ice of the southern Beaufort Sea is degrading (Gloersen et al. 1992). October is usually the month of freeze-up in the southern Beaufort Sea and may be the first time in months when ice is available over the more productive shallow water near-shore. Polar bears summering on the persistent pack ice quickly move into shallow-water areas as soon as new annual ice forms in autumn, and they disperse easterly and westerly as ice solidifies through winter.

In the Beaufort Sea, total annual movements for individual female bears averaged 3,415 km and ranged up to 6,200 km. Movement rates of >4 km/hr were sometimes sustained for long periods, and movements of >50 km/day were observed (Amstrup et al. 2000).

F. Feeding Habits

The polar bear diet is strictly carnivorus, unlike other bear species that are typically omnivores, and they are an upper level predator of the Arctic marine ecosystem. Polar bears prey heavily throughout their range on ringed seals (*Phoca hispida*) and, to a lesser extent, bearded seals (*Erignathus barbatus*) and in some locales, other seal species. Although seals are their primary prey, polar bears also have been known to kill much larger animals such as walruses (*Odobenus*

Comment Does Gloersen et al. 1992 have anything about bears??

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Is there data that shows this actually happens? If so, provide the reference.

Comment : The ability to conserve energy by reducing energy expended is an important adaptation that allows polar bears to be successful in a habitat like Hudson Bay where they forego feeding for long periods of time. It might be good to describe this ability in more detail as it may allow polar bears to be more successful in dealing with changes in their habitats than is thought they will be.

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rosmarus) and belugas (*Delphinapterus leucas*) (Stirling and Archibald 1977; Kiliaan et al. 1978; Smith 1980, 1985; Lowry et al. 1987; Calvert and Stirling 1990). In some areas and under some conditions, prey other than seals may be quite important to polar bear sustenance. Stirling and Øritsland (1995) suggested that in areas where ringed seal populations were reduced, other prey species were being substituted. Like other ursids, polar bears will eat human garbage (Lunn and Stirling 1985), and when confined to land for long periods they will consume coastal marine and terrestrial plants and other terrestrial foods, but t). The significance of other terrestrial foods to polar bears may be limited (Lunn and Stirling 1985; Derocher et al. 1993). Lunn et al. (1985) found that in the case of polar bears in Canada's Churchill area; however, alternative foods such as the Churchill dump could play an important role in physical condition of some individuals.

Other studies (Iverson et al. 2006) indicate that polar bears may shift feeding preferences, presumably based on the availability of seal species. Overall, polar bears are most effective as predators of young ringed seals, possibly because young seals are naive with regard to predator avoidance. In spring, polar bears may concentrate on capturing new-born ringed seal pups (Smith and Stirling 1975; Smith 1980). Predation on pups may be extensive regionally. Hammill and Smith (1991) estimated that polar bears annually kill up to 44% of new born seal pups. Beyond the pupping season, polar bears mainly prey on young seals from the first two year classes (Stirling et al. 1977a; Smith 1980).

Polar bears have high digestive efficiency for protein (84%) and fat (97%) comprising an average energy utilization of 92% of the food consumed (Stirling 1998; Best 1985). On average an adult polar bear needs approximately 11 lbs (2 kg) of seal fat per day to survive (Stirling 1998). This nutrition must be obtained, and stored as fat, primarily during times of the year when prey is abundant and available (Stirling 1998). They prefer the fat of seals to muscle and other tissues and consume it first (Stirling 1974). Because over half of the calories in a whole seal carcass may be in the fat (Stirling and McEwan 1975), a bear that quickly consumes the fat has maximized its caloric return. Also, the digestion of fat releases water (Nelson et al. 1983) while

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digestion of meat/protein requires water. By eating fat, bears maximize water intake and minimize the energetic cost associated with digesting ice and snow (Nelson 1981).

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In the Beaufort Sea, polar bears have recently developed a habit of gathering each year at the butchering sites of bowhead whales (*Balaena mysticetus*) that are killed by local native people. The value of this alternate food is apparently great, as nearly every bear seen near whale carcasses in autumn is large and appears to be in good condition (Miller et al. 2006).

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G. Reproduction

Polar bears are characterized by a late age of sexual maturity, small litter sizes, and extended parental investment in raising young, factors that combine to contribute to a very low reproductive rate. Intrinsic rates of recruitment are difficult to estimate for the species. Taylor et al. (2004) estimated the rate of increase for Baffin Bay without a harvest to be 5.5% per annum. Reproduction in the female polar bear is similar to that in other ursids. They enter a prolonged estrus between March and June, when breeding occurs. Ovulation is thought to be induced by mating (Wimsatt 1963; Ramsay and Dunbrack 1986; Derocher and Stirling 1992). Lønø (1970) reported that breeding pairs were observed as early as 8 March and as late as 20 June. Histological evidence of testes and ovaries indicates that breeding could last into July (Lønø 1970). Implantation is delayed until autumn, and total gestation is 195–265 days (Uspenski 1977), although during most of this time, active development of the fetus is suspended. The timing of implantation, and therefore the timing of birth, is likely dependent on body condition of the female, which depends on a variety of environmental factors. In East Greenland, the peak of the mating season was apparently somewhat earlier and shorter than reported for Svalbard (i.e. was late May – late May; Rosing-Asvid et al. 2003).

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Comment It is first stated that the reproductive rate of polar bears is very low and then two examples of ca. 6% annual rate of increase are given. That seems to me a little contradictory. 6% net increase per year for a triennial breeders is not that bad at all. I suggest that a sentence be inserted that states that the 6% are maximum net increase rates!

The exact timing of birth may vary across the range of polar bears. Harington (1968) reported births as early as 30 November with a median date of 2 December. Derocher et al. (1992) reported that births of Hudson Bay bears probably occur from mid-November through mid-

December. Messier et al. (1994) suggested that polar bears give birth by 15 December. In the Beaufort Sea many pregnant females did not enter dens until late November or early December (Amstrup and Gardner 1994) and a later date of birth is assumed. Newborn polar bears are helpless, have hair, but are blind and weigh only 0.6 kg (Blix and Lentfer 1979). Cubs grow rapidly, and may weigh 10–12 kg by the time they emerge from the den in the spring. Young bears will stay with their mothers until weaning, which occurs most commonly in early spring when the cubs are 2.5 years of age. Female polar bears are available to breed again after their cubs are edweaning. Therefore, in most areas, the minimum successful reproductive interval for polar bears is 3 years.

Age of maturation in polar bear populations appears to be largely dependent on numbers and productivity of ringed seals. For example, in the Beaufort Sea, ringed seal densities are lower than in some areas of the Canadian High Arctic or Hudson Bay. As a possible consequence, female polar bears in the Beaufort Sea usually do not breed for the first time until they are 5 years of age (Stirling et al. 1976; Lentfer and Hensel 1980). This means they give birth for the first time at age 6. In contrast, in many areas of Canada females reach maturity at age 4 and produce their first young at age 5 (Stirling et al. 1977b, 1980, 1984; Ramsay and Stirling 1982, 1988; Furnell and Schweinsburg 1984).

Derocher et al. (1992) calculated an average age of first breeding in the Hudson Bay area of 4.1 years. Cub production, assessed by estimated pregnancy rates, remained high between 5 and 20 years of age and declined thereafter (Derocher et al. 1992). Average age of first reproduction and pregnancy rates declined in the 1990s in Hudson Bay with corresponding declines in population size (Stirling et al. 1999, Reghr et al. in prep).

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1. Litter size and production rate

Just as with age of first reproduction, litter size and litter production rate vary by geographic area and are expected to change with population size relative to carrying capacity. Furthermore, litter size may change in response to hunting pressure, environmental factors and other population perturbations. Litters of two cubs are most common. Litters of three cubs are seen sporadically across the Arctic, and most commonly reported in the Hudson Bay region (Stirling et al. 1977b; Ramsay and Stirling 1988; Derocher and Stirling 1992). The average litter size encountered during multiple studies throughout the range of polar bears varies from 1.4 to 1.8 cubs. Evidence of a link between availability of seal prey and reproduction in polar bears has been documented for areas in the northerly parts of their range. Body weights of mothers and their cubs decreased markedly in the mid-1970s in the Beaufort Sea following a decline in ringed and bearded seal populations (Stirling et al. 1976, 1977b; Kingsley 1979; DeMaster et al. 1980; Stirling et al. 1982; Amstrup et al. 1986). Declines in reproductive parameters varied by region and date with the severity of ice conditions and corresponding reduction in numbers and productivity of seals (Amstrup et al. 1986).

In the Beaufort Sea, females produce a litter of cubs at an annual rate of 0.25 litters per adult female (Amstrup 1995). In early years in Hudson Bay, females produced a litter of cubs at the rate of 0.45 litters per adult female (Derocher and Stirling 1992). Annual litter production rate in the Hudson Bay region declined from 0.45 litters/female in the period 1965–1979 to 0.35 during 1985–1990 (Derocher and Stirling 1992).

Polar bears may “defer” reproduction in favor of survival when foraging conditions are difficult (Derocher et al. 1992). A complete reproductive effort is energetically expensive for polar bears. When energetically stressed, female polar bears may forgo reproduction rather than risk incurring the energetic costs and consequent reduced physical fitness of a potentially unsuccessful reproductive process. The reproductive cycle lends itself to convenient early termination and may occur without extensive energetic investment on the part of the female (Ramsay and Dunbrack 1986; Derocher and Stirling 1992). Persistent deferral of reproduction would cause a declining population trend in a population with an intrinsically low rate of growth.

2. Reproductive maturity and senescence.

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As far as I know there was no documentation of a decline in bearded seal populations at this time. In fact, there weren't any efforts to measure bearded seal population size.
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Age of maturation in mammals is often associated with attainment of a threshold body mass (Sadleir 1969), which could be more difficult to attain as competition for resources increases or resources diminish or become less accessible. Historically the average age for first reproduction in adult female polar bears is 5 to 6 years of age. Craighead and Mitchell (1982:527) reported that in grizzly bears "reproductive longevity approximates physical longevity." Until recently, data from long-term monitoring regarding reproductive senescence of individual polar bears was unavailable or had not been analyzed. Richardson et al. (2006) analyzed data from Western Hudson Bay and found that based on micro-satellite genetic markers reproductive senescence in female and male polar bears was associated with the beginning of survival senescence. For females this occurred at about 20 years of age and for males it occurred at about 17 years of age. Senescence in females resulted in reductions in litter size, cub mass, and the proportion of females with young.

H. Survival

Polar bears are long-lived mammals. The oldest known wild female polar bear was 32 years of age and the oldest known wild male was 28, though few live to be older than 20 (Stirling 1990, 1998). The longest-lived captive bear lived to be 41 years old in a zoo in London. (Stirling 1998). Due to extremely low reproductive rates polar bears require a high rate of survival to maintain population levels. Taylor et al. (unpublished data, 2002, 2005, 2006 in press) describes survival rates that vary by age class and population, which e from 35-75% for cubs-of-the-year, 63-98% for 1-4 year old bears, 95-99% for adults age 5-20; and 72-99% for adults greater than 20 years of age (Table 2). High survival rates are necessary required for population growth or stability for a species with inherently low productivity potential.

In general, spproximately 20 years ofCubs-of-the-year have the lowest survival rates. In the Hudson Bay region during the 1980s, the survival rate of more than 200 cubs from spring through the ice-free period of autumn was 44% (Derocher and Stirling 1996). In the Beaufort

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Sea, survival of cubs was approximately 65% from den exit to the end of their first year of life. Survival of Hudson Bay cubs from their first to their second autumn was 35% (Derocher and Stirling 1996). Survival of cubs is dependent on their weight (Derocher and Stirling 1992). Annual survival of yearlings ranged from 43% to 53%. Yearling survival rates improved with 86% surviving to weaning (Amstrup and Durner 1995). Most cub mortality occurred early in the period after emergence from the den (Amstrup and Durner 1995; Derocher and Stirling 1996). Derocher and Stirling (1996) suggested that a heavy harvest accounted for much of the yearling mortality in Hudson Bay. Elsewhere, early age mortality is thought to be associated with starvation (Derocher and Stirling 1996).

Survival of cubs to weaning stage, generally 27-28 months, is estimated to range from 15% to 56% of births. In one Hudson Bay study only 15% of the cubs born survive through their second autumn. This differs from a 56% survival from birth to weaning of cubs in the Beaufort Sea. Even at the higher survival rates approximately 50% of the cubs do not survive to the subadult stage. Survival rates for subsadult are poorly understood becausetelemetry collars cannot be used on rapidly growing individuals and measuring survival over time by other means is problematic. Ppopulation age structure data indicate that subadults aged 2–5 years survive at lower rates than adults (Amstrup 1995), probably because their hunting and survival skills are not fully developed. Eberhardt (1985) hypothesized that adult survival must be in the upper 90% range to sustain polar bear populations. Survival estimates derived from Hudson Bay, where the intensity of marking exceeds all other study areas, have ranged between 0.86 and 0.90 (Derocher and Stirling 1995a; Lunn et al. 1997). Recentsudies estimated that survival of adult females in prime age groups may exceed 96 (Amstrup and Durner 1995)%.

Polar bears that avoid serious injury may become too old and feeble to catch food, and in a stable environment most are generally believed to die of old age. Local and widespread climatic phenomena that make seals less abundant or less available also can significantly affect polar bear populations (Stirling et al. 1976; Kingsley 1979; DeMaster et al. 1980; Amstrup et al. 1986).

Injuries sustained in fights over mates or in predation attempts can lead to mortalities of polar bears. In an extensive review of ursid parasites, Rogers and Rogers (1976) found that seven

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endoparasites had been reported in polar bears. Only *Trichinella* spp., however, had been observed in wild polar bears. Certain species of nematodes and cestodes reported in captive polar bears have not occurred in the wild. *Trichinella* can be quite common in polar bears and has been observed throughout their range. Concentrations of this parasite in some tissues can be high, but infections are not normally fatal (Rausch 1970; Dick and Belosevic 1978; Larsen and Kjos-Hanssen 1983; Taylor et al. 1985).

III. HABITAT CHARACTERISTICS

A. SEA ICE

Sea ice is the defining characteristic of the marine Arctic. "Approximately two-thirds of the Arctic is ocean, including the Arctic Ocean and its shelf seas plus the Nordic, Labrador, and Bering seas" (AICA 2005). The two primary forms of sea ice are seasonal (or first year) ice and perennial (or multi-year) ice. Seasonal ice is in its first winter of growth or first summer of melt. Its thickness in undeformed floes ranges from a few tenths of a meter near the southern margin of ice extentcryosphere to 2.5 m in the high Arctic at the end of winter. Some first-year ice survives the summer and becomes multi-year ice. This ice develops its distinctive hummocky appearance through thermal weathering, becoming harder and almost salt-free over several years. In the present climate, old multi-year ice floes that have not been deformed by pressure ingridges are about 3 m thick at the end of winter. The extent of sea ice decreases from roughly 15 million km^2 in March to 7 million km^2 in September, as much of the first-year ice melts during the summer (Parkinson et al., 1999). The area of multi-year sea ice, mostly over the Arctic Ocean basins, the East Siberian Sea, and the Canadian polar shelf, is about 5 million km^2 (Johannessen et al., 1999). Land-fast ice (or fast ice) may be present in some areas for up to 10 months each year depending on coastal geometry or persistence of grounded ice ridges (stamukhi). Within the Canadian Archipelago in late winter, land-fast ice covers channels up to 200 km wide and covers an area of 1 million km^2. Some of this ice is trapped for decades as multi-year land-fast ice (Reimnitz et al., 1995). Land-fast ice may create habitat for some

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I think this would be better if organized with subsections something like: a) sea ice habitats; b) open water habitats; c) terrestrial habitats; d) weather factors (snow, rain, wind); e) prey; f) likely impacts of climate change on polar bear habitats. That would link much better with the way I've suggested arranging section V.A. (see pages 74-76).

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species (e.g., ringed seal); may facilitate the formation of polynyas in some areas, and may impede navigation in others (e.g., the Northwest Passage).

Sea ice is an important component of the climate system. It provides insulation between the ocean and atmosphere and reflects back toward space most of the solar radiation reaching it. Its impacts extend far south of the Arctic, perhaps globally, e.g., through impacting deepwater formation that influences global ocean circulation. Ice flow in the Arctic often includes a clockwise circulation of sea ice within the Canada Basin and a transpolar drift stream that carries sea ice from the Siberian shelves to the Barents Sea and Fram Strait. (The European-most portion of the clockwise circulation merges with the Arctic portion of the transpolar drift stream.) On average, 10% of Arctic sea ice exits through Fram Strait each year. Sea ice also leaves the Arctic via Nares Strait and Smith Sound between NW Greenland and Ellesmere Island in High Arctic Canada, from whence it flows into Baffin Bay, joining in situ seasonal sea ice in Baffin Bay and drifting south along the Labrador coast. The remnants reach Newfoundland in March. At the ice edge in this location, the supply of sea ice from the north balances the loss by melt in the warm ocean waters. Similar "conveyor belt" sea-ice regimes also exist in the Barents, Greenland and Bering Seas, where northern regions of growth export ice to temperate waters. A small amount of ice exits the Arctic through the narrow Bering Strait.

Arctic marine ecosystems are unique in having a very high proportion of shallow water and coastal shelves. In common with terrestrial and freshwater ecosystems in the Arctic, they experience strong seasonality in sunlight and temperatures and are also influenced by freshwaters delivered mainly by the large rivers flowing into the Arctic Ocean mainly from Siberia. Ice cover is an important physical characteristic, affecting heat exchange between water and atmosphere, light penetration to organisms in the water below, and providing a biological habitat above, within, and beneath the ice. The marginal ice zone, at the edge of the pack ice, is important for plankton production and plankton-feeding fish. In general, arctic marine ecosystems are relatively simple, productivity and biodiversity are low, and species are long-lived and slow growing. The simplicity of arctic marine ecosystems, together with the

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Comment: Page: 25 They really aren't unique--there are many other areas of extensive shallow water and depending on how you draw boundaries they could have similar of greater proportions of shallow water.

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specialization of many of its species, makes them potentially quite sensitive to environmental changes.

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1. Polar bear-ice relationships - general

Polar bears are distributed throughout the ice-covered waters of the circumpolar Arctic (Stirling 1998), and are reliant on the sea ice as their primary habitat (Amstrup 2005). Polar bears depend on sea ice as a substrate to hunt and eat upon seals, seek mates and breed, make long-distance movements to terrestrial maternity denning areas or sometimes for maternity denning to (Stirling and Derocher 1993). Polar bear distributions are not uniform throughout the Arctic, but depend upon the type of sea ice and its location and extent over time, availability of prey, and reproductive status (Durner et al. 2004). Mauritzen et al. (2003) indicated that habitat use by polar bears during certain seasons may involve a trade-off between selecting habitats with abundant prey availability versus the use of safer, retreat habitats with less prey. Their findings indicate that population distribution may not be solely a reflection of prey availability, but instead other factors may operate to influence distributions.

The sea ice environment is highly dynamic and follows cyclical patterns of expansion and contraction annually. Movements of sea ice are related to winds, currents, and seasonal temperature fluctuations that promote its formation and degradation. A number of systems exist to classify sea ice (NOAA 2000). These systems generally categorize the stage of development, form, concentration, and type of ice. Stirling et al. (1993) defined seven types of sea-ice habitat and classified polar bear use of these ice types based on the presence of bears or tracks in order to determine habitat preferences. The seven types of sea ice were: stable fast ice with drifts; stable fast ice without drifts; floe edge ice; moving ice; continuous stable pressure ridges; coastal low level pressure ridges; and j [spell either as fjord or fiord, but be consistent; 'fiord' is used on p.26] fjords and bays. In another assessment of polar bear – habitat relationships the authors categorized ice types/zones in Alaska as follows: pack ice; shore-fast ice; transition zone ice; and polynyas and leads (USFWS 1995).

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As reported by Stirling (1993), stable fast ice with drifts was suitable for ringed seal haul-out and birth lairs. This habitat is most prevalent in the mouths of bays and near coastlines or offshore islands because that is where the annual ice is most stable. Stable fast ice without drifts did not contain habitats preferred by ringed seals for constructing birth lairs and maintaining breathing holes with lower risk from predation. Floe edge habitat was suitable for bearded seals of all age and sex classes and non-breeding ringed seals. Moving ice shifting constantly because of wind and ocean currents was generally not thought to be stable enough to be suitable for ringed seal birth lair habitat, though bearded seals of all age and sex classes and non-breeding ringed seals were generally abundant in this habitat, and some ringed seals have been observed to occupy and pup in offshore active ice environs. Continuous heavy pressure ice was a compressed aggregate of rough, stable ice that was generally unsuitable for seals. Coastal pressure ridges accumulate drifted snow and they were noted as being suitable for ringed seal haul-out and birth lairs. Fiords and bays such as in Prince Albert Sound developed snow-drifted pressure ridges and cracks that refroze and edremain flat, and were used by ringed seals for birth lairs and breathing holes. Fiord and bay habitat is not widespread in other areas of the Arctic. Polar bears were not evenly distributed over these sea-ice habitats, but concentrated on the floe ice edge, on stable fast ice with drifts, areas of moving ice (Stirling 1990; 1993).

Pack ice seals

As reported by USFWS (1995), pack ice consists of annual and multi-year ice that is in constant motion caused by winds and currents. Pack ice is used by polar bears for traveling, feeding, and denning and it is the sole summer habitat for Alaska polar bears. Shore-fast ice is ice that has become grounded near shore and may includeby pressure ridges caused by the movement of pack ice against it. Shorefast ice is important in the spring for feeding on seal pups, traveling, and lyoccasional denning. The transition zone is located seaward of the shore-fast ice and eis characterized by lead systems (linear openings) that open and close between the active pack ice and shore-fast ice. The transition zone is important in the winter and spring for feeding and travel. Leads and polynyas (nonlinear openings) predictable in their location in which case they calledas they often in approximately the same locationsas recurring. Recurring leads and

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polynyas attract seals andare used by polar bears for feeding, especially during the winter. ephemeral leads and polynyas are used opportunistically by polar bears for hunting.

2. Polar bear – ice relations - specific

Stirling et al. (1993, 1998) observed a strong preference by polar bears in the Beaufort Sea for the floe edge, fast ice with drifts, and moving ice with greater than [or, by the next two sentences, should this be "less than" instead?]7/8 ice cover. The preference is almost certainly because these areas are whereand seals are most accessible to polar bears for hunting.

yPolynas, apreferred habitat by polar bears, represent areas of increased biological productivity at all trophic levels, especially when they occur over continental shelves (Stirling 1997). Recurring polynyas may be preferred habitatsbecausesince location is predictablebears shows; they afford resting areas, and may operate as a barrier to escape predation (Stirling 1997). In the Canadian Arctic, polar bears concentrate each year at the North Water polynya in Smith Sound and northwestern Baffin Bay, which is open water all year, and at smaller permanent polynyas at Cardigan Strait-Hell Gate, Penny Strait-Queens Channel, and in the eastern entrance to Fury and Hecla Strait (Stirling 1980). Polar bears also concentrate at shore leads where seals maintain their breathing holes (Stirling 1980).).

In the Viscount Melville Sound area Messier et al. (1992) and Ferguson et al. (2001) found that ringed seals, edoccurring at lower densities than in most other areas of polar bear habitat from Alaska east to West Greenland (Stirling and Øritsland 1995 possibly because there is a greater proportion of multi-year ice in this areawhich is less preferred by ringed seals. Ringed seals), tend to be concentrated along tidal cracks and pressure ridges that parallel the island coastlines (Kingsley et al. 1985). is a relatively By contrast, in the southern Beaufort Sea, seasonal ice that predominates is more dynamic and allows a greater amount of sunlight into the water column to support primary productivity. This area supports higher densities and numbers of ringed seals and polar bears in more variable ice habitats (Stirling et al. 1982; Kingsley et al. 1985; Stirling and Øritsland 1995).

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Given the differences in ringed seal densities, polar bears in the Beaufort Sea may spend more time in winter actively foraging, and those in the Viscount Melville Sound area may spend more time resting and conserving energy. Messier et al. (1992) reported that long periods of "sheltering" were common among bears wintering in Viscount Melville Sound, and attributed this behavior to the poor foraging conditions there. Another factor may be the greater predictability of the foraging conditions in the stable ice of the High Arctic. With less change in the character of the sea-ice after freeze-up, polar bears may be able to determine where the best hunting areas will be in early winter. Predictable sea-ice conditions could help bears minimize midwinter searching for good hunting areas and maximize benefits of sheltering. The fluctuating sea-ice conditions in regions like the Beaufort Sea or Baffin Bay, however, may require modifications of foraging strategy from month to month or even day to day during break-up, freeze-up, or periods of strong winds. Polar bears are adaptable enough to modify their foraging patterns for the extreme range of sea-ice scenarios (Ferguson et al. 2001).

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Polar bears must move throughout the year to adjust to the changing distribution of sea ice and seals (Stirling 1998; FWS 1995). In some areas, like Hudson Bay and James Bay, bears remain on land when the sea ice retreats in the spring, where they must fast for several months (up to eight months for pregnant females) before freeze-up again in the fall (Stirling 1998; Derocher et al. 2004). Other populations unconstrained by land masses, such as those in the Barents, Chukchi and Beaufort Seas, spend each summer on the multiyear ice of the polar basin (Derocher et al. 2004). In island areas such as the Canadian Arctic archipelago or Svalbard and Franz Josef Land archipelagos, bears stay with the ice most of the time, but in some years they may spend up to a few months on land (Stirling 1998). Most populations use terrestrial habitat partially or exclusively for maternity denning, therefore, females must adjust their movements in order to access land at the appropriate time (Stirling 1998; Derocher et al. 2004).

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Polar bears appear to have good navigational ability and are able to return to previously used areas after long distances of active and passive transport (Amstrup 2003). As radiotelemetry studies have shown, female polar bears show only general fidelity to seasonal feeding areas

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(Ferguson et al. 1997; Amstrup et al. 2000A quantitative analysis of the movements of female polar bears over a multi-year period in the Beaufort Sea has made it possible to). develop models to predict polar bear distribution Durner et al. (2004). These models may be useful in making predictions of polar bear distribution and spills(Durner et al. 2004).

3. Inter-annual variations in sea ice and polar bear

Sea ice changes in response to environmental factors may have consequences to the distribution and productivity of polar bears because of changes inas their prey. In the southern Beaufort Sea heavy ice conditions in the mid-1970s and mid-1980s caused significant declines in productivity of ringed seals. Each event lasted approximately three years and caused similar declines in the natality of polar bears and survival of subadults, after which reproductive success and survival of both species increased again. The changes in the sea ice environment, and their consequent effects on polar bears, are demonstrable in parallel fluctuations in the mean ages of polar bears killed each year by Inuit huntersThere has been more open water in the eastern Beaufort Sea in recent years, perhaps due to. decadal-scale fluctuations of ice conditions in response to oceanographic and climatic factors.

Telemetry data from radio-collared female polar bears confirm that individuals occupy home ranges (or "multiannual activity areas") which they seldom leave (Amstrup 2003:592). The size of a polar bear's home range is determined, at least in part, by the annual pattern of freeze-up and break-up of the sea ice, and therefore by the distance a bear must travel to obtain access to prey (Stirling 1998). A bear that has consistent access to ice, leads, and seals may have a small home range, while bears in areas such as the Barents, Greenland, Chukchi, or Bering seas and Baffin Bay may have to move many hundreds of kilometers each year to remain in contact with sea ice from which they can hunt (Stirling 1998; Amstrup 2003; Ferguson et al. 2001; Wiig et al. 2003). aries

B. alMaternity Denning Habitat

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Throughout their range, most pregnant female polar bears excavate dens in snow located on land in the fall-early winter period (Harington 1968; Lentfer and Hensel 1980; Ramsay and Stirling 1990; Amstrup and Gardner 1994). The only known exceptions are in Western Hudson Bay where polar bears excavate earthen dens and later reposition into adjacent snow drifts, and in the southern Beaufort Sea where a portion of the population dens in snow caves located on pack and shorefast ice. Successful denning by polar bears requires accumulation of sufficient snow for den construction and maintenance. Adequate and timely snowfall combined with winds to cause snow accumulation leeward of topographic features create conditions suitable for denning. Polar sbear give birth in the dens during midwinter (Kostyan 1954; Harington 1968; Ramsay and Dunbrack 1986). Survival and growth of cubs depends on the warmth and stable environment within the maternal den (Blix and Lentfer 1979). Family groups emerge from dens in March and April when cubs are approximately three months old.

Distribution of Denning. Most polar bear sdenning occur on land in "core areas" of each population's range (Harington 1968). The location of sethe denning areas are well known and include the Svalbard Archipelago (Lønø 1970; Larsen 1985); Franz Josef Land, Novaya Zemlya, Wrangel Island, Herald Island (Uspenski and Chernyavski 1965; Uspenski and Kistchinski 1972); and the west coast of Hudson Bay, (Harington 1968; Jonkel et al. 1975; Stirling et al. 1977b; Ramsay and Andriashek 1986, Ramsay and Stirling 1990). IPpolar bears also den over large areas at low density. (Lentfer and Hensel 1980; Stirling and Andriashek 1992; Amstrup 1993; Amstrup and Gardner 1994; Messier et al. 1994; Born 1995; Ferguson et al. 2000a; Durner et al. 2001, 2003). Areas of known low density denning occur on the north slope of Alaska, Chukchi Peninsula of Russia, Banks Island, Simpson Peninsula, eEastern Southhampton Island, eEastern Baffin Island and other areas in Canada. and East and NW Greenland.

Habitat characteristics of denning areas vary and include rugged mountains and fjordlands of the Svalbard Islands, large islands north of the Russian coast (Uspenski and Chernyavski 1965; Lønø 1970; Uspenski and Kistchinski 1972; Larsen 1985), low relief topography characterized by

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tundra with riverine banks and coastal bluffs, of Hudson Bay (Ramsay and Andriashek 1986; Ramsay and Stirling 1990) and the NSnorth slope of Alaska (Amstrup 1993; Amstrup and Gardner 1994; Durner et al. 2001, 2003) relativelyand offshore pack ice pressure ridge habitat. The common characteristic of denning habitat is abilitytopographic features that catch snow in autumn and early winter (Durner et al. 2003). The northern Alaskan coast gets minimalfalllittle snow. However, the landscape is flat and snow is blown throughout the winter creating drifts in areas with relief. Mmost polar bear dens occur relatively near the coast with the exception ofin western Hudson Bay where females regularly den 29–118 km inland (Kolenosky and Prevett 1983; Stirling and Ramsay 1986).

Fidelity to Denning Locales. Amstrup and Garner (1994) followed 27 females for up to four maternity dens. Bears that denned once on pack ice were more likely to den on pack ice than on land in subsequent years, and vice versa. Similarly, bears were faithful to general geographic areas. Those that denned once in the eastern half of the Alaskan coast were more likely to den there than to the west in subsequent years. When all years were considered, denning polar bears preferred some areas, but no areas were used by collared bears in all years. Weather, ice conditions, and prey availability, all of which varied annually, probably determined where bears denned. Those annual variations and the long-distance movements of polar bears (Amstrup et al. 1986, 2000; Garner et al.1990) make seasonal recurrence at exactly the same location unlikely.

The only other region where data are available on fidelity to denning areas is Hudson Bay. There, pregnant females initiate their over winter denning period in earthen dens they occupy in summer. During winter, they burrow into adjacent snow drifts (Watts and Hansen 1987). There was greater fidelity to local areas than in the Beaufort Sea, but site-specific philopatry was not apparent (Ramsay and Stirling 1990).

Despite general fidelity to local areas, the overall distribution of denning along the west coast of Hudson Bay shifted markedly over a 20-year period (Ramsay and Stirling 1990). Because bears are able ability to return to the same area, the reason for the shift is not clear. A similar shift

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appears to be occurring in the Beaufort Sea region as well. In the southern Beaufort Sea a trend of decreasing use of pack ice for denning has been detected (Fischbach et al. in prep.). Analysis of satellite telemetry data showededreveals that during 1986-1994, X62% of X () known dens were located on sea ice, compared to 40% of dens during 1998-2004X of X (). The potential reasons for the change in distribution included reductions in hunting pressure on land; availability of bowhead whale carcasses in the fall on land; climate induced changes in sea ice characteristicsChanges in denning areas and/or other unidentified ecological factors. Harington (1968), Larsen (1985), and Lønø (1970) concluded that variation in the local pattern of sea-ice movements during the preceding summer and autumn accounts for annual changes in the distribution of winter dens. Multiple-year trends in changing sea-ice patterns clearly could alter denning and other behavioral patterns.

Denning Chronology. Pregnant female polar bears enter their dens in the autumn (September to November) after drifts large enough to excavate a snow cave are formed. The annually variable snow and ice conditions determine when and where bears enter their dens each autumn. Polar bears depart dens in the spring (February-April) when their cubs are able to survive in the outside climate.

Tthe chronology of denning varies somewhat between populations. In the Beaufort Sea, mean dates of den entry were 11 and 22 November for land (n = 20) and pack-ice (n = 16) dens, respectively (Amstrup and Gardner 1994). Female bears continued foraging right up to the time of den entry and, and t denned bynear. The mean date of emergence was 26 March forthe pack ice dens(n = 10) and 5 April foron land dens(n = 18). Messier et al. (1994) Iin the Canadian Arctic, the mean date of entry was 17 September (n=XX) and mean emergence was 21 March (n=XX). Females and their cubs remained near dens for a mean 13 (SE = 3) days in the spring before leaving the denning area. This may indicate an earlier and more protracted denning period at higher latitudes than in the Beaufort Sea. Ferguson et al. (2000a), observed that bears denning at higher latitudes entered their dens a bit later than those to the south, but that exit times did not

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differ by latitude. They reported a mean den entry of 15 September (1 September–7 October), a mean exit of 20 March (15–28 March), and a mean 180 days in dens (163–200 days). As noted earlier, initiation of denning depends on sufficient snow accumulation to allow excavation of a den cavity. For bears denning on sea-ice or moving from sea-ice to land denning habitat, timing of sea ice consolidation can alter the onset of denning. Sea-ice dens must be in ice stable enough to stay intact for up to 164 days while possibly being moved hundreds of kilometers by currents (Amstrup 2003).

Scott and Stirling (2002) examined the chronology of terrestrial den use by polar bears in western Hudson Bay as indicated by tree growth anomalies. Historical denning activity was determined by examining tree growth anomalies in the black spruce (Picea mariana) around and above 31 den sites. Trees sampled at these den sites ranged in age from 46 to 236 years (n = 83, mean = 136). Some individual den sites dated back at least 200 years. Increased denning activity in the area was correlated with reductions in disturbance due to humans at the York Factory. Mark-recapture studies undertaken from 1970 to 2000 indicate that female polar bears in the Western Hudson Bay population have a long-term fidelity to this specific area for maternity denning, and the area has been used for denning at least several hundred years (Scott and Stirling 2002).

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IV. Population Status and Trend (final draft material for all of Section IV extracted in total from PBSG 14th Working Group Proceedings)

A. Distinct Population Segments

Just as the labile nature of the sea-ice results in annual variability in the distribution of suitable habitat for polar bears, it also eliminates any benefit to polar bears of defending territories. The location of resources is less predictable than resources on which terrestrial predators depend. Seals tend to be distributed over very large areas at low densities (Bunnell and Hamilton 1983).

Furthermore, their distribution, density, and productivity are extremely variable among years (DeMaster et al. 1980; Stirling et al. 1982; Stirling and Øritsland 1995). Absence of strict fidelity, especially during breeding and denning seasons (Garner et al. 1994; Amstrup and Gardner 1994), essentially prohibits defendable territories. Males similarly must be free of the need to defend territories if they are to maximize their potential for finding mates each year (Ramsay and Stirling 1986b). Although there may be limited spatial segregation among individual polar bears, telemetry studies have demonstrated spatial segregation among groups or stocks of polar bears in different regions (Schweinsburg and Lee 1982; Amstrup et al. 1986, 2000; Garner et al. 1990, 1994; Messier et al. 1992; Amstrup and Gardner 1994; Bethke et al. 1996; Ferguson et al. 1999).

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B. Status and distribution

Polar bears are not evenly distributed throughout the Arctic, nor do they comprise a single nomadic cosmopolitan population, but rather occur in 19 relatively discrete sub-populations (Fig. 1). The total number of polar bears worldwide is estimated to be 20,000-25,000. The following sub-population summaries are the result of discussions of the IUCN/SSC Polar Bear Specialist Group held in Seattle, Washington, U.S.A. in June 2005 and updated with results that became available as of June 2006. The information on each sub-population is based on the status reports and revisions given by each nation. We present estimated sub-population sizes and associated uncertainty in estimates, historic and predicted human-caused mortality, and sub-population trends, and rationale for our determinations of status. Where data allowed, or the approach was deemed appropriate for a jurisdiction, results of stochastic sub-population viability analyses (PVA) to estimate the likelihood of future population decline are presented.

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Why are these being called sub-populations instead of populations? This seems unnecessary and will be confusing to many people.

Status Table Structure

Sub-population Size

Table 1 presents sub-population sizes and uncertainty in the estimates as ± 2 standard errors of the mean (SE) or ranges. These estimates are based on scientific research using mark and recapture analysis or aerial surveys, and the years in which data were collected is presented to give an indication of the current reliability of sub-population estimates. For some sub-populations, scientific data were not available and population estimates were extrapolated from density estimates and/or local traditional ecological knowledge (TEK). In some cases, this also includes simulations based on the minimum size necessary to support local knowledge of sub-population trends. Although these data are presented in addition to or in some cases as an alternative to dated scientific estimates, methods other than mark and recapture analysis or aerial surveys have unknown and in most cases inestimable errors.

Human-Caused Mortality

For most sub-populations, particularly those in North America, harvesting of polar bears is a regulated activity. In many cases, harvesting is the major cause of mortality for bears. In most jurisdictions, the total numbers of bears killed by humans in pursuit of sport and subsistence hunting, accident, and in defence of life or property are documented. Where data allow, we present the 5-year mean of known human-caused mortality (removals) for each sub-population. We also present the anticipated removal rate of polar bears in each jurisdiction based on known increases in hunting quotas and/or the average removal rate of polar bears by jurisdiction over the past 5 years.

Trend and Status

Qualitative categories of trend and status are presented for each polar bear sub-population (Table 1). Categories of trend include our assessment of whether the sub-population is currently increasing, stable, or declining, or if we have insufficient data to estimate trend (data deficient). Categories of status include our assessment of whether sub-populations are not reduced, reduced, or severely reduced from historic levels of abundance, or if we have insufficient data to estimate status (data deficient).

Sub-population Viability Analysis

For some sub-populations, recent quantitative estimates of abundance and parameters of survival and reproduction are available to determine likelihoods of future sub-population decline using PVA. We used the PVA model RISKMAN (Taylor *et al.* 2001*a*) to estimate risks of future declines in polar bear sub-populations given demographic parameters and uncertainty in data. The model and documentation detailing the model's structure are available at http://www.nrdpfc.ca/riskman/riskman.htm. Publications based on the RISKMAN model include Eastridge and Clark (2001), McLoughlin *et al.* (2003), and Taylor *et al.* (2002).

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RISKMAN can incorporate stochasticity into its sub-population model at several levels, including sampling error in initial sub-population size, variance about vital rates due to sample size and annual environmental variation (survival, reproduction, sex ratio), and demographic stochasticity. RISKMAN uses Monte Carlo techniques to generate a distribution of results, and then uses this distribution to estimate sub-population size at a future time, sub-population growth rate, and proportion of runs that result in a sub-population decline set at a predetermined level by the user. We adopted the latter to estimate persistence probability.

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Does it allow for a trend in vital rates over time? This is the key factor that will drive trends.

Our approach to variance in this simulation was to pool sampling and environmental variances for survival and reproduction. We did this because: 1) variances for reproductive parameters often did not lend themselves to separating the sampling component of variance from environmental variance, and 2) we were interested in quantifying the risks of sub-population decline including all sources of uncertainty in the data (i.e., pooling sampling error with environmental error presents more conservative outcomes of sub-population persistence).

For each sub-population model, the frequency of occurrence of sub-population declines and/or increases after 10 years was reported as the cumulative proportion of total simulation runs (2,500 simulations). We chose to conduct model projections using these criteria because: 1) the sub-population inventory cycle for most areas is planned to be 10–15 years in duration, and 2) we do not advocate using PVA over long time periods in view of potential significant changes to habitat resulting from Arctic climate change, in Individual runs subpopulations could recover from 'depletion', but not from a condition where all males or all females or both were lost.

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Required sub-population parameter estimates and standard error inputs included annual natural survival rate (stratified by age and sex as supported by the data), age of first reproduction, age-specific litter production rates for females available to have cubs (i.e., females with no cubs and females with 2-year-olds), litter size, the sex ratio of cubs, initial sub-population size, and the sex, age, and family status distribution of the harvest. Input data are shown in Tables 1-3.

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The standing age distribution was always female-biased, likely due to long-term harvesting of males in sub-populations for which simulations were performed (Table 1). Because we wished to err on the side of caution, for all simulations we used the stable age distribution expected for the sub-population at the anticipated annual removal rate as the initial age/sex distribution (i.e., initializing the sub-population at the stable age distribution produced more conservative outcomes compared to that of the existing standing age distribution). The harvest selectivity and vulnerability array was identified by comparing the standing age distribution of the historical harvest of sub-populations to the total mortality, stable age distribution. Harvest was stratified by sex, age (cubs and yearlings, age 2–5, age 6–19, and age >20) and family status (alone, or with cubs and yearlings, or with 2-year-olds). We ran harvest simulations using natural survival rates, upon which anticipated annual removal rates (i.e., human-caused mortality from all sources) were added.

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what is this, the actual age distribution of the population measured in some way from field studies?

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It's not clear what "natural" survival rates means in this context. If this means survival rates expected in the absence of any human effects, including climate change, then you might want to state that explicitly. One of the challenges for you in this case will be to determine how those rates will be affected, not only by harvesting, but especially by climate change.

C. Population Summary

1. East Greenland (EG)

No inventories have been conducted in recent years to determine the size of the polar bear sub-population in eastern Greenland. Satellite-telemetry has indicated that polar bears range widely along the coast of eastern Greenland and in the pack ice in the Greenland Sea and Fram Strait (Born *et al.* 1997, Wiig *et al.* 2003). However, various studies have indicated that more or less resident groups of bears may occur within this range (Born 1995, Sandell *et al.* 2001). Although there is little evidence of a genetic difference between sub-populations in the eastern Greenland and Svalbard – Franz Josef Land regions (Paetkau *et al.* 1999), satellite telemetry and movement of marked animals indicate that the exchange between these sub-populations is minimal (Wiig 1995, Born *et al.* 1997, Wiig *et al.* 2003).

During 1999-2003 (last five years of recording), the annual catch in eastern and southwestern Greenland averaged 70 bears (range, 56-84 bears per year) (Born and Sonne 2006). The catch of polar bears taken in southwestern Greenland, south of 62° N, must be added to the catch statistics from eastern Greenland because polar bears arrive in the southwestern region with the drift ice that comes around the southern tip from eastern Greenland (Sandell *et al.* 2001). During 1993 (first year of instituting a new catch recording system) and 2003 there was no significant trend in the catch of polar bears in eastern and southwestern Greenland (Born and Sonne 2006). Greenland introduced polar bear quotas taking effect on 1 January 2006. The total quota for 2006 is 50 polar bears for the two East Greenland municipalties Ittoqqortoormiit (30) and Ammassalik (20). The maximum quota for those municipalities in SW Greenland that hunt bears coming from the East Greenland population is 7 for 2006 (Born, in litt.).

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Despite an increasing practice by hunters from Scoresby Sound in cCentral East Greenland to go further north to take polar bears during spring, there is no information to indicate an overall increase in hunting by East Greenlanders (Sandell *et al.* 2001). Based on harvest sampling from 109 polar bears in Scoresby Sound during 1999-2001, the proportion of adult (=independent) female polar bears in the catch in eastern Greenland is estimated at 0.43 (Danish National Environmental Research Institute, unpubl. data).

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Given the estimates of the proportion of adult females in the catch and an annual catch of about 70 bears (*i.e.*, eastern and southwestern Greenland combined), a minimum sub-population of about 2,000 individuals would be needed to sustain this take. However, the actual number of animals in the exploited sub-population is unknown.

During the last decades, the ice in the East Greenland area has diminished both in extent (*e.g.*, Parkinson et al. 1999; a and thickness (reference?2000). It has been predicted that this trend will continue in this century (Rysgaard *et al.* 2003). Furthermore, polar bears in East Greenland have

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relatively high body burdens of organic pollutants (Norstrom *et al.* 1998, Dietz *et al.* 2004) and levels of these pollutants seem to have increased between 1990 and 1999-2001 (Dietz *et al.* 2004). Several studies indicate that organic pollutants may have negatively affected polar bears in this region (overview in Born and Sonne 2006).

The effects of Arctic warming on East Greenland polar bears have not been documented. However, considering the effects of climate change in other parts of the Arctic (*e.g.*, western Hudson Bay), these environmental changes may also be in effect and cause concern about how polar bears in East Greenland may be negatively affected.

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2. Barents Sea (BS)

The size of the Barents Sea sub-population was estimated to be about 3,000 in August 2004, which suggests that earlier estimates based on den counts and ship surveys (Larsen 1986) were too high. This suggestion is further supported by ecological data that indicate the sub-population grew steadily during the first decade after protection from hunting in 1973, and then either continued to grow or stabilized after that. Denning occurs on several islands both on Franz Josef Land (Belikov and Matveev 1983) and Svalbard (Larsen 1985). Studies on individual movement and sub-population ecology by use of telemetry data and mark-recapture have been conducted in the Svalbard area since the early 1970s (Larsen 1972, 1986, Wiig 1995, Mauritzen *et al.* 2001, 2002). Studies on movements using telemetry data show that some polar bears associated with Svalbard are very restricted in their movements but bears from the Barents Sea range widely between Svalbard and Franz Josef Land (Wiig 1995, Mauritzen *et al.* 2001). Sub-population boundaries based on satellite telemetry data indicate that the Barents Sea has a natural sub-population unit, albeit with some overlap to the east with the Kara Sea sub-population (Mauritzen *et al.* 2002). Although overlap between the Barents Sea and East Greenland may be limited (Born *et al.* 1997), low levels of genetic structure among all these sub-populations indicates substantial gene flow (Paetkau *et al.* 1999). The Barents Sea sub-population is currently unharvested with the exception of bears killed in defence of life and property (Gjertz and Persen 1987, Gjertz *et al.* 1993, Gjertz and Scheie 1997). The sub-population was depleted by over-

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harvest but a total ban on hunting in 1973 in Norway and in 1956 in Russia allowed itpopulation to increase (Larsen 1986, Prestrud and Stirling 1994). High levels of PCBs have been detected in samples of polar bears from this area which raises concern about the effects of pollutants on polar bear survival and reproduction (Skaare *et al.* 1994, Bernhoft *et al.* 1997, Norstrom *et al.* 1998, Andersen *et al.* 2001, Derocher *et al.* 2003). Recent studies suggest a decline and levelling of some pollutants (Henriksen *et al.* 2001) while new pollutants have been discovered (Wolkers *et al.* 2004). Oil exploration in polar bear habitat may increase in the near future (Isaksen *et al.* 1998).

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3. Kara Sea (KS)

This sub-population includes the Kara Sea and overlaps in the west with the Barents Sea sub-population in the area of Franz Josef Land and Novaya Zemlya archipelagos. Data for the Kara and Barents Seas, in the vicinity of Franz Josef Land and Novaya Zemlya, are mainly based on aerial surveys and den counts (Parovshikov 1965, Belikov and Matveev 1983, Uspenski 1989, Belikov *et al.* 1991, Belikov and Gorbunov 1991, Belikov 1993). Telemetry studies of movements have been done throughout the area but data to define the eastern boundary are incomplete (Belikov *et al.* 1998, Mauritzen *et al.* 2002). The sub-population abundance estimate of XXXX should be regarded as preliminary. Reported harvest activities have been limited to defence kills and an unknown number of illegal kills, and these are not thought to be having an impact on the size of the sub-population. However, contaminant levels in rivers flowing into this area and recent information on nuclear and industrial waste disposal raise concerns about the possibility of environmental damage. Recent studies show that polar bears from the Kara Sea have some of the highest organochlorine pollution levels in the Arctic (Andersen *et al.* 2001, Lie *et al.* 2003).

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say what the estimate is.

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needs reference

4. Laptev Sea (LS)

The Laptev sub-population area includes the western half of the East Siberian Sea and most of the Laptev Sea, including the Novosibirsk and possibly Severnaya Zemlya islands (Belikov *et al.* 1998). The estimate of sub-population size for the Laptev Sea (800-1,200) is based on aerial counts of dens on the Severnaya Zemlya in 1982 (Belikov and Randala 1987) and on anecdotal data collected from 1960 through the 1980s on the number of females coming to dens on Novosibirsk Islands and on the mainland coast (Kischinski 1969, Uspenski 1989). This estimate should therefore be regarded as preliminary. Reported harvest activities in this sub-population are limited to defence kills and an apparently small but unknown number of illegal kills. The current levels of harvest are not thought to be having a detrimental impact on the sub-population.

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5. Chukchi Sea (CS)

Cooperative studies between the USA and Russia have revealed that polar bears in this area, also known as the Alaska-Chukota sub-population, are widely distributed on the pack ice of the northern Bering, Chukchi, and eastern portions of the East Siberian seas (Garner *et al.* 1990, 1994, 1995). Based upon these telemetry studies, the western boundary of the sub-population was set near Chaunskaya Bay in northeastern Russia. The eastern boundary was set at Icy Cape, Alaska, which also is the previous western boundary of the southern Beaufort Sea sub-population (Amstrup *et al.* 1986, Amstrup and DeMaster 1988, Garner *et al.* 1990, Amstrup *et al.* 1995, 2004, 2005). This eastern boundary constitutes a large overlap zone with bears in the SB sub-population.

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Estimates of the size of the sub-population have been derived from observations of dens, and aerial surveys (Chelintsev 1977, Stishov 1991*a,b*, Stishov *et al.* 1991) Hhowever these estimates have wide ranges and are considered to be of little value for management. Reliable estimates of sub-population size based upon mark and recapture are not available for this region although recent studies provide data for analyses using new spatial modelling techniques as reported in the southern Beaufort Sea sub-population section. Probabilistic distribution information for zones of overlap between the Chukchi and sSouthern Beaufort Sea sub-populations is now available. This information can be used to more accurately describe sustainable harvest levels once defensible estimates of abundance are developed (Amstrup *et al.* 2004, 2005). The approximate boundaries

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of this sub-population for illustration purposes are as described above and as reported previously (Lunn *et al.* 2002).

The status of the Chukchi sub-population, which was believed to have increased after the level of harvest was reduced in 1972, is now thought to be uncertain or declining. Measuring population sizeremains a research challenge and recent reports of substantial levels of illegal harvest in Russia are cause for concern. Legal harvesting activities are currently restricted to Inuit in wWestern Alaska. In Alaska, average annual harvest levels declined by approximately 50% between the 1980s and the 1990s (Schliebe *et al.* 1998) and haveedremain at that low level in recent yearstoday. There are several factors potentially affecting the harvest level in western Alaska. The factor of greatest direct relevance is the substantial illegal harvest in Chukotka. In addition, other factors such as climatic change and its effects on pack ice distribution as well as changing demographics and hunting effort in native communities (Schliebe *et al.* 2002) could influence the declining take. Recent measures undertaken by regional authorities in Chukotka may have reduced the illegal hunt. The unknown rate of illegal take makes the stable designation uncertain and tentative and as a precaution the Chukchi sub-population is designated as declining.

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Implementation of the Russia-United States Agreement on the Conservation and Management of Polar Bear is designed to ensure a scientifically-based sustainable management program is instituted. Management will include active involvement of Native hunters' organizations from Alaska and Chukotka.

As with the Beaufort Sea sub-population, the primary concerns for this region are the impacts of climate change, human activities including industrial development within the near-shore environment, increases in the atmospheric and oceanic transport of contaminants into the region, and possible over-harvest of a stressed or declining sub-population.

6. Southern Beaufort Sea (SB)

The Southern Beaufort Sea (SB) polar bear sub-population is shared between Canada and Alaska. During the early 1980s, radio-collared polar bears were followed from the Canadian Beaufort Sea into the eastern Chukchi Sea of Alaska (Amstrup *et al.* 1986, Amstrup and DeMaster 1988). Radio-telemetry data, combined with earlier tag returns from harvested bears, suggested that the SB region comprised a single sub-population with a western boundary near Icy Cape, Alaska, and an eastern boundary near Pearce Point, Northwest Territories, Canada (Amstrup *et al.* 1986, Amstrup and DeMaster 1988, Stirling *et al.* 1988). Recognition that the polar bears within this region were shared by Canada and Alaska prompted development of the "Polar Bear Management Agreement for the Southern Beaufort Sea" (Agreement) between the Inuvialuit Game Council (IGC) of Canada, and the North Slope Borough (NSB) of Alaska. The Agreement was ratified by both parties in 1988. The text of the Agreement included provisions to protect bears in dens and females with cubs, and stated that the annual sustainable harvest from the SB polar bear sub-population would be shared between the two jurisdictions. Harvest levels also were to be reviewed annually in light of the best scientific information available (Treseder and Carpenter 1989, Nageak *et al.* 1991). An evaluation of the effectiveness of the Agreement during the first 10 years (Brower *et al.* 2002) concluded that the Agreement had been successful in ensuring that the total harvest, and the proportion of the harvest comprised of adult females, remained within sustainable limits. The evaluation also noted that increased monitoring efforts and continued restraint in harvesting females were necessary to ensure continued compliance with the provisions of the Agreement.

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This is good and interesting but seems somewhat out of place in a section on population status and trend. Also, if this level of detail is to be given about management structure for this population, the same should be done for all other populations.

Early estimates suggested the size of the SB sub-population was approximately 1,800 polar bears, although uneven sampling was known to compromise the accuracy of that estimate (Amstrup *et al.* 1986, Amstrup and DeMaster 1988, Amstrup 1995). New population estimation techniques are emerging and continue to be refined (Amstrup *et al.* 2001, 2005; McDonald and Amstrup 2001). The field work for an intensive capture-recapture effort in the SB region, coordinated between the U.S. and Canada, was completed in spring 2006. A preliminary analysis of the joint data was completed in June 2006, and a final population analysis and report will be available by summer 2007. preliminary. That analysis indicated the population of the region between Icy Cape and Pearce Point is now approximately 1,500 polar bears (95% confidence

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intervals approximately 1,000 - 2,000). Further analyses are likely to tighten the confidence intervals, but not likely to change the point estimate appreciably. Although the confidence intervals of the current population estimate overlap the previous population estimate of 1,800, other statistical and ecological evidence (e.g., high recapture rates encountered in the field) suggest that the current population is actually smaller than has been estimated for this area in the past. Observations of changes in polar bear body condition and unusual hunting behaviours in polar bears (e.g. cannibalism, digging through solid ice to find seals) suggest foraging success may have declined (Amstrup *et al.* 2006). These observations parallel those made in western Hudson Bay (see below), where changes in sea ice, caused by warmer temperatures, have caused a population reduction. Although the new SB population estimate is preliminary, we believe it should be used for current status assessments.

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Stirling (2002) reviewed the ecology of polar bears and seals in the Canadian sector of the Beaufort Sea from 1970 through 2000. Research incorporating the collection and analysis of radio-telemetry data in the SB region has continued on a nearly annual basis through the present time. Recent analyses of radio-telemetry data using new spatial modelling techniques suggest realignment of the boundaries of the SB area (Amstrup *et al.* 2004, 2005). We now know that nearly all bears in the central coastal region of the Beaufort Sea are from the SB sub-population, and that proportional representation of SB bears decreases to both the west and east. For example only 50% of the bears occurring in Barrow (Alaska) and Tuktoyaktuk (Northwest Territories) are SB bears, with the remainder being from the Chukchi (CS) and northern Beaufort Sea (NB) sub-populations, respectively. The recent radio-telemetry data indicate that bears from the SB sub-population seldom reach Pearce Point, which is currently on the eastern management boundary for the SB sub-population.

Historically, a principal assumption of the IGC/NSB Agreement was that polar bears harvested within the SB region came from a single sub-population. However, our improved understanding of the spatiotemporal use patterns of bears in the SB region provides the foundation for improved harvest management, based on the geographic probability of bears occurring in specific areas at specific times of the year (Amstrup *et al.* 2005). Assignment of new boundaries based upon this information will probably necessitate a readjustment of the total size of the SB sub-population, to correspond with a smaller geographic area. This adjustment is likely to reduce the estimated size of the SB sub-population because some polar bears formerly assigned to the SB will be re-assigned to the NB and CS sub-populations. For purposes of this report, however, we continue to use the previously-published boundaries for the SB sub-population. This sub-population is assessed using the sustainable yield criteria previously reported.

The primary management and conservation concerns for the SB sub-population are: 1) climate warming, which continues to increase both the expanse and duration of open water in summer and fall; 2) human activities, including hydrocarbon exploration and development occurring within the near-shore environment; 3) changing atmospheric and oceanic transport of contaminants into the region; and 4) possible inadvertent over-harvest of the SB sub-population, if it becomes increasingly nutritionally-stressed or declines due to some combination of the aforementioned threats.

7. Northern Beaufort Sea (NB)

Studies of movements and sub-population estimates of polar bears in the eastern Beaufort Sea have been conducted using telemetry and mark-recapture at intervals since the early 1970s (Stirling *et al.* 1975, 1988, DeMaster *et al.* 1980, Lunn *et al.* 1995). As a result, it was recognized that there were separate sub-populations in the North and South Beaufort Sea areas and not a single sub-population as was suspected initially (Stirling *et al.* 1988, Amstrup 1995, Taylor and Lee 1995, Bethke *et al.* 1996). The density of polar bears using the multi-year ice north of the main study area was lower than it was further south. The sub-population estimate of 1,200 polar bears (Stirling *et al.* 1988) for the North Beaufort Sea (NB) was believed to be unbiased at the time but the northwestern coast of Banks Island was not completely surveyed because of perceived conflicts with guided sport hunters in the area at that time. A coordinated, intensive mark and recapture study covering the whole of the Beaufort Sea and Amundsen Gulf will be completed in 2006; a final analysis and report will follow. Until this new estimate is available, the previous estimate and quota will continue to be used for management purposes. The harvest is being closely monitored and appears to be sustainable.

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needs reference

Recent analyses, using data from satellite tracking of female polar bears and new spatial modelling techniques, indicate the boundary between NB and the SB sub-populations needs to be adjusted, probably expanding the area occupied by bears from NB and retracting that of SB (Amstrup *et al.* 2004, 2005).

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The primary concerns for this sub-population are from climate warming that continues to expand both the expanse and duration of open water in summer and fall, changing characteristics of atmospheric and oceanic transport of contaminants into the region, and possible inadvertent over-harvest of a sub-population stressed or declining as a result of the previous threats.

8. Viscount Melville Sound (VM)

A five-year study of movements and size of the Viscount Melville Sound (VM) sub-population size, using telemetry and mark-recapture, was completed in 1992 (Messier *et al.* 1992, 1994, Taylor *et al.* 2002). Sub-population boundaries are based on observed movements of female polar bears with satellite radio-collars and movements of bears tagged in and out of the study area (Bethke *et al.* 1996, Taylor *et al.* 2001*b*). The current sub-population estimate of 215 was based on estimates time referenced to 1993 (Taylor *et al.* 2002). When quotas were originally allocated in the 1970s, the size and productivity of the sub-population was thought to be greater because they occurred in such a large geographic area. However, this area is characterized by heavy multi-year ice and low densities of ringed seals (Kingsley *et al.* 1985), and the productivity and density of polar bears was lower than initially expected. Consequently, quotas were reduced and a five-year moratorium on hunting began in 1994/95. Hunting resumed in 1999/2000 with an annual quota of 4 bears.

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What does this mean? It would be more useful to say when the data were collected.

In 1999, the former Northwest Territories (NWT) was divided into two new territories: NWT and Nunavut and resulted in the VM sub-population being shared between the two jurisdictions.

In 2004/2005 the annual quota was increased to 7 bears (NWT – 4, Nunavut – 3 The sub-population is regarded as severely reduced in relation to historic population size (PBSG 2006).).

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This is much more detail about quotas than given for previous populations--should be consistent. Also needs references.

9. Norwegian Bay (NW)

The Norwegian Bay (NW) polar bear sub-population is bounded by heavy multi-year ice to the west, islands to the north, east, and west, and polynyas to the south (Stirling 1980, 1997, Taylor *et al.* 2001*b*, unpubl. data). From data collected during mark-recapture studies, and from satellite radio-tracking of adult female polar bears, it appears that most of the polar bears in this sub-population are concentrated along the coastal tide cracks and ridges along the north, east, and southern boundaries (Taylor *et al.* 2001*b*). The preponderance of heavy multi-year ice through most of the central and western areas has resulted in low densities of ringed seals (Kingsley *et al.* 1985) and, consequently, low densities of polar bears. Based on preliminary data, the current estimate for this sub-population based on data collected during 1993-1997 is 190 bears (M.K. Taylor *et al.*, unpubl. data). Survival rate estimates for the NW sub-population were derived from pooled Lancaster Sound and NW data because the sub-populations are adjacent and because the number of bears captured in Lancaster Sound was too small for reliable survival estimates. Recruitment estimates were derived from the standing age distribution (Taylor *et al.* 2000). The harvest quota for the NW sub-population was reduced to 4 bears (3 males and 1 female) in 1996. The sub-population is regarded to decline (PBSG 2006)

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10. Lancaster Sound (LS)

The central and western portion of the Lancaster Sound (LS) sub-population region is characterized by high biological productivity and high densities of ringed seals and polar bears (Schweinsburg *et al.* 1982, Stirling *et al.* 1984, Kingsley *et al.* 1985, Welch *et al.* 1992). The western third of this region (eastern Viscount Melville Sound) is dominated by heavy, multi-year ice and apparently low biological productivity, as evidenced by low densities of ringed seals (Kingsley *et al.* 1985). In the spring and summer, densities of polar bears in the western third of the area are low; however, as break-up occurs, polar bears move west to summer on the multi-year pack. Recent information on the movements of adult female polar bears monitored by satellite radio-collars, and mark-recapture data from past years, has shown that this sub-population is distinct from the adjoining Viscount Melville Sound, M'Clintock Channel, Gulf of Boothia, Baffin Bay and Norwegian Bay sub-populations (Taylor *et al.* 2001*b*). For PVA in this status report, survival rates of polar bears in the Norwegian Bay and Lancaster Sound sub-populations were pooled to minimize sampling errors. The current sub-population estimate of 2,541 bears is based on an analysis of both historical and current mark-recapture data to 1997 (M.K. Taylor *et al.*, unpubl. data). This estimate is considerably larger than a previous estimate of 1,675 that included Norwegian Bay (Stirling *et al.* 1984), and was considered to be conservative. Taylor *et al.* (unpubl. data) also estimate a suite of survival and recruitment parameters (Table 2) that suggest this sub-population has a lower renewal rate than previously estimated.

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This is a new concept in this report, and somewhat unusual. Use another term or define.

11. M'Clintock Channel (MC)

The current sub-population boundaries for the M'Clintock Channel (MC) sub-population of polar bears are based on recovery of tagged bears and movements of adult females with satellite telemetry collars in adjacent areas (Taylor and Lee 1995, Taylor *et al.* 2001*b*). These boundaries appear to be a consequence of large islands to the east and west, the mainland to the south, and the heavy multi-year ice in Viscount Melville Sound to the north. A six-year mark-recapture study covered most of this area in the mid-1970s (Furnell and Schweinsburg 1984). An estimate of 900 bears was derived from the data collected within the boundaries of the M'Clintock Channel sub-population, as part of a study conducted over a larger area of the Central Arctic (Furnell and Schweinsburg 1984). More recently, local hunters suggested 900 might be too high, so the Canadian Polar Bear Technical Committee accepted a recommendation to reduce the estimate to 700.

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Following the completion of a mark-recapture inventory in spring 2000, the sub-population estimate was 284 (Taylor *et al.* in review). Natural survival and recruitment rates (Table 2) were also estimated at values lower than previous standardized estimates (Taylor *et al.* 1987). The

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Government of Nunavut implemented a moratorium on hunting for the 2001/2002 and 2002/2003 hunting seasons. The current annual quota for MC is 3 bears. The sub-population is regarded to be severely reduced (PBSG 2006).

12. Gulf of Boothia (GB)

The boundaries of the Gulf of Boothia (GB) polar bear sub-population are based on genetic studies (Paetkau *et al.* 1999), movements of tagged bears (Stirling *et al.* 1978, Taylor and Lee 1995), movements of adult females with satellite radio-collars in GB and adjacent areas (Taylor *et al.* 2001*b*), and interpretations by local Inuit hunters of how local conditions influence the movements of polar bears in the area. An initial sub-population estimate of 333 bears was derived from data collected as part of a study conducted over a larger area of the Central Arctic (Furnell and Schweinsburg 1984). Although sub-population data from GB were limited, local hunters reported that the sub-population was stable or had increased since the time of the Central Arctic polar bear survey. Based on Inuit knowledge, recognition of sampling deficiencies, and polar bear densities in other areas, in the 1990s an interim sub-population estimate of 900 for GB was established.

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Following the completion of a mark-recapture inventory in spring 2000, the sub-population was estimated to number 1,523 bears (M.K. Taylor *et al.*, unpubl. data). Natural survival and recruitment rates (Table 2) were estimated at values higher than the previous standardized estimates (Taylor *et al.* 1987).

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13. Foxe Basin (FB)

Based on 12 years of mark-recapture studies, tracking of female bears with conventional radios, and satellite tracking of adult females in western Hudson Bay and southern Hudson Bay, the Foxe Basin (FB) sub-population of polar bears appears to occur in Foxe Basin, northern Hudson Bay, and the western end of Hudson Strait (Taylor and Lee 1995). During the ice-free season, polar bears are concentrated on Southampton Island and along the Wager Bay coast; however, significant numbers of bears are also encountered on the islands and coastal regions throughout the Foxe Basin area. A total sub-population estimate of 2,119 bears was developed in 1996 (M.K. Taylor, unpubl. data) from a mark-recapture analysis based on tetracycline biomarkers (Taylor and Lee 1994). The marking effort was conducted during the ice-free season, and distributed throughout the entire area. The sub-population estimate is believed to be accurate, but dated. Simulation studies suggest that the harvests prior to 1996 reduced the sub-population from about 3,000 bears in the early 1970s to about 2,100 bears in 1996. Harvest levels were reduced in 1996 to levels that were predicted permit slow recovery of this sub-population, provided that the kill in Québec did not increase.

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In December 2004, TEK indicated that the sub-population had increased. After consultations with native communities, Nunavut increased the harvest quota to a level consistent with a sub-population level of 2,300 bears. Co-management discussions with Québec are ongoing. Survival and recruitment rates used for risk assessment are based on the rates obtained for the adjacent Baffin Bay sub-population (Taylor *et al.* 2005).

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14. Western Hudson Bay (WH)

The distribution, abundance, and population boundaries of the Western Hudson Bay (WH) polar bear sub-population have been the subject of research programs since the late 1960s (Stirling *et al.* 1977, 1999, Derocher and Stirling 1995*a* ,*b*, Taylor and Lee 1995, Lunn *et al.* 1997). Over 80% of the adults in the sub-population is marked, and there are extensive records from capture-recapture studies and tag returns from polar bears killed by Inuit hunters. During the open water season, the WH sub-population appears to be geographically segregated from the Southern Hudson Bay sub-population to the east and the Foxe Basin sub-population to the north. During the winter and spring, the three sub-populations mix extensively on the sea ice covering Hudson Bay (Stirling *et al.* 1977, Derocher and Stirling 1990, Stirling and Derocher 1993, Taylor and Lee 1995). The size of the WH sub-population was estimated to be 1,200 bears in autumn, in 1988 and 1995 (Derocher and Stirling 1995*a*, Lunn *et al.* 1997). At that time, the size of the WH sub-population appeared to be stable, and the harvest was believed to be sustainable.

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Over the past three decades, there have been significant declines in the body condition of adult male and female polar bears, and in the proportion of independent yearlings captured during the open water season in western Hudson Bay (Derocher and Stirling 1992, 1995*b*, Stirling and Lunn 1997, Stirling *et al.* 1999, N. Lunn and I. Stirling, unpubl. data). Over the same period, the average date of spring break-up of the sea ice in the region has advanced by three weeks (Stirling *et al.* 1999, 2004 [ideally, it would be better to have a sea ice reference here rather than a polar bear reference; since Ian Stirling is a reviewer, I'll leave it to him to provide the sea ice reference that he used]), presumably due to increasing spring air temperatures. Warming rates in western Hudson Bay between 1971 and 2001 ranged from a minimum 0.5° C per decade at Churchill, Manitoba, to 0.8° C per decade at Chesterfield Inlet, Nunavut (Gagnon and Gough 2005). Stirling *et al.* (1999) documented a significant correlation between the timing of sea ice break-up and the body condition of adult female polar bears (i.e., early break-up was associated with poor body condition). Stirling et al. (1999) also suggested that the declines in various life history parameters of polar bears in western Hudson Bay were the result of nutritional stress associated with the trend toward earlier break-up, which in turn appears to be due to long-term warming.

An updated analysis of capture-recapture data from the WH sub-population was completed in 2005 (E. Regehr *et al.*, in review). Between 1987 and 2004, the estimated number of polar bears in the WH sub-population declined from 1,194 to 935, a reduction of about 22%. This decline appears to have been initiated by progressive declines in the body condition and survival of cubs, subadults, and bears 20 years of age and older, caused by the earlier break-up of spring sea ice. Once the sub-population began to decline because of changing environmental conditions, the existing harvest was no longer sustainable, and the additive effects of climate change and over-harvest most likely accelerated the decline in abundancesize between 1987 and 2004. The harvest sex ratio of 2 males per female has resulted in skewed sex ratio within the sub-population of 65% female and 35% male polar bears (E. Regehr *et al.*, unpubl. data).

Concurrent with the recent re-assessment of the size of the WH sub-population, an increased number of polar bears shave been reported in and around human settlements along the coast of

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western Hudson Bay. In some communities, this increase in polar bear sightings has been interpreted as evidence that the size of the WH sub-population is increasing. Based on this perception, the government of Nunavut in December 2004 increased its quota for the number of polar bears that could be harvested from the WH sub-population from 55 to 64 polar bears. In order to sustain this increased level of harvest, Nunavut estimated that the size of the WH sub-population would have to be at least 1,400 bears; this is the sub-population estimate currently used by Nunavut for management purposes. An alternate explanation for the apparent increase in polar bears in the vicinity of human settlements and hunting camps is that, because of declines in body condition associated with the earlier sea ice break-up, polar bears in western Hudson Bay have less time to accumulate the fat reserves that they depend on during the open water season. As polar bears deplete their fat reserves toward the end of the open water season, they are more likely to seek alternative food sources around human settlements to sustain themselves until freeze-up.

15. Southern Hudson Bay (SH)

Boundaries of the Southern Hudson Bay (SH) polar bear sub-population are based on movements of marked bears and telemetry studies (Jonkel *et al.* 1976, Kolenosky and Prevett 1983, Kolenosky *et al.* 1992, Taylor and Lee 1995). Recently completed research using satellite telemetry collared bears was aimed at refining the boundaries of this sub-population and estimating the sub-population size and rates of birth and death (M. Obbard, M.K. Taylor, and F. Messier unpubl. data). The current estimate of the size of the sub-population comes from a three-year (1984–1986) mark-recapture study, conducted mainly along the Ontario coastline (Kolenosky *et al.* 1992). This study and the more recent telemetry data have documented seasonal fidelity to the Ontario coast during the ice-free season, and some intermixing with the WHBay and FB sub-populations during months when the bay is frozen over. In 1988, the results of a modelling workshop included an increase in the sub-population estimate from 900 to 1,000 bears because portions of the eastern and western coastal areas were not included during original sampling. Additionally, the area away from the coast may have been under-sampled due to difficulties in locating polar bears inland (i.e., below the tree line). Thus, some classes of bears,

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especially pregnant females, may have been under-sampled. The estimate of 1,000 bears in this status report is considered dated. The final year of a mark-recapture inventory was completed in fall 2005; a new sub-population estimate should be available soon.

Based on the estimate of 1,000 bears, the total harvest by Nunavut, Ontario, and Québec appears to be sustainable. Recent analysis of coastal survey data (Stirling *et al.* 2004) suggests that polar bear numbers in SH have remained unchanged in recent years. A pattern of decline in body condition was documented for the SH sub-population when comparing bears captured in 1984-86 with those captured in 2000-04 (M. Obbard, unpubl. data); however, it is unknown whether changes in demographic parameters like those described by Stirling *et al.* (1999) and Derocher *et al.* (2004) for WH have occurred.

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16. Kane Basin (KB)

Based on the movements of adult females with satellite telemetry collars and recaptures of tagged animals, the boundaries of the Kane Basin (KB) polar bear sub-population include the North Water Polynya (to the south of KB), and Greenland and Ellesmere Island to the west, north, and east (Taylor *et al.* 2001*b*). Polar bears in Kane Basin do not differ genetically from those in Baffin Bay (Paetkau *et al.* 1999). Prior to 1997, this sub-population was essentially unharvested in Canadian territory because of its distance from Grise Fiord, the closest Canadian community, and because conditions for travel in the region are typically difficult. However, this sub-population has occasionally been harvested by hunters from Grise Fiord since 1997, and continues to be harvested on the Greenland side of Kane Basin. In some years, Greenland hunters have also harvested polar bears in western Kane Basin and Smith Sound (Rosing-Asvid and Born 1990, 1995).

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Few polar bears were encountered by researchers along the Greenland coast from 1994 through 1997, possibly because of previously intense harvest pressure by Greenland hunters. The current estimate of the KB sub-population is 164 (M.K. Taylor, unpubl. data) and the best estimate of the Greenland kill is 10 bears per year during 1999-2003 (Born 2005, Born and Sonne 2005).

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However, the actual number being taken by Greenland hunters is uncertain (Born 2001, Born and Sonne 2005) and must be validated. The Canadian quota for this sub-population is five. The annual combined Canadian and Greenlandic take of 10-15 from the KB sub-population is unsustainable (Table 1, and if harvesting continues at that level population depletion could occur). Although the habitat appears suitable for polar bears on both the Greenland and Canadian sides of Kane Basin, the densities of polar bears on the Greenland side were much lower than on the Canadian side, suggesting that this sub-population may have been larger in past years, and could be managed for sub-population increase. The sub-population is classified as declining by PBSG (2006). Co-management discussions between Greenland and Canada are continuing on (Lønstrup 2006). Greenland introduced polar bear quotas taking effect on 1 January 2006. The total 2006-quota is 30 bears for the municipality of Qaanaaq (NW Greenland) that harvest polar bears in Kane Basin . However, it has not been specifically stated how many of this total of 30 bears that can be taken in Kane Basin (Born in litt.);

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17. Baffin Bay (BB)

Based on the movements of adult females with satellite telemetry collars and recaptures of tagged animals, the area in which the Baffin Bay (BB) sub-population occurs is bounded by the North Water Polynya to the north, Greenland to the east, and Baffin Island to the west (Taylor and Lee 1995, Taylor *et al.* 2001*b*). A relatively distinct southern boundary at Cape Dyer, Baffin Island, is evident from the movements of tagged bears (Stirling *et al.* 1980) and recent movement data from polar bears monitored by satellite telemetry (Taylor *et al.* 2001*b*). A study of microsatellite variation did not reveal any genetic differences between polar bears in Baffin Bay and Kane Basin, although Baffin Bay bears differed significantly from Davis Strait and Lancaster Sound bears (Paetkau *et al.* 1999). An initial sub-population estimate of 300–600 bears was based on mark-recapture data collected in spring (1984–1989) in which the capture effort was restricted to shore-fast ice and the floe edge off northeast Baffin Island (R. E. Schweinsburg and L. J. Lee, unpubl. data). However, recent work has shown that an unknown proportion of the

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sub-population is typically offshore during the spring and, therefore, unavailable for capture. A second study was carried out annually during the months of September and October 1993–1997, when all polar bears were ashore in summer retreat areas on Bylot and Baffin islands. Based on those data Taylor *et al.* (2005) estimated the number of polar bears in BB at 2,074.

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The BB sub-population is shared with Greenland, which until 1 January 2006 did not limit the number of polar bears harvested. Using mark-recapture, Taylor *et al.* (2005) estimated the Greenland annual removal at 18–35 bears for the period 1993–1997. However, Born (2002) had reported that the estimated Greenland average annual catch of polar bears from the BB sub-population was 73 over the period 1993-1998. More recently, Born and Sonne (2006) indicated the BB average annual kill from 1999-2003 for Greenland was 115 (range: 68-206 bears per year) with an increasing trend. In December 2004, based on reports from Inuit hunters that polar bear numbers in BB had grown substantially, Nunavut increased its BB polar bear quotas from 64 to 105 bears.

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The BB sub-population appears to be substantially over-harvested. The current (2004) estimate of sub-population size is less than 1,600 bears based on simulations using the pooled Canadian and Greenland harvest records (Table 1). The sub-population was classified as declining by PBSG (2006). Co-management discussions between Greenland and Canada are ongoing. Greenland introduced polar bear quotas taking effect on 1 January 2006. If the total 2006-quota for those municipalities in NW and W Greenland that catch bears from the BB populations (i.e. Qaanaaq to Sisimiut) is summed a total of 97 polar bears can be taken in Greenland from BB (assuming that 20 of a quota of 30 in Qaanaaq are taken from BB: see Kane Basin).

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18. Davis Strait (DS)

Based on the movements made by tagged animals and, more recently, of adult females with satellite-linked telemetry, the Davis Strait (DS) sub-population includes polar bears in the Labrador Sea, eastern Hudson Strait, Davis Strait south of Cape Dyer, and along the eastern edge of the Davis Strait-southern Baffin Bay pack ice. When bears occur in the latter area they are

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subject to catch from Greenlanders (Stirling and Kiliaan 1980, Stirling *et al.* 1980, Taylor and Lee 1995, Taylor *et al.* 2001*b*). A genetic study (Paetkau *et al.* 1999) indicated significant differences between bears from Davis Strait and both Baffin Bay and Foxe Basin. The initial sub-population estimate of 900 bears for DS (Stirling *et al.* 1980) was based on a subjective correction from the original mark-recapture estimate of 726 bears, which was felt to be too low because of possible bias in the sampling. In 1993, the Canadian Polar Bear Technical Committee increased the estimate to 1,400 bears to account for bias in sampling created by the inability of researchers to survey the extensive area of offshore pack ice (I. Stirling and M.K. Taylor, unpubl. data). Traditional ecological knowledge also suggested that the sub-population had increased over the last 20 years. The principal justification for this adjustment is based on the observation that the annual harvest has been sustained for the last 20 years and on non-quantitative observations that continue to suggest the sub-population has increased.

The IUCN Polar Bear Specialist Group has indicated that the DS sub-population was either stable or perhaps declining due to over-harvest (IUCN/SSC Polar Bear Specialist Group 1995, 1998, 2002).

In December 2004, Nunavut increased its polar bear quota in DS by 12 bears based on Inuit reports that the sub-population had increased since 1996. In order to sustain this increased level of harvest, Nunavut estimated that the size of the DS sub-population would have to be at least 1,650 bears; this is the sub-population estimate currently used by Nunavut for management purposes. A mark-recapture study is currently underway to assess the size of the DS sub-population. Within Canada, this sub-population is harvested by Inuit from Nunavut, Québec, and Labrador. The combined harvest by Canadian jurisdictions and Greenland (*ca.* 1 per year in Greenland during 1999-2003; Born and Sonne 2006) totalled 65 (Table 1). Co-management discussions between Greenland and Canada are continuing (Lonstrup 200%) Greenland introduced polar bear quotas taking effect on 1 January 2006. If the total 2006-quota for those municipalities W Greenland (i.e. Maniitsoq and Nuuk) that catch bears from the DS population is summed a total of 5 polar bears can be taken in Greenland from DS. A population inventory began in summer of 2005 to develop a scientific estimate of sub-population numbers. Survival

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and recruitment rates used for risk assessment are based on the detailed rates obtained for the adjacent BB sub-population (Taylor *et al.* 2005).

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19. Arctic Basin (AB)

The Arctic Basin sub-population is a geographic catch-all to account for bears that may be resident in areas of the circumpolar Arctic that are not clearly part of other sub-populations. Polar bears occur at very low densities in this region, and it is known that bears from other sub-populations use the area (Durner and Amstrup 1995). As climate warming continues, it is anticipated that this area may become more important for polar bears as a refugia but a large part of the area is over the deepest waters of the Arctic Ocean and biological productivity is thought to be low.

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C. Uncertainty

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Anthropogenic and natural changes in Arctic environments, as well as recognition of the shortcomings of our knowledge of polar bear ecology, are increasing the uncertainties of polar bear management. Higher temperatures and erratic weather fluctuations, which are symptoms of global climate change, are increasing across the range of polar bears. Following the predictions of climate modellers, such changes have been most prevalent in Arctic regions (There it would seem the appropriate references would instead be climate modeling studies, e.g., Holland and Bitz 2003] Stirling and Derocher 1993, Stirling and Lunn 1997, Stirling *et al.* 1999, Derocher *et al.* 2004), and have already altered local and global sea-ice conditions (Gloersen and Campbell 1991, Vinnikov *et al.* 1999, Serreze *et al.* 2000, Parkinson and Cavalieri 2002, Comiso 2002, 2003, Gough *et al.* 2004). Because changes in sea-ice are known to alter polar bear numbers and productivity (Stirling and Lunn 1997, Stirling *et al.* 1999, Derocher *et al.* 2004), effects of global climate change can only increase future uncertainty and may increase risks to the welfare of polar bear sub-populations. Uncertainty about effects of climate change on polar bears must be

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included in future management and conservation plans. In the face of climate change, the need for rigorous scientific information will increase.

Persistent organic pollutants, which reach Arctic regions via air and water currents, also increase uncertainty for the welfare of polar bears. Recent studies document new pollutants in polar bear tissues (Smithwick *et al.* 2005, Verrault *et al.* 2005, Muir *et al.* 2006). The effects of pollutants on polar bears are only partially understood. Levels of such pollutants in some polar bear sub-populations, however, are already sufficiently high that they may interfere with hormone regulation, immune system function, and possibly reproduction (Wiig *et al.* 1998, Bernhoft *et al.* 2000, Skaare *et al.* 2000, 2001, Henriksen *et al.* 2001). Sub-population level impacts on polar bears are unknown, at present, but reproductive and survival rates may be affected (Derocher *et al.* 2003, Derocher 2005).

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Our understanding of polar bear sub-population dynamics has greatly improved with new sdevelopment in ticalanalysis methods (Lebreton *et al.* 1992, Amstrup *et al.* 2001, McDonald and Amstrup 2001, Manley *et al.* 2003, Taylor *et al.* 2002, 2005). These new tools suggest that previous estimates of sub-population parameters and numbers can be biased. Vital rates are sub-population specific, and different from the generalized rates that were often used to generate previous status reports (Taylor *et al.* 1987). Additionally, computer simulations (e.g., Taylor *et al.* in review) suggest that harvesting polar bear sub-populations at or near maximum sustained yield(MSY) puts the sub-population at greater risk than previously believed.

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D. Status Summary

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Table 3 summarizes the current status for 18 populations as: data deficient (6); reduced (4); severely reduced (2); and not reduced (6). The table ssummarized observed or predicted trends for the populations as follows: data deficient (6); increasing (2); declining (5); and stable (5). The estimated risk for population declines due to harvest within the next 10 years was categorized as: no estimate (7); very high (3); higher (2); lower (4); and very low (2).

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For six populations, data and information were insufficient to make assessments or predictions of status or trend. Five populations (including four that are hunted) had no estimate of potential risk from over-harvest, although for one of the populations, Chukchi Sea, severe over-harvest was suspected to have occurred during the past 10-15 years. Accurate biological data to assess status, trend and risk to population was not available for 1/3 of the populations. Of the populations for which data are available to assess status and trend, only two are noted to be increasing, and both of these populations had been severely reduced in the past and are recovering under conservative harvest limits. The two populations that have long time series of data, Western Hudson Bay and Southern Beaufort Sea, are both declining.

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V. Discussion of Listing Factors

The Act identifies five factors to be considered in evaluating a species for listing: (1) The present or threatened destruction, modification, or curtailment of the species' habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) the inadequacy of existing regulatory mechanisms; and (5) other natural or manmade factors affecting the species' continued existence.

In the context of the ESA, the term "threatened species" means any species (or subspecies or, for vertebrates, DPS) that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. The term "endangered species" means any species that is in danger of extinction throughout all or a significant portion of its range. The principal considerations in the determination of whether or not a species warrants listing as a threatened or an endangered species under the ESA are the threats that now confront the species and the probability that the species will persist in "the foreseeable future." The ESA does not define the term "foreseeable future." The IUCN/Polar Bear Specialist Group reassessed the status of polar bears globally in June 2005, using the criteria described in the IUCN/SSC Red List process and three generations as the time span. Generations, as defined by IUCN are calculated as the age of sexual maturity (5 years) plus 50% of the length of the life time reproductive period (20 years). Based on these calculations, the projected period for 1

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generation was calculated at 15 years and the projected period for 3 generations was calculated as 45 years.

For other species evaluated for listing as threatened, such as the Yellowstone Cutthroat Trout, the status assessment report (May et al. 2003) considered the "foreseeable future" to be 4 to 10 generations, depending on the productivity of the environment. For the greater sage-grouse the status review agreed by consensus that given all of the uncertainties, a reasonable timeframe for "foreseeable future" for the threatened definition was approximately 30 to 100 years (approximately 10 greater sage-grouse generations or 2 sagebrush habitat regeneration cycles). These time frames were considered reasonable and appropriate for each status review as the time frame is long enough to take into account multi-generational dynamics of life-history and ecological adaptation, yet short enough to incorporate social and political change that affects species management.

In this status review we have adopted the three generation lower limit from the IUCN Red List criteria and used a six generation upper limit as a reasonable range for analysis. **(Note to reviewers – is this an appropriate time frame and rationale for evaluation?)** The time span is based on the life-history and population dynamics of polar bears and the projected rates of change of polar bear habitat. This range in time for the term "foreseeable future" is equivalent to ca. 50 to ca. 100 years.

We examined each of the listing factors in the context of present-day distribution of polar bears. We incorporate by reference published information on each of the listing factors. The evaluation of the five factors with repect to polar bear populations is presented below.

A. Present or Threatened Destruction, Modification, or Curtailment of the Species' Habitat or Range

1. Arctic Climate Change- Overview

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Recently, two comprehensive reports prepared by panels of leading scientists have been published that describe the current state of climate change globally and the impact on the Arctic specifically. The first report, the Intergovernmental Panel on Climate Change's *Climate Change 2001: The Scientific Basis* (IPCC, 2001), is a detailed assessment of current and predicted future climates around the globe. The Intergovernmental Panel on Climate Change (IPCC) has been established by World Meterological Organization and United Nations Environment Programme to assess scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation. The other document, *Impacts of a Warming Arctic, Arctic Climate Impact Assessment* (ACIA, 2004), addresses the changes that will likely occurin the Arctic and their consequences. The ACIA report was an international project of the Arctic Council and the International Arctic Science Committee (IASC), to evaluate and synthesize knowledge on climate variability, climate change, and increased ultraviolet radiation and their consequences. This assessment was prepared over a period of five years by an international team of over 300 scientists, other experts, and knowledgeable members of the indigenous communitiesSs. Ssshorter overview of observational evidence of Arctic change, including changes in sea ice, shrinking glaciers, thawing permafrost, and Arctic greening, areare given by Morison et al. (2000),Sturm et al. (2003), Comiso and Parkinson (2004, and Parkinson (2006).

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Observed Changes in Arctic Sea Ice

Sea ice is the defining characteristic of the marine Arctic (ACIA 2004). It is the primary method through which the Arctic exerts leverage on global climate, by mediating the exchange of radiation, sensible heat, and momentum between the atmosphere and the ocean (ACIA 2004). This section describes observed changes in Arctic sea ice over the past several decades.

Sea ice extent and thickness. Sea-ice extent in the Arctic has a clear seasonal cycle. It is typically at its maximum (14–15 million square kilometers (sq km)) in March and minimum (6–7 million sq km) in September (Parkinson et al. 1999). There is considerable interannual variability both in the maximum and minimum extent of sea ice. In addition, there are decadal and inter-decadal fluctuations in the areal sea-ice extent due to changes in atmospheric pressure patterns and their associated winds, continental discharge, and influx of Atlantic and Pacific waters (Gloersen, 1995; Mysak and Manak, 1989; Kwok, 2000; Parkinson, 2000b; Polyakov et al., 2003; Rigor et al., 2002; Zakharov, 1994).

Observations have shown a decline in late summertime Arctic sea ice extent of 7.7 percent per decade and in the perennial sea ice area of 9.8 percent per decade (Stroeve et al., 2005; Comiso, 2006), a lesser decline of 2.7 percent per decade in yearly averaged sea ice extents (Parkinson and Cavalieri, 2002). The estimated rate of decrease trend in late summer sea ice coverage has increased as the satellite data record has lengthened: From 1978 through 2001 the trend was -6.5 percent per decade; through 2002 it increased to -7.3 percent per decade; and through 2004 it was -7.8 percent per decade. With a fourth consecutive year of substantial ice losses in 2005, the declining sea ice trend is now at a rate of -8.5 percent per decade (Stroeve et al., 2006; Comiso, 2006).

Observations have likewise shown a thinning of the Arctic sea ice of 32 percent from the 1960s and 1970s to the 1990s in some local areas (Yu et al., 2004, updated from Rothrock et al., 1999), with an overall thinning of about 2.5-3.75 percent per decade (ACIA 2004). Lindsay and Zhang (2005) suggest that feedback mechanisms caused a tipping point in Arctic sea ice thinning in the late 1980s, sustaining the continual decline in the sea ice cover. Zhang and Walsh (2006) investigated the reproduction of the sea ice state in the IPCC models and found generally consistent results and an amplified seasonal cycle in sea ice area. They found that the model predicts multiyear ice area shrinks more rapidly than the total sea ice area, which is consistent with observational studies (Johanessen et al., 1999; Comiso 2002). As multiyear ice is generally much thicker than first-year ice, a decline in the multiyear ice amplifies the seasonal melting of the sea ice.

The predominant reasons for amplified decreases in the extent of sea ice are (a) the sea ice

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albedo feedback (i.e., less sea ice cover, which has a high reflectivity, causes more absorption of solar radiation in the ocean and hence more heat storage in the ocean, and a warmer ocean further delays formation of new sea ice cover in the fall), (b) the thinning of the sea ice (including the reduction in perennial ice (Comiso, 2002)), which leads to more rapid melting of sea ice, (c) an increase in melt season length (Stroeve et al., 2006) and decrease in ice season length (Parkinson 2000), which also enhances the sea ice albedo feedback, and (d) the recent transport of multiyear ice out of the Arctic Ocean (Lindsay and Zhang 2005).

In addition to these direct sea ice processes, oceanic circulation plays an important role. Pierce et al. (2006) compared ocean temperature observations with results from two climate models that include anthropogenic forcing and found close agreement. Both model and observations show the largest increase in ocean temperature in the North Atlantic. Similarly, Polyakov et al. (2005) analyzed ocean observations of the Atlantic Water (a water mass that enters the Arctic O andOcean Barents Sea via the Norwegian Sea) and concluded that the Arctic OOcean is in transition towards a warmer state, which has implications for the Arctic sea ice cover. The variability in both the temperature and velocity of the inflow of Atlantic waters in the Barents Sea appears to drive changes in the Arctic surface air temperature (Goose and Holland, 2005).

Melt period. Tthe length of melt period is considered an important factor affecting sea ice cover, especially ice thickness (Hakkinen and Mellor 1990 and Laxon et al. 2003, cited in Comiso 2005). An accumulating body of observations points to an earlier melt onset in spring and lengthening of the melt season, favoring less total ice cover at summer's end (Stroeve et al., 2005). Comiso (2003) examined trends from 1981 to 2001 using satellite thermal infrared (AVHRR) data on surface temperatures, and calculated an increase in the melt season of 10-17 days per decade. Subsequently, Comiso (2005) evaluated 1981-2003 AVHRR data and determined that the length of thesea ice melt seasonis increasing at a rate of approximately 13.1 days per decade. This result is different from Comiso's (2003) previous estimates for sea ice in that ocean areas that become ice-free in spring and summer are included in the analysis. Comiso (2005) states that the relatively high value is probably an important reason for the current rapid decline of the perennial ice cover.

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Further support for extended melt periods comes from Belchansky et al. (2004) based on passive microwave satellite retrievals (SSM/I) (Stroeve et al. 2005). Belchansky et al. (2004) found that "consecutive year changes (1994-2001) in January multiyear ice volume were significantly correlated with duration of the intervening melt season."

In 2005, NSIDC reported that for 2002-2005, melt began earlier on average in all four years. The 2005 melt season arrived the earliest, beating the mean melt onset date by approximately 17 days throughout the Arctic (NSIDC 2005).

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According to Derocher et al. (2004), in western Hudson Bay, break-up of the annual ice is now occurring approximately 2.5 weeks earlier than it did 30 years ago (Stirling et al., 1999 and unpubl data of Stirling and Lunn).

The longer melt season is linked to a shorter ice season throughout much of the seasonal sea ice region. Maps of the trend in ice-season length from 1979 through 1996 as determined from satellite data show the ice season decreasing by as much as 8 days per year in the eastern Barents Sea and by lesser amounts throughout much of the rest of the Arctic (Parkinson, 2000a).Land-fast ice. Fast ice grows seaward from a coast and remains in place throughout the winter. Typically, it is stabilized by grounded pressure ridges at its outer edge, and therefore extends to the draft limit of such ridges, usually about 20 to 30 m. Fast ice is found along the coasts of Siberia, the White Sea, northern Greenland, the Canadian Archipelago, Hudson Bay, and western andernnorth Alaska.

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Polynyas and leads. Polynyas are semi-permanent open water regions ranging in area up to thousands of square kilometers. Flaw leads occur at the border of fast ice when offshore winds separate the drift ice from the fast ice. Polynyas and flaw leads are environmentally important for several reasons (AMAP, 1998):

- they are areas of high heat loss to the atmosphere;
- they typically form the locus of sea-ice breakup in spring;

- they are often locations of intense biological activity; and
- they are regions of deep-water formation.

Other Observed Changes in Arctic Climate

Observed recent trends for various snow and ice parameters of the Arctic cryosphere (taken largely from Table 18.3 of ACIA 2004) are briefly summarized as follows:

Snow cover	Snow-cover extent in the Northern Hemisphere has decreased by 5 to 10% since 1972; trends of such magnitude are rare in GCM simulations.
Glaciers	Glaciers throughout the Northern Hemisphere have shrunk dramatically over the past few decades (e.g., Dyurgerov and Meier, 1997), contributing about 0.15 to 0.30 mm/yr to the average rate of sea-level rise in the 1990s.
Permafrost	Permafrost temperatures in most of the Arctic and subarctic have increased by several tenths of a degree to as much as 2 to 3 °C (depending on location) since the early 1970s. Permafrost thawing has accompanied the warming.
River discharge	River discharge has increased over much of the Arctic during the past few decades and the spring discharge pulse is occurring earlier.
Breakup and freeze-up	Earlier breakup and later freeze-up of rivers and lakes across much of the Arctic have lengthened the ice-free season by 1 to 3 weeks.
Sea-level rise	Global average sea level rose between 10 and 20 cm during the 20th century (IPCC, 2001). This change was amplified or moderated in particular regions by tectonic motion or isostatic rebound.
Precipitation	Observations suggest that precipitation has increased by approximately 8 percent across the Arctic over the past 100 years, although measurement uncertainties and the sparseness of data from certain regions limit confidence in these results (ACIA 2004). In addition to the overall increase, changes in the characteristics of precipitation have also been observed (ACIA 2004). Much of the precipitation increase appears to be coming as rain, mostly in winter

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and to a lesser extent in autumn and spring. The increasing winter rains, which fall on top of existing snow, cause faster snowmelt. Rain-on-snow events have increased significantly across much of the Arctic (ACIA 2004). For example, over the past 50 years in western Russia, rain-on-snow events have increased by 50 percent (ACIA 2004).

Projected Changes in Arctic Climate

Background. To assess future climate change impacts on ecosystems, possible changes in physical climate parameters must first be projected (ACIA 2004). Physical climate change projections must, in turn, be calculated from changes in external factors that can affect the physical climate (ACIA 2004). Physically-based climate models are used to obtain climate scenarios – plausible representations of future climate that are consistent with assumptions about future emissions of greenhouse gases and other pollutants (i.e., emissions scenarios) and with present understanding of the effects of increased atmospheric concentrations of these components on the climate (ACIA 2004). In its Third Assessment Report, the IPCC (2001) produced a Special Report on Emissions Scenarios (SRES) to project a variety of future emissions scenarios that encompass a range of possible futures based on how societies, economies, and energy technologies are likely to evolve, and can be usused to estimate the likely range of future emissions that affect the climate (ACIA, 2004).

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Of the various types of climate models, global coupled atmosphere-ocean general circulation models (AOGCMs) are widely acknowledged as the principal, and most promising rapidly developing tools for simulating the response of the global climate system to increasing GHG concentrations. In its Third Assessment Report, the IPCC (2001) concluded that state-of-the-art AOGCMs in existence at the turn of the century provided "credible simulations of climate, at least down to subcontinental scales and over temporal scales from seasonal to decadal", and as a class were "suitable tools to provide useful projections of the future climate" (McAvaney et al., 2001).

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is this acronym identified earlier?

Projected temperature and sea level changes. The IPCC report states that the "global average temperature and sea level are projected to rise under all IPCC SRES scenarios." The globally averaged surface temperature is projected to increase by somewhere between 1.4 and 5.8° C over the period 1990 to 2100 depending on model parameters and the assumptions made on future CO_2 emissions. The projected rate of warming is much larger than the observed changes during the 20th century and is very likely to be without precedent during at least the last 10,000 years. Specifically for the Arctic, models suggest that global warming is amplified in high northern latitudes (Holland and Bitz, 2003). A comparison of results from 15 models has shown that the range of simulated polar warming in the Arctic is from 1.7 to 4.3 times the global mean warming (Holland and Bitz, 2003). Furthermore, the IPCC reports says "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities" and "human influences will continue to change atmospheric composition throughout the 21st century".

Projected changes in sea ice cover. For the future, all evidence points to the likelihood of continued Arctic warming and continued decreases in the Arctic sea ice cover in the 21st century (Comiso, 2006), due to increasing global temperatures despite a large degree of uncertainty of the actual increase. The anthropogenic climate change impact on sea ice cover is implicated in Vinnikov et al. (1999) and Johannessen et al. (2004) who have shown that the observed decrease in Arctic sea ice extent cannot be explained by natural climate variations. Although there is a large degree of uncertainty regarding the actual increase in global temperature, because of the long residence time of CO_2 in the atmosphere, even a rapid reduction in CO_2 emissions would not stop an increase in global temperature unless the countering cooling effects of aerosols or other factors are stronger than currently thought. Uncertainties about the appropriateness of extrapolation of linear trends into the future and of different model assumptions result in large uncertainties about the future of the Arctic sea ice. Gregory et al. (2002) used four IPCC (SRES) scenarios to model the future of the Arctic sea ice, including extreme scenarios for global temperature increases of (a) 1.9K and (b) 4.2K between 1990 and 2090. For scenario (a) the September sea ice area is projected to decrease from its current value of 4 million sq km in September to less than 2 million sq km by 2100. For scenario (b), however, the Arctic is projected to be sea ice free in summer by 2080. Using results from 12 IPCC 4th Assessment

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what are these values?? They don't look like temperatures.

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models, the analysis of Zhang and Walsh (2006) projects evolution towards a seasonal sea ice cover particularly in SRES scenarios. They also note that natural variability does not appear to have a significant impact on the trends. With the amplification of global warming in the Arctic region, there is a strong likelihood of no sea ice cover during summer in the Arctic Ocean by the end of the 21st century (Johannessen et al., 2004).

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Unclear. Evolution is probably not the right word and what about areas that already are characterized by seasonal ice cover?

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anywhere?

Land-fast ice. Fast ice is not explicitly included in climate model scenarios (ACIA 2004). Although reductions in the extent, thickness, and stability of fast ice are likely to occur, the implications of climate change for fast ice is recognized as a gap in knowledge. Many potential impacts of climate change will be mediated through land-fast ice (ACIA 2004). It protects unstable coastlines and coastal communities from wave damage, flooding by surges, and ice ride-up. It creates a unique and perhaps necessary habitat for northern species such as the ringeddringer seal. It blocks channels, facilitating the formation of polynyas important to northern ecosystems in some areas (ACIA 2004).

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Polynyas. Polynyas such as the North Water Polynya in northern Baffin Bay, owe their existence, at least in part, to winds that move sea ice from the area of its formation southward, so maintaining the area as open water even in the middle of winter. If the winds change, the number and size of polynyas are also likely to change (ACIA 2004). The ACIA (2004) report discusses possible changes to specific spolynya (e.g., St. Lawrence Island polynya region), and the potential implications of those changes to marine flora and fauna.

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would it be proper to add "in direction and/or intensity"?

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Other Predicted Changes in Arctic Climate

Predicted trends for various snow and ice parameters of the Arctic cryosphere (taken largely from Table 18.3 of ACIA 2004) are briefly summarized as follows:

Snow cover — Although increased evaporation (from warming) is likely to lead to some local increases in snow, sSnow-cover extent as a wholeis projected to decrease by about 13% by 2071–2090 under the projected increase in mean annual temperature of about 4 °C. The

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projected reduction is greater in spring. Owing to warmer conditions, some winter precipitation in the form of rain is likely to increase the probability of ice layers over terrestrial vegetation.

Glaciers	The loss of glacial mass through melting is very likely to accelerate throughout the Arctic, including the Greenland Ice Sheet. These changes will increase the rate of sea-level rise.
Permafrost	Over the 21st century, permafrost degradation is likely to occur over 10 to 20% of the present permafrost area, and the southern limit of permafrost is likely to move northward by several hundred kilometers.
River discharge	Models project that total river discharge is likely to increase by an additional 5 to 25% by the late 21st century.
Breakup and freeze-up	The trend toward earlier breakup and later freeze-up of rivers and lakes is very likely to continue, consistent with increasing temperature. Breakup flooding is likely to be less severe.
Sea-level rise	Models project that glacier contributions to sea level rise will accelerate in the 21st century. Combined with the effects of thermal expansion, sea level is likely to rise by 20 to 70 cm (an average of 2 to 7 mm/year) by the end of the 21st century.

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The ACIA (2004) report presents the following summary of general features of projected changes in the arctic atmosphere relevant to marine processes (Table 9.1 from ACIA 2004), and likely scenarios for changes in oceanographic conditions within the ACIA region by 2020, 2050, and 2080 (Table 9.4 from ACIA 2004).

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Table 9.1. Changes in surface and boundary forcing based on model projections and/or extrapolation of observed trends. Unless otherwise specified these projected changes are very likely to happen.

	2020	2050	2080
Air temperature			
annual mean[a]	1–1.5 °C increase	2–3 °C increase	4–5 °C increase
winter	2.5 °C increase	4 °C increase	6 °C increase in the central Arctic
summer	0.5 °C increase	0.5–1.0 °C increase	1 °C increase
seasonality	Reduced seasonality (warmer winters compared to summer)		
interannual variability	No change	No change	No change
Wind			
means	While changes in winds are expected, there is at present no consistent agreement from general circulation models as to the magnitude of the changes in either speed or direction		
storm frequency	Possible increase in storm intensity regionally (Labrador, Beaufort, Nordic Seas); in general, winter storms will decrease slightly in intensity because the pole to equator temperature gradient decreases		
storm tracks	Probable northward shift in storm tracks		
regional issues	In areas of sea-ice retreat, there will be an increase in wind-driven effects (currents, waves) because of longer fetch and higher air–sea exchange		
Precipitation/runoff			
mean[b]	2% increase	6% increase	10% increase
seasonality	Decreased seasonality in runoff related to earlier snow melt. Seasonality in precipitation unclear		
snow on ice	1–2% increase	3–5% increase	6–8% increase
Sea level	5 cm rise	15 cm rise	25 cm rise
Cloud cover			
general	3% increase	5% increase	8% increase
spring, autumn	4–5% increase	5–7% increase	8–12% increase
winter, summer	1–2% increase	3–5% increase	4–8% increase
Cloud albedo	Not available	Not available	Not available

[a]These numbers are averages and should be higher in the central Arctic and lower over southern regions; [b]based on the estimates of precipitation minus evaporation in Chapter 6.

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Table 9.4. Summary of changes projected in ocean conditions according to the five ACIA-designated models relative to baseline conditions. Unless otherwise specified these projected changes are very likely to happen.

	2020	2050	2080
Sea ice			
duration	Shorter by 10 days	Shorter by 15–20 days	Shorter by 20–30 days
winter extent	6–10% reduction	15–20% reduction	Probable open areas in high Arctic (Barents Sea and possibly Nansen Basin)
summer extent	Shelves likely to be ice free	30–50% reduction from present	50–100% reduction from present
export to North Atlantic	No change	Reduction beginning	Strongly reduced
type	Some reduction in multi-year ice, especially on shelves	Significant loss of multi-year ice, with no multi-year ice on shelves	Little or no multi-year ice
landfast ice	Possible thinning and a retreat in southern regions	Probable thinning and further retreat in southern regions	Possible thinning and reduction in extent in all arctic marine areas
Sea surface temperature			
winter/summer (outside THC regions and depending upon stratification and advection)	An increase by about the same amount as the air temperatures in ice-free regions. No change in ice-covered regions		
seasonality	All shelf seas to undergo seasonal changes	30–50% of Arctic Ocean to undergo seasonal changes	50–100% of Arctic Ocean to undergo seasonal changes
Mixed-layer depth	Increase during summer in areas with reduced ice cover and increased wind		
Currents	In regions affected by THC, modifications to the THC will change the strength of the currents		
Ocean fronts	Fronts are often tied to topography but with altered current flows, may rapidly shift their position		
Light exposure	With decreasing ice duration and areal extent, more areas to be exposed to direct sunlight		
Nutrient levels	Substantial increases over the shelf regions due to retreat of the sea ice beyond the shelf break	High levels on shelves and in deep arctic basins; higher levels due to deeper mixed layer in areas of reduced ice cover	

Summary Statements

Excerpted from ACIA, 2004:

Changes in climate that have already taken place are manifested in the decrease in extent and thickness of Arctic sea ice, permafrost thawing, coastal erosion, changes in ice sheets and ice shelves, and altered distribution and abundance of species in polar regions (high confidence). Climate change in Polar Regions is expected to be among the largest and most rapid of any region on the Earth, and will cause major physical, ecological, sociological, and economic impacts, especially in the Arctic, Antarctic Peninsula, and Southern Ocean (high confidence). Polar Regions contain important drivers of climate change. Once triggered, they may continue for centuries, long after greenhouse gas concentrations are stabilized, and cause irreversible impacts on ice sheets, global ocean circulation, and sea-level rise (medium confidence). (ACIA, 2004)

Excerpted from ACIA, 2004:

Changes in the Arctic are very likely to have significant impacts on the global climate system. For example, a reduction in snow-cover extent and a shrinking of the marine cryosphere would increase heating of the surface, which is very likely to accelerate warming of the Arctic and reduce the equator-to-pole temperature gradient. Freshening of the Arctic Ocean by increased precipitation and runoff is likely to reduce the formation of cold deep water, thereby slowing the global thermohaline circulation. It is likely that a slowdown of the thermohaline circulation would lead to a more rapid rate of rise of global sea level, reduce upwelling of nutrients, and exert a chilling influence on the North Atlantic region as Gulf Stream heat transport is reduced. It would also decrease the rate at which CO_2 is transported to the deep ocean. Finally, temperature increases over permafrost areas could possibly lead to the release of additional CH_4 into the atmosphere; if seabed temperatures rise by a few degrees, hydrated CH_4 trapped in solid form could also escape into the atmosphere (ACIA 2004).

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This doesn't seem very necessary given all that is said before.

2. Biological effect on polar bears

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Polar bears are completely dependent upon Arctic sea-ice habitat for survival. They need sea ice as a platform from which to hunt their primary prey, ringed seals, to make seasonal migrations between the sea ice and their terrestrial denning areas, and for resting and mating. ¶
Lentfer (1972) first noted that a general warming trend had been observed in the Arctic prior to

SUGGESTIONS FOR THE REMAINDER OF SECTION V.A. (NOT TEXT TO BE ADDED DIRECTLY)

This section is supposed to be about destruction, modification, or curtailment of habitats and range, not just GCC as it is now written. There are other issues, like oil and gas development, other coastal developments such as port facilities and human habitations, shipping, military activities, etc. This entire section would be much better if it were reorganized and condensed. What you want to do is quickly make the reader see what specific things about habitat may make the species qualify as likely to become extinct or likely to become endangered. You need to state what has been found in studies but with the goal of making it obvious at the end that some current or predicted habitat issue is or is not likely to be a real problem.

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I would try organizing the section with the following subsections. In each subsection you want to briefly state what the situation is like now and how it may change over time, including all of the useful data from each population. I wouldn't at this point speculate about populations with no data.

1. Sea ice habitats--A major question whether sea ice itself is really important to PBs or is it just that is where ringed seals are and therefore they go there to hunt them. I'm not sure I see what it is about ice itself that is all that necessary except that it provides them a place to live away from humans, which may not be trivial.

2. Open water habitat--The issue here might best be framed as open water is bad habitat--they can't hunt in it, their cubs may freeze or drown, etc. But, if they are in a situation where they can't make a living on the ice they may try to cross the open water to get to shore (presumably only in those areas where they have some experience that feeding is better on shore) and that will cause mortalities.

3. Terrestrial habitats--These are important where they are used and I don't think should be downplayed. It apparently works for denning if conditions are right and can provide good feeding opportunities. A very big question is how much use of this habitat can be increased as ice diminishes. Also, what kind of tradeoffs there will be, like exposure to humans and the problems that brings. These are things that are likely to be very population specific.

4. Weather (rain, snow, wind)--From what I read in this section I'm inclined to believe that the biggest problem overall could be with snow. Not enough snow for dens=zero cub survival=the population disappears.

5. Prey abundance and availability--Ringed seals are big in the present circumstance, but I think other species may play a bigger role that recognized in what is here. I understand that Greg Thiemann (student of Iverson and Stirling) has completed and defended his thesis that give diet estimates for several pops and other species are not always trivial. It would be very good to incorporate that information here. Also, as ice conditions change other species will move into previously unused areas and you can't neglect that PBs may be able to use them.

6. Direct human impacts on habitats (this is for things other than GCC like oil and gas, other coastal/offshore development, vessel traffic, military activities, etc.)--There's nothing about this in the draft now, and for completeness there needs to be.

7. Evaluation and summary--The summary/evaluation should include a table with rows for each of the populations and columns for each of the habitat threats (these are specific threats that are identified in and come directly from the sections above, e.g., increased open water between feeding and denning areas, reduced snowfall, decreased abundance of ringed seals, increased vessel traffic). Fill in the cells of the tables with some kind of assessment of how much the threat applies to that population (e.g., very likely to occur, unlikely to occur, don't know) and how confident you can be of making that assesssment (e.g., very confident based on data for that population, reasonably confident based on extrapolation from data on other populations, don't know). The text should briefly describe how you assigned categories in the table and summarize what comes out of it. This could give you a picture of how much specific populations are threatened (i.e., some may have multiple threats likely to occur while other may have few or none) as well as how broadly a specific threat may affect the species as a whole (e.g., fewer ringed seals may affect all or nearly all populations while increased vessel traffic may affect only one or a few). I think that is the kind of information you need to feed into making a finding.

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Polar bears are completely dependent upon Arctic sea-ice habitat for survival. They need sea ice as a platform from which to hunt their primary prey, ringed seals, to make seasonal migrations between the sea ice and their terrestrial denning areas, and for resting and mating.

Comment [. charpter on ice variability in theArctic through the lifetime of polar bear as a species would have been useful.

Lentfer (1972) first noted that a general warming trend had been observed in the Arctic prior to 1950s, and that the polar bear could be adversely impacted by warming via changes in the sea ice and snow cover. He hypothesized that a general warming of the Arctic could adversely affect denning since alteration in ice conditions could result in fewer bears reaching some preferred denning areas. Vibe (1967) indicated that to successfully den and produce offspring bears and ringed seals require relatively stable climates with an absence of periods of thawing and melting of snow during the winter. Warming trends would reduce the extent of suitable denning areas.

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Loss of ice cover, a possibility described by Budyko (1966), was believed to result in a severe impact on denning and the food chain supporting the polar bear.

For polar bears and other species, the evaluation and quantification of cause and effect relationships between climate change and specific life history parameters or population status and trend are extremely difficult and require long time series of data that are only available for a few populations. In the absence of lengthy time series of data on polar bears scientists have been required to sub-sample key parameters over time or compare these parameters to averaged benchmarks for other population or sub-populations, acknowledging that natural variation related to system ry(?)caring capacity and environmental factors are inherent within each of the population units.

Hudson Bay in Canada is considered an area that typifies change in the Arctic due to its relatively southern location and occurrence on a divide between a warming and a cooling region (AMAP 2003). It is an ideal area to study the impacts of global climate change. Hudson Bay has the most significant long term time series of data on the ecology of polar bears and the site of the first documented evidence of major and ongoing impacts to polar bears from global warming.

Stirling and Derocher (1993) predicted an array of impacts to polar bears from global warming, including reduced abundance of and access to seals and effects on the marine ecosystem that influence productivity. Stirling and Derocher (1993) noted that changes in polar bear parameters such as declining body condition, lowered reproductive rates, and reduced cub survival were present in the Western Hudson Bay population, but at that time the changes could not be linked to global warming. In subsequent years, multi-disciplinary research continued to document the relationships between climate, sea ice, and physiological and demographic parameters of polar bear and, as well as similar relationships for other species (Gaston et al. 2003). Using data from a 19-year period, Stirling et al. (1999) established a statistically significant link between global warming and observed impacts to polar bear physical and reproductive parameters, including body condition and natality.

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Deleted: IPCC (2001) reports that most of the warming that has occurred during the 20th century has come during two periods, from 1910-1945, and from 1976-2000

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Comment [ ]: Page: 77 Here's an example of my problem with using "sub-population"--what is the difference between population and subpopulation in this case?

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Hudson Bay is a relatively closed system and is ice-free in the summer and freezes over in the winter (Parkinson et al., 1987; Gough et al. 2004). Typically it is completely covered in ice from January to May and is ice-free from mid-August to late OctoberParkinson et al., 1987;, with intermediate levels of ice forming or breaking up in the intervening periods. Break-up begins first in James Bay, at the southern end of Hudson Bay close to the western shoreline, due to warm winds, and also in the eastern region of Hudson Bay, from spring runoff. The last place to break up in the spring, however, is often the southwestern region of Hudson Bay, part of the Southern Hudson Bay polar bear population's territory and south of the terrestrial denning area of the Western Hudson Bay polar bear population. Gough et al. (2004) found that the trend towards earlier break-up of the ice in the southwestern region of Hudson Bay and the northwestern region of James Bay was consistent with the results of Stirling et al. (1999) and Derocher et al. (2004).

a. Increased polar bear movements or travel

Global warming is expected to decrease the thickness of multi-year sea ice and therefore increase the rate of movement of the ice (Derocher et al. 2004). Since polar bears catch very few seals in open water, sea ice is the essential platform from which they hunt (FWS 1995; Stirling 1998; Derocher et al. 2004).

Polar bear body temperature will stay fairly constant at walking speeds up to 4 km per hour (about 2.5 mph) at air temperatures ranging from -15° C to -25° C (approximately -4° F to -12° F), (Stirling 1998). After that, however, body temperature begins to climb rapidly, until at about 7 km per hour (4.2 mph), it is about 39° C (100° F), which is equivalent to a fever in humans (Stirling 1998). In addition, to move at this relatively slow speed, a polar bear must burn 13 times more energy than it would if it were lying down (Stirling 1998). These factors explain why a polar bear's average lumbering gait, which it can maintain for hours, is only about 5.5 km per hour (3.5 mph) (Stirling 1998).

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This is a general review article and doesn't present new information on bears or ice.

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Polar bears are extremely inefficient walkers (and runners), expending about twice the average energy use of other mammals when walking (Best 1982; Stirling 1998). The inefficiency of polar bear locomotion likely explains why polar bears are not known to hunt musk oxen or snow geese, potential prey species that co-occur with the polar bear in many areas (Stirling 1998). The energy needed to catch such species would almost certainly exceed the amount of energy a kill would provide (Stirling 1998).

Polar bears tend to walk against the movement of ice in order to maintain position within large geographical home ranges (Mauritzen et al. 2003. Increased rates and ttextend of ice movement will require additional efforts and energy expenditure for bears to maintain their position near preferred habitats (Derocher et al. 2004). Ferguson et al. (2001) found that polar bears inhabiting areas of highly dynamic ice had much larger activity areas and movement rates compared to those inhabiting more stable, persistent ice habitat. This finding indicates adaptation by polar bears in accommodating a fluid or moving environment. However, even in the areas of highly dynamic ice movement, there was predictability in inter-annual location of the habitat (Mauritzen et al. 2003). The areal extent, timing (rate of movement) and distances of ice retraction in recent years in certain areas of the Arctic brings to question the ability of polar bears to adapt to this rapidly changing landscape. These large scale ice movements have an effect of reducing and fragmenting areas of sea ice (Derocher et al. 2004). During summer periods the remaining ice in much of the central Arctic is now positioned away from more productive continental shelf waters and over much deeper, less productive waters. If the width of leads or extent of open-water increases, the transit time for bears and the need to swim or to travel will increase (Derocher et al. 2004). Polar bears are capable of swimming great distances, but exhibit a strong preference for sea ice. However, they have been shown to quickly abandon sea ice for land once the sea-ice concentration drops below 50% (Derocher et al. 2004). Researchers believe this is likely due to the increased energetic costs of locomotion since moving through highly fragmented sea ice is difficult and likely more energy intensive than walking over consolidated sea ice (Derocher et al. 2004). Derocher et al. (2004) suggest that as habitat patch sizes decrease, available food resources are likely to decline, resulting in reduced residency time and thus increased movement rates (Derocher et al. 2004).

Comment : We don't really know why they do this. It could be in most cases they are walking into the wind to use scent for hunting. It is a way to cover more area with less energy, but I don't think you can say they do it to stay in a home range.

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Data on the energetic costs of walking and swimming are not available, but it is likely that swimming is more costly, even though wSubadult polar bears are more vulnerable than adults to environmental effects (Taylor et al., 1987). Observations of density dependent and density independent effects on populations of other marine mammals indicate that environmental effects typically manifest as reductions in annual breeding success and reduced subadult survival rates (Eberhardt and Siniff, 1977). Therefore the relative impacts of an increased need for travel, and corresponding energy expenditures, will disproportionately impact younger animals (Derocher et al. 2004).

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Another possible impact is that as movement of sea ice increases and areas of unconsolidated ice increase, some bears may lose contact with the main body of ice and drift into unsuitable habitat from which it may be difficult to return. This already occurs in some areas such as sSouthwest Greenland and offshore from the island of Newfoundland. Increased frequency of such events could negatively impact survival rates and contribute to population declines (Derocher et al. 2004). The earlier-than-normal break-up of ice in Hudson Bay in 1999 may have contributed to an extremely rare extralimital sighting of a polar bear at Burnett Lake in Saskatchewan at 59° 02' N, 102° 18' W (Goodyear 2003).

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Space-use patterns of polar bears differ widely both among populations and between males and females within a population. Due to these differences, impacts from climate change on populations will likely show a large geographic variation and may also impact males and females in different ways (Derocher et al. 2004).

Comment [ ]: This statement is interesting. If it is true, then much more details must be presented. If males and females are impacted differently it must be explained how. On the other hand, I remember an Amstrup et al. telemetry study that indicated thate the overall space use of males and females (adults) was the same; similarly, the Taylor et al. (2001b) study did not indicate different space use between adult M and F whereas subadult seemed to roam a little wider. Please, check. And anyway be more careful with this section.

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b. Polar bear distribution changes and access to prey

In Western Hudson Bay, break-up of the annual ice occurs approximately 2.5 weeks earlier than it did 30 years ago, reducing the amount of time that bears are able to feed on seals during late spring and early summer, the most important time of the year for feeding purposes (Derocher et al. 2004). A highly significant relationship between break-up of the sea ice and condition of the bears when they come ashore has been determined (Stirling et al. (1999) in Derocher et al. 2004). Bears that arrive ashore earlier have foregone feeding opportunities and consequently have lower fat reserves required for a 4-month open water fasting period (Derocher et al. 2004). Declining reproductive rates, subadult survival, and body mass (weights) have resulted from the progressively earlier break-up of the sea ice caused by an increase in spring temperatures (Stirling et al. 1999, Derocher et al. 2004).

Stirling et al. (1999) reported that ice cover in Hudson Bay during the study period showed a long-term, but not statistically isignificant declining trend for total area of ice coverage related to variation in the timing of break-up, freeze-up, or both. In years of large ice extent, the date of break-up tended to be later while the date of freeze-up was earlier, and conversely in years with relatively low ice extent. The 20-year period 1979-1998 revealed a trend of earlier spring breakup that approached statistical significance (Stirling et al. 1999). The earlier breakup was probably due to spring air temperatures in the region warming at a rate of 0.2-0.3° C per decade since 1950 (Skinner et al. 1998). There was no trend for the timing of freeze-up, and c increase in. Consequently the number of ice-free days was due to the trend for an earlier break-up (Stirling et al. 1999).

The earlier spring breakup wasa highly edcorrelation with the mean dates on which radio-collared female polar bears came ashore (Stirling et al. 1999). Between 1991 and 1998, female bears with radio collars came ashore an average of 24.6 days after break-up, indicating that they remained on the ice to hunt seals well after a significant reduction in total ice cover (Stirling et al. 1999).

Stirling et al. (1999) reported a significant decline in body condition (weights) of both male and female adult polar bears since the 1980s in Western Hudson Bay, which was interrupted by improved condition in 1992 and 1993. They also found a statistically significant relationship over the 19-year study among the date of break-up, bodythe condition of adult females coming ashore, and natality (Stirling et al. 1999). EyEearlier break-up dates ererelated to poorbody condition of females coming on shore and resulted in lower natality rates (Stirling et al. 1999).

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Why not just cite the Stirling et al article? Throughout these section an editor needs to go through and fix the citations--there doesn't need to be a citation for every sentence.

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Polar bears are extremely inefficient walkers (and runners), expending about twice the average energy use of other mammals when walking (Best 1982; Stirling 1998). The inefficiency of polar bear locomotion likely explains why polar bears are not known to hunt musk oxen or snow geese, potential prey species that co-occur with the polar bear in many areas (Stirling 1998). The energy needed to catch such species would almost certainly exceed the amount of energy a kill would provide (Stirling 1998).

Polar bears tend to walk against the movement of ice in order to maintain position within large geographical home ranges (Mauritzen et al. 2003. Increased rates and ttextend of ice movement will require additional efforts and energy expenditure for bears to maintain their position near preferred habitats (Derocher et al. 2004). Ferguson et al. (2001) found that polar bears inhabiting areas of highly dynamic ice had much larger activity areas and movement rates compared to those inhabiting more stable, persistent ice habitat. This finding indicates adaptation by polar bears in accommodating a fluid or moving environment. However, even in the areas of highly dynamic ice movement, there was predictability in inter-annual location of the habitat (Mauritzen et al. 2003). The areal extent, timing (rate of movement) and distances of ice retraction in recent years in certain areas of the Arctic brings to question the ability of polar bears to adapt to this rapidly changing landscape. These large scale ice movements have an effect of reducing and fragmenting areas of sea ice (Derocher et al. 2004). During summer periods the remaining ice in much of the central Arctic is now positioned away from more productive continental shelf waters and over much deeper, less productive waters. If the width of leads or extent of open-water increases, the transit time for bears and the need to swim or to travel will increase (Derocher et al. 2004). Polar bears are capable of swimming great distances, but exhibit a strong preference for sea ice. However, they have been shown to quickly abandon sea ice for land once the sea-ice concentration drops below 50% (Derocher et al. 2004). Researchers believe this is likely due to the increased energetic costs of locomotion since moving through highly fragmented sea ice is difficult and likely more energy intensive than walking over consolidated sea ice (Derocher et al. 2004). Derocher et al. (2004) suggest that as habitat patch sizes decrease, available food resources are likely to decline, resulting in reduced residency time and thus increased movement rates (Derocher et al. 2004).

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Data on the energetic costs of walking and swimming are not available, but it is likely that swimming is more costly, even though wSubadult polar bears are more vulnerable than adults to environmental effects (Taylor et al., 1987). Observations of density dependent and density independent effects on populations of other marine mammals indicate that environmental effects typically manifest as reductions in annual breeding success and reduced subadult survival rates (Eberhardt and Siniff, 1977). Therefore the relative impacts of an increased need for travel, and corresponding energy expenditures, will disproportionately impact younger animals (Derocher et al. 2004).

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Another possible impact is that as movement of sea ice increases and areas of unconsolidated ice increase, some bears may lose contact with the main body of ice and drift into unsuitable habitat from which it may be difficult to return. This already occurs in some areas such as sSouthwest Greenland and offshore from the island of Newfoundland. Increased frequency of such events could negatively impact survival rates and contribute to population declines (Derocher et al. 2004). The earlier-than-normal break-up of ice in Hudson Bay in 1999 may have contributed to an extremely rare extralimital sighting of a polar bear at Burnett Lake in Saskatchewan at 59° 02' N, 102° 18' W (Goodyear 2003).

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Space-use patterns of polar bears differ widely both among populations and between males and females within a population. Due to these differences, impacts from climate change on populations will likely show a large geographic variation and may also impact males and females in different ways (Derocher et al. 2004).

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b. Polar bear distribution changes and access to prey

In Western Hudson Bay, break-up of the annual ice occurs approximately 2.5 weeks earlier than it did 30 years ago, reducing the amount of time that bears are able to feed on seals during late spring and early summer, the most important time of the year for feeding purposes (Derocher et al. 2004). A highly significant relationship between break-up of the sea ice and condition of the

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bears when they come ashore has been determined (Stirling et al. (1999) in Derocher et al. 2004). Bears that arrive ashore earlier have foregone feeding opportunities and consequently have lower fat reserves required for a 4-month open water fasting period (Derocher et al. 2004). Declining reproductive rates, subadult survival, and body mass (weights) have resulted from the progressively earlier break-up of the sea ice caused by an increase in spring temperatures (Stirling et al. 1999, Derocher et al. 2004).

Stirling et al. (1999) reported that ice cover in Hudson Bay during the study period showed a long-term, but not statistically isignificant declining trend for total area of ice coverage related to variation in the timing of break-up, freeze-up, or both. In years of large ice extent, the date of break-up tended to be later while the date of freeze-up was earlier, and conversely in years with relatively low ice extent. The 20-year period 1979-1998 revealed a trend of earlier spring breakup that approached statistical significance (Stirling et al. 1999). The earlier breakup was probably due to spring air temperatures in the region warming at a rate of 0.2-0.3° C per decade since 1950 (Skinner et al. 1998). There was no trend for the timing of freeze-up, and c increase in. Consequently the number of ice-free days was due to the trend for an earlier break-up (Stirling et al. 1999).

The earlier spring breakup wasa highly edcorrelation with the mean dates on which radio-collared female polar bears came ashore (Stirling et al. 1999). Between 1991 and 1998, female bears with radio collars came ashore an average of 24.6 days after break-up, indicating that they remained on the ice to hunt seals well after a significant reduction in total ice cover (Stirling et al. 1999).

Stirling et al. (1999) reported a significant decline in body condition (weights) of both male and female adult polar bears since the 1980s in Western Hudson Bay, which was interrupted by improved condition in 1992 and 1993. They also found a statistically significant relationship over the 19-year study among the date of break-up bodythe condition of adult females coming ashore, and natality (Stirling et al. 1999). EyEearlier break-up dates ererelated to poorbody condition of females coming on shore and resulted in lower natality rates (Stirling et al. 1999).

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Adult female polar bears in the study showed a strong fidelity to specific terrestrial areas that took precedence over remaining on drifting ice. A positive relationship between body mass of females with cubs and survival of cubs has also been established (Derocher and Stirling, 1996; 1998). The survival of cubs from when they left their dens in early March to the following August-September when the radio-collared females and accompanying cubs were resited (?) also declined from 60-65% in the 1980s to just over 50% through the late 1980s and early 1990s and then increased to 70-80% through the mid-to-late 1990s (Stirling et al. 1999). The proportion of yearlings that had already been weaned in the annual capture samples fluctuated greatly, but overall the proportions of independent yearlings declined from about 60% in 1982 to 15-20% since 1991, however, there was no statistically significant trend between the proportion of lone yearlings and the time of break-up in the same year (Stirling et al. 1999).

In 1992 and 1994 radio-collared females arrived on shore later than in other years (Stirling et al. 1999). In 1992, break-up occurred three weeks later than usual, probably due to the short-term cooling effect of the eruption of Mount Pinatubo, and radio-collared animals arrived later based on a later break-up (Stirling et al. 1999). The additional feeding opportunities resulted in both males and females being in better condition than in other years (Stirling et al. 1999). Both cub production and survival of cubs was significantly greater in the following year (Stirling et al. 1999). Following 1994, condition of males and females, cub production rates, and the proportion of lone yearlings began to decline again (Stirling et al. 1999).

The Western Hudson Bay population had far higher natality than any other polar bear population in the early to mid 1980s (Stirling et al. 1999). In some of those years, females successfully weaned up to approximately 40% of their cubs at 1.5 years of age, as opposed to the 2.5 years of age that is the norm in other populations that have been studied (Stirling et al. 1999). In the late 1980s and early 1990s, a long-term decline in both natality and condition of adult males and females was observed (Stirling et al. 1999). Stirling et al. (1999) cautioned that although downward trends in the population abundance had not been detected, if trends in natality and condition of adults continued in the same direction "they will eventually have a detrimental effect on the ability of the population to sustain itself." Population level declines have now been

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determined based on a recent analysis of an ongoing mark-recapture population study. Between 1987 and 2004, the number of polar bears in the Western Hudson Bay sub-population declined from 1,194 to 935, a reduction of about 22% (E. Regehr *et al.*, in press). Progressive declines in the condition and survival of cubs, subadults, and bears 20 years of age and older, probably initiated the decline in the size of the Westen Hudson Bay sub-population.

In the Southern Beaufort Sea, Schliebe et al. (in prep. 2006) report an increasing trend of use of coastal areas by polar bears during the fall open water starting in the 1990s. Weekly aerial surveys were flown during the interval from en which polar bears first appear in coastal areas until polar bear numbers have decreased as they return to sea-ice environments as it develops near shore. An analysis of the number of bears using coastal habitats and the distance to the pack ice was conducted. The study period included record extreme minima ice conditions for the month of September in four of the six years. Food sources in the form of bowhead whale carcass remains from native subsistence hunting were available in all years of the study. In all years, the number of bears on shore increased to a certain date and then decreased as pack ice became available near-shore. There was a significant relationship between the mean distance to ice edge and the numbers of bears observed on the coast. As distance to ice increased, the number of bears near shore increased; conversely as ice advanced toward shore the number of bears near shore decreased. These results suggest that environmental factors, possibly similar to those that operated in Western Hudson Bay, are influencing the distribution of polar bears in the southern Beaufort Sea. These also suggest that increased use of coastal areas may continue to occur if minimal ice conditions become more common in the future as predicted (Serezze et al. 2000; Serezze and Barry 2005).

Gleason and Monnett (in prep) analyzed 27 years (1979-2005) of fall bowhead whale aerial survey data in the Alaska Beaufort Sea. In addition to bowhead whale observations, environmental data and other marine mammal sightings were also recorded. Annual surveys were conducted roughly between Sept. 1 and October 20th. The northern extent of the surveys was generally 72° N. latitude between 148° – 156° W. longitude and 71° 10′ N. latitude westward to 140 ° longitude. Their study was divided into three periods (1979-1986, 1987-1996, and

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In summary, significant declines in the condition of polar bears in the Western Hudson Bay population resulted from climatic change and earlier break-up of the sea ice. The earlier the date of break-up, the poorer the condition of female polar bears coming ashore to den, and the lower the natality level. Cub survival also declined as the study area warmed. These effects were exacerbated unknowingly by harvest rates that were not sustainable. (Stirling et al. 1999)

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1997-2005). The September distribution of polar bears during the three year periods changed from bears being primarily associated with offshore ice (83%) during 1979-1986, to a distribution predominated by observations on land (80%) and in open water (20%) during 1997-2005. These findings are consistent with the lack of pack ice (concentrations >50%) caused by a retraction of ice in the study area during the latter period (Stroeve et al. 2004, Comiso 2002a, b; Comiso 2003, Comiso 2005).

For analysis of long-term changes in sea ice dynamics, Gleason and Monnett (in prep) selected two 50km^2 blocks, one near Barrow and one near Kaktovik, as representative subsamples for a more detailed analysis. Ice type and concentration for September and October for each block over the three previously described periods were evaluated. Ice types were classified as old (multi-year), new (first year), and no ice. The most obvious change in ice types for both Barrow and Kaktovik was an increase in the "no ice" category and a decline in the "old" and "new" ice types. Further analysis of the percentage of ice present (<25%, 25-75%, >75%) within the 50km^2 blocks over the study period confirmed the a strong trend of declining ice coverage in September for both Barrow and Kaktovik during 1997-2005. The results for October, although less dramatic, were consistent with the trend of declining ice coverage.

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Gleason and Monnett's (in prep) findings are consistent with those reported by Schliebe et al. (2006), and confirm a notable increasing trend in use of coastal areas by polar bears in the southern Beaufort Sea in recent years. The proximate cause for changes in polar bear distribution are thought to be retraction of pack ice far to the north for increasingly greater periods of time in the fall, and later freeze-up of coastal waters. The long time series of data for their study is unique to the southern Beaufort Sea population of polar bears. Other populations exhibiting larger numbers of polar bears onshore include Chukchi Sea, Baffin Bay, Davis Strait, and the western Hudson Bay. Similar long-term datasets are not available to show if pack ice position or other environmental factors are influencing the distribution of bears in these populations. Durner et al. (2006) evaluated habitat selection of radio-collared adult female polar bears occupying the southern Beaufort Sea. The authors found a general shift to the north and east in distribution of polar bears during summer and fall periods over time. Models used also

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indicated that during the period of study, polar bears used ice habitat over relatively shallow water close to an ice interface characterized by high total ice concentration.

Indications of potential distribution changes have been noted during a similar period of time for the northern coast of Chukotka (Kochnev 2006) and distribution changes have been noted on Wrangel Island, Russia (Ovsyanikov pers. com.). Kochnev (2006) reports that in the autumn seasons of 1990, 1991, 1993, 1995, 1996, and 1997 the ice edge retreated to 80-380 km to the north and to the west of Wrangel Island. During these years walruses occupied coastal haulout sites in substantial numbers for protracted periods of time. Wwalrus carcasses on the beaches became a food-source for polar bears and were the main factor attracting bears to these locations (Kochnev 2001a). Following a walrus mortality event such as a stampede, the number of bears increased and usually reached a peak in the second half of October.

The relationship between number of bears present and walrus carcasses continued to exist until the freezing of the sea. When bears reached their maximum density in the study areas before sea froze over and the level of walrus mortality was low, bears usually consumed all available food and departed when sea ice began to consolidate. The relationship between the maximum number of polar bears, the number of dead walruses, quantity of accessible food, and the distance of the ice-edge from Wrangel Island was evaluated. The regression analysis revealed that the strongest correlation was between bear numbers and distance to the ice-edge, although there were also less strong relationships with the number of walrus carcasses present, and walrus biomass availability. (Kochnev 2006)

In Baffin Bay, traditional Inuit knowledge studies and anecdotal reports indicate that in many areas that greater numbers of polar bears are being encountered on land during the summer and fall open water seasons. Interviews were conducted with elders and senior hunters in the three Nunavut communities that harvest polar bears from the Baffin Bay population(Dowsley 2005)[ed. (Dowsley)Most respondents (83%) believed that the population had increased because more bears were seen near the communities and near cabins and camps, and hunters encountered bear signs in areas not previously used by bears. Some people noted that these observations

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could reflect a change in bear behavior rather than an increase in population. Many (62%) respondents believed that bears were less fearful of humans now than 15 years ago. Most (57%) respondents reported bears to be skinnier now and 5 people in one community reported an increase in fighting among bears (Dowsley 2005).

Respondents also discussed climate change and they indicated a high degree of variability in the observed environment. Some indicated a general trend for ice floe edge to be closer to the shore than in the past, the sea ice to be thinner, fewer icebergs present, and glaciers receding. Fewer grounded icebergs, from which shorefast ice forms and extends, were thought to be partially responsible for the shift of the ice edge nearer to shore. Respondents were uncertain if climate change was affecting polar bears or what form the effects may beingtake (Dowsley 2005).

c. Access to and Alteration of Denning Areas

Many female polar bears return repeatedlyto specific denning areas on land. In order for a bear to reach a preferred terrestrial den site, either the ice must drift close enough or must freeze early enough in the fall for pregnant females to be able to walk to shore or they swim to the coast, in time to dig a den in late October or early November (Derocher et al. 2004). The relationship betweenof increasing distance from the pack ice to historical den areas or habitat and successful reproduction is difficult to forecast. In addition to increased travel distances another habitat component for which no forecasts or models exist is the amount and quality of snow that provides suitable denning strata. Derocher et al. (2004) theorized that as distance increases between the southern edge of the pack ice, where some polar bear populations spend the summer, and coastal areas, where pregnant females den, it will become increasingly difficult for pregnant females to reach their presently preferred locations. D habitat located at more southerly latitudes will likely be affected first, however those populations denning at erhigh latitudes Archipelago islands the effects may notmay become evident until much later.

Areas of concentrated land denning include the islands of Kong Karls Land, Nordaustlandet, Edgeøya, and Barentstøya in the Svalbard Archipelago north of Norway (Larsen 1985), Franz

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Josef Land, Novaya Zemlya, Wrangel Island in Russia, the west coast of Hudson Bay, and the Arctic National Wildlife Refuge on the Beaufort Sea coast in the United States (Amstrup 2002). Larger interannual variation in the distance between the ice and denning areas is already occurring (Derocher et al. 2004). As global warming progresses, the distance between the edge of the pack ice and land will increase (ACIA 2004).

Some climate models predict the complete disappearance of summer sea ice by 2100 (ACIA 2004a). One regional model predicts the complete disappearance of summer sea ice from Hudson Bay by 2050 (Gough et al. 2000). The average of five models used by ACIA (2004a) projects large distances between summer sea ice and polar bear terrestrial denning sites. Additionally, the ACIA projections are based on the IPCC B2 emissions scenario and uses climate sensitivity measures that may be conservative or understated and losses of sea ice may be much greater than predicted. A number of scientists have predicted more extreme projections of the timing and extent of polar pack ice retraction (Zhang and Walsh, 2006), although a few climatologists dispute these findings regarding climate change (Kandekar, 2004; Kandekar et al., 2005).

Derocher et al. (2004) predicted that under any of these climate change scenarios, pregnant female polar bears will likely be unable to reach many of the most important denning areas in the Svalbard Archipelago, Franz Josef Land, Novaya Zemlya, Wrangel Island, Hudson Bay, and the Arctic National Wildlife Refuge and north coast of the Beaufort. Scientists do not know how quickly female polar bears that previously denned on land might learn to exploit alternate denning habitat such as the drifting pack ice if they were unable to access land, or if they would respond this way at all, or if drifting pack ice would continue to be a suitable substrate for denning.

Another anticipated impact of a climate change on polar bear denning will be the thinning of sea ice and likely increased drift rates of ice floes (Derocher et al. 2004). In northern Alaska, between 1981 and 1991, approximately 53% of polar bear maternity dens were found on drifting multiyear ice several hundred kilometers north of the coast (Amstrup and Gardner 1994, Derocher et al. 2004). While othese bears appeared to successfully raise cubs, between den entry

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and emergence, these dens drifted between 19 and 997 km from their location when the female first entered them (Amstrup and Gardner 1994, Derocher et al. 2004). Increased drifting of sea ice with maternity dens could cause females with small cubs to travel longer distances and expend additional energy to return to the core of their normal home range (Derocher et al. 2004). Cubs emerging from dens in sub-optimal habitats could also experience reduced survival (Derocher et al. 2004). overall and suggests that this habitat may be available for use by females that find their land den areas unsuitable The stability of pack ice and its use for denning in the future, however, are uncertain.

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In some locations, female polar bears might adopt the current denning strategy used by bears in the Western Hudson Bay population, where pregnant females leave the ice at break-up and summer in the same locations where they ultimately den (Derocher et al. 2004). This strategy requires females to accumulate sufficient fat stores to fast for up to approximately 8 months before they can return to sea ice to resume feeding on seals (Derocher et al. 2004). If the sea ice these bears use is over the deep polar basin where seal densities are low, pregnant females may not be able to meet the energetic requirements for such a long period of fasting and nursing cubs (Derocher et al. 2004).

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In addition to changes in access to or movement of denning areas, in traditional denning areas, there may be changes in the habitat available for denning (Derocher et al. 2004). For example, in Hudson Bay, pregnant females make extensive use of terrestrial dens dug into permafrost peat banks under black spruce in riparian areas (Derocher et al. 2004). Some dens may be used repeatedly (by different bears) over a period of over 200 years (Derocher et al. 2004). As temperatures warm, fire frequency will increase, and fire will destabilize the riparian banks where polar bear dens occur, making the banks unsuitable for denning (Derocher et al. 2004).

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Climate change could also impact populations where females den in snow (Derocher et al. 2004). Insufficient snow would prevent den construction or result in use of poor sites where the roof could collapse (Derocher et al. 2004). Too much snow could necessitate the reconfiguration of the den by the female throughout the winter (Derocher et al. 2004). Changes in amount and timing of snowfall could also impact the thermal properties of the dens (Derocher et al. 2004). Sinceof polar bear cubs are born helpless and need to nurse for three months before emerging from the den, major changes in the thermal properties of dens could negatively impact cub survival (Derocher et al. 2004). to a captive femaletwo

Finally, unusual rain events are projected to increase throughout the Arctic in winter (ACIA 2004a), and increased rain in late winter and early spring could cause den collapse (Stirling and Smith 2004) and could suffocate mothers with cubs (Derocher et al. 2004). After March 1990 brought unseasonable rain south of Churchill, Manitoba, researchers observed large snow banks along creeks and rivers used for denning that had collapsed because of the weight of the wet snow, and noted that had there been maternity dens in this area the bears would likely have been crushed (Stirling and Derocher 1993).

d. Open water swimming

Monnett and Gleason (2006) found that during aerial surveys in September 1987–2003, 315 polar bears were observed. Of these 12 (3.8%) were in open water. During aerial surveys in early September 2004, 51 polar bears were observed and of those 10 (19.9%) were in open water variable distances from the sea ice and land. In September 2004, the sea ice edge was 160-320 km from shore representingduring record minimal ice conditions. On surveys following a major storm with wind speeds recorded at 46-54 km/hr and seas estimated at 2 meters, four dead polar bear were seen floating in open waterit is presumed that the animals Bin the water bears are difficult to see from survey altitudes of 457 m under ideal conditions and some may have sunk or drifted out of the study areas so the number of deaths due to the combination of ice and storm conditions was likely much larger. Monnett and Gleason (2006) speculate that mortalities due to offshore swimming during late-ice (or mild ice) years may be an important and unaccounted source of natural mortality given energetic demands placed on individual bears engaged in long-distance swimming. This evidence suggests that drowning-related deaths of polar bears may increase in the future if the observed trend of regression of pack ice and/or longer open water periods continues. The effect of ice reduction and increases in areas of open water will causeto

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an increase in the size of waves since fetch is gathered over greater distances than in a marine environment where there is no sea ice to buffer wave action (Monnette and Gleason 2006).

e. Demographic Effects on Polar Bear

Derocher et al. (2004) predict a cascade of demographic impacts on polar bear populations as a result of global warming. Polar bear characteristics, including specialized diet, habitat specialization, large body size, low fecundity, long lifespan, low genetic variability, and sensitivity to events that alter adult female survival rates, are all associated with high extinction risk (Derocher et al. 2004). In general, Derocher et al. (2004) predict demographic impacts that will adversely affect female reproductive rates and juvenile survival first and will only affect adult female survival rates under severe conditions.

Declines in fat reserves during critical times in the polar bear life cycle will lead to an array of impacts (Derocher et al. 2004). Because female polar bears accrue body fat throughout their lives until approximately 15 years of age, the age of first successful reproduction could be delayed as growth rates and fat stores of females are reduced (Derocher et al. 2004). A decline in body condition will reduce the proportion of pregnant females that are able to initiate denning (Derocher et al. 2004). Females with lower fat stores will likely produce more single cub litters, fewer cubs overall, and smaller cubs with lower survival rates (Derocher et al. 2004). This is because body mass in adult females is correlated with cub mass at den emergence that is in turn correlated with cub survival (Derocher et al. 2004). A higher proportion of females that do initiate denning are likely to abandon the effort mid-winter (Derocher et al. 2004). Insufficiency of maternal resources or poor hunting conditions in the early spring after den emergence could lead to increased cub mortality (Derocher et al. 2004). For example, researchers believe that young cubs are unable to survive immersion in icy water for more than approximately 10 minutes (Blix and Lentfer 1979; Larsen 1985). This is because young cubs have little insulating fat, and polar bear fur loses its insulating value when wet (though it sheds water and recovers its insulating properties very quickly), and therefore core body temperature drops rapidly in young

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This is interesting and important stuff. But there are a lot of assumptions and extrapolations and I would like to see the paper peer-reviewed before too much faith is put in anything more than the basic observations of floating dead bears.

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polar bear cubs when they are immersed in icy water (Blix and Lentfer 1979). If declining sea ice forces females to swim from den areas to pack ice, cub mortality could increase due to hypothermia (Derocher et al. 2004).

> **Comment [_ : Page: 92** this looks to belong in the previous section

> **Deleted:** Because female polar bears accrue body fat throughout their lives until approximately 15 years of age, the age of first successful reproduction could be delayed as growth rates and fat stores of females are reduced (Derocher et al. 2004). Derocher et al. (2004) also predict, overall, a lengthening of the time between successful weanings of offspring.

Derocher et al. (2004) caution that reduced reproductive rates in females may be difficult to measure, and that the decline will likely be highly variable (Derocher et al. 2004). Time lags in the system may initially obscure trends, but if conditions decline sufficiently adult survival may be impacted and sudden population declines could occur (Derocher et al. 2004). Because researchers believe mortality of polar bears is already highest in winter when fat stores are low, and because polar bears already use winter dens when necessary to conserve fat stores, Derocher et al. (2004) believe it is unlikely that the impacts described above could be compensated for with increased feeding in winter.

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3. Biological effect onon polar bear prey

> **Comment , Page: 93** This section should not just discuss changes that may happen to ringed seals but also to other currently used prey items (bearded seals, walrus, beluga, carcasses) and future potential prey (harbor, harp, hooded, spotted seals, sea lions, other whales).

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a. Prey Availability

Major declines in sea-ice habitat will also likely result in a decline in polar bear abundance over time due to reduced availability of prey (Derocher et al. 2004). The effects of declining ice habitat on seals will vary depending on the location, timing and extent of reductions. It is possible that reduced ice cover and increased open water periods with warmer water will enhance primary productivity and promote growth of fishes and invertebrates preyed upon by ringed and bearded seals. Increased food sources for seals may increase seal physical condition and contribute to higher productivity. While these effects may have some initial benefits for polar bears they are thought to be transitory in their timing and with increased area and duration of open water, polar bears will have reduced access to prey during critical periods of the year. Ultimately productivity of ringed seals is thought to be diminished over time. The arctic food web is driven by the complex interactions between ice, light penetration, nutrient supply, and

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> **Comment _ J:** well, well. If I assume that ringed seals mainly prey on Arctic cod (B. saida) I am not so sure that anybody knows what will happen to this fish species. At any rate, I suggest that you be more specific here.

> **Comment _ : Page: 93** The stuff about seals and seal prey here looks very speculative to me. Are there any references to actual studies or data? If not, you should make clear it is speculation and make clear whether it is speculation of others or your own.

productivity (Tynan and DeMaster 1997; Rosing-Asvid 2006). Due to the Arctic Ocean's relatively low species diversity, it may be particularly vulnerable to trophic-level alterations caused by global warming (Derocher et al. 2004). Arctic cod (*Boreogadus saida*), one of the primary prey species of ringed seals, is strongly associated with sea ice throughout its range and makes use of the underside of the ice to escape from predators (Gaston et al. 2003). It is therefore likely that a decrease in seasonal ice cover could have adverse effects on Arctic cod (Tynan and DeMaster 1997; Gaston et al. 2003).

Commen .]: This ma be a relevant place to cite this study – see list of reference – it is appropriate here and the existence of the study must be acknowled in this report.

Comment[Be careful to show that you talk about B. saida (in the US you call this species Arctic cod whereas the UKs call it Polar cod – and vice versa (Arctogadus saida = Polar cod in USA and Arctic cod in UK)

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Ringed seals are the primary prey of the polar bear in most areas, though bearded seals, walrus, harbor seals, and beluga whales are sometimes taken and may be locally important to some populations (Derocher et al. 2004). Polar bears have been observed using terrestrial food items such as blueberries, snow geese, and reindeer, but researchers do not believe that these alternate foods represent significant sources of energy (Derocher et al. 2004).

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Hasn't Stirling found that harp and maybe hooded seals are also of some importance? What about whale carcasses?

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Polar bear populations are known to fluctuate based on prey availability. During the winters of 1973-1974 and 1974-1975, ringed and bearded seal numbers in the Beaufort Sea dropped by about 50% and productivity by about 90%, apparently in response to severe ice conditions (Stirling 1980; Stirling 2002). Numbers and productivity of polar bears also declined markedly in response (Stirling 1980; Stirling 2002). A similar reduction in seal productivity, with a subsequent decline in polar bear productivity, occurred in the mid-1980s as well (Stirling and Øritsland 1995; Stirling 2002).

Stirling and Øritsland (1995) calculated that a hypothetical polar bear population containing 1,800 bears would need approximately 77,400-80,293 ringed seals per year for all bears to meet their nutritive requirements. Kingsley (1998) estimated that the polar bears in the Baffin Bay and associated waters (N= ca. 4000) would need to eat 120 000 to 160 000 ringed seals per year to sustain themselves. In the absence of solid data, it has generally been assumed that seal populations occur at high numbers and are relatively stable and that there are enough ringed seals to fulfill the needs of both polar bears and Inuit hunters (Ferguson et al. 2005). However, one study found an unexpectedly low pregnancy rate and proportion of young-of-the-year among ringed seals in an open water sample from Arviat in 1991-1992 (Holst et al. 1999; Ferguson et al. 2005), and a follow up study with data from 1998-2000 also found a lower than expected pregnancy rate and proportion of young-of-the-year. These results indicate that ringed seal recruitment may be in decline, and that ultimately ringed seal populations, and therefore food availability for polar bears, may decline as well (Stirling 2002).

Ice-associated seals, including the ringed seal, may be particularly vulnerable to habitat loss from changes in the extent or concentration of Arctic ice because they depend on pack-ice habitat for pupping, foraging, molting, and resting (Tynan and DeMaster 1997; ACIA 2004a; Derocher et al. 2004). The southern edge of ringed seal ranges may also shift north, because ringed seals stay with the ice as it annually advances and retreats (Tynan and DeMaster 1997). Whether ringed seals will continue to move north with retreating ice over the deeper less productive arctic basin waters and whether forage fishes that they prey on will also move north is uncertain.

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b. Seal productivity

Ringed seal pups are born between mid-March and mid-April, nursed for about six weeks, and weaned prior to spring break-up in June (Ferguson et al. 2005). During the weeks of nursing, ringed seal pups spend about half of their time in lairs excavated in snow covering the top of the sea ice, and about half underwater diving (Ferguson et al. 2005). During this time period both ringed seal pups and adults are hunted by polar bears (Ferguson et al. 2005). One common hunting method used by polar bears is to locate a seal lair by smell and then crash through the top of the den and seize the surprised seal (Stirling 1998).

Ferguson et al. (2005) demonstrated that decreasing snow depth, possibly influenced by the timing of spring break-up, may have a detrimental effect on ringed seal recruitment in Western Hudson Bay. These researchers examined trends in ringed seal recruitment in Western Hudson Bay relative to snow depth, snowfall, rainfall, temperature in April and May, the North Atlantic Oscillation ("NAO") from the previous winter, and timing of spring break-up. Samples from 639 ringed seals killed by Inuit hunters between 1991-1992 and 1999-2001 were used to determine the age of seals killed and to generate a survivorship curve which represents the number of seals born in any year that survived to be included in the hunt (Ferguson et al. 2005). The relative difference from the expected survivorship as were the dependent variable in correlated regression analyses of environmental factors (Ferguson et al. 2005). Snowfall and ringed seal recruitment varied from lower than average in the 1970s, to higher in the 1980s and lower in the 1990s (Ferguson et al. 2005).

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The study demonstrated that decreasing snow depth in April and May may be linked to decreased recruitment in ringed seals in Hudson Bay (Ferguson et al. 2005). Reduced snowfall may also result in less snow drift accumulation leeward of pressure ridges, and consequently reduced protection for pups from predators that are afforded easier access (Ferguson et al. 2005). Warming temperatures may also melt snow covered ringed seal birth lairs and contribute to the decreased recruitment (Ferguson et al. 2005). Therefore, pups in lairs with thin snow roofs are more vulnerable to predation than pups in lairs with thick roofs (Ferguson et al. 2005). Ringed seal pup survival can also be affected by hypothermia resulting from exposure if lairs collapse (Ferguson et al. 2005). Continued access to birth lairs for thermoregulation is probably critical to the survival of pups when temperatures fall below 0° C (Stirling and Smith 2004). Ferguson et al. (2005:121) conclude "Earlier spring break-up of sea ice together with snow trends suggest continued low pup survival in western Hudson Bay."

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Did this study or some other that it cites actually measure this?

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In a similar study of variation in reproduction and body condition of the ringed seal in Prince Albert Sound, Harwood et al. (2000) found that an early spring break-up in 1998 negatively impacted the growth, condition, and probably the survival of unweaned pups. Early breakup in 1998 was believed to have caused an interruption in lactation of pups, which affected the condition and growth of pups. The authors indicate that the event occurred when food appeared to be abundant and available for the other age classes of ringed seals (Harwood et al. 2000). Earlier break-up similar to those documented by Harwood et al. (2000) and Ferguson et al. (2005) are predicted to be more frequent in occurrence based on climate change models.

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Increased rain on snow events during the late winter also impact ringed seals by damaging or eliminating snow covered pupping lairs, increasing exposure and the risk of hypothermia, and facilitating predation by polar bears and Arctic foxes (Derocher et al. 2004; Stirling and Smith 2004). In April and May of 1979, researchers evaluated the distribution and density of ringed seal lairs on the Hall Peninsula of southeastern Baffin Island in Nunavut (Stirling and Smith 2004). Predation on seals by polar bears was also evaluated from on ice and aerial observations (Stirling and Smith 2004). Rain fell steadily or sporadically on the study area during April 9-11 (Stirling and Smith 2004). Before the rain event in April, there were two other periods during late March and early April when daily maximum temperatures were at or close to freezing (Stirling and Smith 2004). Outside of these periods weather was normal for this area.

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The roofs of 40% (6/15) of the haul-out and birth lairs found by the end of March and 50% (15/30) of those located in the first week of April had melted and collapsed, something not seen before at these latitudes (Stirling and Smith 2004). After the April rain event, 28% of the lairs in one part of the study area had collapsed, but this is an underestimate since an unknown number of previously collapsed lairs were not recorded (Stirling and Smith 2004). Following the rain event, many instances of adult seals and pups laying on the bare ice, exposing the pups to hypothermia were noted. Predation of pups by polar bears was observed, and the researchers "suspect that most of the pups in these areas were eventually killed by polar bears, arctic foxes, or possibly gulls" (Stirling and Smith 2004).

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Stirling and Smith (2004) state that the observations from 1979 have direct relevance to the impact of climate change on polar bears:

> Should early season rain become regular and widespread at some future time, we predict that mortality of ringed seal pups will increase, especially in more southerly parts of their range, and that local populations may be significantly reduced....a significant decline in ringed seal numbers, especially in the production of young, is capable of producing negative effects on the reproduction and survival of polar bears (Smith and Stirling 2004: 66).

Ringed seals, and consequently polar bears, may also be impacted by changes in trophic dynamics. Changes in climate, sea-ice extent, and the timing of sea-ice formation and break-up will have variable affects on the lower trophic levels of the food web upon which polar bears depend (Derocher et al. 2004).

c. Reduced Access to Prey

Scientists predict that the decreases in adult body condition, natality, and cub survival in the Western Hudson Bay polar bear population observed to date due to earlier break-up dates and a shorter seal-hunting period will continue until female polar bears are in such poor condition that they do not reproduce (Derocher et al. 2004). Using parameters including the amount of polar bear body mass lost during fasts, predicted shortening of the feeding period and lengthening of the fasting period, and the apparent 189 kg body weight needed for females to reproduce, Derocher et al. (2004) calculate that most females in the Western Hudson Bay population will stopingsuccessfully reproduce somewhere between 2012 and 2104 [seems excessively wide a range].

Derocher et al. (2004) note that these calculations are simplifications, and that long-term trends may not be readily observable due to shorter-term fluctuations as climate change proceeds, but the authors predict, overall, a continuing gradual decline in population-related parameters that ultimately lead to population losses. Trends toward either earlier break-up or later freeze-up, or both, will likely occur in other areas in addition to Western Hudson Bay where polar bears seasonally use the land, such as Foxe Basin and south-eastern Baffin Island (Derocher et al. 2004). These populations will likely experience impacts comparable to those already observable in Western Hudson Bay (Derocher et al. 2004).

While predicting changes in trophic dynamics from climate change is complex and difficult, the likely impact on Arctic cod is significant for the polar bear. Global warming could increase productivity of some Arctic waters in the short term (Derocher et al. 2004). As Tynan and

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DeMaster (1997:315) observed, "[o]ne of the central questions regarding climate change and the effects on Arctic marine mammals is whether a reduction of sea ice will increase productivity in a way that maintains suitable densities of important prey species, such as arctic cod." In northern Hudson Bay it does not appear that arctic cod will maintain former levels of abundance during periods of reduced sea ice habitat. Moreover, if areas of leads, polynyas, and open water shift northward to areas over the less productive waters of the deep polar basin, there may be little increase in productivity since the deep polar basin waters are less productive to begin with (Tynan and DeMaster 1997; Derocher et al. 2004). This could negatively impact other polar bear prey species. Species such as bearded seals and walrus feed on benthic prey, and are therefore found on ice cover over the shallow continental shelf areas (Derocher et al. 2004). As sea ice declines these species are forced further offshore to find suitable habitat for pupping and feeding, making activities more difficult, ultimately leading to a likely net reduction in abundance of these species (ACIA 2004a; Derocher et al. 2004).

Ringed seal young-of-the-year provide the majority of the polar bear diet, therefore, fluctuations in the productivity of ringed seal pups will likely be reflected immediately on polar bear reproduction and cub survival (Stirling and Lunn 1997). Stirling and Lunn (1997:176) report that "the most critical factor affecting reproductive success, subsequent condition and probably survival of polar bears is the availability of ringed seal pups from about mid-April through to break-up sometime in July," and that this is especially so for females with cubs of the year. Moreover, high levels of polar bear predation sustained by ringed seal populations are only possible because a large proportion of seals taken are young of the year (Stirling and Lunn 1997). In some areas, polar bear predation already is having a significant impact on numbers and productivity of ringed seals (Amstrup 2000).

Changes in prey availability may have especially large impacts on immature bears. Polar bears feed preferentially on blubber and adult bears often leave much of the protein behind, which is then scavenged by younger bears who are not skilled hunters (Derocher et al. 2004). As prey availability decreases due to global warming, younger bears may be disproportionately impacted if there is less excess prey to scavenge (Derocher et al. 2004)

Comment: The fate of walruses in the Atlantic might not be that bad. See Born 2005 (Dr Philos thesis University of Oalo.

Comment: I realize that this is correctly cited, bt I do think that Derocher's statement at least for walruses is nonsense.. Walruses are adapted to haul-out on land and feed <100 km from terrestrial haul-outs. If the fast ice decreases in duration they have longer time to feed indshore as they do in East Greenland and Canada. See Born, E.W., S. Rysgaard, G. Ehlmé, M. Sejr, M. Acquarone and N. Levermann 2003. Underwater observations of foraging free-living walruses (*Odobenus rosmarus*) including estimates of their food consumption. Polar Biology 26: 348-357.

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This was already discussed some in subsection a of this section.

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It would be helpful to have the full reference here, as this is an important point that merits checking.

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I'm not aware of any area where data on ringed seal numbers and productivity are good enough to support this statement.

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Because there are fewer kills made, a higher proportion is consumed by the killers, or both?

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d. Summary - reductions in seal populations

Comment : I miss a fuller treatment of possible fate of all Arctic seals. Also the change in distribution of possible food of these seals would be useful.

Climate change will likely alter ringed seal distribution as well as ringed seal abundance (Derocher et al. 2004). A key issue will be whether prey species are accessible within the altered ice environment (Derocher et al. 2004). Increased amounts of open water may reduce the hunting efficiency of polar bears because seals may become less restrained by their need to maintain breathing holes and haul-out sites and thus become less predictable for foraging bears (Derocher et al. 2004). Bears have only rarely been reported to capture a ringed seal in open water, so it is unlikely that hunting in ice-free water would compensate for loss of ice access to ringed seals (Derocher et al. 2004). It is unlikely that increased take of bearded seals, walrus, or harbor seals, even where they are available, could or would compensate for reduced availability of ringed seals (Derocher et al. 2004). Altered prey distribution would likely lead to increased competition for prey between dominant and subordinate bears, to the detriment of the subordinates (Derocher et al. 2004).

Comment : What about harps and hoods? Or narwhal and beluga?

In summary, climate change will alter the availability of polar bear prey, to the detriment of polar bears, in ways including the following (Derocher et al. 2004):

- Reductions in sea ice, which ringed seals use for birth lairs, will alter ringed seal distribution and abundance;
- Reduced ringed seal abundance will occur because warmer winter temperatures and increased rain will damage and destroy ringed seal lairs and decrease ringed seal recruitment;
- Warmer temperatures will also likely alter trophic dynamics resulting in reduction in the availability of Arctic cod, one of the ringed seal's primary prey species, and therefore both reduce ringed seal abundance and change ringed seal distribution;
- It is uncertain if other forage fish species will pioneer into open water habitats and provide seals with alternate forage species.

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- Reductions in ringed seal abundance and changes in ringed seal distribution will likely have a disproportionate impact on subadult polar bears;
- As ringed seal abundance and availability decrease, polar bear populations will decline.

4. Projected population specific effects and timing sequence

(discussion is incomplete – peer review thoughts sought)

s[??? more affected than the polar bear populations in Hudson Bay ???] p

T Some of these species could become established and provide prey for ringed seals and polar bears.

B. Overutilization for commercial, recreational, scientific, or educational purposes

1. Overview of harvest

History of Polar Bear Hunting and Harvest Management

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Polar bears have historically been and continue to be an important renewable resource for coastal communities throughout the Arctic. Polar bears and polar bear hunting were an important part of indigenous peoples' myths and legends; polar bear hunting is considered a source of pride, prestige, and accomplishment. Polar bears provide a source of meat and raw materials for handicrafts, including functional clothing such as mittens, boots (mukluks), parka ruffs, and pants.

Prior to the 1950s most hunting was done by indigenous people for subsistence purposes. However, population declines due to sport hunting became an increasing international concern during the 1950s and 1960s. As a result, in 1968, biologists from the five nations with polar bears in their respective jurisdictions met and formed the Polar Bear Specialist Group (PBSG) under the International Union for Conservation of Nature and Natural Resources (IUCN). The PBSG was largely responsible for the development and ratification of the *1973 International Agreement on the Conservation of Polar Bears (1973 Agreement),* which calls for cooperative international management of polar bear populations based on sound conservation practices. It prohibits polar bear hunting except by local people using traditional methods, calls for protection of females and denning bears, and bans use of aircraft and large motorized vessels to hunt polar bears. The *1973 Agreement* itself is not self-implementing and each signatory nation has its own national legislation to implement the *1973 Agreement's* terms, including individual harvest management practices. The PBSG meets every 3-5 years to review all aspects of polar bear science and management, including harvest management.

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Principles of Harvest Management

Polar bears are a K-selected species: they are long-lived, take a relatively long time to mature, and have low reproductive rates and small litter sizes (DeMaster and Stirling 1981). Although this is compensated for with high adult survival rates, polar bear populations can be easily depleted through harvest (Taylor et al. 1987). To effectively manage polar bear populations using harvest management, scientists must know certain characteristics of the population, such as population size, and birth (recruitment), survival, and mortality rates. Generally, harvest

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management is based on the principle that, if recruitment and survival rates exceed mortality rates, the population will grow or remain stable.

Mortality can be separated into deaths from natural vs. unnatural (human) causes; the latter include accidental kills, such as research mortalities or ingestion/exposure to toxins, and intentional kills such as for sport hunting, subsistence hunting, or defense of life. H mortalityhunting) can be managed through establishment of limits (quotas) on the number of animals killed per year in relation to population sustainability.

Setting appropriate harvest quotas is dependent on accurate population estimates and age-specific survival and reproduction rates. With good population data, the total allowable harvest (TAH) can be used to adjust for population growth or declines. For example, if polar bear populations decline, a reduction in harvest quotas could be used to attempt to mitigate declines. Unfortunately, the cost and logistical challenges of conducting these studies has made obtaining reliable data difficult or impossible for many populations.

The Marine Mammal Protection Act requires tFWS to calculate the allowable level of human-caused mortality (potential biological removal (PBR) level) for polar bear populations (also referred to as "stocks") in the U.S.by using a minimum population size estimate (N min) multiplied by ½ of the estimated maximum netproductivity rate (R max) of the population. PBR is: an estimate of the number of animals that can be taken without causing the population to decline below its optimum sustainable population (OSP) level, or that will allow a population already below OSP to increase to that level., If the population is known to be reduced or declining a recovery factor (Fr) can be used to reduce PBR.

In Nunavut, tThe TAH is determined using a "Riskman" computer model that incorporates population data such as survival rates, age of first reproduction, age-specific litter production rates for females available to have cubs; litter size, sex ratio of cubs; sex, age, and family status distribution of harvest, and population size (Taylor et al. 2000, Taylor et al. 2001a). The model also incorporates uncertainty due to sampling error and environmental variation.

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Another approach (Taylor et al. 1987) used by NWT calculates sustainable harvest based on a population size estimate (N), estimated rates of birth and death, and harvest sex ratios where:

$$\text{Sustainable harvest} = \frac{N \times 0.015}{\text{Proportion of harvest that was female}}$$

Both the Riskman and Taylor et al. (1987) approach project current life history demographic parameters into the future and ascribe a sustainable harvest level based on population parameters previously documented through capture research. The underlying assumption is that the populations will remain stable or increase during intervening years. Since there generally is a lengthy period between population inventory cycles this approach has limitations for populations experiencing changes in survival or recruitment.

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2. Harvest Management by Nation

Canada

Canada manages (or shares management responsibility for) 13 of the world's 19 polar bear sub-populations. Wildlife management is the responsibility of the Provincial and Territorial governments; the Federal government (Canadian Wildlife Service) has an ongoing research program and is involved in management of wildlife populations shared with other jurisdictions, especially ones with other nations. Canada has formed the Federal Provincial Technical and Administrative Committees for Polar Bear Research and Management (PBTC and PBAC, respectively) to ensure coordinated management; the committees include provincial, territorial, and federal representatives who meet annually to review research and management activities.

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Human-caused mortality such as hunting, defense of life, and incidental kills are all included in TAH. Hunting is allowed by Inuit people of communities in Nunavut, Northwest Territories (NWT), Manitoba, Labrador, Newfoundland, Ontario, and Quebec. In Nunavut and NWT, each community obtains an annual harvest quota which is based on the best available scientific information and monitored through distribution of harvest tags to local hunter groups, who work with scientists to help set quotas. Some communities may hold tags for several separate polar bear sub-populations. Native hunters may use their harvest tags to guide sport hunts from approved sub-populations; sport hunts must occur using traditional methods, e.g. dog teams. Local Hunter and Trapper Organizations (HTO) determine how many tags shall be allocated to sport hunts, and monitor, regulate, and enforce hunting regulations. A flexible quota system is used in all but the DS sub-populations hunted by Nunavut. Quebec and Ontario do not set quotas but do monitor and report harvest.

In April 1999, the Nunavut Territory, formerly part of the NWT, officially joined the Federation of Canada. Nunavut now has primary management responsibility for 12 of the 13 Canadian polar bear sub-populations and has committed to conducting 15-year population inventory cycles for each sub-population. Their harvest approach, implemented beginning with the 2004/2005 harvst season, consists of two phases: 1) conservative harvest rate, which begins after a scientific population inventory is completed, and continues for the next 7 years. Harvest is limited to "the number of bears that can be taken per year with not more than 10% risk of a population decline that would require more than 5 years of harvest moratorium to recover to the current numbers". This is thought to allow for slight population growth; and 2) guided harvest rate, which means "the number of bears that can be taken without reducing the population below the target number, which takes into account that scientific data is becoming increasingly dated and allows for Inuit ecological knowledge (IQ) to increase or decrease the harvest rate. Riskman modeling is used to identify sustainable harvest levels. Harvest is based on the assumption that providing protection to reproductive females by setting a sex-selected harvest of 2:1 males: females increase the potentially allowable harvest by 50% (Testa 1997). If the quota for female polar bears is inadvertently exceeded, it results in an automatic reduction in next year's quota, so the average take of females over a two year period cannot exceed the sustainable rate (Testa 1997). This system is based on a stable or increasing population trend.

Comment [ ]: What about Nunavut's use of IQ?

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Comment [ ]: What about NWT?

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It would seem that one of the Taylor articles would be a better reference than Testa here and above.

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Not clear what this means. What happens if the trend is not stable or increasing--does the model not run or does it give results that cause overharvest?

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Tthe Canadian system has resulted in tight controls on the size of harvest and high quality harvest reporting. It allows reduction of quotas in response to population declines resulting from over-hunting (PBSG 1993). In 2004, the existing polar bear harvest practices became more controversial when Nunavut identified quota increases for 8 sub-populations, 5 of which are shared with other jurisdictions (PBSG 2005 Canadian management report, p. 3). Quota increases were largely based on IQ and the perception that some sub-populations are increasing from historic levels; it was also done without input from jurisdictions with shared management responsibility. This action resulted in an overall increase from the 2003/2004 quota of 398 bears to 507 bears in 2004/2005 (PBSG 2005 Canadian Management Report p.14 Table 6). Concern has been expressed by PBSG and PBTC members whether raising harvest quotas based on IQ constitutes a sound conservation practice, as called for in the *1973 Agreement* (PBSG 2006).

USFWS in its overall evaluation of the Canadian management program relative to approving specific populations for importation of polar bear trophies by US hunters found three key characteristics of the NWT calculation of sustainable harvest from the population estimates. These are: (a) assumption of no density effects; (b) emphasis on conservation of female bears through hunting at a ratio of two males to one female; and (c) use of pooled best estimates for vital rates (e.g., rates of birth and death) for all Canadian polar bear populations with the exception of Viscount Melville Sound (USFWS 1997). In his review and evaluation of the procedures used by the NWT to estimate sustainable harvests, Testa (1997) tested the polar bear parameters provided by Taylor et al. (1987) with a general population model. He concluded that a 3 percent harvest of the female segment of the polar bear population is sustainable and probably conservative, and that the assumptions made for calculation of the sustainable harvest are reasonable. Additionally, he noted that these low rates of harvest, even if somewhat greater than 3 percent, are unlikely to result in irreversible reductions of bear numbers on the time scale of Canada's research and management actions. Harvests of 4 to 6 percent of the original population would take from 9 to 23 years to reduce the female population by 30 percent. In this context overharvest is possible, but reversible in the same or shorter time span by regulating quotas, particularly if density dependent effects come into play (Testa 1997; FWS 1999 FR Doc. 99-55501)

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Comment: Page: 109 You don't need to give page numbers here or anywhere else unless it is for a quote.

Comment: This is confusing because Nunavut's new management was previously introduced. Suggest moving

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Comment: See also Wiig 2005 Science

Comment: Add information regarding changes in Flexible Quota System and use of credits?

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Comment: Page: 110 If you are going to go into this level of detail--which I think is not necessary--you should describe the whole trophy import requirement story before going into this part of the discussion.

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Tthe IUCN/SSC Polar Bear Specialist Group recently expressed concerns about the application of IQknowledge (IQ) by the Government of Nunavut in determining harvest rates in the absence of supportive scientific data. The PBSG advocated that a precautionary approach be used when setting future harvest levels in a warming Arctic. The group noted that during recent decades the area of the sea ice in the Arctic has declined significantly and that ice break-up in many areas is occurring earlier and freeze-up later, all of which is predicted to continue and to affect survival and abundance of polar bears in western Hudson Bay. The group recognized that both local hunters and scientists have observed an increased occurrence of polar bears near settlements and outposts and on near-shore sea ice in recent years which may not reflect an increased population size; and that quotas had been increased based on local and traditional knowledge or, in the case of Greenland, based on increased nearshore availability. The group was concerned that the combined effect of habitat loss and increased harvest could threaten populations and recommended that harvest levels be increased only when supported by scientific information. The group noted the recent analysis (Reghr et al. 2006) indicating population declines and recommended that management action for the Western Hudson Bay population be taken to reduced quotas without delay.

Sport hunting is allowable in by communities in Canada (Nunavut and NWT) and Greenland as part of the TAH. Because sport hunters tend to seek out large adult "trophy" bears, sport hunting tends to a lower proportion ofs thein female harvest. The majority of sport hunters in Canada are Americans. Iin 1994 a provision was added to the MMPA to allow these hunters to import their Canadian trophies into the U.S. as long as certain criteria as outlined in the MMPA were met. (see "United States" section). by permit

Greenland

Greenland was governed by Denmark until attaining home rule in May 1979. Greenland's Home Rule Government now manages harvest through a system introduced in 1993 that allows only

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full-time hunters living a subsistence lifestyle to hunt polar bears. Licenses are issued annually forwith a small fee and contingent upon reporting of harvest during the prior 12 months. Until 2006, no quotas were in place but harvest statistics were collected through Piniarneq. In January 2006, a new harvest monitoring and quota system was implemented. Annual quotas are determined in consideration of international agreements, biological advice, user knowledge, and consultation with the Hunting Council. Part of the quota may be used for sport hunting; quotas may be divided into smaller quotas for certain areas. Quotas are distributed among local authorities who administer the issuance and distribution of permits, and establish controls to ensure that the allocated quota is not exceeded. Hunting is allowed only between 1 September and 30 June, except in two areas where hunting is allowed between 1 October and 31 July (Lonstrup 2005??).

Greenland harvests bears from the KB, BB, DS, and EG sub-populations (Born and Sonne 2005, Greenland Research Report to PBSG, p.5). A current concern is that the total harvest of polar bears in Greenland increased significantly during 1993-2003, due to an increase in the catch from the BB sub-population (Born and Sonne 2005, Greenland Research Report to PBSG, p.5), which is shared with Canada. The regional quotas (by municipality) for 2006 represent the average of the annual catch reported since 1993 by each municipality according to a new system of reporting that was introduced in 1993. The total 2006-quota for West Greenland is 100 polar bears, and for East Greenland it is 50 (Born in litt.).

Norway

Norway and Russiashare jurisdiction over the Barents Sseas sub-population of polar bears. Management in Norwayis the responsibility of the Ministry of the Environment. All hunting has been banned since 1973, in response to the *1973 Agreement* that calls for hunting by Natives only. Becauseno Native people live in Norway, no indigenous hunting is allowed. Bears may only be killed in self-defense, protection of property, and "mercy" kills. A rapid increase in tourism in Svalbard has led to an increase in the numbers of polar bears killed in defense of life

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and property; 9 bears were killed in Svalbard in 1997-2000 (PBSG 2002 p.12). The actual annual kill is, however, relatively low.

Russia

Russia is responsible for management of polar bears occurring in the BA, CS, KS, and LA sub-populations through the Ministry of Natural Resources, of is, and management agreements for them.

Polar bear hHunting in Russia has been banned since 1956; some animals are killed in defense of life, and a few cubs are taken annually for zoos. Illegal harvest is occurring in the Chukchi Sea region with limited ability for monitoring or enforcement (PBSG 1993 p.9), and there is significant interest in re-opening a hunt by Russian indigenous peoples. Over-harvest of the CS population resulting from illegal hunting in Russia, combined with legal subsistence harvest in Alaska, is a conservation concern.

In 2000, The *Agreement on the Conservation and Management of the Alaska-Chukotka Polar Bear Population* (*Bilateral Agreement)* was signed in partnership with the U.S. It establishes a conservation program for the CS sub-population of polar bears that would allow for hunting by Native people under a quota system, along with harvest monitoring and enforcement. The Chukotka Union of Marine Mammal Hunters and the Alaska Nanuuq Commission represent indigenous hunters in Russia and the U.S. and they are developing a Native-to-Native agreement to help implement the terms of the *Bilateral Agreement*. To date, neither domestic legislation nor funding has been provided in the U.S. for implementing the *Bilateral Agreement*, and Russia is waiting for U.S. action to occur before moving forward.

United States

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Prior to the 1950s the vast majority of polar bear hunting in the U.S. was done by Alaska Natives for subsistence purposes. Economically, polar bear hunting and the commercial sale of skins became increasingly important to Native Alaskans when whaling began in the 1850s. Trophy hunting using aircraft began in the late 1940s. In the 1960s, S of Alaskastate hunting regulations became more restrictive' and in 1972, aircraft-assisted hunting was stopped altogether. Bbetween 1954 and 1972, an average of 222 polar bears was harvested per year, resulting in a decline in polar bear populations in Alaska.

In 1972, the MMPA was passed which ended all polar bear hunting, except by coastal dwelling sNative fora subsistence and handicraft purposes. The MMPA also prohibits the commercial sale of any marine mammal parts except when they have been significantly altered into handicrafts by Alaska Natives. No sport hunting is allowed.

Tthe U.S. manages the CS and SB polar bear sub-populations. The FWS is responsible for polar bear management and implementation of the MMPA. Under the MMPA, non-wasteful subsistence harvest by Alaska sNative cannot be restricted unless a population is designated as depleted (meaning that it is below the OSP level). The FWS is engaged in co-management of polar bears with the Alaska Nanuuq Commission, a non-profit organization that represents interests of Alaska Native polar bear users.

For the SB sub-population, hunting is regulated voluntarily through an agreement between the Inuvialuit of Canada and the Inupiat of Alaska. The *North Slope Borough/Inuvialuit Game Council Agreement of 1988* established a Joint Commission and Technical Advisory Committee to oversee polar bear management of the SB sub-population, and calls for management based on ablesustained yield. It also calls for protection of females with cubs and denning bears, prohibits hunting using aircraft or large motorized vessels, and establishes (annually reviewed) harvest quotas and hunting seasons. Since development of this agreement, the harvest has generally remained below MSY (Brower et al. 2002). A similar agreement is being worked on for the CS sub-population (the *Bilateral Agreement*) shared with Russia, which will include implementation of a quota system.

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Import of Sport-Hunted Polar Bears From Canada Management

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I think what should be presented in each of the population sections below is:

1. What are the quotas, if any, established for the population for recent years (e.g., the past 5 years).

2. Have the quotas changed over time, and if so how (increase or decrease) and why (new survey data, new data analyis, IQ, etc.)

3. What have been the recent levels of harvest for the population, e.g., the average and range for the most recent 5 years of data. How do these compare to the quota (e.g., is 100% taken, more, less?). What has been the sex ratio of the harvest and if there is a target for sex ratio has it been met?

4. How do recent harvest levels compare to historical (e.g., 5-20 years ago). If they have changed why (e.g., quotas changed, hunters say bears are more or less available)?

5. Has the management system been working well? If not what are the problems.

6. Are there established management mechanisms that will limit or discontinue harvests for declining populations?

For the import of U.S. sport-hunted polar bears from Canada, the MMPA requires the FWS to find that Canada has a monitored and enforced management program based on scientifically sound and sustainable harvest quotas. In addition, the MMPA requires that the management plan is consistent with the International Agreement on the Conservation of Polar Bears which stipulates that polar bear populations be managed based on the best available scientific data. In 1997 (62 FR 7302)the FWS approved the, SB, NB, MC, VM, and WH sub-populations for the import of polar bears trophies by permit. In 1999 (64 FR 1529)the FWS added, LS and NW to the approved list; in 2001 (62 FR 7302) MC was removed from the list in light of new information from Canada indicating that the sub-population has severly declined and no longer meets the import criteria of the MMPA. The FWS is currently reviewing changes to the Government of Nunavut's polar bear management program and other information including

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Such figures aren't given for the other nations, and I would assume they will be given again in the section on harvests by population.

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Overall, the level of harvest in Alaska is declining. During 1980-1990, 130 polar bears per year were taken, whereas in 1990-2000, 85 polar bears per year were taken. In particular, the harvest in the CS has declined by 50% in the last 10 years (PBSG 2002 p.13

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there are other requirements that should also be listed here.

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updated population estimates to determine whether any adjustments to the list of approved populations may be necessary. Funds from a $1,000 permit issuance fee are dedicated to support conservation initiatives for polar bear stocks shared between the U.S. and Russia.

3. Harvest by Population

a. Arctic Basin (AB)

Polar bear densities are believed to be low; the PBTC had made No surveys have been done of the AB population, and a rough abundance estimate is perhaps 200 animals. No harvest quota has been set, and as far as is known there is no harvest except for an occasional defense kill (PBSG 2005)

b. Baffin Bay (BB)

The current size estimate for the BB population, based on 1994-1997 data, is 2,074 bears (PBSG 2005, Greenland Research Report, p.2). Harvest levels in 1999-2003 averaged 115 polar bears annually from the Greenland side (PBSG 2005 Greenland Research Report p.6 and ??? from the Canadian side (citations). Since then, harvest has increased to a combined Canadian and Greenlandic harvest of 170-180 polar bears per year in 1999-2003 (Anonymous 2004 in PBSG 2005, Greenland Research Report, p.7). A quota increase of 41 bears (from 64 to 105) was implemented by Nunavut in 2004/2005 (Dyck et al. 2005, Nunavut Report to PBTC p.14).

Greenland's harvest levels of polar bears in Baffin Bay have increased significantly since 1993 and were particularly high during 2002-2004. It is unknown whether this is related to an increase in hunting effort, increased efficiency of reporting, or because sea ice cover in eastern Baffin Bay has decreased, forcing an increased number of bears on to the shore. Canada and Greenland are holding co-management discussions to address the over-harvest of this population.

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c. Barents Sea (BA)

The current size of the BA population is estimated at 3,000 animals based on a 2004 aerial survey (Aars et al. 2005, Norway Management and Research Report to PBSG, p. 6). Historically e this population was believed to be depleted by over-harvest until a total ban on hunting in 1956 in Russia and in 1973 in Norway allowed the population to increase (Prestrud and Stirling 1994). The population is not currently harvested except for some polar bears taken in defense of life and property (Gjertz and Persen 1987, Gjertz et al. 1993, 1995 in PBSG 2001 p. 23).

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d. Chukchi Sea (CS)

The current size of the CSpopulation is unknown; the best available information indicates it may be comprised of approximately 2,000 animals (PBSG 2001 p.22).

The population is hunted by Yupik and Inupiat Natives in Alaska; hunting is illegal in Russia. No harvest quota has been set in Alaska and an unquantified level of illegal harvest is occurring in Russia. Bbetween the 1980s and 1990s the Alaska harvest declined by 50% (Schliebe et al.1998 in PBSG 2001 p.24). In 2004/2005, 32 bears were harvested in Alaska from this sub-population (Schliebe et al. 2006, Alaska PBTC report, p. 2.).

The Bilateral Agreement was signed in October 2000, after almost a decade of discussions and negotiations between native and government representatives from both countries. The Agreement supports harvest of polar bears in both countries for subsistence purposes, in combination with monitoring and enforcement, but does not allow hunting for commercial purposes.

The PBSG (in prep) recognized the immediate need to coordinate and regulate the harvest the shared population of polar bears occurring in the Chukchi Sea. The lack of a valid population estimate and concern for unsustainable levels of harvest as well as the need to coordinate and conduct research and recommended that the United States and Russia immediately enact and

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It seems to me that for the harvests under U.S. jurisdiction you should give fairly complete details, like maybe a table with all the data for harvests by year.

enforce the terms of the *Agreement between the United States and the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population.*

e. Davis Strait (DS)

The current size of the DSpopulation is unknown. In 1993 na estimate of 1,400 animals was proposed because atwathis is the minimum number of animals required to sustain the existing level of harvest, (PBSG 2001 p.29). Nunavut currently uses a population estimate of 1,650 bears for harvest management purposes. A three-year population survey was initiated in 2005.

The DS sub-population is hunted by both Greenland hunters and Canadian hunters from Nunavut, Labrador, and Quebec. Greenland hunters had an average catch of 1 polar bear per year during 1999-2003 (Born and Sonne 2005, Greenland Research Report to PBSG, p.6). In Nunavut, a harvest quota increase of 12 bears (from 34 to 46) was implemented in 2004/2005 (Dyck et al. 2005, Nunavut Report to PBTC p.14), based on Inuit reports that the sub-population has increased since 1996. Co-management discussions between Greenland and Canada are on-going.

f. East Greenland (EG)

The current size of the EG populationis unknown; a population estimate of 2,000 polar bears has been proposed (Lunn et al. 2000 in PBSG 2005 Greenland Research Report p.2).

The sub-population is hunted by residents of eastern and southwestern Greenland. From 1979-1998, the annual harvest averaged 77 bears (PBSG 2002 p.21). During 1999-2003 harvestsbears averaged 70 bears per year (Born and Sonne 2005 Greenland Research Report to PBSG, p.7). No significant trend in the annual harvest was noted in 1993-2003 (Born and Sonne 2005, Greenland Research Report to PBSG, p.7).

g. Foxe Basin (FB)

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What about harvests in Labrador and Quebec?

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This FB population was estimated to consist of approximately 2,300 animals in 1996 (M. Taylor, unpublished data in PBSG 2002 p.27). Polar bears are harvested by Nunavut, Quebec, and Ontario hunters. Nunavut hunters take the majority of bears from this sub-population; a quota increase of 9 bears (from 97 to 106) for Nunavut was implemented in 2004/2005 (Dyck et al. 2005, Nunavut Report to PBTC p.14). No harvest quotas exist for Quebec and Ontario hunters. In the past, FWS was concerned that no restrictions on hunting cubs, females with cubs, and denning bears were in place in Quebec and Ontario; however, all parties are monitoring their respective harvests and sharing data (Testa 1997 p. 6). A formal harvest agreement among jurisdictions is needed.

h. Gulf of Boothia (GB)

This GBpopulation is currently estimated at 1,523 bears, based on a 1998-2000 mark/recapture study (PBSG 2005 Canadian Research Report p.2). The sub-population is harvested by Nunavut hunters; a quota increase of 33 bears (from 41 to 74) for Nunavut was implemented in 2004/2005 (Dyck et al. 2005, Nunavut Report to PBTC p.14). Sport hunting started in 1987.

i. Kane Basin (KB)

The current size of the KB population, based on 1993-1997 data, is estimated at approximately 165 bears (M. Taylor, unpublished data in PBSG 2005 Greenland Research Report p.2).

Greenland hunters harvested an average of 10 per year [way out of line, with only 165 bears infrom the KB population!]in 1999-2003 (Born and Sonne 2005, Greenland Research Report to PBSG, p. 5). Prior to 1997, this sub-population was harvested only by Greenland hunters, but since 1997, Nunavut hunters from Grise Fjord have also harvested bears from KB (PBSG 2001 p. 28, taking an average of ?? bears per year). The combined harvest of 10-15 bears per year from Greenland and Nunavut is believed to be unsustainable (PBSG 2002 p. 28Tthe current quota in Nunavut is set at 5 bears per year (Dyck et al. 2005, Nunavut Report to PBTC p.14).

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This looks out of place here as it looks like a fairly minor and very specific concern. Also, Testa didn't work for FWS so this is a poor reference to document FWS concerns.

Deleted: In the past, the FWS has been concerned about a small but persistent over-harvest of females (Testa 1997 p.6); a flexible harvest system is used to adjust for high levels of female mortality and ensure that over-harvest of females can be corrected

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Comment [ ]: Page: 120
Provide data on numbers harvested.

Comment[Page: 120
If this type of info is to be given here it should be for all other CA populations. I don't see that it belongs as this section is about harvest levels. What might be interesting and probably should be done would be to provide data on the number of animals being taken by sports hunters from each CA population.

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Greenland and Canada are continuing to hold co-management discussions for this population (PBSG 2002 p. 28).

j. Kara Sea (KS)

The size of the KS population is unknown. Harvest is limited to defense of life kills and some illegal harvest that is not thought to be having a population-level effect (PBSG 2002 p.24).

k. Lancaster Sound (LS)

The size of the LS population was estimated at 1,700 bears in 2002 (PBSG 2002 p. 26).

The sub-population is harvested by Nunavut hunters. A quota increase of 7 bears (from 78 to 85) for Nunavut was implemented in 2004/2005 (Dyck et al. 2005, Nunavut Report to PBTC p.14).

l. Laptev Sea (LA)

eThis size of the LA population is unknown but has been estimated to be 800-1,200 polar bears (PBSG 2001 p.22). Known harvest is limited to defense-of-life kills and some illegal harvest not thought to be having a population-level effect (PBSG 2001 p.24).

m. M'Clintock Channel (MC)

This sub-population is the management responsibility of Canada; its size is estimated at 284 bears (PBSG 2005 Canadian Research Report p.2).

The sub-population is harvested by Nunavut hunters. The harvest quota is set at 3 bears (PBSG 2005 Canadian Research Report p.2). Recent modeling indicates that this sub-population may have been historically harvested at a level resulting in gradual depletion over a long time (> 30 years) (PBSG 2005 Canadian Research Report p.2). Local hunters suggest that declining environmental conditions or disturbance may also be factors causing a reduction in population

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This is a pretty weak statement if there are no data about either size or takes!

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Provide data on numbers harvested.

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numbers. A long period of reduced harvest is needed if the MC sub-population is to recover to its former numbers.

n. Northern Beaufort Sea (NB)

Thepopulation size of the NB population estimate was d at 1,200 bearsin YEARand the harvest was thought to be occurring at a sustainable level (PBSG 2001 p. 25). In 2003 mark-recapture work was begun to reassess population size; this work is ongoing.

The NB sub-population is harvested by hunters from Nunavut and NWT. The harvest quota is 6 bears for Nunavut and 65 from NWT (Dyck et al. 2005, Nunavut Report to PBTC p.14, NWT Report to PBTC, 2005 p.3). An inter-jurisdictional user agreement for the NB sub-population between the Inuvialuit (NWT) and Inuit (Nunavut) was signed on February 4, 2006.

o. Norwegian Bay (NW)

The size of the NW population was estimated at 100 bearsin YEAR(M. Taylor unpubl. data in PBSG 2002 p.26). This sub-population is harvested by hunters from Nunavut, witht. The harvest quota for Nunavut is set at 4 bears.

p. Southern Beaufort Sea (SB)

the U.S. and Amstrup et al. (1986) estimated the SBpopulation size to be 1,800 bearsanimals in YEAR.

Recent analysis (Amstrup et al. in prep.) of a 5-year capture and recapture study completed in 2006indicates that eSBthis population has eddeclining to about 1,500. Although it appears that harvest levels were sustainable in the past, adjustments in the harvest level may be necessary in the future.

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The SB sub-population is harvested by hunters from Alaska and NWT; the harvest quota is 80 bears (40 for Alaska and 40 for NWT). In 2004/2005, the harvest in Alaska and NWT was 27 bears (Schliebe et al. 2006, NSB-IGC Report) and 19 bears respectively (Branigan and Stirling 2006, NSB-IGC Report p. 2). A joint users-group agreement sets harvest quotas and includes provisions to protect bears in dens and females with cubs. Hunters and scientists meet annually to review harvest levels.

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It seems to me that for the harvests under U.S. jurisdiction you should give fairly complete details, like maybe a table with all the data for harvests by year.

q. Southern Hudson Bay (SH)

The estimated size of the SH population in 1988 was 1,000 animals (PBSG 2001 p. 27).

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The sub-population is harvested by hunters from Nunavut, Quebec, and Ontario (Manitoba shares management responsibility but does not hunt this sub-population).

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Provide data on numbers harvested.

r. Viscount Melville Sound (VM)

The current size of the VM sub-population was estimated to be 230 animals in YEAR(M. Taylor, unpubl. Data in PBSG 2001 p. 25).

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This sub-population is harvested by hunters from NWT and Nunavut. In February 2004, the NWT portion of the VM quota was increased to 4 bears annually (PBSG 2005 Canadian Management Report P. 2). An increase of 1 bear (from 2 to 3) was implemented for Nunavut in the 2004/2005 season (Dyck et al. 2005, Nunavut Report to PBTC p. 14). In 2004, the Wildlife Management Advisory Council (NWT) and the Inuvialuit Game Council (Nunavut) initiated discussions to develop an inter-jurisdictional user agreement between NWT and Nunavut hunters (PBSG 2005 Canadian Management Report, p. 2) because both groups hunt from the NB and VM polar bear sub-populations. An agreement was signed on February 4, 2006.

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Provide data on numbers harvested.

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s. Western Hudson Bay (WH)

The size of the WH sub-population was estimated at 977 animals in 2003 with a declining trend (Regehr et al. unpublished data in PBSG 2005 Canadian Research Report p.3).

A quota increase of 9 bears (from 47 to 56) was implemented for Nunavut in 2004/2005 season (Dyck et al. 2005, Nunavut Report to PBTC p.14), based on Native residents' reports that more polar bears are being observed along the coast in recent years, which they interpret as evidence that the sub-population is increasing (PBSG 2005 Canadian Research Report p.3). This finding was disputed by PBSG members in the 2005 IUCN PBSG meeting, who called into question whether this sub-population continues to be managed on the best available scientific data, as called for in the *1973 Agreement*.

Manitoba has a quota of 8 that is used for the Polar Bear Control Program.

Summary

At present, concern exists for potential over-harvest of the BB, CS, KB, and WH sub-populations of polar bears. In other populations like East Greenland and Davis Strait a fair number of polar bears are taken annually despite lack of scientific information about populations size. Considerable debate has occurred regarding the recent changes in population estimates and quota increases for some sub-populations in Nunavut (PBSG 2005). The question arises whether increasing quotas based on local knowledge (and the perception that the populations were increasing because hunters were seeing more bears along the coast) constitutes a "sound conservation practice". Most scientists indicated that increased numbers of bear along the coastline could be related to changes in bear distribution (lack of suitable ice habitat) rather than an increase in the population size, and until additional inventories are done, a precautionary approach should be used when setting polar bear harvest limits. Recent computer simulations (e.g., Taylor et al 2000, 2001 in PBSG 2001 p.29) indicate that harvesting polar bear sub-populations at or near MSY involves more risk than previously believed (PBSG 2001 p.29).

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Provide data on numbers harvested.

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need to explain what this is

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I think this section should include a table showing for each population the information described in the comment on pages 115-116. That way a reader can get a quick but complete view of the harvest situation on one page. Th text in the summary section should describe what the table shows and highlight areas that are of concern, i.e., where there are places that harvest appears to be a threat--that's the point of evaluating this ESA listing factor.

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needs citations

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What kind of risk? I assume risk to the bears, but is it of causing populations to decline or what?

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This is true but it applies to all things and belongs in some kind of overall summary/synthesis.

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On the other hand, for most of the world's harvested polar bear sub-populations, the economic and cultural value associated with both subsistence and sport hunting of polar bears is an important consideration in polar bear conservation. Some comments from the public raised the concern that if polar bears are listed as "threatened" and that action results in a ban on polar bear hunting or import of sport hunted trophies into other countries, a serious economic effect may occur in small hunting communities in Nunavut, and local hunters may see less value in conserving bears and abiding by the harvest management practices that are currently in place, e.g. an increase in nuisance or defense kills may occur. However, each jurisdiction has the sovereign right to manage its own living recources and also at present has management tools in place that accommodate for the sound management of their polar bear populations. In some cases further development of co-management of shared stocks is needed (e.g. between Canada and Greenland).

C. Disease or predation

1. Disease

Except for the presence of *Trichinella* larvae, the occurrence of diseases and parasites in polar bears is relatively rare compared to other bears. Polar bears feed primarily on fat, which is relatively free of parasites, except for Trichinella (Rogers and Rogers 1976, Forbes 2000). Lentfer (1976 p.1) reported that 64% of the polar bears tested from Alaska had *Trichinella* larvae in the masseter muscle tissue. Rogers and Rogers (1976) found that of the seven endoparastes found in captive polar bears, only *Trichinella* had been observed in wild animals. *Trichinella* has been documented in polar bears throughout irthe range and although infestations can be quite high they are normally not fatal (Rausch 1970, Dick and Belosevic 1978, Larsen and Kjos-Hannssen 1983, Taylor et al. 1985, Forbes 2000). Although rabies is commonly found in Arctic foxes (*Alopes lagopus*), there has been only one confirmed instance of rabies in polar bears (Taylor et al. 1991). In a recent study in Svalbard, Norway, antibodies to the rabies virus were not detected (Tryland et al. 2005). Follmann et al. (1996) initially reported the presence of morbilllivirus in polar bears from Alaska and Russia and four mobilliviruses, canine distemper

Comment [ ]: Page: 125
You should cite Friedman's recent article about this in Arctic.

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Public comments don't need to be addressed in the status review, and if you address this one you should do the same for all others. I suggest deleting this and dealing with it in the decision.

Comment [ ]: I suggest a phrase like this in order to acknowledge the fact that irrespective what USA eventually decides about the listing on the ESA, it is the full legal right (and obligation) of the other polar bear nations to manage their bears whether or not other jurisdiction may or may not ban the import of trophees.

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(CDV), dolphin morbillivirus (DMV), phocine distemper (PDV), and porpoise morbillivirus (PMV), were later identified (Garner et al. 2000). More recently, the presence of CDV, DMV, PDV, and PMV was detected in 48% of the Alaskan polar bears tested (n=64) (Cassandra Kirk, 2006, University of Alaska, Fairbanks, pers. comm.). Epizootics including mass mortalities in marine mammals, particularly seals, have been attributed to this group of morbilliviruses (Duignan et al. 1994, Duignan et al. 1995, Mamaev et al 1996, Visser et al. 1993, Kennedy 1998, Duignan et al. 1997, Garner et al. 2000). The bears that were positive for DMV, PDV, or PMV had higher titers for CDV (Cassandra Kirk, 2006, University of Alaska, Fairbanks, pers. comm.), which suggests that that the source is likely from a terrestrial origin (Garner et al. 2000).

Antibodies to the protozoan parasite, *Toxoplasma gondii,* were found in 13% of serum samples from Alaskan polar bears (n=64) (Cassandra Kirk, 2006, University of Alaska, Fairbanks, pers. comm.). Toxoplasmosis has been suspected as a risk factor increasing the susceptibility of southern sea otters to infection (Miller et al. 2002, Krueder et al. 2003). It is currently unknown whether or not the presence of *Toxoplasma gondii* is a health concern for polar.

It is unknown whether polar bears are more susceptible to new pathogens due to their lack of previous exposure to diseases and parasites. Many different pathogens and viruses have been found in seal species that are polar bear prey (Duignan et al. 1997, Measures and Olson 1999, Dubey et al. 2003, Hughes-Hanks et al. 2005), so the potential exists for transmission of these diseases to bears. As polar bears become more stressed they may eat more of the intestines and internal organs than they do presently, thus increasing their potential exposure to parasites and viruses (Derocher et al.2004, Amstrup et al. 2006). It has also been well documented that populations or individuals that are stressed are more susceptible to effects of disease. There is also the potential for pathogens to expand their ranges northward from more southerly areas as the Arctic swarmer (Harvell et al. 2002). For example, *Echinococcus multilocularis* was recently found in brown lemmings (*Lemmus trimucronatus*) along the Arctic coast in Barrow, Alaska, which represents a northern expansion of this disease vector which was previously only found as far north as ?????(Holt et al. 2005).

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Comment : Page: 126 I think toxoplasmosis is the infection, not the risk factor causing some other infection. This needs checked.
Comment : Yes, it's a parasitic infection of Toxoplasma gondii.
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Comment : Page: 127 You can't say this unless you have and show data indicating that the prevalence of toxoplasma has increased over time.
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2. Intraspecific Predation

Intraspecific killing has been reported among all North American bear species. Reasons for interspecific predation in bears species is poorly understood but thought to include population regulation, nutrition, and enhanced breeding opportunities in the case of killingof cubs. Although infanticide by male polar bears has been well documented (Hannsson and Thomassen 1983, Larsen 1985, Taylor et al. 1985, Derocher and Wiig 1999), it isthought that this activity does not account for a large percentage of the cub mortality. By killing cubs sired by other males, the adult male eliminates potential competition with their own offspring and may also create an opportunity to breed with the female whose cubs he killed, thus producing his own cubs. It is thought that this behavior increases the male's relative fitness in the population; however, for this to be successful a male has to recognize his own cubs and have a reasonable opportunity to breed with a female whose cubs he killswhen she comes back into estrus. Another potential reason for infanticide relates to density dependent mechanisms of population controlas this behavior seems to occur more frequently with increasing population size (Derocher and Wiig 1999).

Cannibalism has also [?? Isn't this the topic of the previous paragraph as well ??]been documented in polar bears (Derocher and Wiig 1999, Amstrup et al. 2006). Amstrup et al. (2006) observed three instances of cannibalism in the southern Beaufort Sea during the spring of 2004 involving two adult females, one an unusual mortality of a female in a den, and another of a yearling. In a combined 58 years of research by the senior investigators similar observations had not taken place. Active stalking or hunting preceded the attacks and both of the killed bears were eaten. Adult males were believed to be the predator in the attacks. Amstrup et al, indicated that in general a greater portion of polar bears in the area where the predation occurred were in poor physical condition compared toin other years. Tthe authors hypothesized that adult males may be the first to show the effects of nutritional stres caused bysignificant ice retreat in this area (Skinner et al. 1998; Comiso and Parkinson 2004; Stroeve et al. 2005) because they feed less during the spring mating season and enter the summer in poorer condition than other sex/age classes. Derocher and Wiig (1999) documented a similar intraspecific killing and consumption

Comment Page: 127
What about predation on cubs by wolves? I know there is at least one paper documenting that.

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of another polar bear in Svalbard, Norway, which was attributed to relatively high population densities and food shortages. Taylor et al. (1985) documented that a malnourished female killed and consumed her own cubs, and Lunn and Stenhouse (1985) found an emaciated male consuming an adult female polar bear.

The potential importance of cannibalism and infanticide for population regulation is unknown. Given our current knowledge of disease and predation, we do not believe that these factors currently are having any major population level effects.

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D. Adequacy of existing regulatory mechanisms

1. Description of International Management Structures

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a. International Agreement on the Conservation of Polar Bear

Canada, Denmark on behalf of Greenland, Norway, the Union of Soviet Socialist Republics (now Russia), and the United States signed the Agreement on the Conservation of Polar Bears (Polar Bear Agreement) in 1973 (Appendix 1). The Polar Bear Agreement requires signatories to protect the ecosystems and habitats used by polar bears and to promote polar bear protection efforts through coordinated national measures. The Polar Bear Agreement represented the first effort by five circumpolar nations to address a circumpolar conservation issue (Prestrud and Stirling 1994, Stirling 1998).

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Comment [redacted] : Page: 129
You used "1973 Agreement" before--should be consistent.

In 1976, the United States Senate unanimously provided its advice and consent to the Polar Bear Agreement and by 1978 all five parties had ratified the Polar Bear Agreement. The Polar Bear Agreement, initially in force for five years, became permanent upon agreement by the five parties in 1981. Article II of the Polar Bear Agreement requires each country to "take appropriate action to protect the ecosystem of which polar bears are a part, with special attention to habitat

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components such as denning and feeding sites and migration patterns," and to "manage polar bear populations in accordance with sound conservation practices based on the best available scientific data." Article VI of the Polar Bear Agreement requires each country to "enact and enforce such legislation and other measures as may be necessary" to implement the Polar Bear Agreement. Eeach party must enact implementing legislation where necessary. The Agreement relies on the efforts of each jurisdiction to implement conservation programs, and does not preclude a party from establishing additional controls.

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The Marine Mammal Protection Act of 1972 (MMPA, 16 U.S.C. § 1361 *et seq.*), as amended, is the primary legislation through which the United States meets the obligations of the Polar Bear Agreement. The MMPA addresses domestic conservation of polar bears and other marine mammals under the jurisdiction of the United States.

The initial impetus for the Polar Bear Agreement was a concern that over-harvest of polar bears was negatively impacting the species. The Polar Bear Agreement is widely viewed as a success in that polar bear populations recovered from excessive harvests and severe population reductions in many areas. Need for harvest management improvements, however, such as restricting harvest of females and cubs, establishing sustainable harvest limits, and controlling illegal harvests, have been identified for some populations or locales (PBSG 1998 or Derocher et al. 1998). The lack of protection of critical habitats by the Parties, with few notable exceptions for some denning areas, is a weakness of the Agreement (Prestrud and Stirling 1994). Further, the Parties acknowledged that additional efforts were necessary to protect habitat and emphasized national efforts to identify important denning and feeding habitats (Baur 1996).

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Not clear what you are saying here since at least some of these things were already in the Agreement so how could the be seen as improvements?

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b. IUCN/SSC Polar Bear Specialist Group

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The Polar Bear Specialist Group (PBSG) operates under the IUCN Species Survival Commission. The PBSG was formed in 1968 in response to polar bear conservation needs identified at a September 1965 scientific meeting arranged by the University of Alaska in Fairbanks. This was one of the first major scientific gatherings with the primary task to discuss international conservation measures regarding a single species, the polar bear. Subsequent to its formation, the PBSG contributed to the negotiation and development of the Polar Bear Agreement.

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The PBSG meets periodically at 3 to 5 year intervals so as to comply with Article VII of the Polar Bear Agreement, which instructs the Contracting Parties to "conduct national research programs on polar bears, particularly research relating to the conservation and management of the species. They shall as appropriate coordinate such research with the research carried out by other Parties, consult with other Parties on management of migrating polar bear populations, and exchange information on research and management programs, research results, and data on bears taken." The PBSG held their14th working group meeting in Seattle, Washington, United States in June 2005.

The PBSG first evaluated the status of all polar bear populations in 1980. In 1993, 1997, and 2001 the PBSG conducted circumpolar status assessments, the results of which were published as part of the proceedings of each meeting.

The PBSG also evaluates the status of this species under the IUCN Red List criteria. Previously, under the IUCN Red List program polar bears were classified as "Less rare but believed to be threatened-requires watching" (1965), "Vulnerable" (1982, 1986, 1988, 1990, 1994), and "Lower Risk/Conservation Dependent" (1996). During the 14th working group meeting, the PBSG re-evaluated the status of polar bears, and based on climate change analysis and projected changes in sea ice, effects of climatic change on the distribution of polar bears, and the condition of polar bears including effects on reproduction and survival associated with climate change, the group agreed unanimously that a status designation of "Vulnerable" was warranted.

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c. Inupiat-Inuvialuit Agreement for the Management of Polar Bears of the Southern Beaufort Sea

Telemetry research on polar bears in the 1980s suggested that Alaskan and Canadian polar bear hunters were harvesting from the same southern Beaufort Sea population that ranged between between Icy Cape in Alaska and Pearce Point, to the east of Paulatuk in Canada (Amstrup, 1986; Stirling et al., 1988). Because harvests in Canada and Alaska were being managed differently and independently, recognition that the population was shared raised conservation concerns by the users and managers from each jurisdiction.

The Inuvialuit and the Inupiat recognized the shared responsibility for conservation and need to coordinate harvest practices (Stirling, 1988, Treseder and Carpenter, 1989; Nageak et al., 1991). The user group management agreement for polar bears of the southern Beaufort Sea was signed in Inuvik, NWT in January 1988, following two years of technical discussions and community consultations

Provisions of the Agreement included: annual quotas (which may include problem kills), hunting seasons; protection of bears in or constructing dens and of females accompanied by cubs and yearlings; collection of specimens from killed bears to facilitate monitoring of the sex and age composition of the harvest; agreement to meet annually to exchange information on research and management, to set priorities, and to agree on quotas for the coming year; and, prohibition of hunting with aircraft or large motorized vessels and of trade in products taken in violation of the Agreement. To facilitate implementation, a Joint Commission was formed, comprised of two Commissioners appointed by each party, as well as a Technical Advisory Committee, appointed by the Joint Commission, made up of biologists from government agencies in both countries who were actively involved in collecting research and management data. These two groups meet together annually, and decisions are made by consensus. In Canada, recommendations and decisions from the Commissioners are then implemented through Community Polar Bear Management Agreements, Inuvialuit Settlement Region Community Bylaws, and NWT Big Game Regulations. In Alaska they are implemented

through????d Agreement between the United States of America and the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population

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On October 16, 2000, the United States and Russia signed a bilateral agreement for the conservation and management of polar bear populations shared between the two countries. The *Agreement between the United States of America and the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population* (Bilateral Agreement) represents a significant effort by the United States and Russia to expand upon the progress made through the multi-lateral Polar Bear Agreement and to implement unified conservation programs for this shared population. The Bilateral Agreement reiterates requirements of the Polar Bear 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. The Bilateral Agreement does not allow hunting for commercial purposes or commercial uses of polar bears or their parts. It also commits the Parties to the conservation of ecosystems and important habitats, with a focus on conserving polar bear habitats such as feeding, congregating and denning areas. The United States has yet to enact enabling legislation that would allow the full implemention of the Bilateral Agreement.

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e. Norway-Russia Environmental Agreement

Cooperation between Norway and Russia in the field of environmental protection was formally established by an agreement signed in 1996. Under the agreement a Russian - Norwegian commission meets annually with a goal of establishing collaborative projects with a benefit for environmental conservation. The program places an emphasis on exchange and development of technology and information useful for management of natural resources and establishing mutual policies of environmental protection. The agreement has identified and conducted collaborative polar bear research projects.

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f. The Convention on the International Trade in Endangered Species of Wild Fauna and Flora

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is a treaty aimed at protecting species at risk from international trade. CITES regulates international trade in animals and plants by listing species on one of its three appendices. The level of monitoring and control to which an animal or plant species is subject depends on which of the three appendices the species is listed. Appendix I includes species threatened with extinction, andwhich their trade is only allowed in exceptional circumstances. Appendix II includes species not necessarily threatened with extinction, but for which trade must be controlled in order to avoid utilization incompatible with their survival. Appendix III includes species that are protected in at least one country, and for which that country has asked other CITES Party countries for assistance in controlling and monitoring international trade in that species.

For species to be added or removed from Appendices I or II, a vote is required at a CITES Conference of the Parties, which is held every 2-3 years, but any CITES Party may add a native species to Appendix III unilaterally provided that the Party has domestic laws to protect the species.

Polar bears are currently listed as an Appendix II species under CITES. As such, member countries to CITES must determine, amongst other things, that any polar bear, polar bear part, or product made from polar bearwas legally obtained, and that the export will not be detrimental to the survival of the species, prior to issuing a permit authorizing the export of the animal, part, or product.

gMechanisms to regulate c f. Climate change

Rregulatory mechanisms to comprehensively address the causes of climatechange are still under development. Efforts to address climate change globally began with the United Nations Framework Convention on Climate Change ("UNFCCC"), which was adopted in May 1992.

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The stated objective of the UNFCCC is the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system (EIA 2004). Due to the complexity of climate issues and the widely divergent political positions of the world's nation states, the UNFCCC itself was unable to set emissions targets or limitations, but instead created a framework that set the stage for subsequent actions (UNFCCC 2004). The UNFCCC covers greenhouse gases not otherwise controlled by the Montreal Protocol on ozone-depleting substances (UNFCCC 2004). A key feature of the Framework is the designation of different levels of responsibility to the parties of the convention, based on their differing levels of economic development (UNFCCC 2004). To date, the goals set by the Framework have not been met (International Climate Change Taskforce 2005).

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The Kyoto Protocol, negotiated in 1997, became the first additional agreement added to the UNFCCC to set emissions targets. The Kyoto Protocol set goals for developed countries to reduce their emissions to at least 5% below their 1990 levels (UNFCCC 2004). Implementation of the Kyoto Protocol would only slightly reduce the rate of growth of emissions but would not stabilize the level of emissions in the atmosphere (Williams 2002). Additionally, mechanisms for enforcement of emission reductions have not yet been tested and there are no financial penalties or automatic consequences for failing to meet Kyoto targets (UNFCCC 2004). Climate responds to changes in greenhouse gas concentrations with a time lag; therefore, past emissions have initiated processes that have led and will lead to a certain degree of warming and climate change even after emissions are controlled (IPCC 2001a; Williams 2002; ACIA 2004a).

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2. International Classification Systems

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It doesn't look to me like this section is needed. IUCN could be, and partly already is, dealt with in the section above. NaturServe doesn't seem very important as it is just something private that has no official management significance, and it could be left out.

a. NatureServe List

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NatureServe is a non-profit conservation organization that provides the scientific information and tools needed to help guide effective conservation action. NatureServe and its network of natural heritage programs are a major source for information about rare and endangered species and threatened ecosystems.

NatureServe represents an international network of biological inventories—known as natural heritage programs or conservation data centers—operating in all 50 U.S. states, Canada, Latin America and the Caribbean. The organization collects and manages detailed local information on plants, animals, and ecosystems, and develops information products, data management tools, and conservation services to help meet local, national, and global conservation needs. The scientific information about species and ecosystems developed by NatureServe is used by a variety of government and private sectors to make informed decisions about managing our natural resources.

On October 3, 2005 NatureServe revised its global status rank for polar bears to G3, the equivalent of "Vulnerable," from the previous classification of G4, "apparently secure." The term vulnerable is defined as one that is at moderate risk of extinction due to a restricted range, relatively few populations, recent and widespread declines, or other factors. Polar bears fit this classification as the population is restricted to high northern latitudes with a relatively small total population of 21,500-25,000 individuals located in about 20 relatively discrete major populations. Potential negative impacts from various human activities were cited (e.g., oil and gas exploration and development, harvest, environmental contaminants) as increasing or not well regulated in some areas. G; global warming effects on sea ice could result in major declines in polar bear distribution and abundance. Details regarding eNaturServe and the polar bear status assessment can be found at http://www.natureserve.org and in Appendix 2.

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b. IUCN Red List

The IUCN World Conservation Union through its Red List program assesses the conservation status of species, subspecies, varieties and selected subpopulations to identify taxa threatened with extinction in order to promote their conservation. The program goal is to provide the world with the most objective, scientifically-based information on the current status of globally

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threatened biodiversity. The IUCN Red List of Threatened Species provides taxonomic, conservation status, and distribution information on taxa that have been evaluated using the IUCN Red List Categories and Criteria.

De Grammont and Cuarón (2006) conducted an evaluation of categorization systems that assess the risk of species extinction to evaluate the objectivity and accuracy of threatened or endangered classification systems. Twenty-five categorization systems from 20 countries were evaluated. These included examples of international lists, most national systems used in the American continent, and some systems independently proposed by academics. Fifteen characteristics that should be included in the categorization were assessed. They concluded that of all evaluated systems, the current World Conservation Union system (IUCN) is the most suitable for assessing species extinction risk.

On May 4, 2006, the IUCN/SSC Red List of Threatened Species was updated to include the "Vulnerable" classification of polar bears developed by the PBSG as discussed above.

The assessment was based on an assumed population reduction of greater then 30% within 3 generations (which is calculated to be 45 years by: 3 x [5 years (the age of sexual maturity) + 10 years (50% of the length of the life time reproductive period)]) that would result from a decline in area of occupancy, extent of occurrence, and habitat quality. The assessment, conducted by the Polar Bears Specialist Group, uses the 2001 IUCN criteria (Appendix 4) and found the following:

> "Polar bears rely almost entirely on the marine sea ice environment for their survival so that large scale changes in their habitat will impact the population (Derocher et al. 2004). Global climate change poses a substantial threat to the habitat of polar bears. Recent modeling of the trends for sea ice extent, thickness, and timing of coverage predicts dramatic reductions in sea ice coverage over the next 50-100 years (Hassol 2004). Sea ice has declined considerably over the past half century. Additional declines of roughly 10 - 50% of annual sea ice are predicted by 2100. The summer sea ice is projected to decrease by 50 – 100% during the same period. In addition the quality of the remaining ice will

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decline. This change may also have a negative effect on the population size (Derocher et al. 2004). The effects of sea ice change are likely to show large difference and variability by geographic location and periods of time, although the long term trends clearly reveal substantial global reductions of the extent of ice coverage in the Arctic and the annual time frames when ice is present.

While all bear species have shown adaptability in coping with their surroundings and environment, polar bears are highly specialized for life in the Arctic marine environment. Polar bears exhibit low reproductive rates with long generational spans. These factors make facultative adaptation by polar bears to significantly reduced ice coverage scenarios unlikely. Polar bears did adapt to warmer climate periods of the past. Due to their long generation time and the current greater speed of global warming, it seems unlikely that polar bear will be able to adapt to the current warming trend in the Arctic. If climatic trends continue polar bears may become extirpated from most of their range within 100 years.

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There is little doubt that in the future polar bears will have access to less sea ice for a shorter time period. Also the location of ice that remains may be in areas of lower biological productivity. However, only in Western Hudson Bay are data presently available to link these ice features with the abundance of polar bears. While some have speculated that polar bears might become extinct by the end of the 21st century, which would indicate a population decrease of > 50% in 45 years. (B)ased on a precautious attitude to the uncertainty in data a more realistic attitude to the risk involved in the assessment make it fair to suspect population reduction of > 30%.

Other population stress factors that may also operate to impact recruitment or survival include toxic contaminants, shipping, recreational viewing, oil and gas exploration and development. In addition to this comes a potential risk of over-harvest due to increased quotas or no quotas in Canada and Greenland and poaching in Russia."

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This is all stuff said independently already in this status review. It should be enough here to say what the IUCN category is and what listing criteria were met to put it in that category.

3. Description of Domestic Management Structures

a. United States

Marine Mammal Protection Act of 1972, as amended

The MMPA was enacted in response to growing concerns among scientists and the general public that certain species and populations of marine mammals were in danger of extinction or depletion as a result of human activities. The goal of the MMPA is to protect and conserve marine mammals so that they continue to be significant functioning elements of the ecosystem of which they are a part. The MMPA set forth a national policy to prevent marine mammal species or population stocks from diminishing to the point where they are no longer a significant functioning element of the ecosystems.

The MMPA places an emphasis on habitat and ecosystem protection. The habitat and ecosystem goals set forth in the MMPA include: (1) management of marine mammals to ensure they do not cease to be a significant element of the ecosystem to which they are a part; (2) protection of essential habitats, including rookeries, mating grounds, and areas of similar significance "from the adverse effects of man's action;" (3) recognition that marine mammals "affect the balance of marine ecosystems in a manner that is important to other animals and animal products" and that marine mammals and their habitats should therefore be protected and conserved; and (4) directing that the primary objective of marine mammal management is to maintain "the health and stability of the marine ecosystem." Congressional intent to protect marine mammal habitat is also reflected in the definition of terms set out in section of the MMPA. The terms "conservation" and "management" of marine mammals are specifically defined to include habitat acquisition and improvement.

The Act includes a general moratorium on the taking and importing of marine mammals, which is subject to a number of exceptions. Some of the exceptions include ingtake for scientific purposes, for purpose of public display, subsistence use by Alaska Natives, andunintentional incidental take a coincident with conducting lawful activities.

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At least in the case of Canada you talk about management systems not laws.

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You need to add the National Environmental Policy Act which requires an EIS to be prepared for significant federal actions that could affect the environment. You should probably also include the ESA, because it will come into play if the species is listed.

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Take is defined to include the "harassment" of marine mammals. "Harassment" includes any act of pursuit, torment, or annoyance which "has the potential to injure a marine mammal or marine mammal stock in the wild" (Level A harassment), or "has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering" (Level B harassment).

The Secretaries of Commerce and the Interior have primary responsibility for implementing the MMPA. The Department of Commerce, through the National Oceanic and Atmospheric Administration (NOAA) has authority with respect to whales, porpoises, seals, and sea lions. The remaining marine mammals, including polar bears, walruses, manatees and sea and marine otters, are managed by the Department of the Interior through the U.S. Fish and Wildlife Service. Both agencies are "... responsible for the promulgation of regulations, the issuance of permits, the conduct of scientific research, and enforcement as necessary to carry out the purposes of [the MMPA]".

U.S. citizens who engage in a specified activity other than commercial fishing within a specified geographical region may petition the Secretary of the Interior to authorize the incidental, but not intentional, taking of small numbers of marine mammals within that region for a period of not more than five consecutive years. 16 U.S.C. § 1371(a)(5)(A). The Secretary "shall allow" the incidental taking if the Secretary finds that "the total of such taking during each five-year (or less) period concerned will have a negligible impact on such species or stock and will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses..." If the Secretary allows the incidental taking, the Secretary must also prescribe regulations that specify (1) permissible methods of taking, (2) means of affecting the least practicable adverse impact on the species, their habitat, and their availability for subsistence uses, and (3) requirements for monitoring and reporting. The regulations promulgated do not

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The MMPA places an emphasis on habitat and ecosystem protection. The habitat and ecosystem goals set forth in the MMPA include: (1) management of marine mammals to ensure they do not cease to be a significant element of the ecosystem to which they are a part; (2) protection of essential habitats, including rookeries, mating grounds, and areas of similar significance "from the adverse effects of man's action;" (3) recognition that marine mammals "affect the balance of marine ecosystems in a manner that is important to other animals and animal products" and that marine mammals and their habitats should therefore be protected and conserved; and (4) directing that the primary objective of marine mammal management is to maintain "the health and stability of the marine ecosystem." Congressional intent to protect marine mammal habitat is also reflected in the definition of terms set out in section of the MMPA. The terms "conservation" and "management" of marine mammals are specifically defined to include habitat acquisition and improvement.

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authorize the activities themselves, but authorize the incidental take of polar bears in conjunction with otherwise legal activities described within the regulations.

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Outer Continental Shelf Lands Act

The Outer Continental Shelf Lands Act (OCSLA) established Federal jurisdiction over submerged lands on the Outer Continental Shelf (OCS) seaward of the State boundaries (3-mile limit) in order to expedite exploration and development of oil/gas resources on the OCS.

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Implementation of OCSLA is delegated to the Minerals Management Service (MMS) of the Department of the Interior. OCS projects which could adversely impact the Coastal Zone are subject to Federal consistency requirements under terms of the CZMA, as noted below. OCSLA also mandates that orderly development of OCS energy resources be balanced with protection of human, marine and coastal environments.

Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) was enacted to "preserve, protect, develop, and where possible, to restore or enhance the resources of the Nation's coastal zone." This is a State program subject to Federal approval. The CZMA requires that Federal actions be conducted in a manner consistent with the State's CZM plan to the maximum extent practicable. Federal agencies planning or authorizing an activity that affects any land or water use or natural resource of the coastal zone must provide a consistency determination to the appropriate State agency. The North Slope Borough and Alaska Coastal Management Programs through their project review processes have operated effectively to assist in protection of polar bear habitat in recent times.

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Before this you need to say there is such a program in AK that applies to areas that are polar bear habitats.

Alaska National Interest Lands Conservation Act

The Alaska National Interest Lands Conservation Act (ANILCA) created or expanded National Parks and Refuges in Alaska, including the Arctic National Wildlife Refuge (NWR). One of the establishing purposes of the Arctic NWR is to conserve polar bears. Most of the Arctic National Wildlife Refuge is designated Wilderness and is therefore off limits to oil and gas development. The coastal plain of Arctic NWR (Section 1002 designated lands), which provides important polar bear denning habitat, does not have Wilderness status, however, and could be opened for development by an Act of Congress.

Marine Protection, Research and Sanctuaries Act

The Marine Protection, Research and Sanctuaries Act was enacted in part to "prevent or strictly limit the dumping into ocean waters of any material that would adversely affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities."

Climate change studies

Domestic efforts relative to climate change focus on continued studies programs, support for developing new technologies and use of incentives for supporting reductions in emissions. A strategic plan for the U.S. Climate Change Science Program released by the Departments of Energy and Commerce and the White House Office of Science Technology and Policy is available (http://climatescience.gov/). The strategy is for developing knowledge of variability and change in climate and related environmental and human systems and for encouraging the application of this knowledge. The strategic goal of emissions reductions is measured by emissions intensity, the amount of emissions per unit of economic activity (http://state.gov/g/oes/climate/). This measure differs from an absolute measure of output and while the emissions intensity could decrease while total emissions would still increase, (GAO 2003,)

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b. Canada

In Canada the Federal Government has delegated the management of polar bears to the Provinces and Territories. However, the Federal Government is responsible for CITES related programs and has continued to provide both technical (long-term demographic, ecosystem, and inventory research) and administrative (Federal/Provincial Polar Bear Technical Committee, Federal/Provincial Polar Bear Administrative Committee, and the National Database) support to the Provinces and Territories. The Provinces and Territories have the ultimate authority for management, although in several areas, the decision-making process is shared with aboriginal groups as part of the settlement of land claims. Hunting by aboriginal people is permissible. Harvest quotas or guidelines, in the instance where treaty interest rights are in effect, are based on principles of sustainable use (Derocher et al. 1998).

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In Canada, much of the denning areas in Manitoba have been protected by inclusion within the boundaries of Wapusk National Park. In Ontario, some denning habitat and coastal summer sanctuary habitat are included in Polar Bear Provincial Park. Some polar bear habitat is included coincidentally in some of the National Parks and National Park Reserves in the Northwest Territories. Offshore areas which may be important habitat have variable levels of protection. Additional habitat protection measures include restrictions on harassment and approaching dens and denning bears, and a land use permit review that considers potential impacts of land use activities on wildlife (Derocher et al. 1998).

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Canada's Species at Risk Act

Canada's Species at Risk Act (SARA) became law on December 12, 2002, and went into effect on June 1, 2004 (Walton 2004). Prior to SARA, Canada's overview of species at risk was through the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the Minister of Environment, which continued to function under SARA following passage of SARA. The Committee evaluates species status and provides recommendations to the Minister of the

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Environment, who makes the final listing decision and identifies species specific management actions. SARA provides a number of protections for wildlife species designated to the List of Wildlife Species at Risk, or "Schedule 1" (SARA Registry 2005).

SARA promotes species conservation through a number of mechanisms, including prohibitions on killing listed species and destroying critical habitat, and the implementation of recovery strategies. These prohibitions apply only on Federal lands, such as national parks ; however, SARA includes an exception for species like the polar bear. In such cases, the Federal Cabinet, based on recommendation of the Minister of the Environment, may apply restrictions to non-federal lands in a Province or Territory. This provision has not been tested by the courts (Walton 2004).

The listing criteria used by COSEWIC are based on the 2001 IUCN Red List assessment criteria (Appendix 3). Currently, the polar bear is designated as a Schedule 3 species, "Species of Special Concern," awaiting re-assessment and public consultation for possible addition to Schedule 1 (Environment Canada 2005). The Minister of the Environment did not add the polar bear to the List of Wildlife Species at Risk under SARA at the request of Nunavut which wanted additional consultation. The Minister recognized that there was new knowledge available and a greater need to incorporate Traditional Ecolgical Knowledge (TEK) in the assessment. There is increased interest by COSEWIC for an early re-assessment of the status of polar bears in Canada.

Intra-jurisdiction polar bear agreements within Canada

Polar bears occur in Canada in the NWT, the Yukon Territory, and the provinces of Manitoba, Ontario, Quebec, and Newfoundland and Labrador (Map 1). All 12 Canadian polar bear populations lie within or are shared with the NWT which sinclude all Canadian lands and marine environment north of the 60th parallel (except the Yukon Territory) and all islands and waters in Hudson Bay and Hudson Strait up to the low water mark of Manitoba, Ontario, and Quebec. The offshore marine areas along the coast of Newfoundland and Labrador are under Federal

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jurisdiction (GNWT). Although Canada manages each of the 12 populations of polar bear as separate units, there is a complex sharing of responsibilities. While wildlife management has been delegated to the Provincial and Territorial Governments, the Federal Government (Environment Canada's CWS) has an active research program and is involved in management of wildlife populations shared with other jurisdictions, especially ones with other nations. In the NWT, Native Land Claims resulted in Co-management Boards for most of Canada's polar bear populations. Canada formed the Federal-Provincial Technical and Administrative Committees for Polar Bear Research and Management (PBTC and PBAC, respectively) to ensure a coordinated management process consistent with internal and international management structures and the International Agreement. The committees meet annually to review research and management of polar bears in Canada and have representation from all the Provincial and Territorial jurisdictions with polar bear populations and the Federal Government. Beginning in 1984, the USFWS has attended meetings of the PBTC and biologists from Norway and Denmark have attended a number of meetings as well. In recent years, the PBAC meetings have included the participation of nongovernment groups, such as the Inuvialuit Game Council and the Labrador Inuit Association, for their input at the management level. The annual meetings of the PBTC provide for continuing cooperation between jurisdictions and for recommending management actions to the PBAC (Calvert et al. 1995). The NWT Polar Bear Management Program (GNWT) manages polar bears under the Northwest Territories Act (Canada). The 1960 "Order-in-Council" granted authority to the Commissioner in Council (NWT) to pass ordinances that are applicable to all people to protect polar bear, including the establishment of a quota system. The Wildlife Act, 1988, and Big Game Hunting Regulations provide supporting legislation which addresses each polar bear population. Although the Inuvialuit and Nunavut Land Claim Agreements supersede the Northwest Territories Act (Canada) and the Wildlife Act, no change in management consequences for polar bears is expected since the GNWT retains management and enforcement authority. Under the umbrella of this authority, polar bears are now comanaged through wildlife management boards made up of Land Claim Beneficiaries and Territorial and Federal representatives. One of the strongest aspects of the program is that the management decision process is integrated between jurisdictions and with local hunters and management boards. A main feature of this approach is the development of Local Management

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Agreements between the communities that share a population of polar bears. Management agreements are in place for all NWT populations. In the case of populations that the NWT shares with Quebec and Ontario (neither of which is approved under the criteria specified in this rule), the management agreement is not binding upon residents of communities outside of NWT jurisdiction. The GNWT uses these agreements to develop regulations that implement the agreements. In addition to regulations to enforce the agreements, there is strong incentive to comply with the management agreements since they are developed co-operatively between the government and the resource users who directly benefit from the commitment to long-term maintenance of the population. The interest and willingness of members of the community to conform their activities to observe the law, reinforces other law enforcement measures. Regulations specify who can hunt; season timing and length; age and sex classes that can be hunted; and the total allowable harvest for a given population in Polar Bear Management Areas. The Department of Renewable Resources (DRR) has officers to enforce the regulations in most communities of the NWT. The officers investigate and prosecute incidents of violation of regulations, kills in defense of life, or exceeding a quota (FWS 1997 FR Doc. 97–3954).

Inuit-Inuvialuit Agreement for the Management of Polar Bears of the Northern Beaufort Sea and Viscount Melville Sound

c. Russia

Polar bears are listed in the second issue of the Red Data Book of the Russian Federation (2001). The Red Data Book establishes official policy for protection and restoration of rare and endangered species in Russia. Polar bear populations inhabiting the Barents Sea and part of the Kara Sea (Barents-Kara population) are designated as Category IV (uncertain status); polar bears in the eastern Kara Sea, Laptev Sea and the western East-Siberian Sea (Laptev population) are listed as Category III (rare); and polar bears inhabiting the eastern part of the East-Siberian Sea, Chukchi Sea, and the northern portion of the Bering Sea (Chukchi population) are listed as Category V (restoring). The main government body responsible for management of species listed in the Red Data Book is the Department of Environment Protection and Ecological Safety in

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This is way too much detail on a subject that is somewhat relevant but not crucial to the assessment.

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Telemetry research on polar bears in the 1980s suggested that Alaskan and Canadian polar bear hunters were harvesting from the same southern Beaufort Sea population that ranged between between Icy Cape in Alaska and Pearce Point, to the east of Paulatuk in Canada (Amstrup, 1986; Stirling et al., 1988). Because harvests in Canada and Alaska were being managed differently and independently, recognition that the population was shared raised conservation concerns by the users and managers from each jurisdiction.¶
¶
The Inuvialuit and the Inupiat recognized the shared responsibility for conservation and need to coordinate harvest practices (Stirling, 1988, Treseder and Carpenter, 1989; Nageak et al., 1991). The user group management agreement for polar bears of the southern Beaufort Sea was signed in Inuvik, NWT in January 1988, following two years of technical discussions and community consultations¶
¶
Provisions of the Agreement included: annual quotas (which may include problem kills), hunting seasons; protection of bears in or constructing dens and of females accompanied by cubs and yearlings; collection of specimens from killed bears to facilitate monitoring of the sex and age composition of the harvest; agreement to meet annually to exchange information on research and management, to set priorities, and to agree on quotas for the coming year; and, prohibition of hunting with aircraft or large motorized vessels and of trade in products taken in violation of the Agreement. To facilitate implementation, a Joint Commission was forme ... [361]

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Ministry of Natural Resources of the Russian Federation. Russia regional Committees of Natural Resources are responsible for managing polar bear populations consistent with federal legislation (Belikov et al., 2002).

Ppolar bear hunting has been totally prohibited in the Russian Arctic since 1956 (Belikov et al. 2002). The only permitted take of polar bears is catching cubs for public zoos and circuses. CITES Appendix II regulations are followed for polar bear. There are no data on illegal trade of polar bears, and parts and products derived from them, although considerable concern persists for unquantified levels of illegal harvest that is occurring In the Russian Arctic, Natural Protected Areas (NPAs) have been established that protect marine and associated terrestrial ecosystems including polar bear habitats. In the Russian Arctic, Wrangel and Herald Islands have special conservation status as places with high concentrations of maternity dens and/or polar bears. Wrangel and Herald Islands were included in the Wrangel Island State Nature Reserve in 1976. Also a decree of the Russian Federation Government established a 12-nm marine zone adjacent to Wrangel Island State Nature Reserve, and a decree of the Governor of Chukotsk Autonomous Okruga expanded the protected buffer to 24-nm. Ththe Franz Josef Land State Nature Refuge was established in 1994. Special protected areas are proposed in the Russian High Arctic: the Novosibirsk Islands, Severnaya Zemlya, and Novaya Zemlya. Within these protected areas, conservation and restoration of terrestrial and marine ecosystems, and plant and animal species (including the polar bear), are the main goals. In 2001 the Nenetskiy State Reserve was established. In May 2001 the federal law "Concerning territories of traditional use of nature by small indigenous peoples of North, Siberia, and Far East of the Russian Federation" was passed. This law established areas for traditional use of nature (TTUN) within NPAs of federal, regional, and local levels to support traditional life styles and traditional subsistence use of nature resources for indigenous peoples. This law and the Law "Concerning natural protected territories" (1995) regulate protection of plants and animals on the TTUNs. The latter also regulates organization, protection and use of other types of NPAs: State Nature Reserves (including Biosphere Reserves), National Parks, Natural Parks, and State Nature Refuges. Special measures on protection of polar bears or other resources may be governed by specific regulations of certain NPAs. Outside NPAs protection and use of marine renewable natural

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resources are regulated by federal legislation, Acts of the President of the Russian Federation, regulations of State Duma, Government, and Federal Senate of the Russian Federation, and through regulations issued by appropriate governmental departments. The most important federal laws for nature protection are: "About environment protection" (1991), "About animal world" (1995), "About continental shelf of the Russian Federation" (1995), "About exclusive economical zone of the Russian Federation" (1998), and "About internal sea waters, territorial sea, and adjacent zone of the Russian Federation" (1998).

d. Norway

According to the Spitsbergen Treaty of 1920, Norway exercises full and unlimited sovereignty over the Svalbard area. However, citizens of the countries contracting to the Treaty have the same rights as Norwegians to hunt and fish in the area and to conduct maritime, industrial, mining, and commercial operations, provided they observe the local laws and regulations. The main responsibility for the administration of Svalbard lies with the Norwegian Ministry of Justice. Norwegian civil and penal laws and various other regulations are applicable to Svalbard as well. The Ministry of Environment deals with matters concerning the environment and nature conservation. The highest local authority in Svalbard is the Governor (Sysselmannen) who exercises jurisdictional, police, and administrative authority (Derocher et al. 1998).

After the signing of the Agreement, polar bear hunting was forbidden in Norway. The management of polar bears on Svalbard is regulated by Royal Decree, "Regulations concerning the management of game and freshwater fishes on Svalbard and Jan Mayen," enacted in 1978 (Derocher et al. 1998).

65 Environmental regulations based on the Svalbard Treaty initially claimed jurisdiction out 4 nautical miles. Marine protection was increased in 2004 when the territorial border of the existing protected areas was increased to 12 nautical miles (Aars et al 2006). Norway claims control of waters out to 200 nautical miles (Derocher et al. 1998 and regard polar bear as protected within this area.).

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In 2001 the Norwegian Parliament passed a new Environmental Act for Svalbard which went into effect in July 2002. The Act was designed to ensure that wildlife is protected, with exceptions made for hunting. The regulations included specific provisions on harvesting, motorized traffic, remote camps and camping, mandatory leashing of dogs, environmental pollutants and on environmental impact assessments in connection with planning development or activities in or near settlements. Some of these regulations were specific to the protection of polar bears e.g. through enforcing temporal and spatial restrictions on motorized traffic and through giving provisions on how and where to camp, and to ensure adequate security concerning polar bears in the area (Aars et al., 2006).

In 2003 Svalbard designated six new protected areas: two nature reserves, three national parks and one "biotope protection area". The new protected areas are mostly located around Isfjord, the most populated fjord on the west side of the archipelago. Another protected area, Hopen, has special importance for denning bears and is the most important denning area on Svalbard (Aars et al. 2006).

Protected areas of Svalbard cover 44490 km^2, which is 65 percent of the total land area (Aars et al., 2006), and include all major polar bear denning areas.

e. Denmark/Greenland

Under terms of the Greenland Home Rule (1979) the government of Greenland is responsible for management of all renewable resources including polar bears. Greenland is also responsible for providing scientific data for sound management of polar bear populations and for compliance with terms of the 1973 Agreement on the Conservation of Polar Bears. Hunting and reporting regulations as well as development of coordinated allocations for shared polar bear populations have evolved in recent years. A large amount of habitat is classified within the National Park in North and in East Greenland. Disturbance of denning bears is prohibited (Wiig et al., 1995).

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E. Other natural or manmade factors affecting the continued existence: contaminants, development, human interactions

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1. Contaminants

Understanding the potential effects of contaminants on polar bears is confounded by the wide range of contaminants present, each with different chemical properties and biological effects, and the differing geographic, temporal, and ecological exposure regimes impacting each of the 19 polar bear populations. Further, contaminant concentrations differ with age, sex, reproductive status, and other factors. Contaminant sources and transport, geographical, temporal patterns and trends, and biological effects are detailed in several recent publications (AMAP 1998, 2004a, b). Three main groups of contaminants in the Arctic are thought to present the greatest potential threat to polar bears and other marine mammals: petroleum hydrocarbons, nonPersistent Organic Pollutants (POPSs), and metals.

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a. Petroleum Hydrocarbons

The alalprinciple petroleum hydrocarbons include crude oil, refined oil products, polynuclear aromatic hydrocarbons (PAHs), and natural gas and condensates (AMAP 1998). Petroleum hydrocarbons come from both natural and anthropogenic sources. The primary natural source is oil seeps; anthropogenic sources include activities associated with exploration, development, and production (well blow outs, operational discharges); ship and land based transportation (oil spills from pipelines, accidents, leaks, and ballast washings); discharges from refineries and municipal waste water; and combustion of wood and fossil fuels. In addition to direct contamination, petroleum hydrocarbons are transported from more southerly areas to the Arctic via long range atmospheric and oceanic transport, as well as by north-flowing rivers (AMAP 1998).

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The most direct exposure of polar bears to petroleum hydrocarbons comes from direct contact with and ingestion of oil from acute and chronic oil spills. Polar bear range overlaps with many active and planned oil and gas operations within 25 miles of the coast or offshore. To date, no major oil spills have occurred in the marine environment within the range of polar bears. However spills associated with terrestrial pipelines have occurred in the vicinity of polar bear habitat and denning areas (e.g. Russia, Komi Republic, 1994 oil spill, http://www.american.edu/ted/KOMI.HTM). Despite numerous safeguards to prevent spills, smaller spills do occur. Minerals Management Service (2004 p. 10, 127) estimated an 11% chance of a marine spill greater than 1000 barrels in the Beaufort Sea from the Beaufort Sea Multiple Lease Sale in Alaska. An average of 70 oil and 234 waste product spills per year occurred between 1977 and 1999 in the North Slope oil fields (Federal Register, 71:14456). The largest oil spill (estimated volume of approximately 201,000 gallons) from the North Slope Oil fields in Alaska to date occurred on land in March 2006, resulting from an undetected leak in a corroded pipeline. Similar situations are possible from underwater pipelines. Spills during the fall or spring during the formation or breakup of ice present a greater risk because of difficulties associated with clean up during these periods and the presence of bears in the prime feeding areas over the continental shelf. Amstrup et al. (2000) concluded that the release of oil trapped under the ice from an underwater spill during the winter could be catastrophic during spring break-up. During the autumn freeze-up and spring break-up periods it is expected that any spilled oil in the marine environment would concentrate and accumulate in open leads and polynyas, areas of high activity for both polar bears and seals (Neff 1990 p. 23), resulting in oiling of both polar bears and seals (Neff 1990 p. 23-24.; Amstrup et al. 2000 p. 3; Amstrup et al. 2006 p. 9). Increases in Arctic oil and gas development coupled with increases in shipping and/or development of offshore and land-based pipelines increase the potential for an oil spill to negatively affect polar bears and/or their habitat. Any future declines in the Arctic sea ice may result in increased tanker traffic in high bear use areas (Frantzen and Bambalyak 2003).

Geographic and temporal trends in major active or planned oil and gas development in polar bear habitats

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I think this study give numbers, and it would be better to use those than just say could be catastrophic.

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don't need page numbers here and elsewhere.

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So how does this connect to oiling of PBs? Do you expect tanker spills, ballast discharge, more wells to be developed with spills happening, or what?

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What is given here is way too brief to be of any value. Nothing is said about "temporal trends" and there is very little about geographic extent. Maps showing current and projected development areas in relation to polar bear distribution and population boundaries should be included.

United States

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You should look at the 2003 NRC report "Cumulative effects of oil and gas activities on Alaska's North Slope." It talks about historic, current, and projected activities on the slope.

The most extensive active oil and gas activities in the Arctic occur on Alaska's North Slope and in the adjacent Beaufort Sea. The footprint of oil and gas operations since initial development at Prudhoe Bay in the late 1970s has expanded both to the east and west. Exploration is underway in the National Petroleum Reserve, and seismic operations began in 2006 in the Chukchi Sea.

Canada

Devon Canada Corporation has begun petroleum exploration activities in the shallow areas of the Canadian portion of the Beaufort Sea. The proposed Mackenzie Delta Gas Pipeline has heightened interest in gas field development in the Mackenzie Delta and in parts of the Tuktoyaktuk Peninsula (Devon Corporation 2004).

Greenland

Greenland opened four areas off its west coast, the Lady Franklin Basin, Kangaamiut Basin, Ikermiut Ridge, and Paamiut Basin, for oil and gas exploration and development in 2004 (GBMP 2005).

Norway

The southern part of the Barents Sea has been open to oil and gas activities since 1989. In May 1997, Norway awarded production licenses for seven areas in the Southern Barents Sea (Larstad and Gooderham 2004). The Snøhvit gas field is the first large field scheduled to go into production in this area. Several smaller scale oil and gas developments are planned in the ice free portion of the Barents Sea. Oil and gas operations in the northern part of the Barents Sea are prohibited.

Russia

Russia has plans for development of a pipeline from the Russian oil fields to Murmansk for shipment to the United States by tanker through the Barents Sea (WWF 2003). Additional oil field development is planned in the southeastern Barents Sea and on the Yamal Peninsula (Belikov et al. 2002 p. 87).

Comment: Page: 155
This pretty much duplicates something that is covered in E.2.b!!!!!!!!!

Biological Effects of Petroleum Hydrocarbons

Little information exists on the biological effects of oil on polar bears. Polar bears are most likely to come in contact with oil either directly at preferred feeding areas or through ingesting contaminated prey (Neff 1990 p. 24). Polar bears groom themselves regularly as a means to maintain the insulating properties of their fur, so oil ingestion would likely be by this means (Neff 1990 p. 23). Most direct information comes from an experimental study (St. Aubin 1990) in which two polar bears were involuntarily forced into a pool of oil for 15 minutes and then observed. The animals immediately attempted to clean the oil from their paws and forelegs by licking, and continued grooming trying to clean their fur for five days. After 26 days one bear died of liver and kidney failure and the other bear was euthanized at day 29. Gastrointestinal fungus-containing ulcers, degenerated kidney tubules, low-grade liver lesions, and depressed lymphoid activity were found during necropsy. Other effects included loss of hair (Derocher and Stirling 1991), anemia, anorexia, and stress (St. Aubin 1990). (The fact that oil spills are bad for polar bears should now be well established, so that no further such studies should be permitted.) The results of an earlier study on thermoregulation (Oritsland et al. 1981 in St Aubin 1990), as well as this study, suggest that polar bears are particularly vulnerable to oil spills due to inability to thermo-regulate and to poisoning due to ingestion of oil from grooming and/or eating contaminated prey (St. Aubin 1990). Additionally, polar bears are curious and are likely to investigate oil spills and oil contaminated wildlife. Although it is not known whether healthy polar bears in their natural environment would avoid oil spills and contaminated seals, bears that are hungry are likely to scavenge contaminated seals, as they have shown no aversion to eating and ingesting oil (St Aubin 1990, Derocher and Stirling 1991).

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You should be looking directly at the Oritsland study!

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What about impacts on their food supply, e.g., seals. See the NRC report or other literature on oiling of seals.

Industrial development in polar bear habitat may also expose individuals to hazardous substances through improper storage or spills. For example, one polar bear died in Alaska from consuming ethylene glycol in 1988 (Amstrup et al 1989 p. 317).

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Impact on the population is a function of response of the animals and likelihood of exposure. Where are you going to discuss the impact projections from Amstrup et al. (2000)? E.g., see page 105 of the NRC report above.

b. Persistent Organic Pollutants (POPS)

C of Arctic and sub-Arctic regionscontamination through long-range transport of pollutants has been recognized for over 30 years (Bowes and Jonkel 1975, deMarche et al. 1998, Proshutinsky and Johnson 2001, MacDonald et al. 2003, Lie et al. 2003). These compounds are transported via large rivers, air, and ocean currents from the major industrial and agricultural centers located at more southerly latitudes (Barrie et al. 1992, Li et al. 1998, Proshutinsky and Johnson 2001, Lie et al. 2003). The presence and persistence of these contaminants within the Arctic is dependent on many factors, including transport routes, distance from source, and the quantity and chemical composition of the contaminants released to the environment. The Arctic ecosystem is particularly sensitive to environmental contamination due to the slow rate of breakdown of persistent organic pollutants (POPs), including organochlorine compounds, relatively simple food chains, and the presence of long-lived organisms with low rates of reproduction and high lipid levels. The persistence and lipophilicity of organochlorines increase the potential for bioaccumulation and biomagnification at higher trophic levels (Fisk et al. 2001). Polar bears are ideally suited for monitoring environmental contaminants because of their position at the top of the food chain, wide circumpolar distribution, and ability to accumulate a wide range of persistent contaminants. Organochlorine metabolites, particularly MeSO2-PCB and HO-PCB, which have potential endocrine disrupting properties, are an example of biotransformation of OCs in polar bears (Letcher et al. 1998). Adipose tissue and/or blood samples from most of the polar bear populations in the Arctic have been sampled at least once for the main groups of persistent organic pollutants described below.

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They are called persistent because berakdown is slow, everywhere. Is it that much slower in the Arctic?

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A new word to me. You could say "lipophilic nature".

The most studied POPS in polar bears include polychlorinated biphenyls (PCBs), chlordanes (CHL), DDT and its metabolites, toxaphene, dieldrin, hexachloroabenzene (HCB), hexachlorocyclohexanes (HCHs), and chlorobenzenes (ClBz). Overall, the relative proportion of the more recalcitrant compounds, such as PCB 153 and β-HCH, appears to be increasing in polar bears (Braune et al. 2005 p. 50). Although temporal trend information is lacking, newer compounds, such as polybrominated diphenyl ethers (PBDEs), polychlorinated naphthalenes (PCNs), perflouro-octane sulfonate (PFOS), perfluoroalkyl acids (PFAs), and perflourocarboxylic acids (PFCAs) have been recently found in polar bears. Of this relatively new suite of compounds, there is concern that both PFOS, whichPBDE concentrations are increasing rapidly, and PBDEs are a potential risk to polar bears (deWit 2002, Martin et al. 2004, Braune et al. 2005, Smithwick et al. 2006 Currently the polychlorinated dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs) and dioxin-like PCBs are at relatively low concentrations in polar bears (Letcher et al. 1996).

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Geographic and temporal trends in Persistent Organic Pollutants in polar bears and their habitats

PCBs

The highest Σ PCB concentrations have been found in polar bears from the Russian Arctic (Franz Joseph Land and the Kara Sea), with decreasing concentrations to the east and west (Anderson et al. 2001). Throughout the Arctic the highest concentrations of ΣPCBs in descending order by regionpopulations are Franz Josef Land > Kara Sea > Svalbard ≥East Greenland > North Baffin Island > South Baffin Island > Western Hudson Bay ≥Amundson Gulf ≥Foxe Basin/Gulf of Boothia > Beaufort Sea > Siberian Sea >Chukchi Sea (Norstrom et al. 1998, Muir and Norstrom 2000, cAnderson et al. 2001, Lie et al. 2003, Verreault et al. 2005, Braune et al 2005). In a comparison of polar bear adipose tissues from Alaska, Canada, East Greenland, and Svalbard, Norway from 1996 to 2002, East Greenland and Svalbard populations had the highest concentrations of the more persistent PCB congeners (hepta- to nona-chlorinated) whereas Alaska had the highest proportion of the lower chlorinated PCB congeners (tri- to penta-chlorinated) (Verreault et al. 2005). Andersen et al. (2001), in a comparison of PCB congeners in blood samples from Svalbard, Franz Joseph Land, Kara Sea, Siberian Sea, and Chukchi Sea

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the list that follows does not correspond well with the identified populations.

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(1987-1995), found that the higher chlorinated PCBs decreased from Svalbard east to the Chukchi Sea.

Assessment of temporal trends requires long-term data sets which are available for only a few populations. Direct temporal comparisons between populations or within a population often cannot be made, as contaminant concentrations are influenced by factors such as sex ratio, age composition, nutritional and reproductive status, feeding habits, analytical techniques, congeners analyzed, tissues sampled, and statistical analyses used (AMAP 1998, Muir et al. 1999).

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Braune et al. (2005a) presents a detailed summary of temporal changes in PCBs and chlorinated pesticides for Canadian ringed seal and polar bear populations. The Western Hudson Bay population has been studied since the late 1960s and thus has one of the most complete temporal data sets that can be used to assess temporal changes in organochlorine (OC) concentrations. Although Verreault et al. (2005) reported a 32 % decline in ΣPCBs in adipose tissue from adult females from Western Hudson Bay between the periods 1989-1993 and 1996-2002, Braune et al. (2005) indicated that no long-term trend was evident as the concentrations of ΣPCBs in the 1990s were similar to those of the late 1960s. rNorstom et al. (2000) observed a significant decrease in the ΣPCBs in Western Hudson Bay in the 1990s. The composition of congeners that make up the ΣPCBs in Western Hudson Bay changed from 1968 to 2002, with a decrease in the number of highly chlorinated congeners and an increase in the less chlorinated congeners (Braune et al. 2005a p. 40). Recent trends indicate an average decline of 42% of ΣPCBs from the time periods 1989-1996 (Norstrom et al. 1998) and 1996-2002 (Verreault et al. 2005) for the Alaska populations (Southern Beaufort Sea and the Chukchi Sea combined), Amundsen Gulf, Western Hudson Bay, Foxe Basin/Gulf of Boothia, Lancaster Sound, North Baffin Island, and South Baffin Island (Verreault et al. 2005 p. 380). A comparison of ΣPCBs concentrations between the same time periods indicated a decrease of 50% and 75% in Svalbard and East Greenland (Verreault et al. 2005). Although Derocher et al. (2003) found that ΣPCBs concentrations in blood plasma from polar bears in Svalbard, Norway increased from 1967 to 1993-1994, other studies have found declining ΣPCBs concentrations in both Svalbard (Henriksen et al. 2001) and East Greenland (Dietz et al (2004). Peak Svalbard PCB

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concentrations probably occurred between the mid-1970s to the mid-1980s and may have been quite high (≈100 ppm) based on backward extrapolation from the steep decline in the early 1990s (Henriksen et al. 2001). Overall there is evidence for recent declines in ΣPCBs for most populations.

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Other Chlorinated Hydrocarbon Contaminants

The pattern of distribution of most other chlorinated hydrocarbons and metabolites generally follows that of ΣPCBs, with the highest concentrations of DDT-related compounds and ΣCHL in Franz Joseph Land and the Kara Sea, followed by East Greenland, Svalbard, the eastern Canadian Arctic populations, the western Canadian populations, the Siberian Sea, and finally the lowest concentrations in Alaska populations (Bernhoft et al. 1997, Norstrom et al. 1998, Andersen et al. 2001, Kucklick et al. 2002, Lie et al. 2003, Verreault et al. 2005, Braune et al. 2005). In a comparison of chlorinated hydrocarbon contaminants and metabolites in polar bears from Alaska, Canada, East Greenland, and Svalbard, Norway from 1996 to 2002, ΣCHL concentrations were fairly uniformly distributed throughout the Arctic, with the lowest concentrations occurring in Alaska (Verreault et al. 2005). In contrast to the pattern exhibited by most other OCs, Alaska had the highest concentrations of ΣHCH and pentachlorobenzene (PnClBz), with polar bears from Alaska showing a six fold increase in ΣHCH concentrations relative to Svalbard after adjusting for age (Verreault et al. 2005).

Decreases in ΣHCH in polar bear adipose tissue were noted between 1990 and 2000-2001 in East Greenland (Dietz et al. 2004) and in Svalbard from 1991-1996 (AMAP, 2004). In the Canadian Arctic, ΣHCH declined significantly between 1984 and the 1990s (Braune et al. 2005) and has remained relatively constant for the last decade (Norstrom 2000). From 1968 to the 1990s, the proportion of β-HCH making up the ΣHCHs increased significantly for most populations, whereas the proportion of α-HCH decreased. The prevalence of the β-HCH isomer in polar bears is in contrast to ringed seals, a primary prey item, where α-HCH is the most common isomer (Kucklick et al. 2002). Suspected sources for the high concentrations of β-HCH in Alaska are China and Southeast Asia (Li et al. 1998).

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ΣCHL concentrations have been shown to vary with sex (Muir et al. 1999), age (Dietz et al. 2004), and season (Polischuk et al. 2003, Deitz et al 2004). Concentrations of ΣCHL increased between 1968 and 1984 (Norstrom 1998) and appeared to decline in most populations from 1989-2002, except for Western Hudson Bay where they remained relatively unchanged (Verreault et al. 2005). HCB concentrations also have shown a similar decline (Braune et al. 2005).

ΣDDT concentrations in adipose tissues declined in most Arctic polar bear populations since the active DDT period in the 1970s (Norstrom 2001, Fisk et al. 2003, Dietz et al. 2004, DeWit et al 2004, Verreault et al. 2005, Braune et al. 2005). A comparison of mean p,p'-DDE concentrations from female polar bears during 1989-1993 with samples from 1996-2002 indicated a continued decline in most populations except for Amundsen Gulf and East Greenland populations (Verreault et al. 2005), where p,p'-DDE concentrations remained relatively unchanged. In a similar study, Dietz et al. (2004 p. 107) found that ΣDDT and p,p'-DDE concentrations declined 66% in East Greenland from 1990 to 1999-2000. The BMF for DDE from seals is relatively low, indicating that polar bears can metabolize this compound rather quickly. Although the proportion of DDE with respect to ΣDDT may be increasing, DDE concentrations are generally low compared to other POPs and thus not currently an important POP in polar bears.

aPolybromianted Diphenyl Ethers

deaPolybromianted Diphenyl Ethers (PBDEs) share similar physical-chemical properties with PCBs (Wania and Dugani 2003), and are thought to be transported to the Arctic by similar pathways. Muir et al. (2006) analyzed archived samples (Dietz et al 2004, Verreault et al. 2005) for PBDE concentrations, finding the highest mean ΣPBDE concentrations in female polar bear adipose tissue from East Greenland and Svalbard. Lower concentrations of PBDE were found in adipose tissue from the Canadian and Alaskan populations (Kannan et al 2005, Muir et al. 2006). Overall, ΣPBDEs concentrations are much lower and less of a concern compared to PCBs, oxychlordane, and some of the more recently discovered perfluorinated compounds. Of the four alprinciple PBDE congeners (PBDE 47, 99, 100, and 153), PBDE 47 was the major congener

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Overall, the relative proportion of the more recalcitrant compounds, such as PCB 153, DDE, and β-HCH, appears to be increasing (Braune et al. 2005

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(65-82%) found in polar bears (Ikonomou 2002, Muir et al. 2006). Ikonomou (2002) found that PBDE 47 concentrations were higher in polar bears than ringed seals from the Amundsen Gulf region in western Canada. Samples from the Canadian Arctic populations had higher proportions of PBDE 99, 100, and 153 than the other populations (Muir et al. 2006).

Although Ikonomou (2002) found that ΣPBDEs increased exponentially in ringed seals from the Amundsen Gulf between 1981 and 2000, but more recent data from 2000 to 2003 suggest that ΣPBDE concentrations may be leveling off or declining in this area (Ikonomou 2005). The annual production of PBDEs increased in the 1990s from the 4.0 kt in 1990 (Arias 1992). Use of PBDEs in 1999 was estimated to be 8.5 kt, of which >90% was in North America (AMAP 2004b p. 16). By 2000, the global use of PBDEs was considerably less in Europe compared to 1990 due to restrictions put in place in different countries beginning in 2001 (BSEF 2000).

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Perfluorooctane Sulphonate

Perfluorooctane sulphonate (PFOS) levels were 10 times greater in polar bear livers from eastern Hudson Bay (Martin et al. 2004) than Alaska (Giesy and Kannan 2001, Kannan et al. 2001), which suggests that eastern Hudson Bay may be closer to dominant mid-latitude manufacturing and use centers, relative to Alaska. Although PFOS concentrations have not been determined for most polar bear populations, concentrations found in eastern Hudson Bay indicate that PFOS is the most abundant organohalogen compound found to date (Martin et al. 2004). Even within Alaska, PFOS concentrations in polar bear livers from the Chukchi Sea subpopulation were greater than other persistent organic pollutants analyzed, including PBDEs, PCBs, and other OC compounds (Kannan et al. 2005). Although high concentrations of PFOS in the livers may have toxic significance, PFOS concentrations are probably not a major contaminant of the whole body as are PCBs and oxychlordane. The distribution of PFOS in polar bear tissues is unknown, since liver is the only tissue in which PFOS concentrations have been measured. The best study to date on the distribution of PFOS in the whole body was done in trout (Martin et al. 2003). In that study, the highest PFOS concentrations were in the liver, kidney, and blood plasma and the lowest concentrations were in muscle and adipose tissue and thus were not uniformly distributed

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Assuming you know where the manufacturing and use is you should be able to just measure this and say it is or it isn't.

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throughout the body (Martin et al. 2003). The unique toxicological properties of PFOS, its environmental persistence and the increasing concentrations reported in polar bear livers from 1972 to 2002 by Smithwick et al. (2006) are of concern. Doubling times in the eastern (near Baffin Island, Canada) and western (Barrow, Alaska) Arctic populations were 3.6 years and 13.1 years, respectively (Smithwick et al. 2006), indicate that polar bear populations closer to source areas experience increased risk.

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Biological Effects of Persistent Organic Pollutants

Although baseline information on contaminant concentrations is available, determining the biological effects of these contaminants in polar bears is difficult. The synergistic effects of different contaminants (Payne et al. 2001), variations in bioaccumulation and biomagnification rates of different compounds through the food web, variation in the persistence and changes in chemical composition of compounds due to metabolism and abiotic degradation, and polar bear physiology (delayed implantation, lactation, fat metabolism, food habits, reproductive status, condition, age) are all factors to be considered in determining overall biological effects (Fisk et al. 2001, Fisk et al. 2005). PCBs have been linked directly to impaired reproduction in ringed seals (Addison 1980), but not polar bears, since controlled experiments have not been conducted. However, field observations of reproductive impairment in females, lower survival of cubs, and increased mortality of females in Svalbard, Norway (Wiig 1998, Wiig et al. 1998, Skaare et al. 2000, Haave et al. 2003, Oskam et al. 2003, Derocher et al. 2003) suggest that high concentrations of PCBs may have contributed to population level effects in the pastCurrently it is not thought that present PCB concentrations are having population level effects. Other effects linked to PCB exposure in polar bears include induction of hepatic P450 enzymes (Letcher et al. 1996), altered and impaired immune systems (Bernhoft et al. 2000, Skaare et al. 2001b, Larsen et al. 2002, Lie et al. 2004), and changes in endocrine system function (Braethen et al. 2000, Skaare et al. 2001a, Letcher et al. 2002, Haave et al. 2003, Oskam et al. 2003). Table X summarizes biological effects (AMAP 2004).

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Table 3-1. Overview of toxic properties of various POPs. ▼= suppression or decrease, ▲ = induction

	Reproductive/ developmental effects	*Neurotoxic effects*	*Cytochrome P450 effects*	*Immune effects*	*Thyroid/ retinol effects*
Aldrin and dieldrin	▼ Reproduction		Induces cyto-chrome P450 2B	Suppresses immune system	
Chlordanes	▼ Reproduction		Induces cyto-chrome P450 2B	Suppresses immune system	
DDT and metabolites	Egg-shell thinning in bird eggs. ▼ Reproduction		Induces cyto-chrome P450 2B	Suppresses immune system	▼ Thyroid weight
HCBz	Fetotoxic. Teratogenic. ▼ Reproduction		Induces cytochrome P450 1A and 2B	Suppresses immune system	▼ T3 and T4 ▲ TSH ▲ Thyroid weigh
α-HCH	No information		Induces cyto-chrome P450 2B		
β-HCH	Estrogenic		Induces cyto-chrome P450 2B	Suppresses immune system	▲ Thyroid weight
γ-HCH (lindane)	Estrogenic and antiestrogenic. ▼ Reproduction		Induces cyto-chrome P450 1A and 2B		
Mirex	▼ Reproduction		Induces cyto-chrome P450 2B	Suppresses immune system	
Toxaphenes	Fetotoxic. ▼ Reproduction		Induces cytochrome P450 1A, 2B and 3A	Suppresses immune system	▲ Thyroid-weight ▲ TSH
Endosulfan	Fetotoxic. ▼ Reproduction		Induces cyto-chrome P450 1A and 2B	Suppresses immune system	
PCDD/Fs and nPCBs and meta-bolites	Fetotoxic. Deformities. ▼ Reproduction	Permanent changes in learning, behavior, memory (nPCB)	Induces cytochrome P450 1A	Thymic atrophy. Suppresses immune system	▼ T3 and T4 ▼ Vitamin A
Other PCBs	Fetotoxic. Deformities. ▼ Reproduction	Permanent changes in learning, behavior, memory. Decreased dopamine	Induces cytochrome P450 2B	Suppresses immune system	▼ T3 and T4 ▼ Vitamin A
SCCPs	Fetotoxic Deformities. ▼ Reproduction	▼ Motor perform-ance	Induces cytochrome P450 1A	No information	▼ T4 ▲ TSH
PCNs	Embryotoxic. ▼ Reproduction		Induces cyto-chrome P450 1A		
Octachloro-styrene and metabolites			Induces cytochrome P450 1A and 2B		Binds to TTR *in vitro*
PBDEs	Estrogenic and antiestrogenic	Permanent changes in learning, behavior, memory	Induces cytochrome P450 1A and 2B	Suppresses immune system	▼ T4 ▼ Vitamin A
PFOS/PFOA	▼ Reproduction				
TBT and metabolites	Imposex in invertebrates. Deformities. ▼ Reproduction		Inhibits liver cytochrome P450 1A, 2B, and 3A	Suppresses immune system	

Polar bears are able to biotransform OC contaminants, resulting in high concentrations of OC metabolites, some of which have demonstrated endocrine disrupting activity (Letcher et al. 2000, Braune et al. 2005). Braune et al. (2005 p. 23) concluded that the "effects of OC exposure in Arctic wildlife are greatest for this species" because of the high OC concentrations and the ability of polar bears to metabolize these compound to toxic metabolites. PCBs and hydroxylated (HO) PCBs have been shown to interfere with retinol (vitamin A) (Rolland 2000, Simms and Ross, 2000) and thyroid hormones (Brouwer et al. 1989, Braethen et al. 2004) which are important for the growth and development of mammals (Skaare et al. 2001). Specifically retinol is thought to be important in the growth and development of epithelial tissues and the immune system, (Skaare et al. 2001). The presence of 4-OH-HpCS, a metabolite of octochlorostyrene, is thought to be able to bind to transthyretin (TTR), a transport protein, thus affecting the transport of the thyroid hormone and circulating retinol concentrations (Sandau et al. 2000). Polar bears with higher ΣPCBs concentration had significantly lower retinol concentrations (Sandau 2000). In contrast, polar bears with higher concentrations of HO-PCBs (Letcher et al. 2005, Sandala et al. 2004, Sandau et al. 2000) had higher retinol concentrations. It is thought that the persistent PCBs have a greater effect of plasma retinol concentrations through retinol metabolism and storage in the liver than HO-PCBs which interfere with the transport of retinol via TTR (Fisk et al. 2005 p64). PCB metabolites have also been shown to disrupt the normal activity of thyroid and estrogen in endocrine system in laboratory animals (Letcher et al. 2000). High levels of PBDEs have been shown to affect thyroid function and have been associated with developmental toxicity in laboratory rats (de Wit 2002) and in polar bears from Svalbard (Braethen et al. 2004, Skaare et al. 2001). In contrast, concentrations of ΣPCBs, ΣCHLs, ΣDDTs, ΣHCHs, HCB, Dieldrin, and ΣPBDEs found in polar bears from East Greenland were not thought to have adverse effects on lymph nodes, spleen, thyroid and thymus tissues which are involved in immunological responses (Kirkegaard et al. 2005 p. 130). The presence of higher secondary follicle counts in response to higher concentrations of ΣCHLs ΣHCHs HCB, and dieldrin may indicate increased infection rates in the spleens from East Greenland polar bears. High

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concentrations of ΣPCBs, ΣCHLs, ΣDDTs, and dieldrin are suspected to reduce the bone mineral density in subadult male and female polar bears and adult males (Sonne et al. 2004 p1715).

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Reproduction

Numerous laboratory studies have linked PCBs and OC pesticides, including PCDDs, PCDFs, PCBs, SCCPs, PCNs, OCs, PBDEs, and PFOS to reproductive and developmental toxicity (de Wit et al. 2004). However, more study is needed to fully understand the biological effects of contaminants on polar bear recruitment and survival rates. cPolishcuk et al. (1995, 2002) found that adult female polar bears with cubs had significantly lower concentrations of ΣPCBs, ΣDDTs, ΣCHLs, ΣHCHs, ΣClBzs than females that had lost their cubs by the following fall. The loss of these contaminants from the females that retained their cubs was not due to offloading the contaminants to the cubs through nursing because the contaminants were measured in milk as the females emerged from the den when all females still had their cubs. Polischuk et al. (2002) found that concentrations of ΣPCBs and ΣCHLs in milk approximately doubled when polar bears were sutilizing their fat resources (i.e., fasting), thus increasing the exposure of nursing cubs to high concentrations of OCs during a critical developmental period. The data from Polischuk et al. 1995, suggests that the critical point for cub survival may be between 1-6 ppm in the breast milk. However this may also be due to the low fat content in the female which in turn may result in higher PCB concentrations. However, if there is a toxic link between PCB concentrations and cub survival this would explain the lower cub survival and a scarcity of older females (≥16 yrs) in the Svalbard population (Wiig et al. 1998, Derocher et al. 2003). Adult female polar bears with higher PCB concentrations from Svalbard, Norway exhibited higher progesterone concentrations (Haave et al. 2003). Haave et al. (2003) speculated that high levels of progesterone could inhibit secretion of follicle-stimulating hormone, thus preventing normal ovulation from occurring.

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Immune System

An assessment of the effects of high concentrations of OCs on the immune system of free ranging polar bears in Svalbard, Norway, and Churchill, Canada, found that bears with high concentrations of ΣPCBs, sum of organochlorine pesticides (ΣOCPs), or the interaction of the ΣPCBs and ΣOCPs had decreased ability to produce antibodies to influenza-, reo- and herpes viruses, tetanus toxoid, and *Mannheimia sp*. (Lie et al. 2004). Lie et al. 5(2004) also found that high ΣPCBs and ΣOCPs concentrations reduced the ability of lymphocyte populations to proliferate after stimulation with mitogens and antigens in vitro. Thus polar bears with high concentrations of ΣPCBs and ΣOCPs may to be more susceptible to infections than polar bears with lower contaminant concentrations. The importance of immune competence is something that would only be tested during an epizootic event.

c. Metals

Numerous essential and non-essential elements have been reported on for polar bears, but the focus has been primarily on the most toxic and/or abundant elements in marine mammals, including mercury, cadmium, selenium, and lead. Increased development in the Arctic, release from natural deposits, and long-range transport of metals to the Arctic and sub-Arctic have raised concern about in the potential effects on polar bears and other marine mammals (Norstrom et al. 1986, Braune et al. 1991, Pacyna and Keeler 1995, Pacyna 1996, Dietz et al. 1998, Lindberg et al. 2002, and Braune et al. 2005a). Although other elements are of potential concern, the focus of this section will be on mercury, because of its potential toxicity at relatively low concentrations, ability to biomagnify and bioaccumulate in the food web, and 7-11 fold increases in the Arctic since pre-industrial times (Braune et al. 2005b, Nilsson and Huntington 2002, Dietz et al., 2006). Mercury is a non-essential element that arises from both natural and anthropogenic sources (Dietz et al. 1998, Lindberg et al. 2002, Skov et al. 2004). Dietz et al. 1998 estimated that 200-300 tons of mercury are transported to the Arctic annually through long-range atmospheric, oceanic, and riverine import. The primary source of mercury in polar bears is from their diet of phocid seals. Although mercury concentrations generally decrease in the order of liver > kidney > muscle in most marine mammals, the highest observed concentrations occur in the kidney in polar bears, followed by liver and muscle tissue.

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Geographic and temporal trends in mercury concentrations in polar bears and their habitat

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Polar bears from the western Canadian Arctic and southwest Melville Island, Canada (Braune et al. 1991, Norstrom et al. 1986), and ringed seals from the western Canadian Arctic (Wagemann et al. 1996, Deitz et al. 1998, Dehn et al. 2005 p. 731, Riget et al. 2005 p. 312), have some of the highest known mercury concentrations. Wagemann et al. (1996) observed an increase in mercury from eastern to western Canadian ringed seal populations and attributed this pattern to a geologic gradient in natural mercury deposits.

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Assessment of temporal trends is limited by lack of long-term data sets, poor or limited geographical coverage, and datasets that use varying analytical methods, statistical analyses, and sampling protocols. Analysis of mercury concentrations in sediments, peat bogs, and ice (Braune et al. 2005), beluga teeth from the Mackenzie Delta (Outridge et al. 2002), and polar bear hair from Greenland (Wheatley and Wheatley 1988, Dietz et al. 2005) all indicate that mercury concentrations have increased from the pre-industrial era to the present. Despite reductions in mercury emissions in North America and Western Europe, global emissions may be increasing (Marcy et al. p. 137). Recent trends from short-term data sets are variable, with mercury levels declining (East Greenland, Dietz et al. 2006), remaining stable (European Arctic, Braune et. al. 2004), or increasing (Pond Inlet, Canada, Wagemann et al. 1996; East Greenland, Deitz et al. 2006).

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Biological effects of mercury

Although the contaminant concentrations of mercury found in marine mammals often exceed those found to cause effects in terrestrial mammals (Fisk et al. 2003 p. 107), most marine mammals appear to have evolved effective biochemical mechanisms to tolerate high concentrations of mercury. Prior to 1997, almost no information was available to assess the effects of mercury on marine mammals, including polar bears (Fisk et al. 2005). The biological effects of mercury are determined by the amount and type of exposure, overall health of the bear, and age (Derome et al. 2004). Methylmercury (organic mercury) is more toxic than inorganic mercury, and more readily accumulated. Thus the amount of methylmercury and the percentage of organic mercury to total mercury are important biological measures. Mercury poisoning in mammals is characterized by neurological impairment, compromised immune response, and damage to the central nervous system, liver, and kidney (WHO 1989, 1990, 1991). Consumption of as little as 4μg of mercury per kilogram of body weight in humans can elicit clinical signs of mercury poisoning (Clarkson 1987). Ffetuses and polar bear cubs may be particularly susceptible to methylmercury during development of the central nervous system (Dietz et al. 1998). Evidence of mercury poisoning is rare in marine mammals, but, Marine mammals with high concentrations of mercury often have high concentrations of selenium which combines with the mercury forming mercuric selenide in the liver (Derome et al. p. 123). The 1:1 molar ratio of mercury to selenium which is commonly found in marine mammal livers, including polar bear, and the lack of evidence of mercury toxicity suggest that polar bears are able to demethylate Hg, by forming Hg/Se complexes, and accumulate higher levels of mercury than their terrestrial counterparts without detrimental effects. Dietz et al. (1990) noted that sick marine mammals often have higher concentrations of methylmercury, suggesting that these animals may no longer be able to detoxify methylmercury. Hepatic mercury concentrations are well below those expected to cause biological effects in most polar bear populations (Derome et al. 2004 p.118). Only two polar bear populations have concentrations of mercury close to the biological threshold levels of 60μg ww reported for marine mammals (Law et al. 1996), the Viscount Melville (southwest Melville Sound), Canada and the Southern Beaufort Sea (eastern Beaufort Sea) (Dietz et al. 1998).

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d. Future Impacts from Contaminants

The highest concentrations of OCs have been found in species at the top of the marine food chains such as glaucous gulls which scavenge on marine mammals and polar bears which feed primarily on seals (Braune et al. 2005 p.49). Consistent patterns between OC and mercury contamination and trophic status have been documented in Arctic marine food webs (Braune et al. 2005 p. 49). Changes in the food web dynamics could further change availability and access to seals which in turn could result in polar bears becoming more nutritionally stressed and perhaps more susceptible to effects of contaminants. These types of impacts are likely to vary between polar bear populations, age and sex cohorts, habitat use patterns, and the ability of polar bears to adapt to changes in sea ice dynamics.

Data analyses suggest that the Arctic marine environment is warming at a relatively rapid rate (Serreze et al. 2000, Parkinson and Cavalieri 2002, Comiso 2002a, 2002b, 2003). Potential changes to contaminant pathways and contaminant concentrations as a result of global warming, which are presented in the AMAP report (McDonald et al. 2003), are discussed below.

Changes in circulation patterns of atmospheric and oceanic currents would result in changes to contaminant transport pathways. This could result in both increases and decreases of contaminant concentrations. Loss of sea ice will affect the deposition and volatilization of certain compounds, particularly POPs. Increased precipitation would increase deposition of airborne contaminants, particularly those associated with particulates. Warmer temperatures could influence microbial degradation rates and species composition, which could affect the release of some compounds such as HCH. In addition, cChanges in the climate and sea ice conditions due to warming could result in the release of contaminants trapped in the pack ice,Arctic, dincrease exposure to new contaminants, increased bear densitiesdensities on the remaining sea ice, and changes in habitat use, and an increase in energetic demands associated with locating food. All of these factors could reduce the overall health of the polar bear populations. Polar bears that become nutritionally stressed may become more susceptible to mercury poisoning and the effects of other contaminants, and presumably Eastern Greenland It has been documented that concentrations of PCBs and oxychlordane are inversely proportional to fat content of the western Russian Arctic,bear (Polischuk et al. 2002). Thus starvation will induce significantly higher

Deleted: Polar bears are not distributed evenly throughout the Arctic and concentrate in the most productive areas over the continental shelf and the inter-island archipelagos surrounding the Arctic basin (Derocher 2004). Although polar bears can den on the sea-ice, adult females from most populations den on land along the coastal area or on islands (Stishov 1991a, Stishov 1991b, Amstrup 2003). Polar bears are completely dependent on the sea ice to capture their primary prey, ringed and bearded seals which are also dependent on the sea ice for their survival. Polar bears tend to concentrate in areas between the shore-fast and multi-year ice or adjacent to recurring leads or polynyas.

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With the exception of the Svalbard polar bear population, contaminant concentrations in all tissues (Polischuk et al. 2002). Currently PFOS concentrations are group of POPs that are of the most concern because of their widespread use, potentially toxic effects at least in the livers, and the rapidly increasing concentrations found in Arctic marine mammals (Smithwick et al. 2006). Cmost populations are presently not thought to have population level effects. However, one or several factors acting independently or together, such as loss or degradation of the sea ice habitat, decreased prey availability and accessibility, and increased exposure to contaminants have the potential to lower the recruitment and survival rates which ultimately would have negative population level effects.

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Increases in Arctic oil and gas development and trans-Arctic shipping will increase the probability of an oil spill and release of contaminants. Melting of the permafrost could also affect pipelines in some parts of the Arctic. In addition, a large oil spill could have immediate population effects. The median number of bears affected by a hypothetical oil spill (5912 bbl – the largest spill thought probable from a pipeline spill) from the proposed Liberty offshore oil well, in the Beaufort Sea in Alaska, during the autumn freeze-up was less than 12 (range 0-61 bears). For the purposes of this "worst-case scenario" it was assumed that a polar bear would die if it contacted oil. However, iIt should be noted that oil is expected to persist and last many months to years in this cold environment, not just the 10 days following the spill which was the limit of the model's analytical power. Peterson et al. (2003), when evaluating the long-term effects of the Exxon Valdez oil spill in the sub-Arctic Prince William Sound, noted that persistence of toxic subsurface oil and chronic exposure through bioaccumulation, even at sub-lethal concentrations, can have long-term effects on wildlife.

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To determine whether polar bears will experience negative biological effects from exposure to environmental contaminant concentrations, additional research needs to be conducted to determine threshold values (including sublethal effects such as reduced resistance to disease, potential for endocrine disruption, and altered behavior) for all contaminants found in polar bear tissues. We also need a better understanding of how contaminant mixtures may affect polar bears, as contaminants are rarely found in isolation. Factors that need to be considered in a final assessment should include the biological effects of contaminant concentrations that exceed currently defined threshold levels, research to document the exposure to new organohalogen compounds of concern, and the effects of climate change on contaminant exposure and biological effects on polar bears.

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Final assessment of what? Are you referring to this status review? If so, you should be considering those factors now.

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research in not really a "factor" in this context

e. Status of regulatory actions pertaining to contaminants

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What follows is more about production and use than about regulatory actions. Also, regulatory actions would be more properly dealt with in section D.

The formation of the Arctic Environmental Protection Strategy (AEPS) in 1989, supported by Canada, Denmark/Greenland, Iceland, Norway, Sweden, Russia, and the United States, was one of the first international initiatives to address environmental protection of the Arctic (AEPS 1991a, Wilson 1998). Five programs, the Arctic Monitoring and Assessment Programme (AMAP), Conservation of Arctic Flora and Fauna (CAFF), Emergency Prevention, Preparedness and Response (EPPR), Protection of the Arctic Marine Environment (PAMI), and Sustainable Development and Utilization (SDU), were created under AEPS to implement this initiative. Since then there have been many international and national initiatives and agreements that recognize the need to prevent and reduce environmental impacts of contaminants to the Arctic (AEPS 1991b, see Wilson 1998 p.2-3 for list and brief summary of some of these initiatives and agreements). Some of the pollutants now regulated by international treaties include a suite of POPs, including PCBs, dioxins, furans, hexachlorobenzene, aldrin, chlordane, dieldrin, DDT, endrin, heptachlor, mirex, and toxaphene. Two of the more important agreements, which have been signed, but not ratified by all the countries that participate in AEPS, are the Convention of the Long-range Transboundary Air Pollution (LRTAP) and the Stockholm Convention on Persistent Organic Pollutants (AMAP 2002). The LRTAP convention seeks to reduce and control existing transboundary air pollution and new sources throughout the Arctic and mid-latitude regions. The Stockholm Convention on Persistent Organic Pollutants identified a suite of POPs to be banned or restricted (UNEP 2001). Although it is difficult to assess the success and implementation of individual agreements, the manufacture, use, and emissions of some of the pollutants found in the Arctic has been reduced.

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The Montreal Protocol set standards to reduce the production of CFCs and other ozone-depleting substances (Albritton et al. 2001). The greenhouse gases which cause depletion of the stratospheric ozone layer seem to be in decline after peaking in 1994 (Albritton et al. 2001). This overall decline is occurring even though some new greenhouse gases such as hydrochloroflurocarbons (HCFCs) and hydroflurocarbons (HFCs), which either were previously used or developed to replace the currently regulated CFCs, are increasing (Albritton et al. 2001).

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PCBs, which have been produced in the United States since 1929, decreased from a high of 38,630 metric tons in 1970 to 18,400 metric tons in 1971 (Chemical Engineering News 1971). Breivik et al. (2002) estimated the 86% of the use of PCBs occurred in the industrialized areas in the northern hemisphere (30° to 60° N). Within this area the United States, Japan, Italy, Germany, France, United Kingdom, and Spain contributed 68% of the global usage (Breivik et al. 2002). In the United States and Canada the use of PCBs is now restricted to closed systems that existed before the ban took effect in 1974 (Ramamoorthy and Ramamoorthy 1997 p. 131-132). Approximately 2000 capacitors (closed systems) out of an estimated 2.8 million in the United States rupture every year, spilling PCBs into the environment (Ramamoorthy and Ramamoorthy 1997 p. 131). Although Russia stopped production in 1992, a significant amount of PCBs are still being used and are being released annually to the environment (AMAP 2000). In Norway approximately 650 tons of PCBs out of 1500 tons of technical PCB are contained in products that are still in use (de Marche et al. 1998 p. 193). In Sweden, approximately 8000-10,000 tons PCBs were imported to be used in condensers and transformers. Open use of PCBs was banned in Sweden 1971 and closed sources in 1994 (de March et al. 1998 p. 193). In Sweden it is estimated that approximately 100-500 tons of PCBs used in sealants in pre-fabricated buildings prior to 1972, which are currently eroding (Hammar 1992 in De Marche et al. 1998 p. 193), 50-100 tons in existing insulated window glass, and 20-30 tons in floor paints (KEMI 1996a in De March et al. 1998 p. 193) occur in Sweden. Iceland banned PCBs in 1988 and sent all equipment containing PCBs abroad for destruction.

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Production of Technical HCH, which consists of α-, β-, γ- (the only insecticidally active isomer), and δ-HCH isomers, began in 1943; between 1948 and 1997 it is estimated that 10,000 million tons were used globally (Li et al. 1998a p 121). China was the largest producer of technical HCH from 1945-1983. Technical HCH was banned, which means the use was actually stopped, in Canada in 1971, the United States in 1976, China in 1983, and the Russian Federation in 1990 (Li et al. 1998b). In 1980, 95% of the global consumption of α-HCH occurred in India, China, and the Russian Federation. From 1980 to 1990 the estimated annual tonnage of α-HCH increased in India and the former Soviet Union and decreased dramatically in China (de March et al. 1998 p. 192). India banned technical HCH in 1990 for agricultural use but kept it for public health uses (De Wit et al p.12).

Lindane, which contains almost 100% γ-HCH, replaced technical HCH in the late 1970s and 1980s in the United States, Canada, and western Europe and in China in 1991 (De Wit et al 2004 p. 12) and was used as a crop pesticide and seed treatment by France, Canada, and the United States in the 1990s. By 1990 the use of lindane increased in India, the former Soviet Union, France, Canada, Nigeria, and Mexico and decreased in China, Italy, East Germany, and the United States (Li et al. 1997, de March et al. 1998 p. 192). Although lindane is still used worldwide, the global usage dropped significantly by 2000, compared to 1980, due primarily to restrictions and bans implemented by many countries (De Witt et al. p.12-13).

Production of DDT has decreased globally since 1980 in most countries. Based on information provided to the UNEP, at the Stockholm Convention, only India (the largest producer) and China currently produce DDT for fighting malaria and other insect-borne diseases (UNEP 2002).

Since 1992, the use of polychlorobornanes and polychlorinated camphenes (toxaphene), have been either banned or severely restricted worldwide. Current information from the Stockholm Convention suggests that production of toxaphene may have ceased globally (De Wit et al. 2004 p. 14). However toxaphene is still being released from agricultural soils in United States, Mexico, Central America, and the former Soviet Union (De Wit et al. 2004 p. 14).

The United States was the primary producer and user of technical grade chlordane, which consists of 120 compounds, and is used primarily as a soil insecticide and termiticide. Following the voluntary closure of the national and international plants of the sole U.S. manufacturer in 1997, Singapore and China have the only remaining chlordane production facilities (de Wit et al. 2004 p. 14).

Although production of dieldrin ceased in 1991, emissions from old stock piles which were donated to African countries in the 1980 and 1990s still continue (UNEP 2002). Dieldrin is used as a soil insecticide and in tropical countries for locust and disease vector control (De Wit et al. 2004 p. 14).

PBDEs have been used as flame retardants in North America and Europe, including polyurethane foams, since the 1970s (de Boer et al. 2000). Between 2001 and 2004 several European nations restricted the use and manufacture of PBDEs resulting in sharp decrease in global use in Europe by 1999 (BSEF 2000). Canada recently implemented a notice to list all PBDEs under CEPA (**Canadian Energy Pipeline Association). Although it is not yet a national policy, eight states, within the United States, have either passed or proposed legislation to ban penta-BDE and Octa-BDE. It is expected the global use of PBDEs will gradually decline in Canadian Arctic and United States although the large inventory of polyurethane foam may continue to be a source of PBDEs for some time to come.

Currently there is not enough information to assess the temporal trends of PAHs or PCDD/Fs, and PFOS, and PFOA in the Arctic. The PAHs that are the most abundant in the atmosphere are primarily from the burring of fossil fuels to produce electricity and heat, vehicle exhausts, forest fires, fertilizer production and production of ferrous and non-ferrous metals (de Wit et al. p. 16). The primary sources of PCDD/Fs include the burning of plastics and other materials that contain chlorines, exhaust from vehicles that burn leaded gasoline, pulp and paper mills, and metallurgical industries (de Wit et al. 2004 p. 15).

Overall the Arctic monitoring data suggests that the global circulation for most of the POPs is reaching equilibrium in the Arctic. The evidence for this comes from the lack of circumpolar variation in HCB, relatively uniform concentrations in chlordanes, and the narrowing of the differences between the PCB concentrations in polar bears the European and the Canadian Arctic. Many of the POPs in the Arctic, such as PCBs, DDT and DDE, and chlordanes, are declining or relatively flat.

Despite the regulatory steps taken to decrease the production or emissions of toxic chemicals, increases in hexachlorobenzene (HCB) and relatively new compounds such as PBDEs and PFOSs, are cause for concern. PBDEs, which may have impacts similar to already regulated chemicals such as PCBs, have increased in the last decade (AMAP 2002, IkonomouSmithwick et al. 2002, Muir 2006). PFCs remain the class of chemicals of most concern as we do not know how long it will take for voluntary phase-outs or bans to result in declines because of the widespread use of these compounds in consumer products. More information is needed on the specific biological effects of many of these contaminants on Arctic marine mammals in order to assess the potential impact on polar bears, and their primary prey, ringed and bearded seals.

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2. Oil and gas exploration, development and production

a. Overview

Each of the Parties to the Agreement on the Conservation of Polar Bears has developed detailed regulations pertaining to the extraction of oil and gas within their countries. The greatest level of oil and gas activity within polar bear habitat is currently occurring in the United States (Alaska). Exploration and production activities are also actively underway in Russia, Canada, Norway, and Denmark (Greenland) to varying degrees. In the U.S. all leasing and production activities are required to be consistent with the National Environmental Policy Act and a multitude of other regulatory acts guide exploration, development, and production.

The greatest concern for future oil and gas development is for those activities that occur in the marine environment due to the chances for oil spills to impacts habitats used by polar bears. Another area of concern is for activities that occur in areas suitable for polar bear denning.

NRC (2003) concluded the following regarding cumulative effects of oil and gas development on polar bears and seals in Alaska:

- Industrial activity in the marine waters of the Beaufort Sea has been limited and sporadic and likely has not caused serious cumulative effects to polar bears and ringed seals.
- Contact with spilled oil or other contaminants would harm polar bears and ringed seals and have major effects.
- Careful mitigation can help to reduce the effects of oil and gas development and their accumulation, especially if there is no major oil spill. However, the effects of full-scale industrial development of waters off the North Slope would accumulate through the displacement of polar bears and ringed seals from their habitats, increased mortality, and decreased reproductive success.
- Frequency of contacts between polar bears and people of development structures is a function of the amount of activity taking place in polar bear habitat.
- Climatic warming at predicted rates in the Beaufort Sea region are likely to have serious consequences to polar bears and ringed seals, and the effects will accumulate with the effects of oil and gas development
- Unless studies to address the potential accumulation of effects on North Slope polar bears or ringed seals are designed, funded, and conducted over long periods of time, it will be impossible to verify whether such effects occur, to measure them, or to explain their causes.

Historically oil and gas activities have resulted in little direct mortality to polar bears.
Future oil and gas activities are increasing as development continues to expand throughout the United States Arctic and internationally. Oil and gas exploration and development occur within

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Comment : Page: 175
Not clear what is happening here. Four of these items are direct quotes from the reports findings (although they aren't indicated as quotes, one is a bad paraphrasing of a finding, and another does not show up at all in the findings. The best thing would be to just list the findings verbatim as a quote.

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Comment [ ] Page: 175
This is not what it says!!!! It says "a major oil spill in the Beaufort Sea would have major effects on polar bears and ringed seals." It's OK to paraphrase, but you have to get the meaning right, and what you did here is not right.

Comment : Page: 175
I'm not sure where this comes from, but it is not a finding listed in the report.

the Arctic on land as well as offshore in the marine environment, although today the development of offshore production sites has been limited to two facilities located in the Beaufort Sea. Lentfer (1990) stated that oil and gas exploration and development in the Arctic can impact polar bears in the following ways: (1) damage or destruction of essential habitat; (2) contact with and ingestion of oil from acute and chronic oil spills; (3) contact with and ingestion of other contaminants; (4) attraction to or disturbance by industrial noise and harassment by aircraft, ships, and other vehicles; (5) death, injury, or harassment resulting from interactions with humans; (6) increased hunting pressures; and (7) potential mortality, injury, and stress resulting from capture, handling and interaction associated with studies to evaluate the previous concerns.

Comment Page: 175
say what they are

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To date, oil and gas exploration and development activities have been more extensive in Alaska than in other areas of the Arctic, but Canada, Norway, Russia and Greenland also are experiencing oil and gas exploration and development.

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b. Oil and gas development by Country

1. United States (Alaska)

There are 31 producing oil fields on Alaska's Arctic Slope (Minerals Management Service ("MMS") 2003, 2004). A network of roads, pipelines, and power lines serve as infrastructure to connect drill sites, production facilities, support facilities, and transportation hubs. The area of activity extends from nNortheastern portion of the National Petroleum Reserve – Alaska ("National Reserve") to the Canning River and the ebEastern Boundary of the Arctic National Wildlife Refuge ("Arctic Refuge") (NRC 2003).

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Seven of the 31 producing oil fields are offshore. Three additional onshore fields are in the planning stages for development. Other potential future development includes 16 discoveries that may undergo some development-related activities within the next 15-20 years. Nine of sixteen potential fields are located offshore (MMS 2003, 2004).

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Offshore oil development is expanding and is forecasted to continue into the future. To date, offshore oil development accounts for only a small percentage of oil production on Alaska's Arctic slope – as of December 2001 only about 0.429 billion barrels have been produced offshore compared to approximately 13.256 billion barrels on shore (NRC 2003).

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A 2001 Presidential Executive Order 13212 directed U.S. departments and agencies to expedite projects that increase the production, transmission, or conservation of energy. A Proposed Final 5-Year Offshore Oil and Gas Leasing Program for 2002-2007 has been developed and includes three lease sales on the Beaufort Sea outer continental shelf, covering approximately 9.8 million acres for leasing (MMS 2003). Leasing incentives have included reduced royalties on oil production and lowered the minimum bid amount and rental rates for tracts leased (MMS 2004). The MMS states that at oil prices of $39 per barrel or greater the incentives would not be needed since the high price alone would spur exploration and development activities (MMS 2004).

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Other developments planned or proposed for Alaska's Arctic will contribute to the cumulative effect of development. These include a gas pipeline to transport natural gas from the Arctic to market, and the State of Alaska's proposal to expand the Arctic Slope road networks connecting the Arctic Slope villages to Interior Alaska and to the North American road network (MMS 2004.

Comment: Page: 177
Seems like some information from the NRC report should be included here since it is all about cumulative impacts.

2. Canada

In the Canadian Beaufort Sea extensive exploration was conducted in the 1970s and 1980s, including 85 offshore exploration programs that resulted in significant oil and gas discoveries (Devon Canada Corporation 2004). Recently the Canadian government granted the Devon Canada Corporation an exploration license to conduct petroleum exploration within polar bear habitat in the sSouthern Beaufort Sea (Devon Canada Corporation 2004). Nine offshore drilling locations within the landfast ice zone have been. Devon must drill at least one well in each of four areas delineated within the general lease prior to expiration of the license in 2009. Failure to comply results in drilling rights reverting back to the federal government. Devon plans to drill

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What does significant mean, and did all 85 find that?

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So what happened with these?

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Deleted: (Devon Canada Corporation 2004) the first well during the winter of 2005-2006, and one well per winter season thereafter through 2009.

> **Comment: Page: 178** Lots of detail about this--it looks like a report from this company is the only thing you looked at. What else is going on?
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The largest potential future development in the region is the Mackenzie Gas Project, a pipeline through the Mackenzie River corridor to transport natural gas to market (Devon Canada Corporation 2004). The proposed gas pipeline has spurred a great deal of exploration for natural gas in the Mackenzie Delta and parts of the Tuktoyaktuk Peninsula (MMS 2003; Devon Canada Corporation 2004). In eastern Canada, the provinces of Newfoundland and Quebec oversee regulatory actions that may lead to additional exploration and production of the Hebron, Ben Nevis, and West Ben Nevis prospects. Existing producing fields in this area include the Hibernia, Terra Nova, White Rose, and Grand Banks.

> **Comment: Page: 178** Unclear what relevance this has to PBs. Are any of these fields in PB habitat, if not what is the impact going to be? You're going to needs some maps showing the developments in relation to PB habitat.

3. Norway

Oil and gas development in polar bear habitat in Norwegian territory (Barents Sea) is relatively recent. In May 1997, the Norwegian government awarded production licenses for seven areas of the Barents Sea, including four as seismic testing areas (Larstad and Gooderham 2004). In December 2003, the Norwegian government opened areas of the southern Barents Sea to continued year-round petroleum operations, with the exception of certain areas that will be re-assessed in an integrated management plan for the Barents Sea (Andresen and Gooderham 2004).

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>
> **Comment: Page: 178** do you mean exploration?

The first producing gas field in this area, the Snøhvit field, was approved in 2002 and is expected to begin producing in 2007 (Norwegian Petroleum Directorate 2006). In order to promote the discovery of additional gas resources near Snøhvit, the Norwegian government included an area close to Snøhvit in the announcement of awards in pre-defined areas for 2004 (Larstad and Gooderham 2004). A facility is also under construction at Melkøya outside of Hammerfest to process gas and natural gas liquids from Snøhvit, from which gas is transported under water from the gas field to the production facility, with production scheduled to begin in 2006, now delayed to late 2007 (Norwegian Petroleum Directorate 2006, Andresen and Gooderham 2004). The government has recognized special environmental constraints on oil production in the Barents Sea region (Andresen and Gooderham 2004; Larstad and Gooderham 2004), although oil and gas development in the Norwegian Arctic in polar bear habitat is expected to continue and to increase. The management plan is open for reevaluation in 2010, and then new areas and fields could be opened. Present constraints include no petroleum activities in areas closer than 50 km of land, no activities closer than 65 km from Bjørnøya (Bear Island), and no activities in the areas of the polar front and ice edge.

Comment: Page: 179
Can't tell where any of this is in relation to areas used by PBs (except for what's said in the last sentence and it's not clear that closed area is part of an area that would otherwise be explored).

4. Denmark (Greenland)

The Greenland and Danish governments have been promoting oil and gas exploration and development off the coast of Greenland, and oil and gas activities have increased during the past several years (GBMP 2004). The 3,985 km^2 Attamik license area about 200 km northwest of Nuuk, Greenland was licensed to EnCana corporation and NUNAOIL A/S, a state-owned oil company (GBMP 2004). In 2003, EnCana carried out extensive exploration off the coast of West Greenland (GBMP 2004). Seismic testing has been conducted on an 50,000 km^2 area since 1990 (GBMP 2004).

Comment: Page: 179
Again, need maps to show where these areas are.

In 2004, Greenland opened four areas off the west coast of Greenland in the Labrador Sea, Davis Strait, and Baffin Bay to oil exploration. A 2,897 km^2 area was licensed to EnCana and NUNAOIL over the Lady Franklin Basin (GBMP 2005a). Large petroleum deposits are thought to exist offshore of Western Greenland (GBMP 2005). The Labrador Sea, Davis Strait, and Baffin Bay all pose serious challenges to oil exploration and development, including extreme climates and broken ice conditions for much of the year (GBMP 2004). Greenland and Danish governments' have promoted oil and gas exploration and development off the East Coast of Greenland that may also increase in the future.

5. Russia

Parallel plans for oil and gas development in the Russian Barents Sea are also moving forward (Derocher et al. 2002). Large offshore oil and gas fields are likely to be developed within a few years. The Russian government has approved plans for a privately owned oil pipeline from Russia's oil fields to Murmansk in northwest Russia. Should the pipeline be built, major oil shipping terminals could be operating at Murmansk by 2007. Approximately 2.5 million barrels of oil a day could be transported by tanker from Murmansk to the U.S. through the Barents Sea (WWF 2003).

There are also plans for industrial oil production on the oil fields in the southeastern part of the Barents Sea and gas production on Yamal Peninsula (Belikov et al. 2002).

3. Bear-Human Interactions

Polar bear distribution changes will likely contribute to an increase in bear-human interactions in the coming years. In addition to polar bear distribution changes, climate change will likely promote human populations to shift northward, increasing direct interactions between bears and humans (AMAP 2003; Derocher et al. 2004). Other consequences beyond direct interactions with humans include increased development pressure, disturbance to bears from increased shipping activity, potential prey availability reductions from expanded commercial fisheries, and increased risk of oil spills (AMAP 2003). In many instances the results of human interactions are fatal to polar bears or may result in injury or disturbance. In some instance these interactions can result in injuries or death humans.

Polar bears come into conflict with humans partly because they will scavenge for food at sites of human habitation and also because they may occasionally prey or attempt to prey upon humans (Stirling 1998). "Problem bears" are most often sub-adults, because these are inexperienced hunters and have the most difficulty hunting, and because their feeding habits include more of scavenging than adult bears (Stirling 1998). In the Northwest Territories, a preliminary study found that 36 of 44 "problem bears" killed between 1972 and 1999 were under five years of age (Lunn et al. 2002b). In the Canadian Beaufort Sea, 12 of the 16 "problem bears" from 1973-1983

Comment: Page: 180 Where are these in relation to PBs?

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Comment: Page: 180 It looks to me like this is probably not complete coverage of all that is going on and may happen in Russia.

Comment: Page: 180 This could well go into section B, as it is a type of human "use" and the question being evaluated in that section is whether the sum of all uses is too much. ... [366]

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killed whose ages were determined were five years of age or less, with an average age of 2.25 years (Stirling 1998). After sub-adults, females with cubs are the most likely type of bear to interact with humans, because females with cubs are likely to be thinner and hungrier than single adult bears, andsStarving bears will risk death in an attempt to obtain food (Stirling 1998). In Churchill, an area of predictably high polar bear use, in years when bears came ashore in poorer condition, more females with cubs fed at the dump in the fall when their stored fat reserves ran low (Stirling 1998).

Research indicates that human-bear interactions, and the number of defense kills, increase when food is less available in the wild. Following a period of reduced seal abundance iIn the eastern Beaufort Sea during spring 1974, , researchers predicted that subadults would be in poorer condition, interact more with humans, and suffer a higher death rate in the winter of 1974-75. The predictions proved true with seven defense kills that winter.Inin subsequent years when seal populations had recovered defense kills declined to an aveage oftwo per winter(Stirling 1998).

Adult male polar bears, unlike adult black or brown bears, are less likely to frequentat areas of human habitation, presumably because adult male polar bears are usually in better physical condition than other sex or age classes (Stirling 1998). In the Beaufort Sea adult males were present for protracted periods of time near settlements feeding on bowhead whale remains during the fall period of 2002-2005 (Miller et al. 2006). The reason for the unusual presence of adult males near a north slope village is unknown but raises some cause for concern that these animals may have been nutritionally stressed.

In Nunavut, Canada the details from 618 polar bear defense of life and property (DLP) kills that occurred from 1970-2000 were analyzed (Dyck, 2006). The study confirmed that most bears were ≤ 6 years of age (73%), the majority of bears killed were males (71%), and most interactions occurred at Native hunting camps (74%). Sources of food were believed to be a contributing factor in many instances but other possible reasons were an increase in land use activities or the number of camps, dincrease human populations in areas of high polar bear activity, dincrease polar bear population size, and climatic warming related to earlier departure from ice habitat to terrestrial habitats. The implementation of a DLP monitoring program in

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1980 resulted in a e in the numberdecreasing of kills. More recently (PBTC and PBSG, Dowsley) increased levels of DLP kills have been reported. The Baffin Region accounted for 74% of the DLP kills. Reasons for the sex bias toward males may be related to the following: young and subadult males account for > 50% of the population based on capture data; male subadult dispersal has been noted for other species with polygynous mating systems (Greenwood 1980, Dobson 1982, Derocher and Stirling 1990, McClellan and Hovey 2001, in Dyck 2006); males tend to be more aggressive (Tate and Pelton 1983, Ramsay and Stirling 1986, 1988); and subadults may be more curious and less cautious, and possibly more nutritionally stressed than older bears (Stirling and Latour 1978, MacArthur Jope 1983—in Dyck 2006). Increased future interactions were predicted based on expanding human populations, resource extraction and exploration activities. Enhanced monitoring of bear-human interactions would be useful in better understanding and mitigating for these incidents.

Defense kills of "problem bears" are a concern when they are not included in an area's hunting quota, because the number of interactions and bears killed can increase quickly and cause a major impact on the population. Some experts predict that the number of interactions and defense kills will increase as climate change continues (Derocher et al. 2004). Amstrup (2000) observed that direct interactions between people and bears in Alaska have increased markedly in recent years, and that this trend is expected to continue. Schliebe et al. (2006)ed confirm this observation with data from hunter harvested polar bears in Alaska (Figure 3). The number of bears taken for safety reasons, based on 3 year running averages, increased steadily from about 3 per year in 1993, to about 12 in 1998, and has averagedat about 10 in recent years. There are several plausible explanations for this increase. First it could be an artifact of increased reporting by the hunters, or of an increased polar bear population and corresponding increased probability of interactions with humans. Alternatively or in combination, polar bears from the Southern Beaufort and Chukchi Sea populations typically move from the pack ice to the near shore environment in the fall to take advantage of the higher productivity of ice seals over the continental shelf. In the 1980s and early 1990s the near shore environment would have been frozen by early or mid October, allowing polar bears to effectively access seals in the area. Since the late 1990s the timing of ice formation in the fall has occurred later in November or

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Why should a monitoring program have decresed the number of kills?

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if these are citations they are incomplete

Comment Page: 182
This happened everywhere in Nunavut?

Comment Page: 183
why aren't you citing the primary paper?

Comment Page: 183
why aren't you citing the primary paper?

Comment Page: 183
Really? I can't see any reason why this would be. They are occasional events that may occur or not occur, but that isn't the same as increasing quickly.

Comment Page: 183
It would only be a "major impact" if many animals were killed and many of them were females. I think this is a relatively small issue that would only become important with a total failure of management to react if it started to grow.

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early December, resulting in an increased amount of time that the area was not accessible to polar bears. Consequently, bears spent a greater amount of time on land and not feeding. The later formation of near-shore ice increases the probability of bear-human interactions occurring in coastal villages. The increased use of coastal habitats by polar bears during the fall in recent years is further supported by data from aerial surveys along the coast and barrier islands from Barrow to the Canadian border and from information from local residents in coastal villages in northern and western Alaska.

4. Shipping and Transportation

Observations over the past 50 years show a decline in arctic sea-ice extent in all seasons, with the most prominent retreat in the summer. Some studies estimate arctic-wide reductions in annual average sea-ice extent of about 5-10% and a reduction in the average thickness of about 10-15% over the past few decades. These trends indicate an Arctic Ocean with longer seasons of reduced sea-ice cover, which will improve ship accessibility around the margins of the Arctic Basin – although increased accessibility will not be uniformly distributed (ACIA 2004).

Climate models project an acceleration of this trend with periods of extensive melting that will spread progressively further away from most arctic land masses into the spring and autumn, thus opening new shipping routes and extending the period that shipping is practical (ACIA 2004).

The navigation season is normally defined as the number of days per year when less than 50% ice cover persists. The navigation season for the northern sea route is projected to increase from 20-30 days per year to 90-100 days per year. Since navigation for ships with ice-breaking capability is possible in seas with up to 75% ice coverage, this navigation season may extend to 150 days per year by 2080.

Comment: Page: 184
This is all fine, but realize you say the increase happened 1993-1998 and the number has been more or less stable at a level below that of 1998 for the past 7-8 years. In other words, it hasn't been a steady and continual increase. So, your scenario should not only explain the increased but also the leveling off.

Comment: Page: 184
needs citations

Comment: Page: 184
The subject here is human conflicts other than hunting, not quotas.

Deleted: In Nunavut, increased bear-human encounters reported by residents of numerous communities (Dowsley 2006) resulted in quota increases for Western Hudson Bay, Baffin Bay, and Davis Strait. Whether the increased incidence of polar bear use of terrestrial habitat in the open water season is evidence of increased population size or a change in distribution is a subject to conjecture. In the case of one population, Western Hudson Bay, traditional knowledge indicating increased population size was used to support increased harvest quotas, in contrast to research indicating that the population was not increasing, but instead had been in steady decline for a number of years

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There is a Navy report about implications of a ice-free arctic that should be referred to here--it is at http://www.natice.noaa.gov/icefree/FinalArcticReport.pdf

The Northern Sea Route is the name for the seasonally ice-covered marine shipping routes across the north of Eurasia from Novaya Zemlya in the west to the Bering Strait in the east (ACIA 2004a). The Northern Sea Route is administered by the Russian Ministry of Transport and has been open to marine traffic of all nations since 1991 (ACIA 2004a). For trans-Arctic voyages, the Northern Sea Route represents up to a 40% savings in distance from northern Europe to northeastern Asia and the northwest coast of North America compared to southerly routes via the Suez or Panama Canals (ACIA 2004a). Wiig et al. 1996, Brude et al. 1998,

Regional as well as trans-Arctic shipping along the Northern Sea Route is very likely to benefit from a continuing reduction in sea ice, which currently poses major challenges and requires specially reinforced ships as well as ice-breakers (ACIA 2004a). The further north the ice edge retreats, the further north ships can sail in open water on trans-Arctic voyages, thereby avoiding the shallow shelf waters (which require ships of shallow draft, thereby reducing the amount of cargo that may be carried and profitability) and narrow straits of the Russian Arctic (ACIA 2004a). Ships involved in expanded use of the Northern Sea Route would likely use leads and polynyas to avoid breaking ice and reduce transit time (FWS 1995 Russian scientists cite increasing use of a Northern Sea Route for transit and regional development as a major source of disturbance in the Russian Arctic (Belikov and Boltunov 1998). Commercial navigation on the Northern Sea Route could disturb polar bear feeding and other behaviors and would increase the risk of oil spills (Belikov et al. 2002).). y

Increased shipping activity may disturb polar bears in the marine environment, adding additional energetic stresses. If ice breaking activities occur they may alter habitats used by polar bears, possibly creating emphemeral lead systems and concentrating ringed seals within the leads. This in turn may allow for easier access to ringed seals and may have some beneficial values. Conversely, this may cause polar bears to use areas that may have a higher incidence of human encounters as well as increased likelihood of exposure to oil, waste products, or food wastes that are intentionally or accidentally placed into the marine environment. If shipping involved the tanker transport of crude oil or oil products there would be some increased likelihood of small to

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Comment Page: 185
disturbance to PBs?

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Deleted: polynas are essential habitat for polar bears, especially in winter and spring, and heavy shipping traffic could disturb the bears during critical times (FWS 1995).

Comment Page: 186
This seems to imply bears hunting seals swimming in the leads. I didn't know that was a common strategy.

large volume spills and corresponding oiling of polar bears as well as potential effects on seal prey species (Richardson et al. 2005b).

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The PBSG (2006 in prep) recognized the potential for increased shipping and marine transportation in the Arctic with declining summer/fall ice conditions. The group recommended that the Parties to the International Agreement on the Conservation of Polar Bears take appropriate measures to monitor, regulate, and mitigate ship traffic impacts on polar bear subpopulations and habitats.

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5. Tourism

Comment(Page: 186
This is definitely a use and should go in section B.

Increasing levels of tourism and photography in polar bear viewing areas and natural habitats is of concern. In some such situations, carelessness or ignorance have resulted in polar bear being killed to protect people (PBSG 2006 in prep). As tourism continues to increase in the Arctic, the number of conflicts is expected to rise.

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Tourists and photographers may inadvertently displace bears from preferred habitats or alter natural behaviors. Polar bears are inquisitive animals and often investigate novel odors or sights. This trait can lead to polar bears being killed at cabins and remote stations where they investigate food smells. Dumps near human settlements have a history of being frequented by polar bears.

Comment Page: 187
is this one really a tourism issue?

Clark (2003) documented 52 perceived aggressive interactions between people and polar bears, and one interaction that resulted in human injury, in Canadian National Parks. Two interactions resulted in bears fatalities. Most (87%) interactions took place in Wapusk National Park, outside of Churchill, Manitoba, where most of the Western Hudson Bay pPopulation comes on shore between July and November. Interactions took place on land during summer or fall. The number of interactions and the number of bears captured in and around Churchill appeared to be greater during years when bears came ashore earlier.

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Clark (2003) found no relationship between the rates of interaction and park visitation, suggesting that sea-ice availability and the amount of time the bears spend on land may be a more important variable in the rate of interactions than park visitation itself. Clark's analyses were consistent with Derocher et al.'s (2004) hypothesis that longer ice-free periods will contribute to an increase in the number of polar bear-human interactions.

Clark (2003) found that bears were reported killed in only 4% of the perceived aggressive interactions, which was much less than the 61% reported by a previous study. Possible explanations for the difference include the fact that Clark's study was confined to interactions in national parks, where visitors are not encouraged to carry firearms and are educated on bear safety, and that many interactions took place near established research camps that have formalized bear response procedures, including non-lethal deterrent measures.

Bear sightings near camps were also much more likely to lead to perceived aggressive interactions than bear sightings away from camps. This could be due to a number of factors, including the fact that attractants such as food motivate bears into encounters with people, and the fact that people may perceive bears as more aggressive near a camp than far from it (Clark 2003).

6. Other

Commercial fisheries are also expected to expand into Arctic waters. Expanded commercial fisheries could alter the food web structure in the oceans (AMAP 2003), further reducing prey availability for ringed seals and polar bears in turn.

VI. SUMMARY OF DRAFT FINDINGS

(To be determined based on information contained within the status assessment and comments or information derived from peer review)

Comment: Page: 187 what aspect of park visitation, the number of visitors in the park at one time, the total number of visitors, or what?

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Comment: Page: 187 This is the wrong way to state things if park visitation is not important at all!

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Comment: Page: 187 citation for that study?

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Comment: Page: 187 What were the characteristics of the other study?

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Comment: Page: 188 Yes, but changes in food webs could theoretically increase prey for ringed seals. This is so short and speculative that it isn't worth including.

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(in development)

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IX. Appendices, Figure, Tables

Appendix 1. Agreement on the Conservation of Polar Bears [November 1973]

Agreement on the Conservation of Polar Bears.

The Governments of Canada, Denmark, Norway, and the Union of Soviet Socialist republics, and the United States of America,

Recognizing the special responsibilities and special interests of the States of the Arctic Region in relation to the protection of the fauna and flora of the Arctic Region;

Recognizing that the polar bear is a significant resource of the Arctic Region which requires additional protection;

Having decided that such protection should be achieved through co-ordinated national measures taken by the States of the Arctic Region;

Desiring to take immediate action to bring further conservation and management measures into effect;

Have agreed as follows:

ARTICLE I

1. The taking of polar bears shall be prohibited except as provided in Article III.
2. For the purpose of this Agreement, the term "taking" includes hunting, killing and capturing.

ARTICLE II

Each Contracting Party shall take appropriate action to protect the ecosystems of which polar bears are part, with special attention to habitat components such as denning and feeding sites and migration patterns and shall manage polar bear populations in accordance with sound conservation practices based on the best available scientific data.

ARTICLE III

1. Subject to the provisions of Articles II and IV, and Contracting Party may allow the taking of polar bears when such taking is carried out:

(a) for *bona fide* scientific purposes; or
(b) by that Party for conservation purposes; or
(c) to prevent serious disturbance of the management of other living resources, subject to forfeiture to that Party of the skins and other items of value resulting form such taking; or
(d) by local people using traditional methods in the exercise of their traditional rights and in accordance with the laws of that Party; or
~~(e) wherever polar bears have or might have~~ been subject to taking by traditional means by its nationals.

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2. The skins and other items of value resulting from taking under sub-paragraphs (b) and (c) of paragraph 1 of this Article shall not be available for commercial purposes.

ARTICLE IV

The use of aircraft and large motorized vessels for the purpose of taking polar bears shall be prohibited, except where the application of such prohibition would be inconsistent with domestic laws.

ARTICLE V

A Contracting Party shall prohibit the exportation from, the importation and delivery into, and traffic within, its territory of polar bears or any part or product thereof taken in violation of this Agreement.

ARTICLE VI

1. Each Contracting Party shall enact and enforce such legislation and other measures as may be necessary for the purpose of giving effect to this Agreement.
2. Nothing in this Agreement shall prevent a Contracting Party from maintaining or amending existing legislation or other measures or establishing new measures on the taking of polar bears so as to provide more stringent controls than those required under the provisions of this Agreement.

ARTICLE VII

The Contracting Parties shall conduct national research programs on polar bears, particularly research relating to the conservation and management of the species. They shall as appropriate coordinate such research with research carried out by other Parties, consult with other Parties on the management of migrating polar bear populations, and exchange information on research and management programs, research results and data on bears taken.

ARTICLE VIII

Each Contracting Party shall take action as appropriate to promote compliance with the provisions of the Agreement by nationals of States not party to this Agreement.

ARTICLE IX

The Contracting Parties shall continue to consult with one another with the object of giving further protection to polar bears.

ARTICLE X

1. This Agreement shall be open for signature at Oslo by the Governments of Canada, Denmark, Norway, the Union of Soviet Socialist Republics and the United States of America until 31st March 1974.

2. This Agreement shall be subject to ratification or approval by the signatory Governments. Instruments of ratification or approval shall be deposited with the Government of Norway as soon as possible.

3. This Agreement shall be open for accession by the Governments referred to in paragraph 1 of this Article. Instruments of accession shall be deposited with the Depositary Government.

4. This Agreement shall enter into force ninety days after the deposit of the third instrument of ratification, approval, or accession. Thereafter, it shall enter into force for a signatory or acceding Government on the date of deposit of its instrument of ratification, approval or accession.

5. This Agreement shall remain in force initially for a period of five years from its date of entry into force, and unless any Contracting party during that period requests the termination of the Agreement at the end of that period, it shall continue in force thereafter.

6. On the request addressed to the Depositary Government by any of the Governments referred to in paragraph 1 of this Article, consultations shall be conducted with a view to convening a meeting of representatives of the five Governments to consider the revision or amendment of this Agreement.

7. Any Party may denounce this Agreement by written notification to the Depositary Government at any time after five years from the date of entry into force of the Agreement. The denunciation shall take effect twelve months after the Depositary Government has received the notification.

8. The Depositary Government shall notify the Governments referred to in paragraph 1 of this Article of the deposit of instruments of ratification, approval or accession, of the entry into force of this Agreement and of the receipt of notifications of denunciation and any other communications from a Contracting Party specifically provided for in this Agreement.

9. The original of this Agreement shall be deposited with the Government of Norway which shall deliver certified copies thereof to each of the Governments referred to in paragraph 1 of this Article.

10. The Depositary Government shall transmit certified copies of this Agreement to the Secretary General of the United Nations for registration and publication in accordance with Article 102 of the Charter of the United Nations.

IN WITNESS WHEREOF the undersigned, being duly authorized by their Governments, have signed this Agreement.

DONE at Oslo, in the English and Russian languages, each text being equally authentic, this fifteenth day of November, 1973.

I hereby certify that this is a true copy of the original document deposited in the archive of the Royal Norwegian Ministry of Foreign Affairs.

Per Tresselt.
Head of Division, Legal Department
Royal Norwegian Ministry of Foreign Affairs.

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Resolution E appended to the 1973 Agreement on the Conservation of Polar Bears by the Plenipotentiaries who signed the Polar Bear Agreement

RESOLUTION ON SPECIAL PROTECTION MEASURES

THE CONFERENCE,

BEING CONVINCED that female polar bears with cubs and their cubs should receive special protection;

BEING CONVINCED FURTHER that the measures suggested below are generally accepted by knowledgeable scientists to be sound conservation practices within the meaning of Article II of the Agreement on the Conservation of Polar Bears;

HEREBY REQUESTS the Governments of Canada, Denmark, Norway, the Union of Socialist Republics and the United States of America to take such steps as possible to:

1. Provide a complete ban on the hunting of female polar bears with cubs and their cubs; and

2. Prohibit the hunting of polar bears in denning areas during periods when bears are moving into denning areas or are in dens.

Appendix 2. NatureServe Conservation Status

Determining which plants and animals are thriving and which are rare or declining is crucial for targeting conservation towards those species and habitats in greatest need. NatureServe and its natural heritage member programs have developed a consistent method for evaluating the relative imperilment of both species and ecological communities. These assessments lead to the designation of a conservation status rank. For plant and animal species these ranks provide an estimate of extinction risk, while for ecological communities they provide an estimate of the risk of elimination. There are currently no conservation status ranks determined for Ecological Systems.

Conservation status ranks are based on a one to five scale, ranging from critically imperiled (G1) to demonstrably secure (G5). Status is assessed and documented at three distinct geographic scales-global (G), national (N), and state/province (S). These status assessments are based on the best available information, and consider a variety of factors such as abundance, distribution, population trends, and threats.

Interpreting NatureServe Conservation Status Ranks

The conservation status of a species or community is designated by a number from 1 to 5, preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global), N = National, and S = Subnational). The numbers have the following meaning:

1 = critically imperiled
2 = imperiled
3 = vulnerable to extirpation or extinction
4 = apparently secure
5 = demonstrably widespread, abundant, and secure.

For example, G1 would indicate that a species is critically imperiled across its entire range (i.e., globally). In this sense the species as a whole is regarded as being at very high risk of extinction. A rank of S3 would indicate the species is vulnerable and at moderate risk within a particular state or province, even though it may be more secure elsewhere.

Extinct or missing species and ecological communities are designated with either an "X" (presumed extinct or extirpated) if there is no expectation that they still survive, or an "H" (possibly extinct or extirpated) if they are known only from historical records but there is a chance they may still exist. Other variants and qualifiers are used to add information or indicate any range of uncertainty. See the following conservation status rank definitions for complete descriptions of ranks and qualifiers.

- Global Conservation Status Definitions
- National and Subnational Conservation Status Definitions

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Global, National, and Subnational Assessments

(S-rank) document the condition of the species or community within a particular state or province. Again, there may be as many subnational conservation status ranks as the number of states or provinces in which the species or community occurs.

National and subnational status ranks must always be equal to or lower than the global rank for a particular species or community (in this sense a "lower" number indicates greater risk). On the other hand, it is possible for a species or community to be more imperiled in a given nation or state/province than it is range-wide. As an example, a species may be common and secure globally (G5), vulnerable in the United States as a whole (N3), yet critically imperiled in Florida (S1). In the United States and Canada, the combination of global and subnational ranks (e.g., G3S1) are widely used to place local priorities within a broader conservation context.

Global conservation status assessments generally are carried out by NatureServe scientists with input from relevant natural heritage member programs and experts on particular taxonomic groups. NatureServe scientists similarly take the lead on national-level status assessments in the United States and Canada, while state and provincial member programs assess the subnational conservation status for species found in their respective jurisdictions.

Status assessments ideally should reflect current conditions and understanding, and NatureServe and its member programs strive to update these assessments with new information from field surveys, monitoring activities, consultation, and scientific publications. NatureServe Explorer users with significant new or additional information are encouraged to contact NatureServe or the relevant natural heritage program.

To ensure that NatureServe's central databases represent the most current knowledge from across our network of member programs, data exchanges are carried out with each natural heritage program at least once a year. The subnational conservation status ranks (S-ranks) presented in NatureServe Explorer are therefore only as current as the last data exchange with each local natural heritage program, coupled with the latest web site update (shown in the "small print" at the bottom of each NatureServe Explorer report). Although most subnational conservation status ranks do not change frequently, the most current S-ranks can be obtained directly from the relevant local natural heritage program (contact information available at http://www.natureserve.org/visitLocal/index.jsp).

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Status Assessment Criteria

Use of standard criteria and rank definitions makes NatureServe conservation status ranks comparable across organism types and political boundaries. Thus, G1 has the same basic meaning whether applied to a salamander, a moss species, or a forest community. Similarly, an S1 has the same meaning whether applied to a species or community in Manitoba, Minnesota, or Mississippi. This standardization in turn allows NatureServe scientists to use the subnational ranks assigned by local natural heritage programs to help determine and refine global conservation status ranks.

Status assessments are based on a combination of quantitative and qualitative information. Criteria for assigning ranks serve as guidelines, however, rather than arithmetic rules. The assessor's overall knowledge of the species or community allows them to weigh each factor in relation to the others, and to consider all pertinent information. The general factors considered in assessing species and ecological communities are similar, but the relative weight given to each factor differs.

For species, the following factors are considered in assessing conservation status:

- total number and condition of occurrences (e.g., populations)
- population size
- range extent and area of occupancy
- short- and long-term trends in the above factors
- scope, severity, and immediacy of threats
- number of protected and managed occurrences
- intrinsic vulnerability
- environmental specificity

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For ecological communities, the association level generally is the classification unit assessed and ranked (see Classification of Ecological Communities for an explanation of the classification hierarchy). Only global conservation status ranks are currently available for ecological communities on *NatureServe Explorer*. The primary factors for assessing community status are:

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Species known in an area only from historical records are ranked as either H (possibly extirpated/possibly extinct) or X (presumed extirpated/presumed extinct). Other codes, rank variants, and qualifiers are also allowed in order to add information about the element or indicate uncertainty. See the lists of conservation status rank definitions for complete descriptions of ranks and qualifiers.

- total number of occurrences (e.g., forest stands)
- total acreage occupied by the community.

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Secondary factors include the geographic range over which the community occurs, threats, and integrity of the occurrences. Because detailed information on these factors may not be available, especially for poorly understood or inventoried communities, preliminary assessments are often based on the following:

- geographic range over which the community occurs
- long-term trends across this range
- short-term trend (i.e., threats)
- degree of site/environmental specificity exhibited by the community
- imperilment or rarity across the range as indicated by subnational ranks assigned by local natural heritage programs.

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Relationship to Other Status Designations

NatureServe conservation status ranks are a valuable complement to legal status designations assigned by government agencies such as the U.S. Fish and Wildlife Service and the National Marine Fisheries Service in administering the U.S. Endangered Species Act (ESA), and the Canadian Wildlife Service in administering the Species at Risk Act (SARA). NatureServe status ranks, and the documentation that support them, are often used by such agencies in making official determinations, particularly in the identification of candidates for legal protection. Because NatureServe assessment procedures-and subsequent lists of imperiled and vulnerable species-have different criteria, evidence requirements, purposes, and taxonomic coverage than official lists of endangered and threatened species, they do not necessarily coincide.

The IUCN Red List of threatened species is similar in concept to NatureServe's global conservation status assessments. Due to the independent development of these two systems, however, minor differences exist in their respective criteria and implementation. Recent studies indicate that when applied by experienced assessors using comparable information, the outputs from the two systems are generally concordant. NatureServe is an active participant in the IUCN Red List Programme, and in the region covered by *NatureServe Explorer*, NatureServe status ranks and their underlying documentation often form a basis for Red List threat assessments.

Global Conservation Status Definitions

Listed below are definitions for interpreting NatureServe global conservation status ranks (G-ranks). These ranks reflect an assessment of the condition of the species or ecological community across its entire range. Where indicated, definitions differ for species and ecological communities.

NatureServe Global Conservation Status Ranks

Basic Ranks

Rank	Definition
GX	**Presumed Extinct** (species)— Not located despite intensive searches and virtually no likelihood of rediscovery. **Eliminated** (ecological communities)—Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species.
GH	**Possibly Extinct** (species)— Missing; known from only historical occurrences but still some hope of rediscovery. **Presumed Eliminated**— (Historic, ecological communities)-Presumed eliminated throughout its range, with no or virtually no likelihood that it will be rediscovered, but with the potential for restoration, for example, American Chestnut Forest.

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G1	**Critically Imperiled**—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
G2	**Imperiled**—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
G3	**Vulnerable**—At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
G4	**Apparently Secure**—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
G5	**Secure**—Common; widespread and abundant.

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Variant Ranks

Rank	Definition
G#G#	**Range Rank**—A numeric range rank (e.g., G2G3) is used to indicate the range of uncertainty in the status of a species or community. Ranges cannot skip more than one rank (e.g., GU should be used rather than G1G4).
GU	**Unrankable**—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. Whenever possible, the most likely rank is assigned and the question mark qualifier is added (e.g., G2?) to express uncertainty, or a range rank (e.g., G2G3) is used to delineate the limits (range) of uncertainty.
GNR	**Unranked**—Global rank not yet assessed.
GNA	**Not Applicable**—A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

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Rank Qualifiers

Rank	Definition
?	**Inexact Numeric Rank**—Denotes inexact numeric rank (e.g., G2?)
Q	**Questionable taxonomy**—Taxonomic distinctiveness of this entity at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or the inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority conservation priority.
C	**Captive or Cultivated Only**—At present extant only in captivity or cultivation, or as a reintroduced population not yet established.

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Infraspecific Taxon Conservation Status Ranks
Infraspecific taxa refer to subspecies, varieties and other designations below the level of the species. Infraspecific taxon status ranks (T-ranks) apply to plants and animal species only; these T-ranks do not apply to ecological communities.

Rank	Definition
T#	**Infraspecific Taxon** (trinomial)—The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank. Rules for assigning T-ranks follow the same principles outlined above for global conservation status ranks. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A T-rank cannot imply the subspecies or variety is more abundant than the species as a whole-for example, a G1T2 cannot occur. A vertebrate animal population, such as those listed as distinct population segments under under the U.S. Endangered Species Act, may be considered an infraspecific taxon and assigned a T-rank; in such cases a Q is used after the T-rank to denote the taxon's informal taxonomic status. At this time, the T rank is not used for ecological communities.

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National and Subnational Conservation Status Definitions

Listed below are definitions for interpreting NatureServe conservation status ranks at the national (N-rank) and subnational (S-rank) levels. The term "subnational" refers to state or province-level jurisdictions (e.g., California, Ontario).

Assigning national and subnational conservation status ranks for species and ecological communities follows the same general principles as used in assigning global status ranks. A subnational rank, however, cannot imply that the species or community is more secure at the state/province level than it is nationally or globally (i.e., a rank of G1S3 cannot occur), and similarly, a national rank cannot exceed the global rank. Subnational ranks are assigned and maintained by state or provincial natural heritage programs and conservation data centers.

National (N) and Subnational (S) Conservation Status Ranks

Status	Definition
NX **SX**	**Presumed Extirpated**—Species or community is believed to be extirpated from the nation or state/province. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
NH **SH**	**Possibly Extirpated** (Historical)—Species or community occurred historically in the nation or state/province, and there is some possibility

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	that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or community could become NH or SH without such a 20-40 year delay if the only known occurrences in a nation or state/province were destroyed or if it had been extensively and unsuccessfully looked for. The NH or SH rank is reserved for species or communities for which some effort has been made to relocate occurrences, rather than simply using this status for all elements not known from verified extant occurrences.
N1 **S1**	**Critically Imperiled**—Critically imperiled in the nation or state/province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province.
N2 **S2**	**Imperiled**—Imperiled in the nation or state/province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province.
N3 **S3**	**Vulnerable**—Vulnerable in the nation or state/province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.
N4 **S4**	**Apparently Secure**—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
N5 **S5**	**Secure**—Common, widespread, and abundant in the nation or state/province.
NNR **SNR**	**Unranked**—Nation or state/province conservation status not yet assessed.
NU **SU**	**Unrankable**—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
NNA **SNA**	**Not Applicable** —A conservation status rank is not applicable because the species is not a suitable target for conservation activities.
N#N# **S#S#**	**Range Rank** —A numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species or community. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4).
Not Provided	Species is known to occur in this nation or state/province. Contact the relevant natural heritage program for assigned conservation status.

Contact information for individual natural heritage programs is available at http://www.natureserve.org/visitLocal/index.jsp.

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Breeding Status Qualifiers

Qualifier	**Definition**

B	**Breeding**—Conservation status refers to the breeding population of the species in the nation or state/province.
N	**Nonbreeding**—Conservation status refers to the non-breeding population of the species in the nation or state/province.
M	**Migrant**—Migrant species occurring regularly on migration at particular staging areas or concentration spots where the species might warrant conservation attention. Conservation status refers to the aggregating transient population of the species in the nation or state/province.

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Note: A breeding status is only used for species that have distinct breeding and/or non-breeding populations in the nation or state/province. A breeding-status S-rank can be coupled with its complementary non-breeding-status S-rank if the species also winters in the nation or state/province, and/or a migrant-status S-rank if the species occurs regularly on migration at particular staging areas or concentration spots where the species might warrant conservation attention. The two (or rarely, three) status ranks are separated by a comma (e.g., "S2B,S3N" or "SHN,S4B,S1M").

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Other Qualifiers

Rank	Definition
?	**Inexact or Uncertain**—Denotes inexact or uncertain numeric rank. (The ? qualifies the character immediately preceding it in the S-rank.)

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Appendix 3. Criteria for Listing Species as Threatened or Endangered under the Canadian Species at Risk Act

Source: Adapted from SARA Registry 2005.

	ENDANGERED	THREATENED
A. DECLINING TOTAL POPULATION – Reduction in population size based on any of the following 4 options and specifying a-e as appropriate		
	≥70 %	≥50 %
(1) population size reduction that is observed, estimated, inferred, or suspected in the past 10 years or 3 generations, whichever is longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any combination of a-e below.		
	≥50 %	≥30 %
(2) population size reduction that is observed, estimated, inferred, or suspected in the past 10 years or 3 generations, whichever is longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any combination of a-e below.		
(3) population size reduction that is projected or suspected to be met within in the next 10 years or 3 generations, whichever is longer (up to a maximum of 100 years), based on (and specifying) and combination of b-e below.		
(4) population size reduction that is observed, estimated, inferred, projected or suspected over any 10 year or 3 generation period, whichever is longer (up to a maximum of 100 years), where the time period includes both the past and the future, AND where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any combination of a-e below.		
a) direct observation **b)** an index of abundance appropriate for the taxon **c)** a decline in area of occupancy, extent of occurrence and/or quality of habitat **d)** actual or potential levels of exploitation **e)** the effects of introduced taxa, hybridization, pathogens, pollutants, competitors, or parasites		
B. SMALL DISTRIBUTION, AND DECLINE OR FLUCTUATION		
1. Extent of occurrence	< 5,000 km²	< 20,000 km²
OR		
2. Area of occupancy	< 500	< 2,000 km²

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	km²	
For either of the above, specify at least two of a-c:		
(a) either severely fragmented or known to exist at # locations	≤5	≤10
(b) continuing decline observed, inferred or projected in any of the following:		

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<table>
<tr><th colspan="2">ENDANGERED</th><th colspan="2">THREATENED</th></tr>
<tr><td colspan="4">i) extent of occurrence
ii) area of occupancy
iii) area, extent and/or quality of habitat
iv) number of locations or populations
v) number of mature animals</td></tr>
<tr><td>(c) extreme fluctuations in any of the following:</td><td colspan="2">> 1 order of magnitude</td><td>> 1 order of magnitude</td></tr>
<tr><td colspan="4">i) extent of occurrence
ii) area of occupancy
iii) number of locations or populations
iv) number of mature animals</td></tr>
<tr><td colspan="4">C. SMALL TOTAL POPULATION SIZE AND DECLINE</td></tr>
<tr><td>Number of mature individuals</td><td colspan="2">< 2,500</td><td>< 10,000</td></tr>
<tr><td colspan="4">And 1 of the following 2:</td></tr>
<tr><td>(1) an estimate of continuing decline at a rate of at least:</td><td colspan="2">20% in 5 years or 2 generations
(up to a maximum of 100 years in the future)</td><td>10% in 10 years or 3 generations
(up to a maximum of 100 years in the future)</td></tr>
<tr><td colspan="4">(2) continuing decline, observed, projected or inferred, in numbers of mature individuals and at least one of the following (a-b):</td></tr>
<tr><td>(a) fragmentation – population structure in the form of one of the following:</td><td colspan="2">(i) no population estimated to contain >250 mature individuals</td><td>(i) no population estimated to contain >1,000 mature individuals</td></tr>
<tr><td colspan="2">(ii) at least 95% of mature individuals in one population</td><td colspan="2">(ii) all mature individuals are in one population</td></tr>
<tr><td colspan="4">(b) extreme fluctuations in the number of mature individuals</td></tr>
<tr><td colspan="4">D. VERY SMALL POPULATION OR RESTRICTED DISTRIBUTION</td></tr>
<tr><td>(1) Number of mature individuals</td><td colspan="2">< 250</td><td>< 1,000</td></tr>
<tr><td colspan="4">(2) Applies only to threatened: Population with a very restricted area of occupancy or number of locations such that is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and thus is capable of becoming highly endangered or even extinct in a very short time period.</td></tr>
<tr><td colspan="2">(not applicable)</td><td colspan="2">Area of occupancy typically < 20 km² or number of locations ≤5</td></tr>
<tr><td colspan="4">E. QUANTITATIVE ANALYSIS</td></tr>
<tr><td>Indicating the probability of extinction in the wild to be at least:</td><td colspan="2">20 % in 20 years or 5 generations, whichever is longer (up to a maximum of 100 years)</td><td>10 % in 100 years</td></tr>
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Appendix 4. IUCN Red List Criteria (Vulnerable)

IUCN Red List Criteria Definitions and criteria are available in the IUCN Red List of Threatened Species, 2001, Categories and criteria (v.3.1) and can be found at http://www.iucn.org/themes/ssc/redlists/RLcats2001booklet.html.
A synopsis of the 5 main categories and the evaluation for polar bears (2006) follows.

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VULNERABLE (VU)
A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥50% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are: clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
   (a) direct observation
   (b) an index of abundance appropriate to the taxon
   (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
   (d) actual or potential levels of exploitation
   (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥30% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥30%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥30% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 20,000 km², and estimates indicating at least two of a-c:

   a. Severely fragmented or known to exist at no more than 10 locations.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.
   c. Extreme fluctuations in any of the following:
      i) extent of occurrence
      (ii) area of occupancy
      (iii) number of locations or subpopulations
      (iv) number of mature individuals.

2. Area of occupancy estimated to be less than 2000 km², and estimates indicating at least two of a-c:
   a. Severely fragmented or known to exist at no more than 10 locations.

b. Continuing decline, observed, inferred or projected, in any of the following:
- (i) extent of occurrence
- (ii) area of occupancy
- (iii) area, extent and/or quality of habitat
- (iv) number of locations or subpopulations
- (v) number of mature individuals.

c. Extreme fluctuations in any of the following:
- (i) extent of occurrence
- (ii) area of occupancy
- (iii) number of locations or subpopulations
- (iv) number of mature individuals.

C. Population size estimated to number fewer than 10,000 mature individuals and either:

1. An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):

(a) Population structure in the form of one of the following:
- (i) no subpopulation estimated to contain more than 1000 mature individuals, OR
- (ii) all mature individuals are in one subpopulation.

(b) Extreme fluctuations in number of mature individuals.

D. Population very small or restricted in the form of either of the following:

1. Population size estimated to number fewer than 1000 mature individuals.
2. Population with a very restricted area of occupancy (typically less than 20 km²) or number of locations
(typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period.

E. Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

Relationship between loss of habitat and population reduction

Under criterion A, a reduction in population size may be based on a decline in area of occupancy, extent of occurrence and/or quality of habitat. The assumptions made about the relationship between habitat loss and population reduction have an important effect on the outcome of an assessment. The sensible use of inference and projection is encouraged when estimating population reductions from changes in habitat. For example, if a forest species' extent of occurrence has been 70% clear cut in the last five years it might be justified to infer a 50% decline in the population over the past ten years. The species would therefore qualify as Endangered A2c.

In all cases, an understanding of the taxon and its relationship to its habitat, and the threats facing the habitat is central to making the most appropriate assumptions about habitat loss and subsequent population reduction. All assumptions about this relationship, and the information used should be included with the assessment documentation.

Data on effects of change in habitat quality on polar bears

- CA: Evidence of substantial variation in body size and reproductive output over short periods (3-4 yrs) mediated by varying ice conditions and for longer term changes (+10 yrs) in reproduction and body mass
- WHB: Declining reproductive rates, subadult survival, and body size was postulated to be affected by earlier break up of sea ice
- WHB: decline in abundance due to decline in habitat quality
- SVAL: Number of maternity dens dependent on sea ice conditions in autumn

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- There is no doubt that polar bears will have a much less AOO, EOO and habitat quality in the future. However, no direct relation is established between these measures and the

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Other population stress factors that may operate to impact recruitment or survival include toxic contaminants, shipping, recreational viewing, oil and gas industry.

In addition to this comes a potential risk of overharvest due to increased quotas or free quotas in Canada and Greenland and poaching in Russia

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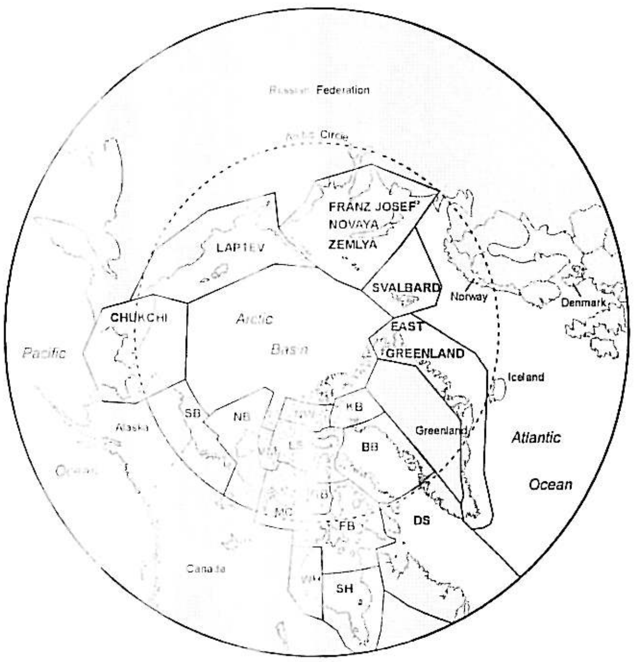

Distribution of Polar Bear Populations

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Figure1. Distribution of Polar Bear Population

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Figure 2. Circumpolar Map of Higher Density Polar Bear Denning Areas

Selected Polar Bear Terrestrial Denning Areas Compared to Past, Present, and Future Summer Sea-Ice Extent Source: Adapted from Lunn et al. (2002a:23) and ACIA (2004a:25, 30)

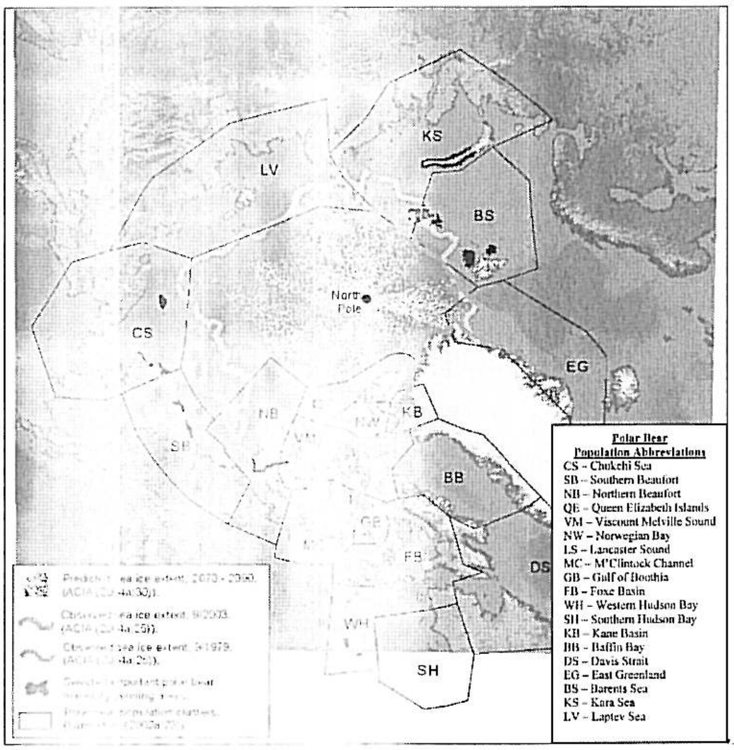

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Figure 3. Graph of Defense of Life Kills in Alaska, 1990-2004

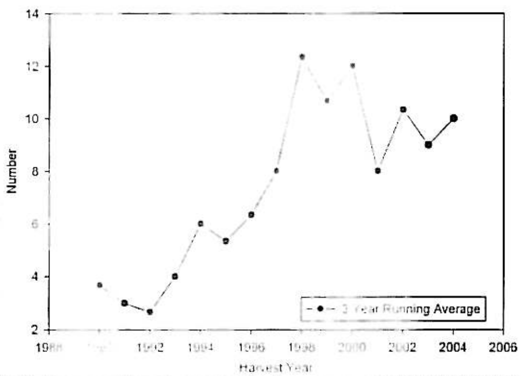

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Table 1. PBSG Status Table (PBSG 2006 in prep).

DRAFT PBSG STATUS TABLE (in prep)

	Aerial Survey/M-R Analysis		Additional/Alternative Analysis										
Subpopulation	Number (year of estimate)	±2 SE	Number (year of estimate)	±2 SE[1] or min-max[2] range	Simulation	Density	TEK/IQ	Historical annual removals (5 yr mean)	Potential maximum annual removals	Observed or predicted trend	Status	Estimated risk of future decline (10 yrs)	Comments
East Greenland	unknown							70	50	Data deficient	Data deficient	No Estimate	No population inventories have been conducted in East Greenland and therefore the size of the population is not known. During the last decades the extent of sea ice has decreased in the East Greenland area (e.g. Parkinson 2000). This decline is likely to continue (e.g. Rysgaard et al. 2003) resulting in a continued habitat destruction for polar bears in this area. Furthermore, various studies indicate that East Greenland polar bears may be negatively affected by relatively high body burden of organic pollutants (cf. Born & Sonne, this volume). During the last 5 years the total catch from the East Greenland population has decreased from 81 (1999) to 59 (2003) (Born & Sonne, this volume). Proposed quota (effective 1 Jan 2006) for East Greenland is 50 bears/year.
Barents Sea	3000 (2004)									Data deficient	Data deficient	No Estimate	
Kara Sea	unknown									Data deficient	Data deficient	No Estimate	The population size is unknown and no population surveys have been conducted in the Kara Sea.

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Laptev Sea	800-1200									Data deficient	Data deficient	No Estimate	The population is based on Belikov (1993) using aerial counts of dens on the Severnaya Zemlya in 1982 and on anecdotal data collected in 1960s on the number of females coming to dens on Novosibirsk Islands and on mainland coast. The estimate should therefore be regarded as preliminary.
Chukchi Sea			2000 (1993)		a			37 + Alaska unk. but substantial in Chukotka	uncertain	Data deficient	Data deficient	No Estimate	The population was estimated at 2000-5000 animals (Derocher et al. 1998) based on extrapolation of multiple years of spring den numbers data collected on Wrangel Island. The estimate was revised to 2000 animals with low confidence (Lunn et al. 2002). Abundance estimates with measurable levels of precision are not available. The population trend 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. These harvest levels have been occurrng for approximately the past 10-15 years. Without implementation of US-Russia polar bear treaty the levels of harvest are expected to continue and the risk for population depletion is rated as high.
Southern Beaufort Sea	1500 (2006)	1000 - 2000						58	81	Declining	Reduced	No Estimate	The 2006 population estimate is based on a preliminary analysis of capture-recapture data collected jointly by the U.S. and Canada, from 2001-2006. The 2006 population estimate was derived using the historic management boundaries for the SB sub-population (i.e., from Icy Cape, Alaska, to Pierce Point, Northwest Territories, Canada). A final analysis of the recent capture-recapture data will be reported in 2007, along with suggestions for new management boundaries based on recent analyses of radiotelemetry data.
Northern Beaufort Sea	1200 (1986)	133 - 2097						36	65	Stable	Not reduced	No Estimate	A coordinated, intensive mark and recapture study covering the whole of the Beaufort Sea and Amundsen Gulf will be completed in 2006; a final analysis and report will follow.
Viscount Melville	161 (1992)	121 - 201	215 (1996)	99 - 331[1]	a			4	7	Increasing	Severely reduced	Very Low	14.0% of PVA simulation runs resulted in population decline after 10 years (86.0% resulted in population increase after 10 years). Simulations based on 1996 projected abundance.
Norwegian Bay	190 (1998)	102 - 278						3	4	Declining	Not reduced	Higher	79.7% of PVA simulation runs resulted in population decline after 10 years (20.3% resulted in population increase after 10 years).
Lancaster Sound	2541 (1998)	1759 -3323						74	85	Stable	Not reduced	Higher	78.3% of PVA simulation runs resulted in population decline after 10 years (21.7% resulted in population increase after 10 years). PVA estimate should be regarded as conservative due to unique male-bias in harvest (males decline over short term but not females); over longer time horizons PVA suggests sustainability of harvest.

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Western Hudson Bay	935 (2004)	794 - 1076						45	64	Declining	Reduced	Very High	100.0% of PVA simulation runs resulted in population decline after 10 years (0.0% resulted in population increase after 10 years).
Southern Hudson Bay	1000 (1988)	684 - 1116						37	43	Stable	Not reduced	Lower	22.7% of PVA simulation runs resulted in population decline after 10 years (77.3% resulted in population increase after 10 years).
Kane Basin	164 (1998)	94 -234						11	15	Declining	Reduced	Very High	100.0% of PVA simulation runs resulted in population decline after 10 years (0.0% resulted in population increase after 10 years).
Baffin Bay	2074 (1998)	1544 - 2604	1546 (2004)	690 - 2402[1]	a			217	234	Declining	Reduced	Very High	100.0% of PVA simulation runs resulted in population decline after 10 years (0.0% resulted in population increase after 10 years).
Davis Strait			1650 (2004)	1000 - 2300[2]	a		a	65	74	Data deficient	Data deficient	Lower	The population was estimated at 1400 in 1996 based on traditional ecological knowledge (TEK) that the population had increased with historical harvest levels; and simulation results suggesting that population could not have sustained the historical harvest at numbers less than 1400. In 2004, the population estimate was increased to 1650 based on TEK that the population had continued to increase; and simulations suggesting that an increase of about 250 (from 1400 to 1650) from 1996 was reasonable at post-1996 harvest levels. In 2005 a multi-year M-R survey was initiated to confirm population numbers and status. Using Baffin Bay survival and recruitment rates, and abundance as above, 23.4% of PVA simulation runs under projected harvest (potential maximum removals) resulted in population decline after 10 years (76.6% resulted in population increase after 10 years).
Arctic Basin	unknown												

ª Where PVA simulations have been conducted, risk of decline is classed as Very Low (0-20%), Lower (20-40%), Moderate (40-60%), Higher (60-80%), and Very High (80-100%).

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Table 2. Survival rates for population with data

Mean (and standard error [SE]) of natural (i.e., unharvested) survival parameters used in the assessment of risk for sub-populations listed in Table 1, and best estimates of parameters to model natural survival in FB, SH, WH, DS, NB, and SB. It is to these rates that anticipated annual removal rate are added for simulation.

	Males				Females			
	Survival estimates of unharvested bears				Survival estimates of unharvested bears			
Sub-population	Cubs-of-the-year	1-4 yrs	5-20 yrs	>20 yrs	Cubs-of-the-year	1-4 yrs	5-20 yrs	>20 yrs
BB	0.570 (0.094)	0.938 (0.045)	0.947 (0.022)	0.887 (0.060)	0.620 (0.095)	0.938 (0.042)	0.953 (0.020)	0.919 (0.050)
DS[1]	0.570 (0.094)	0.938 (0.045)	0.947 (0.022)	0.887 (0.060)	0.620 (0.095)	0.938 (0.042)	0.953 (0.020)	0.919 (0.050)
FB[2]	0.570 (0.094)	0.938 (0.045)	0.947 (0.022)	0.887 (0.060)	0.620 (0.095)	0.938 (0.042)	0.953 (0.020)	0.919 (0.050)
GB	0.817 (0.201)	0.907 (0.084)	0.959 (0.039)	0.959 (0.039)	0.817 (0.201)	0.907 (0.084)	0.959 (0.039)	0.959 (0.039)
KB	0.345 (0.200)	0.663 (0.197)	0.997 (0.026)	0.997 (0.026)	0.410 (0.200)	0.756 (0.159)	0.997 (0.026)	0.997 (0.026)
LS[3]	0.634 (0.123)	0.838 (0.075)	0.974 (0.030)	0.715 (0.095)	0.750 (0.104)	0.898 (0.005)	0.946 (0.018)	0.771 (0.054)
MC	0.619 (0.151)	0.983 (0.034)	0.921 (0.046)	0.921 (0.046)	0.619 (0.151)	0.983 (0.034)	0.977 (0.033)	0.977 (0.033)
NB[4]	0.651 (0.020)	0.838 (0.075)	0.974 (0.030)	0.715 (0.095)	0.651 (0.020)	0.860 (0.040)	0.996 (0.005)	0.996 (0.005)
NW[3]	0.634 (0.123)	0.838 (0.075)	0.974 (0.030)	0.715 (0.095)	0.750 (0.104)	0.898 (0.005)	0.946 (0.018)	0.771 (0.054)
SB[5]	0.651 (0.020)	0.838 (0.075)	0.974 (0.030)	0.715 (0.095)	0.651 (0.020)	0.860 (0.040)	0.996 (0.005)	0.996 (0.005)
SH[2]	0.570 (0.094)	0.938 (0.045)	0.947 (0.022)	0.887 (0.060)	0.620 (0.095)	0.938 (0.042)	0.953 (0.020)	0.919 (0.050)
VM	0.448 (0.216)	0.924 (0.109)	0.924 (0.109)	0.924 (0.109)	0.693 (0.183)	0.957 (0.028)	0.957 (0.028)	0.957 (0.028)
WH[6]	0.625 (0.072)	0.625 (0.072)	0.974 (0.030)	0.715 (0.095)	0.709 (0.065)	0.709 (0.065)	0.975 (0.029)	0.832 (0.048)

[1] Incorporates 1993-1998 BB data (Taylor *et al.* 2005).
[2] Incorporates 1993-1998 BB data (Taylor *et al.* 2005).
[3] Survival estimates pooled for LS and NW (see text for LS and NW).
[4] Based on female, cub, and yearling survival rates for SB provided by E. Regher (USGS, Alaska Science Centre, Anchorage, AK). Subadult survival (ages 2-4) from WH (0.900, SE = 0.058 males, SE = 0.048 females [not shown]). Adult male survival rates from LS-NW (see text).
[5] Based on female, cub, and yearling survival rates for SB provided by E. Regher (USGS, Alaska Science Centre, Anchorage, AK). Subadult survival (ages 2-4) from WH (0.900, SE = 0.058 males, SE = 0.048 females [not shown]). Adult male survival rates from LS-NW (see text).
[6] Based on survival rates provided by E. Regher (USGS, Alaska Science Centre, Anchorage, AK). Subadult survival (ages 2-4) from WH is 0.900, SE = 0.058 males, SE = 0.048 females (not shown]). Adult male survival rates from LS-NW (see text).

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F or C?

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A graphic example of the importance of dens was the fate of two polar bear cubs that were born unexpectedly

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1978 in an outdoor uninsulated cage when the temperature was approximately -45

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How far was ice from the coast?

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live

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with

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animals

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>2 km north of the Alaska Beaufort Sea coastline or

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During this period no polar bear carcasses were observed.

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55

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seen

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, 51 were alive

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To me 30 mph winds don't sound like a very major storm for that area.

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regional

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peaks

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The text in yellow should be deleted. There is not enough information here to extrapolate in a meaningful way.

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carcasses

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and

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drowned

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Seas during this period were rough with wave heights estimated to exceed 2 meters.

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In general, wave height (sea state) increases as a function of the amount of open water surface area.

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Spatial extrapolation of these data indicated that as many as 36 bears may have been swimming in the area and that 27 bears may have died as a result of the high offshore winds. This suggests that the survival rate of swimming bears under these conditions was low (9/36 = 25%). No detection correction factors for bears present but not observed were incorporated into the analysis, therefore the estimates should be considered as an underestimate of the actual number affected

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. Some animals that drowned may have

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I would suggest deleting this section, just make sure the concepts are covered in the earlier text.

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Arctic basin polar bear populations that occur in areas without significant land mass constraints, or open basin

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population

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population such as the Chukchi Sea, Barents Sea, Southern Beaufort Sea and possibly the Kara and Laptev seas populations will be the most affected

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by large scale dramatic fluctuations in seasonal ice movements. The increased summer ice retreat into the polar basin, over deeper and less productive waters, will impact polar bears by increasing individual movements, reducing access to prey, increasing energetic demands, and correspondingly result in diminished physical body condition of bears. Prey species such as ringed seals will likely remain distributed in shallower more productive southerly areas characterized by vast expanses of open water. Secondary effects of diminished condition of polar bears, such as reduced reproductive rates, decreases in survival rates for cubs and possibly reduced survival rates for older age classes, have been demonstrated in the Western Hudson Bay (Stirling et al. 2004???,).

More southerly

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opulations currently exhibiting or expected to exhibit population distribution and demographic parameter effects include: Western Hudson Bay, Southern Beaufort Sea, Southern Hudson Bay, Baffin Bay, Davis Strait,`Foxe Basin, Chukchi Sea, and the Barents Sea.

Future Threats to Polar Bears from Global Climate Change

Table 4: Likely Impacts to the Polar Bear from Global Climate Change
Source: Adapted from Derocher et al. (2004:171).

Characteristic	Time Frame[1]	Projected Change

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Cha	Tin	Pro

racteristic	**e Frane**[1]	**jected Change**

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Body condition	Short	Decline, Increased variation

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M	S	A

ovenent patterns	hort	lteration of existing patterns

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Cub survival	Short	Decline, Incre

		ased variation

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Reproductive rates	Short	Variable, Increased variation

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Bear-human interactions	Variable	Increase

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Den areas	Medium	Change in areas and

		substrates

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Growth rates	Medium	Variable

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Prey composition	Medium	Change in species,

		utilization, age of prey

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Population bounda	Medium	Mixing of adjacen

ries		t populations

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Population size	Medium	Variable

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Intraspecific	Variable	Increased

aggression		

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Characteristic Time Frame Projected Change

Cannibalism	Variable	Possible increase

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Adult su	Long	Decline,

rvival		Increased variation

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1 Short = <10 years, Medium = 10-20 years, Long = >20 years. Time frame of impact will vary between populations and is dependent upon rate of change in a given population.

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Of course this is a very important section: However, I do not find it appropriate that this sections introduces a bulk of new information (with citations) – rather it should be the conclusion of what has been presented in previous sections. The information that you do present under "conclusions" is relevant but it must be presented before and in the relevant context.

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The rest of this chapter could be more fully treated in a separate chapter

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The text in yellow suggests an alternative explanation. The mothers of the calves could have been harvested by subsistence hunting. It is not likely that the calves would survive and the adult females would not if this were an ice related phenomenon.

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This is all either a repeat of things already said or additional evidence that GCC is occurring and species are responding. That isn't the point here. You are trying to identify what specific changes in habitats will cause threats to the survival of bears and how likely those threats are to cause the bears to become extinct or endangered.

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Worldwide, habitat loss is the primary cause of species extinction (Primack 2001). For polar bears, documented changes to habitat include seasonal retraction of sea ice in the fall, thinning and fragmentation of sea ice, and earlier spring breakup. While not all changes occur evenly throughout the Arctic, many changes are wide-spread. As the Polar Bear Specialist Group, the scientific advisory body to IUCN for polar bear, summarizes on their website, "[t]here is little doubt that polar bears and other ice-inhabiting marine mammals in the Arctic, are being, or will be, negatively affected by the effects of climate change via changes to their habitats" (PBSG 2005).

According to the ACIA, "the reduction in sea ice is very likely to have devastating consequences for polar bears, ice-dependent seals, and local people for whom these animals are a primary food source" (ACIA 2004b:1). The ACIA concludes that "polar bears are unlikely to survive as a species if there is an almost complete loss of summer sea-ice cover, which is projected to occur before the end of this century by some climate models. The loss of polar bears is likely to have significant and rapid consequences for the ecosystems that they currently occupy." (ACIA 2004a:58).

Derocher et al. (2004) published a comprehensive account of likely impacts to the polar bear from global warming, based on past and ongoing research. The predictions and additional information are summarized in the sections that follow. Overall, these scientists conclude that the "future persistence of polar bears is tenuous" (Derocher et al. 2004:172), reinforcing their earlier warnings that "[u]ltimately, if sea ice disappeared altogether, polar bears would become extinct" (Stirling and Derocher 1993:243).

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The ACIA has also concluded that "polar bears are unlikely to survive as a species if there is an almost complete loss of summer sea-ice cover, which is projected to occur before the end of this century by some climate models." (ACIA 2004a:58).

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Observations of changes related to climate change are mounting on many fronts. As one recent report noted "If current trends continue, polar bears and other species that require a stable ice platform for survival could become extinct by the end of the century" (Rosentrater 2005:3).

A recent study of the Bering Sea, one of the most productive marine ecosystems on the planet, concluded that "[a] change from arctic to subarctic conditions is underway in the northern Bering Sea" (Grebmeier et al. 2006). This is being caused by warmer air and water temperatures, and less sea ice. Even bottom water temperatures are demonstrably increasing. The impacts are many, and include the decline of the prey base of benthic (bottom) feeding walrus, endangered sea ducks (like spectacled eiders), and gray whales (Grebmeier et al. 2006). Some pelagic (open sea) species like pollock, on the other hand, are increasing their range (Grebmeier et al. 2006). "These observations support a continued trend toward more subarctic ecosystem conditions in the northern Bering Sea, which may have profound impacts on Arctic marine mammal and diving seabird populations as well as commercial and subsistence fisheries" (Grebmeier et al. 2006).

Cooper

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et al. 2006 observed at least nine apparently orphaned Pacific walrus in waters as deep as 3,000 m in July and August 2004 in the Canada Basin of the Arctic Ocean. Given limited visibility from the ship, many additional calves may have been separated in the overall study area. These conditions appear to be related to the transport of unusually warm (7° C) Bering Sea water into this area north of Alaska. Walruses invest considerable maternal resources while caring for calves on seasonally ice-covered continental shelves for periods of up to 2 years or more and only rarely separate from their young

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. These observations indicate that the Pacific walrus population may be ill-adapted to rapid seasonal sea-ice retreat off Arctic continental shelves.

Decreases in Arctic cod abundance have already been recorded and correlated with shrinking ice cover. Gaston et al. (2003) inferred changes in Arctic cod abundance in northern Hudson Bay by analyzing the composition of the diet fed to thick-billed murre chicks (Gaston et al. 2003). Between 1980-82 and 1999, the percentage of cod in the diet of thick-billed murre chicks fell from 51.5% to 18.9%, while the percentage of capelin increased from 6.7% to 41% over the same time period.

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the extent of ice cover greater than 10% on July 15th of each year

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also declined significantly between 1981 and 1999. Gaston et al. (2003:231) concluded that the trends observed related to real changes in fish populations that suggest a switch from an Arctic to a subarctic fish community occurred from 1997 onwards. Given the relative ecology of arctic cod and capelin, the trends identified seem best explained by changes in the oceanography of northern Hudson Bay, perhaps driven by temperature increases over recent decades.

Babaluk et al. (June 2000) report the first records of sockeye (Oncorhynchus nerka) and pink salmon (O. gorbuscha) from Banks Island and other records of Pacific salmon in Northwest Territories. The authors report capture of eight sexually mature sockeye (Oncorhynchus nerka) and one sexually mature pink salmon (O. gorbuscha) in the subsistence fishery in the Sachs River estuary at Sachs Harbour, Banks Island, Northwest Territories (NT) in August 1993. They also report a first record for coho salmon (O.

kisutch) in Great Bear Lake, NT. These capture locations are well outside the known distributions for the species. A pink salmon captured in the West Channel, Mackenzie River near Aklavik, NT, and a chum salmon (O. keta) from Cache Creek, NT, also represent new capture locations within the distribution of the species.
In sum

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these numerous citings of extra-limital occurrence of a variety of species is indicative of environmental change in the marine systems, likely associated with the warming trend of marine waters

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This section should not be just about hunting, it needs to deal with all kinds of human uses. So there needs to be something specific about mortality, injuries, or disturbance caused by research; tourism; and anything else relevant. Defense of life/propery kills could also go here, although it isn't specifically in the title. I see that a couple of these subjects are dealt with in the "other" section, but they belong here.

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, identifying whether the population trend is stable, growing, or declining. Since no reliable population estimate is available for the CS

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sub-population, no PBR can be calculated

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Regarding the harvest of polar bears, t

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recently for

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traditional ecological

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knowledge

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instituted

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Awkward sentence

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and

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e

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unclear how Greenland fits into this critique of what Nunavut did.

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expanded this recommendation, noting

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appropriate

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(

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Sport Hunting

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Remove and move to Greenland section? This section is discussing sport hunting in Canada

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Since

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contributes

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Don't necessarily have to be a U.S. "citizen"

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made

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if the bears had been taken in a legal manner from approved sub-populations

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also

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Import of sport-hunted polar bears into the U.S. is currently allowed

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from the SB, NB, VM, LS, NW and WH sub-populations

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; GB and WH are currently being reviewed for status change (PBTC draft report, 2006, p.16

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Nevertheless, b

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lifestyle

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hides

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by Alaska Natives

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polar bears occur only in Alaska and are divided

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Native

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subsistence harvest

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regulated by a quota

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system

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becomes

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Need to say something about what co-management means.

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. In 1997, SB, NB, MC VM, and WH were sub-populations approved for import of polar bears trophies. In 1999, LS and NW were added; in 2001 MC was removed from the list in light of new information indicating that the sub-population was severely depleted. At present (2006), the FWS is considering removing WH from the list.

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The MMPA was amended in 1994 to provide for

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3. Harvest

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importer from Canada. Prior to issuing

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permit for import of such trophies, the Service must make certain determinations rergarding the status

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The MMPA allows for American hunters to import sport-hunted polar bears

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from Canada, providing they have proof of legal take[LL1].

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If Proposed Rule is published prior to December, will need to update that information here.

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At present [LL2](2006), the FWS is considering removing WH from the list.

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In 2003, Canada recommended that the Queen Elizabeth Islands polar bear sub-population, previously identified as a discrete Canadian sub-population be included as part of an Arctic Basin sub-population. The Arctic Basin is really a geographic catch-all for bears that are resident to the Arctic outside of jurisdictional boundaries. The formerly designated Queen Elizabeth sub-population only existed because it was the area left over after all other Canadian population boundaries were delineated

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a rough population estimate of perhaps 200 animals (PBSG 2005, Canadian Management Report p.2).

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This sub-population is the shared management responsibility of Canada and Greenland.

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This makes no sense because since then seems to refer back to 1999-2003??

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estimate

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current

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The sub-population's low numbers and low reproductive rate make it susceptible to any increase in harvest or mortality.

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Provide data on numbers harvested and a citation for the quota figure.

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This sub-population is the shared management responsibility of

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Canada

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In 2001, mark/recapture work was initiated to obtain a more current population estimate.

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ing

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(N=

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have

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been

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, primarily because hunters harvested fewer animals than the quota allowed

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that

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will

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bears it may be indicative of changes occurring in the Arctic marine ecosystem

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This sentence is unclear and doesn't say much and should be deleted.

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needs citations

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This is an example of a disease vector that has moved north. It is true that E. multilocularis was not found in lemmings in Barrow in the 1950s –1970s was found in lemmings there in the 1990s, however it is not likely to be picked it up by polar bears eating lemmings. E. granulosis is the wolf-ungulate version and may be more of a threat to bears scavenging caribou.

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Amstrup et al. (2006) hypothesized that the two adult females and one yearling male were killed for food by other polar bears.

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Inupiat-Inuvialuit Agreement for the Management of Polar Bears of the Southern Beaufort Sea

Telemetry research on polar bears in the 1980s suggested that Alaskan and Canadian polar bear hunters were harvesting from the same southern Beaufort Sea population that ranged between between Icy Cape in Alaska and Pearce Point, to the east of Paulatuk in Canada (Amstrup, 1986; Stirling et al., 1988). Because harvests in Canada and Alaska were being managed differently and independently, recognition that the population was shared raised conservation concerns by the users and managers from each jurisdiction.

The Inuvialuit and the Inupiat recognized the shared responsibility for conservation and need to coordinate harvest practices (Stirling, 1988, Treseder and Carpenter, 1989; Nageak et al., 1991). The user group management agreement for polar bears of the southern Beaufort Sea was signed in Inuvik, NWT in January 1988, following two years of technical discussions and community consultations

Provisions of the Agreement included: annual quotas (which may include problem kills), hunting seasons; protection of bears in or constructing dens and of females accompanied by cubs and yearlings; collection of specimens from killed bears to facilitate monitoring of the sex and age composition of the harvest; agreement to meet annually to exchange information on research and management, to set priorities, and to agree on quotas for the coming year; and, prohibition of hunting with aircraft or large motorized vessels and of trade in products taken in violation of the Agreement. To facilitate implementation, a Joint Commission was formed, comprised of two Commissioners appointed by each party, as well as a Technical Advisory Committee, appointed by the Joint Commission, made up of biologists from government agencies in both countries who were actively involved in collecting research and management data. These two groups meet annually at the same time and place, and decisions are made by consensus. In Canada, recommendations and decisions from the Commissioners are then implemented through Community Polar Bear Management Agreements, Inuvialuit Settlement Region Community Bylaws, and NWT Big Game Regulations.

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exposure to contaminants already present in the Arctic

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force bears to move to new areas

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more energy in search for food

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With the exception of the Svalbard, Norway

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This could well go into section B, as it is a type of human "use" and the question being evaluated in that section is whether the sum of all uses is too much. For example in the case of Steller sea lion ESA threat evaluation incidental take in fisheries is evaluated in the same section as subsistenc harvest.

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around the edges of the polar seas and

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and fulfilling their nutritional requirements

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Subadults are also more vulnerable than adults to environmental effects (Taylor et al., 1987). Observations of density dependent and density independent effects on populations of

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marine mammals indicate that environmental effects are typically first manifested as reductions in annual breeding success and reduced subadult survival rates (Eberhardt and Siniff 1977). Because of the greater maternal investment a weaned subadult represents, reduced survival rates of subadults have a greater impact on population growth rate than reduced litter production rates (Taylor 1987).

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from a high of seven bears killed per winter

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In Churchill, an area of predictably high polar bear use, in years when bears came ashore in poorer condition, more females with cubs fed at the dump in the fall when their stored fat reserves ran low (Stirling 1998).

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I thought the reason was very well known--they are there to feed on the whale carcasses.

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It may have confirmed that most were young, but there is no evidence previously cited that most are males (in fact the opposite is suggested) or most are killed at Native hunting camps.

Table 3. Reproductive parameters for polar bear populations with data

Mean (and standard error [SE]) of reproductive parameters (standing age capture data) used in the assessment of risk for populations listed in Table 1, and best estimates of parameters to model FB, SH, WH, DS, NB, and SB.

		Litter-production rate				
Sub-population	Litter size	4-year-olds	5-year-olds	6-year-olds	>6-year-olds	Proportion male cubs
BB	1.587 (0.073)	0.096 (0.120)	0.881 (0.398)	1.000 (0.167)	1.000 (0.167)	0.493 (0.029)
DS[1,2]	1.587 (0.073)	0.096 (0.120)	0.881 (0.398)	1.000 (0.167)	1.000 (0.167)	0.493 (0.029)
FB[1]	1.587 (0.073)	0.096 (0.120)	0.881 (0.398)	1.000 (0.167)	1.000 (0.167)	0.493 (0.029)
GB	1.648 (0.098)	0.000 (0.000)	0.194 (0.178)	0.467 (0.168)	0.334 (0.300)	0.460 (0.091)
KB	1.667 (0.083)	0.000 (0.000)	0.000 (0.000)	0.357 (0.731)	0.478 (0.085)	0.426 (0.029)
LS	1.688 (0.012)	0.000 (0.000)	0.107 (0.050)	0.312 (0.210)	0.954 (0.083)	0.531 (0.048)
MC	1.680 (0.147)	0.000 (0.000)	0.111 (0.101)	0.191 (0.289)	0.604 (0.928)	0.545 (0.057)
NB[2]	1.756 (0.166)	0.000 (0.000)	0.118 (0.183)	0.283 (0.515)	0.883 (0.622)	0.502 (0.035)
NW	1.714 (0.081)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.689 (0.534)	0.544 (0.066)
SB[2]	1.600 (0.300)	0.000 (0.000)	0.103 (0.046)	0.338 (0.241)	0.942 (0.193)	0.515 (0.077)
SH[2]	1.575 (0.116)	0.087 (0.202)	0.966 (0.821)	0.967 (0.022)	0.967 (0.022)	0.467 (0.086)
VM	1.640 (0.125)	0.000 (0.000)	0.623 (0.414)	0.872 (0.712)	0.872 (0.712)	0.535 (0.118)
WH[2]	1.540 (0.098)	0.000 (0.000)	0.257 (0.442)	0.950 (0.352)	0.950 (0.022)	0.490 (0.022)

[1] Reproductive estimates from BB (Taylor *et al.* 2005).
[2] Best estimates for modeling exercise only (from standing age capture data).

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Page: 13
Is this the later season part of the surveys or the surveys flown in most recent years? Also, are these the bowhead surveys mentioned above or some other surveys?

Page 13: [111] Comment 7/25/2006 11:06:00 AM
How many years does "the later period of the aerial surveys" cover? What do you mean by water habitats? Freshwater on land? Polynyas?

Page 13: [112] Comment 1/17/2007 2:13:00 PM
Page: 13
All year or during some season(s)?

Page 13: [113] Comment 1/17/2007 2:13:00 PM
Reference Stirling/Parkinson article Arctic 59:3 Sept. 2006?

Page 13: [114] Comment 7/25/2006 11:06:00 AM
Baffin Bay, Davis Strait, western Hudson Bay and other areas of Canada cover a lot of territory over a range of latitudes and different things could be going on in different places. The polar bear population could be increasing in the northern areas (Baffin Bay, Davis Strait) and decreasing due to environmental stress caused by less ice in Hudson Bay. The Hudson Bay data set is not a good one to use to extrapolate to other areas. Hudson Bay is at the most extreme southern edge of polar bear distribution and polar bears there stay on land for longer periods of time than elsewhere.

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found that the size of this population had declined from 1,194 bears in 1987 to 935 bears in 2004

Page 13: [116] Comment [1/17/2007 2:13:00 PM
Suggest standardizing throughout document – other sections refer to "sub-populations", etc.

Page 14: [117] Deleted 7/9/2006 10:17:00 AM
groups

Page 14: [117] Deleted 7/9/2006 10:17:00 AM
groups

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These boundaries are considered to be ecologically meaningful, and the units they describe are managed as populations.

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The

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19th polar bear population may occur in

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(Figure 1)

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although

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nearer shore

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Each of the 19 populations is considered to be discrete based on behavioral and ecological factors. Furthermore, genetic variation among polar bear populations is correlated with these movement data, reinforcing the appropriateness of the population designations (Paetkau et al. 1999; Amstrup 2003

Page 14: [121] Comment [**1/17/2007 2:13:00 PM**
Page: 14
Population units is a very important issue that merits thorough coverage. It might be best to make it a separate section that comes after "movements" since movements information is also important in determining population discreetness. Also, it would be good to include a table showing for each population what data are available for use in making discreetness determinations, i.e., telemetry data, surveys, marking and tagging studies, genetics, and traditional knowledge. This would make it much easier for a reader to see how good, or how limited, the data are that are used in indentifying each population. I realize this is revisited in the distinct population segments section later--the important thing is that here, there, or in combination the subject is throughly treated.

Page 14: [122] Comment **1/17/2007 2:13:00 PM**
Page: 14
This section would benefit from some rearranging to put all of the information on movements first, then discuss home ranges and activity areas.

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s do not wander aimlessly on the ice

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are they carried passively with

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are

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since they retain

Page 14: [125] Comment [ ] **1/17/2007 2:13:00 PM**
Page: 14
Here and elsewhere it would be good to be clear about what studies are done with satellite-linked telemetry and what are done with radio telemetry. I believe that mostly you are referring to satellite-linked, and if so references to radio are in error.

Page 14: [126] Comment [ ] **1/17/2007 2:13:00 PM**
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Some might wonder why juvenile bears are not tagged, and the answer is not here.

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on the neck as opposed to adult males whose necks are larger than their skulls and will not retain collars

Page 14: [128] Comment [**1/17/2007 2:13:00 PM**
Page: 14
This appears contradictory, that there is strong fidelity but they vary by year. Requires clearer wording or additional explanation.

Page 14: [129] Comment **1/17/2007 2:13:00 PM**
Page: 14
Are these core regions the same every year, or is it just that there is a core region used every year?

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areas

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. Annual activity areas of female polar bears, monitored by radiotelemetry for multi-year periods, varied among years

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. Collared animals generally use seasonally preferred or "core" regions every year

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despite variation in annual activity area boundaries

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compiled

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are

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A

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will

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from year to year

Page 14: [133] Comment **1/17/2007 2:13:00 PM**
Page: 15
Is "habitat quality" measured in some way or is what is measured actually sea ice characteristics? If the former it would be useful to describe what constitutes good quality and poor quality habitat as that will be important with sea ice changes.

Page 14: [134] Comment [**1/17/2007 2:58:00 PM**
See also: Born e al. 1997, Mauritzen et al 2001, Wiig 1995, Wiig et al. 2003 for pattern in the European Arctic.

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Page: 15
This is not how pelagic is usually used, i.e., to mean free swimming or floating. This sentence is really not needed.

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These findings confirm that polar bears are pelagic

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The previous two sentences are not well explained. I am not sure what survival senescence means and I don't know how micro-satellite markers can tell you age at survival senescence.

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, based on micro-satellite genetic markers,

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Page: 22
This implies that they don't die of these things which is very untrue!

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not known to be susceptible to disease, parasites, or injury

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in the wild

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polar bears in the wild

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longest lived

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in captivity in a zoo in London

Page 21: [142] Comment 1/17/2007 2:13:00 PM

This sentence seems to fit in better later in this sections as it refers to newer information (than presented in the following).

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unclear, does the unpublished data refer to all these years, or do the years refer to publications?

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Danish, Highlight

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Highlight

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Inimical means harmful. I think you mean "required" or "mandatory"

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urvival rates increase with age up to

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produced

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with

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-

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-

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adult

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Page 22: [151] Deleted **7/18/2006 9:45:00 PM**
animals

Page 22: [151] Deleted **7/18/2006 9:45:00 PM**
since

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can not

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placed

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determining

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success

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the

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of adult marine mammals

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still

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In more recent years

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%

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.

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Survival estimates are a reflection of the characteristics and qualities of an ecosystem to maintain the health of individual bears.

Page 22: [156] Comment **1/17/2007 2:13:00 PM**
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What does this mean, and what would they die of in an "unstable" environment.

Page 22: [157] Comment **1/17/2007 2:13:00 PM**
Page: 23
This is out of place unless you make some link to survival which is the subject of this section.

Page 22: [158] Comment **1/17/2007 2:13:00 PM**
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citation

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Some injuries are immediately fatal.

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(*Phoca hispida*) birth lairs

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migrating

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)

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;

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;

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other

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s

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These areas are

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s

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global

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Page 24: [164] Deleted 7/3/2006 12:51:00 PM

A

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It merges on its eastern side with clockwise circulation of sea ice within Canada Basin.

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. Joined by

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, it drifts

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to

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An

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is established

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where

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low

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of

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This para and the one above would be strengthened by citations.

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Page 26: [171] Comment [**1/17/2007 2:13:00 PM**
Page: 27
other than what?

Page 26: [172] Comment **1/17/2007 2:13:00 PM**
I do not agree: Entire East Greenland and major parts of NW Greenland and Baffin Island have fiord and bay habitat with ringed seals (and bears).

Page 26: [173] Comment **1/17/2007 2:13:00 PM**
Somewhere in this document it must be described that the offshore pack ice is an extensive habitat for ringed seals (several studies on that) and furthermore the importance of ice to other ice breeding seals must be mentioned (harp, hooded, ribbon etc. what happens with these seals when the World is becoming warmer; recent studies indicate that har seals may suffer).

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Seasonally, this ice type is more important in the spring period.

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by highly dynamic depending on environmental conditions. It

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used by polar bears most frequently

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linear areas of open water. Lead systems are linear openings in the ice.

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Others are ephemeral in their location. They occur primarily in the winter and spring seasons.

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Open water at these locations attracts seals and other marine mammals and provides preferred hunting habitats during winter and spring. The e

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appear and disappear throughout the ice covered seasons and

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This is an awkward way to divide things and also makes it repetitious.

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have the highest seal concentrations and

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is fidelity to their reoccurring location

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It does not seem like resting areas are limited for polar bears.

Page 27: [185] Comment **7/25/2006 11:06:00 AM**
Predation from what? Human hunters? The attraction to polynyas is access to food.

Page 27: [186] Comment [**1/17/2007 2:13:00 PM**
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how are they a barrier and who is escaping predation from whom?

Page 27: [187] Comment **7/25/2006 11:06:00 AM**
I recommend deleting this sentence.

Page 27: [188] Comment [**1/17/2007 2:13:00 PM**
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My impression is that when seals are using leads they do not need to maintain breathing holes because they can just surface in the lead.

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Changes in wind and current patterns or ice abalation and formation processes could alter the location and persistence of polynyas (ACIA 2004)

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This northerly area is typified by a greater proportion of multi-year ice and

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abundance and assist in predicting and responding to initial impacts from threats such as oil

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development and climate change

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very little of what follows actuallytalks about inter-annual variations.

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polar bear what?

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in the eastern Beaufort Sea changed

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Need references here.

Page 29: [198] Comment **1/17/2007 2:13:00 PM**
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para needs citations.

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, and this change has resulted in greater amounts of open water in recent years

Page 29: [200] Comment **1/17/2007 2:13:00 PM**
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you only need to give pages if it is a quote.

Page 29: [201] Comment **1/17/2007 2:58:00 PM**
See Born et al. 1997, Mauritzen et al. 2001, Wiig et al 2003.

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bounds based on differing movement patterns.

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) reports that telemetry data have confirmed polar bears' close ties to the ice, and that "[s]easonal movement patterns of polar bears serve to emphasize the role of sea-ice in their life cycle."

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bear

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within their

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s

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"core"

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d particular

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islands of

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north of Norway

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;

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and

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and

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in Russia

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Page 30: [210] Comment 7/25/2006 11:06:00 AM
Put above references (highlighted in blue) in next sentence with corresponding areas.

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substantially

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from the

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or the

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that have relatively flat topography characterized by tundra with

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minor relief from riverine banks and coastal bluffs,

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to

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key

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all

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predictably

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to

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that

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continuously

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. Any

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are filled solidly with snow from the very early winter. Across their range, m

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. The main

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to coastal denning occurs in

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moved

Page 31: [218] Deleted **7/19/2006 4:22:00 PM**

from

Page 31: [218] Deleted **7/19/2006 4:22:00 PM**

to

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to traditional denning areas

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isn't data from the 60s and 70s "historical"?

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are there really data showing that prey availability varied annually, or is this an assumption?

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Although there are no historical data

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regarding denning fidelity, it has logically been assumed that concentrated denning areas are maintained by fidelity of individual females to those sites (Uspenski and Chernyavski 1965; Lønø 1970; Uspenski and Kistchinski 1972; Larsen 1985). Pregnant females return, it is assumed, to areas where they have successfully denned in the past. The greatest number of records of den-site fidelity comes from the Beaufort Sea where 27 polar bears were followed to more than one and up to four maternity dens (Amstrup and Gardner 1994). Bears that denned once on pack ice were more likely to den on pack ice than on land in subsequent years, and vice versa. Similarly, bears were faithful to general geographic areas. Those that denned once in the eastern half of the Alaskan coast were more likely to den there than to the west in subsequent years. When all years were considered, denning polar bears preferred some areas, but no areas were used by collared bears in all years. Weather, ice conditions, and prey availability, all of which varied annually

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, probably determined where bears denned. Those annual variations and the long-distance movements of polar bears (Amstrup et al. 1986, 2000; Garner et al.1990) make seasonal recurrence at exactly the same location unlikely.

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Shifted how? To the north?

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62%

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of

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,

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40%

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of dens known from satellite telemetry were located on sea ice

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were:

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may reflect changing ice formation and ablation patterns, food availability,

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clearly

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needs citations.

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This is not information regarding "Denning Chronology" and it is specific to Hudson Bay.

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Polar bears are largely food deprived while on land in the ice-free period. During this time, they survive by mobilizing stored fat. Pregnant females that spend the late summer on land and then go right into dens may not feed for 8 months (Watts and Hansen 1987; Ramsay and Stirling 1988). This may be the longest period of food deprivation of any mammal, and it occurs at a time when the female must give birth and nourishment to her new cubs

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Satellite telemetry data confirm that t

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Page 32: [233] Deleted 7/19/2006 4:40:00 PM

where they happened to be foraging

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On average, Beaufort Sea polar bears emerged from their dens with new cubs on

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if they were on the

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Dates of entry and exit varied somewhat among years depending on sea-ice, snow, and weather conditions.

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reported the mean entry into maternal aens i

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SE=3 days; range 27 August–12 October

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Here you give SE and ranges, earlier you give n. Would be good to be consistent. I suggest giving n and range, or just range.

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SE = 3 days; range 4 March–7 April

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50-100 for simplicity (easier to remember and also signals better the degree of uncertainty about time span)

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I would take this section, condense it considerably, and make it a subsection in section III called something like "Impacts of Arctic climate change on polar bear habitats". The point should not to describe everything everyone is saying about CC, but rather to focus on specifically what is happening and is predicted to happen to the identified habitats.

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Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

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in May and June of 2005 by Marha Dowsley, a researcher from McGill University

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were conducted in each community

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changes in the polar bear population, observations on the climate during the last 15 to 20 years

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and peoples' views of bear management

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Details of the interview and comments are presented in Dowsley 2005.

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Given the highly altricial nature of

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