

PROPOSAL FOR INCLUSION OF SPECIES ON THE APPENDICES OF THE CONVENTION ON THE CONSERVATION OF MIGRATORY SPECIES OF WILD ANIMALS

A. **PROPOSAL:** To list the polar bear, *Ursus maritimus*, on CMS Appendix Appendix II

B. **PROPOSER:** Norway

C. **SUPPORTING STATEMENT**

1. Taxon

1.1 **Classis:** Mammalia

1.2 **Ordo:** Carnivora

1.3 **Family:** Ursidae

1.4 **Genus/Species:** *Ursus maritimus* (Phipps, 1774)

1.5 **Common name(s):**
English: Polar bear
French: Ours blanc, ours polaire
Spanish: Oso polar
Norwegian: Isbjørn
Russian: Бѣлыj медвѣdj, oshkúj
Chukchi: Umka
Inuit: Nanoq, nanuq
Yupik: Nanuuk

2. Biological data

2.1 Distribution

Polar bears, *Ursus maritimus*, are unevenly distributed throughout the ice-covered waters of the circumpolar Arctic, in 19 subpopulations, within five range States: Canada, Denmark (Greenland), Norway, Russian Federation, and the United States. Geographically, polar bears occur in the Chukchi and Beaufort Seas north of Alaska, throughout the East Siberian, Laptev, and Kara Seas of Russia and the Barents Sea of northern Europe. They are found in the northern part of the Greenland Sea, and in Baffin Bay, which separates Canada and Greenland, as well as through most of the Canadian Arctic Archipelago and the southeastern Arctic of Canada (Amstrup 2003).

Polar bear distribution is limited by the southern extent of, as well as the total amount, composition, and type of, sea-ice. Distribution and composition of Arctic sea-ice is pivotal for their survival. Although some subpopulations occur in the permanent multi-year pack ice of the central Arctic basin, polar bears are most common in the annual ice over the continental shelf and inter-island archipelagos that surround the polar basin (Laidre, Stirling et al. 2008; Amstrup et al. 2008; Durner, Douglas et al. 2009; York 2010). Over most of their range, polar bears remain on the sea-ice year-round or visit land only for short periods.

Although polar bear home ranges can be as large as 600,000 km², they vary greatly between individuals (Amstrup, Durner et al. 2000; Mauritzen, Derocher et al. 2001; Wiig, Born et al. 2003). Their large home ranges reflect the low densities of their primary prey (pinnipeds), which are dispersed over very large areas. In general, polar bears inhabiting active offshore ice have larger home ranges than those on land-fast ice (Amstrup, Durner et al. 2000; Mauritzen, Derocher et al. 2003; Wiig, Born et al. 2003).

Polar bear movement and distribution are largely influenced by the use the sea-ice habitat as a platform for feeding, mating, denning and, in some subpopulations, summer retreat areas. They tend to move on drifting ice to remain in productive habitats (Wiig, Born et al. 2003; Durner, Douglas et al. 2009), which often means they move against the direction of drift of the sea-ice to remain in the same general location. In the Barents Sea, for instance, it has been shown that polar bears continuously walked northwards nine months of the year, though they remained largely in the

same area (Mauritzen, Derocher et al. 2003). In the polar basin and adjacent areas, polar bears primarily hunt on the annual ice over the continental shelf but may move into multiannual ice in some areas. Some bears remain on sea-ice year-round. In more southerly areas (such as Hudson Bay, Foxe Basin, Baffin Bay and Davis Strait), the annual ice melts completely and polar bears are forced to spend up to several months on land fasting until freeze-up allows them to return to the ice again (Stirling et al. 1999; Stirling and Parkinson 2006; Schliebe, Evans et al. 2006; Laidre, Stirling et al. 2008; Vongraven and Peacock 2011).

2.2 Populations

In 2009, the International Union for Conservation of Nature/Species Survival Commission (IUCN/SSC) Polar Bear Specialist Group suggested there were about 20,000 – 25,000 bears worldwide based on abundance estimates drawn from some of the 19 subpopulations (Obbard, Thiemann et al. 2010; Vongraven and Peacock 2011). In December 2013 Polar Bear Specialist Group evaluated the status of the polar bear, determining that for the 19 subpopulations:

- four are assessed as declining (Baffin Bay, Kane Basin, Southern Beaufort Sea and Western Hudson Bay);
- nine are assessed as unknown/data deficient (Arctic Basin, Barents Sea, Chukchi Sea, East Greenland, Kara Sea, Lancaster Sound, Laptev Sea, Norwegian Bay and Viscount Melville Sound)
- five are considered stable (Davis Strait, Foxe Basin, Gulf of Boothia, Northern Beaufort Sea, Southern Hudson Bay); and
- one is considered to be increasing (M'Clintock Channel), although this population is still reduced relative to historic levels (approx. 25 year past)

In 2008, IUCN listed the polar bear as Vulnerable based on IUCN criterion A3c because of a '*suspected population reduction of greater-than 30 percent within three generations*' (45 years) due to '*decline in area of occupancy, extent of occurrence and habitat quality*' (Schliebe, Wiig et al. 2008). Furthermore, the Canadian Polar Bear Technical Committee assesses the status of the 13 subpopulations within the Canadian Arctic on an annual basis thereby considering results of surveys as they are completed.

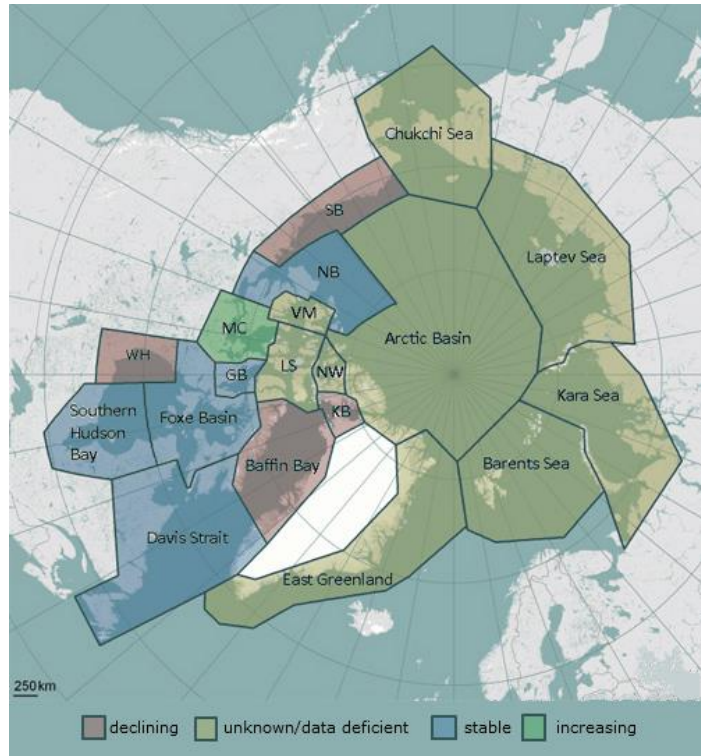
Some studies have indicated that polar bears are decreasing in many parts of their range, and one model has predicted that two-thirds of polar bears will be gone by mid-century (Amstrup, Marcot et al. 2008; Amstrup,

DeWeaver et al. 2010;).

Polar bear reproductive rates are among the lowest in all mammals. They typically have small litter sizes, long dependency periods, and high cub mortality. Their low reproductive rates mean that subpopulation recovery rates are also slow (Derocher, Lunn et al. 2004; Schliebe, Wiig et al. 2008; Durner, Whiteman et al. 2011; Molnár, Derocher et al. 2011).

Limited research data leave some uncertainty about the discreteness of less studied subpopulations, particularly in the Russian Arctic. Considerable overlap between these subpopulations occurs and genetic differences among them are small (Paetkau et al. 1999). Another individual polar bear subpopulation (a 19th) may occur in the central polar basin (Obbard et al. 2010), adding further uncertainty to the status of a number of the current subpopulations.

Figure 1: Distribution and current trend of polar bear subpopulations throughout the circumpolar Arctic (adapted from: Polar Bear Specialist Group web presentation: polar bear population map)



2.2.1 Subpopulation status and distribution

The subpopulation distribution presented clockwise from the Chukchi Sea, is as follows:

Chukchi Sea (Russia, USA)

Status – Data deficient / Subpopulation size estimate – unknown (PBSG 2013)

Polar bears in the Chukchi Sea, also known as the Alaska-Chukotka subpopulation, are widely distributed on the pack ice of the northern Bering, Chukchi, and eastern portions of the East Siberian seas. The western boundary of the subpopulation was set near Chaunskaya Bay in northeastern Russia and the eastern boundary at Icy Cape, Alaska, and the southern boundary is Cape Dyer, Baffin Island (summarized from: Vongraven and Peacock 2011)

Laptev Sea (Russia)

Status – Data deficient / Subpopulation size estimate – unknown (PBSG 2013)

The Laptev Sea subpopulation area includes the western half of the East Siberian Sea and most of the Laptev Sea, including the Novosibirsk and possibly Severnaya Zemlya islands (summarized from: Vongraven and Peacock 2011).

Kara Sea (Russia)

Status – Data deficient / Subpopulation size estimate – unknown (PBSG 2013)

The Kara Sea subpopulation overlaps in the west with the Barents Sea subpopulation in the area of Franz Josef Land and Novaya Zemlya archipelagos (summarized from: Vongraven and Peacock 2011).

Barents Sea (Norway, Russia)

Status – Data deficient / Subpopulation size estimate – 2644 (PBSG 2013)

Studies show that some polar bears associated with Svalbard are very restricted in their movements, but some bears

range widely between Svalbard and Franz Josef Land. There is overlap to the east with the Kara Sea subpopulation and also some with the East Greenland subpopulation. (summarized from: Vongraven and Peacock 2011).

East Greenland (Greenland)

Status – Data deficient / Subpopulation size estimate – unknown (PBSG 2013)

East Greenland polar bears are thought to constitute a single subpopulation that range widely along the coast of eastern Greenland and in the pack ice in the Greenland Sea and Fram Strait and have limited exchange with the Barents Sea subpopulation (summarized from: Vongraven and Peacock 2011).

Davis Strait (Canada, Greenland)

Status: Stable / Subpopulation size estimate – 2158 (PBSG 2013)

The Davis Strait subpopulation occurs in the Labrador Sea, eastern Hudson Strait, Davis Strait south of Cape Dyer, and along an as yet undetermined portion of southwest Greenland. The southernmost movements of some individuals within this subpopulation occur as far south as 47°N (summarized from: Vongraven and Peacock 2011).

Baffin Bay (Canada, Greenland)

Status – Declining / Subpopulation size estimate – 1546 (PBSG 2013)

The Baffin Bay subpopulation is shared between Greenland and Canada and is bounded by the North Water Polynya, Greenland to the east and Baffin Island, Nunavut, Canada to the west with a distinct southern boundary at Cape Dyer, Baffin Island. There do not appear to be significant genetic differences between polar bears in Baffin Bay and neighbouring Kane Basin (summarized from: Vongraven and Peacock 2011).

Kane Basin (Canada, Greenland)

Status – Declining / Subpopulation size estimate – 164 (PBSG 2013)

The boundaries of the Kane Basin subpopulation include the North Water Polynya, and Greenland and Ellesmere Island to the west, north, and east. Polar bears in Kane Basin do not differ genetically from those in Baffin Bay (summarized from: Vongraven and Peacock 2011).

Norwegian Bay (Canada)

Status – Data deficient / Subpopulation size estimate – 203 (PBSG 2013)

The Norwegian Bay subpopulation is bounded by heavy multi-year ice to the west, islands to the north, east, and west, and polynyas to the south. Most of the polar bears in this subpopulation are concentrated along the coastal tide cracks and ridges along the north, east, and southern boundaries (summarized from: Vongraven and Peacock 2011).

Lancaster Sound (Canada)

Status – Data deficient / Subpopulation size estimate – 2541 (PBSG 2013)

This subpopulation inhabits the Lancaster Sound and appears to be distinct from the adjoining Viscount Melville Sound, M'Clintock Channel, Gulf of Boothia, Baffin Bay and Norwegian Bay subpopulations (summarized from: Vongraven and Peacock 2011).

Gulf of Boothia (Canada)

Status – Stable / Subpopulation size estimate – 1592 (PBSG 2013)

The boundaries of the Gulf of Boothia subpopulation are based on genetic studies and movements of tagged bears. This subpopulation has the smallest areal extent north from mainland Nunavut to the northern limit of the Gulf of Boothia and east west from Boothia Peninsula to Baffin Island (summarized from: Vongraven and Peacock 2011).

Foxe Basin (Canada)

Status – Stable / Subpopulation size estimate – 2580 (PBSG 2013)

The Foxe Basin subpopulation appears to occur in Foxe Basin, northern Hudson Bay, and the western end of Hudson Strait. 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 (summarized from: Vongraven and Peacock 2011).

Southern Hudson Bay (Canada)

Status – Stable / Subpopulation size estimate – 970 (PBSG 2013)

Recent studies have documented seasonal fidelity to the Ontario coast during the ice-free season, and some

intermixing with the Western Hudson Bay and Foxe Basin subpopulations during winter and spring months (summarized from: Vongraven and Peacock 2011).

Western Hudson Bay (Canada)

Status – Declining / Subpopulation size estimate – 1000 (PBSG 2013)

During the ice-free season, this subpopulation is generally geographically segregated from both the Southern Hudson Bay subpopulation to the southeast and the Foxe Basin subpopulation to the north. All three subpopulations overlap and mix on the Hudson Bay sea ice during the winter and spring (summarized from: Vongraven and Peacock 2011).

M'Clintock Channel (Canada)

Status – Increasing / Subpopulation size estimate – 284(PBSG 2013)

The boundaries for this subpopulation appear to be the islands to the east and west, the mainland to the south, and the heavy multiyear ice in Viscount Melville Sound to the north (summarized from: Vongraven and Peacock 2011).

Viscount Melville Sound (Canada)

Status – Data deficient / Subpopulation size estimate – 161 (PBSG 2013)

The Viscount Melville Sound subpopulation is found in the north-west of Canada. The boundaries stretch north from Victoria Island to Melville Island and west to Banks Island (summarized from: Vongraven and Peacock 2011).

Northern Beaufort Sea (Canada)

Northern Beaufort Sea Status – Stable / Subpopulation size estimate – 980 (PBSG 2013)

The northern Beaufort Sea subpopulation is found in the west of the Canadian Arctic. The boundary includes most of Banks Island, a section of Melville Island and Victoria Island, on the eastern portion, and the southern portion runs along the coast of Nunavut and the northern portion of the Southern Beaufort Sea subpopulation. The western boundary abuts with the eastern limit of the Southern Beaufort Sea subpopulation (summarized from: Vongraven and Peacock 2011).

Southern Beaufort Sea (Canada, USA)

Southern Beaufort Sea Status – Declining / Subpopulation size estimate – 1526 (PBSG 2013)

The eastern boundary for the Southern Beaufort Sea subpopulation lies between Paulatuk and Baillie Island, Northwest Territories, Canada, with the western boundary near Icy Cape, Alaska. There is known overlap in Barrow, Alaska, USA, with half of the polar bears from the Southern Beaufort Sea subpopulation and the other half from the Chukchi Sea subpopulation. At Tuktoyaktuk, Northwest Territories, Canada, in the east, half of the polar bears are from the Southern Beaufort Sea subpopulation and half are from the Northern Beaufort Sea subpopulation. Based on this analysis, polar bears found in the vicinity of the current eastern boundary near Pearce Point, Northwest Territories, are rarely members of the Southern Beaufort Sea subpopulation (summarized from: Vongraven and Peacock 2011).

Arctic Basin (Canada, Greenland, Norway, Russia, USA)

Status – Data deficient / Subpopulation size estimate – unknown (PBSG 2013)

The large area surrounding the North Pole is a geographic catch-all for polar bears not accounted for by the other delineated subpopulations. Polar bears occur here at very low densities and it is known that bears from various subpopulations use the area (summarized from: Vongraven and Peacock 2011).

2.3 Habitat

During their 2009 meeting, Parties to the 1973 Agreement on the Conservation of Polar Bears agreed that impacts of climate change and the continued and increasing loss and fragmentation of sea ice - the key habitat for both polar bears and their main prey species - constitute the most important threat to polar bear conservation. The Parties expressed deep concern over the escalating rates and extent of changes in the Arctic induced by climate change to date and noted that future changes are projected to be even larger, reaffirming that long term conservation of polar bears depends upon successful mitigation of climate change (Parties to the 1973 Agreement on the Conservation of Polar Bears 2009).

Polar bears are distributed throughout the circumpolar basin with the southern extent of the distribution limited by

the extent of Arctic sea-ice. Their preferred habitat is the annual sea-ice over the continental shelf and inter-island archipelagos that encircle the polar basin (Derocher, Lunn et al. 2004; Amstrup et al. 2008). Sea-ice allows polar bears to exploit the productive marine environment by providing a platform from which they can hunt ringed and bearded seals and occasionally take belugas, narwhals, walrus, harbor seals, reindeer and birds (Stirling and Parkinson 2006; Laidre, Theimann et al. 2008), in an environment that has been largely free of competitors and predators, with the exception of humans in nearshore areas.

Polar bears show fidelity to geographic regions (Amstrup, Durner et al. 2000; Laidre et al. 2012, Stirling et al. 1999). They occupy multiannual home ranges outside of which they seldom venture. Not all areas of their multiannual home ranges are used each year. In areas of volatile ice, a large multiannual home range, of which only a portion is used in any one season or year, is an important part of the polar bear life history strategy (Amstrup 2003; Vongraven and Peacock 2011).

Ferguson, Taylor and Messier (2000) found that, during spring and summer, polar bears in the Arctic archipelago used land-fast ice most intensively, whereas in Baffin Bay moving ice was a stronger preference. In autumn, female polar bears from both regions preferred multiyear ice. Differences were also apparent between the two regions for the distances of bears to the ice edge, as well the preference to closed ice (Ferguson, Taylor et al. 2000). It is likely that further differences exist for each of the other regions. For instance, another study found that polar bears in the Beaufort Sea and Amundsen Gulf in the western Canadian Arctic preferred floe-edge, moving ice, and drifting fast-ice habitats in the late winter and spring (Stirling, Andriashek et al. 1993).

Across most of their range, pregnant female polar bears excavate dens in snow and ice in early winter and give birth in those dens during midwinter, emerging in the spring when their cubs are approximately three months old. In other areas of the range (e.g. Doughty Hudson Bay) polar bears are known to den on land in earth and peat dens (Derocher 2012). In some areas, notably the Beaufort and Chukchi Seas of the polar basin, many females den and give birth to their young on drifting pack ice (Amstrup 2003; Durner, Amstrup et al. 2006).

2.4 Migrations

Of the 19 defined subpopulations, seven directly overlap two or more national jurisdictions, qualifying polar bears as 'migratory' as defined by Article 1 of the Convention on Migratory Species (CMS):

... the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries;

Moreover, linear movements and activity areas of polar bears are very large compared to those of most terrestrial mammals, while varying between regions, presumably because of variation in patterns of productivity and other sea-ice characteristics (Amstrup 2003; Bergen, Durner et al. 2007).

Because polar bears derive their sustenance from the sea, their distribution in most areas changes with the seasonal extent of sea-ice cover. Throughout the polar basin, polar bears spend their summers concentrated along the edge of the persistent pack ice. Significant northerly and southerly movements appear to be dependent on seasonal melting and refreezing of ice near shore (Amstrup, Durner et al. 2000). For example, in winter, sea-ice may extend as much as 400 km south of the Bering Strait, which separates Asia from North America, and polar bears extend their range to the southernmost extreme of the ice. Sea-ice disappears from most of the Bering and Chukchi Seas in summer, and polar bears occupying these areas may migrate as much as 1000 km to stay with the southern edge of the pack ice. In other areas, for example Hudson Bay, James 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 (Ferguson, Taylor et al. 1997; Lunn, Stirling et al. 1997; Stirling et al. 1999; Amstrup, Durner et al. 2000; Mauritzen, Derocher et al. 2001; Amstrup 2003; Durner, Douglas et al. 2007; Gleason and Rode 2009).

Movements of greater than 4 km/hour and greater-than 50 km/day have been observed. The average annual activity area of 75 female polar bears monitored in the Beaufort Sea area was approximately 149,000 km², but ranged up to 597,000 km² (Amstrup, Durner et al. 2000). Cyclical and regular seasonal movements is well described for polar bears (e.g. Belikov and Gorkunov 1991; Belikov et al 1996; Braaten et al. 2000; Cherry et al. 2013; Durner et al.

2009; Flyger and Townsend 1968; Hansson 1991; Laidre et al. 2008; Mauritzen et al 2001, 2002; Wiig 1995; Zeyl et al. 2009).

3. Threat data

3.1 Direct threats

3.1.1 Disease or predation

The available scientific information indicates that disease and predation (including intraspecific predation) do not threaten the species throughout its range. Disease, pathogen exposure from changed diet or the occurrence of new pathogens that have moved northward with a warming environment, and mortality from cannibalism all warrant continued monitoring and may become more significant threats in the future for subpopulations experiencing nutritional stress or declining numbers (Derocher, Lunn et al. 2004; Amstrup, Stirling et al. 2006; Burek, Gulland et al. 2008; Stirling and Ross 2011; Letcher, Bustnes et al. 2010; Jensen, Lydersen et al. 2010; Sonne, Letcher et al. 2012; Rengifo-Herrera, Ortega-Mora et al. 2012).

3.1.2 Contaminants

Increased exposure to contaminants that enter the Arctic via long-range transport on air and ocean currents, river systems, and runoff have the potential to operate in concert with other factors, such as nutritional stress from loss of sea-ice habitat or decreased prey availability and accessibility, to lower recruitment and survival rates that ultimately would have negative subpopulation level effects.

Historical studies of levels of polychlorinated biphenyls (PCBs) in polar bears around the Arctic concluded that the most polluted polar bears lived in Northeast Greenland, the Barents Sea, and the Kara Sea (Verreault, Gabrielsen et al. 2005; Vongraven and Peacock 2011) because of global transport and deposition patterns.

Many pollutants reach high levels in polar bears due to their high fat diet and high trophic position. A number of the organochlorine pollutants are lipophilic; that is, they are deposited in the fat of the animals that consume them. Because animals in the Arctic marine ecosystem are highly dependent on fat for storing energy, growth, insulation and buoyancy, these pollutants are rapidly accumulated progressively up the food chain in a process known as biomagnification (Norstrom, Belikov et al. 1998; Bentzen, Follmann et al. 2008; Vongraven and Peacock 2011).

Polar bears may also be susceptible to contaminant-induced stress that may have an overall sub-clinical impact on their health and subpopulation status via impacts on their immune and reproductive systems (Bernhoft, Skaare et al. 2000; Letcher, Bustnes et al. 2010; Sonne 2010). In female polar bears, the existing body levels of organochlorine compounds may be sequestered effectively when fat reserves are high, but the sequestration away from physiological pathways may be inadequate during a poor feeding season (AMAP 1997; Laidre, Stirling et al. 2008).

New pollutants are also being found in polar bears. Recently, brominated flame retardants and perfluorinated alkyl substances have been detected (Muir, Backus et al. 2005; Smithwick, Mabury et al. 2005; Verreault, Gabrielsen et al. 2005; Dietz, Bossi et al. 2008; Letcher, Bustnes et al. 2010; McKinney, Letcher et al. 2011; McKinney, Letcher et al. 2011).

It is also possible that many other compounds will be identified, and that contaminants in marine systems may change with a changing climate (Usher, Callaghan et al. 2005; Burek, Gulland et al. 2008). However, some pollutants, like PCBs, now banned in most countries, are beginning to show signs of decrease in the Arctic and in polar bears.

3.1.3 Shipping and marine industries

Longer ice-free seasons and reduced ice coverage could increase shipping activity and increase resource exploration, development, and production in areas used by polar bears. Potential effects of shipping on polar bears include pollution, noise, physical disturbance related to ice-breaking, and waste (Lunn, Vongraven et al. 2010).

Mineral and petroleum exploration and extraction in the Arctic poses a wide of range of threats to polar bears, ranging from oil spills and noise disturbance to increasing traffic, icebreaking and human activity. (Schliebe, Rode

et al. 2008; Vongraven and Peacock 2011).

These factors may become more significant threats in the future for polar bear subpopulations experiencing nutritional stress brought on by sea-ice and environmental changes.

3.2 Habitat destruction

Fragmentation and loss of sea-ice are the most critical conservation concerns for polar bears today (Amstrup, Marcot et al. 2007; Durner, Douglas et al. 2009; Regehr, Hunter et al. 2009; Hunter, Caswell et al. 2010; Castro de la Guardia, Derocher et al. 2013). Laidre et al. (2008) quantified the three most climate change-sensitive Arctic species as the hooded seal, the narwhal, and the polar bear, noting that the polar bear was highly sensitive because of its population size and lack of dietary diversity. Recently the US Fish and Wildlife Service has designated ringed and bearded seals as threatened as a consequence of climate change (NOAA Fisheries 2012).

Polar regions have experienced significant warming in recent decades. Increased atmospheric concentrations of greenhouse gases are having a larger effect on climate in the Arctic than anywhere else on the globe. Warming has been most pronounced across the Arctic Ocean Basin and along the Antarctic Peninsula, with significant decreases in the extent and seasonal duration of sea-ice. Rapid retreat of glaciers and disintegration of ice sheets have also been documented. Arctic sea ice extent is now more than two million square kilometres less than it was in the late 20th century, and the duration and magnitude of the current decline in sea ice seem to be unprecedented for the past 1,450 years (ACIA 2004; McBean, Alekseev et al. 2005; Johannessen 2008; Douglas 2010; Kinnard, Zdanowicz et al. 2011).

The sequence of reduced September sea ice extent over the past decade suggests acceleration in the transition towards a seasonally open Arctic Ocean. The downward trend in September ice extent is best explained from a combination of natural variability in air temperature, atmospheric and ocean circulation, and forcing from rising concentrations of atmospheric greenhouse gases. Because of the extensive open water in recent Septembers, ice cover in the following spring is increasingly dominated by thin, first-year ice that is vulnerable to melting out in summer. Thinner ice in spring is more vulnerable to strong summer retreat and the general warming of the Arctic reduces the likelihood of cold years that could bring about temporary recovery of the ice cover. The rate of warming is predicted to continue well into the current century, with continued impacts on snow and sea-ice cover over most of the Arctic (Kattsov, Källén et al. 2005; Loeng, Brander et al. 2005; Moline, Karnovsky et al. 2008; Douglas 2010; Stroeve, Serreze et al. 2012) and an additional decline of 10-50 percent of annual average sea-ice extent is predicted by 2100. Climate models predict the complete loss of summer sea-ice in the Arctic in about 30 years (Loeng, Brander et al. 2005; Amstrup, Marcot et al. 2007; Pachauri and Reisinger 2007). It is very likely that there will be earlier sea-ice melt and later freeze-up.

While impacts of climate warming will be experienced differently among the subpopulations of polar bears in the Arctic (Bergen, Durner et al. 2007), the observed changes from 1985 through to 2006 have already shown pronounced losses of polar bear habitat during the spring and summer in the Southern Beaufort, Chukchi, Barents, and East Greenland seas. Forward projections indicate pronounced losses in the nearshore regions of the Laptev and Kara seas as well. Either scenario presents energetic challenges that could jeopardize these subpopulations (Durner, Douglas et al. 2009). By the end of the 21st century the Canadian Archipelago and Greenland may be the only remaining regions with polar bear subpopulations (Amstrup, Marcot et al. 2007).

Polar bears give birth to young in dens of snow and ice during mid-winter. Maternal dens are built adjacent to landscape or sea-ice features that capture and accumulate wind-blown snow (Bergen, Durner et al. 2007). In the southern Beaufort Sea, researchers are finding an increasingly greater proportion of dens are occurring on land (Fischbach, Amstrup et al. 2007). Polar bear survival is dependent on the sea-ice as a platform from which they capture seals and pregnant polar bears must transit between pelagic foraging habitats and terrestrial denning habitats. Autumn sea-ice development therefore determines the distribution of polar bear terrestrial dens. Researchers have found that denning is occurring at greater frequency on land near persistent summer sea-ice, or waters that develop sea-ice early in the autumn (Fischbach, Amstrup et al. 2007). As a result of warming in winter and unseasonal rain, it is possible that there will be increased mortality of female polar bears in dens with newborn cubs and ringed seals,

the primary food of polar bears, on the sea ice (Clarkson and Irish 1991; Stirling and Smith 2004)

Body condition (lipid stores) is also an important determinant to successful rearing of healthy young in the spring (Atkinson and Ramsay 1995) and it is thought that denning success is inversely related to the distance a pregnant polar bear is required to travel to reach denning habitat. In recent years, pregnant polar bears are expending greater energetic expense in reaching traditional denning regions as sea-ice loss increases and in some areas, such as Western Hudson Bay, they are fasting for longer periods of time on reduced fat reserves. This in turn will affect individual fitness, denning success, and ultimately subpopulations of polar bears (Aars, Lunn et al. 2005; Molnar and Derocher 2011; Stirling and Derocher 2011).

Bergen et al. (2007) have suggested that the minimum distance that polar bears are now travelling from ice habitats to denning habitats in northeast Alaska has increased (between 1979-2006) at a rate of six to eight km/year, and this long-term rate almost doubled after 1992. Based on projected sea-ice distributions the minimum distance that polar bears will travel from ice habitats to denning habitats in northeast Alaska will increase almost three-fold, reaching upwards of 1,500 – 2,000 km by 2060, with pronounced increases commencing around the year 2030 (Bergen, Durner et al. 2007). Similarly, the arrival of sea ice at Hopen Island, Svalbard, Norway, in autumn shifted from late October to mid-December during the period 1979 to 2010. Fewer maternity dens were found on Hopen Island in years when sea ice arrived later in the autumn. Later arrival of sea ice in the autumn at Hopen Island was correlated with lower body mass of adult females and their cubs at emergence, and researchers have suggested that the trend of later arrival of sea ice in autumn may be affecting the denning ecology of polar bears at the southern extent of their range in Svalbard (Derocher, Andersen et al. 2011).

Polar bears in some regions are already demonstrating reduced physical condition, reduced reproductive success, and increased mortality (Monnett and Gleason 2006; Parks, Derocher et al. 2006; Regehr, Lunn et al. 2007; Cherry, Derocher et al. 2008; Schliebe, Rode et al. 2008; Stirling, Richardson et al. 2008; Wiig, Aars et al. 2008; Regehr, Hunter et al. 2009; Kirk, Amstrup et al. 2010; Molnár, Derocher et al. 2010; Rode, Amstrup et al. 2010; Molnár, Derocher et al. 2011; Rode, Peacock et al. 2011). However in other areas polar bears have shown improvements in body condition over periods of sea ice loss, highlighting variability in responses across regions that may be related to differences in productivity (Rode et al. 2013). The tightly constrained diets of some individuals, particularly adult females and subadults, may make them especially sensitive to future climate change impacts (Rockwell and Gormezano 2008; Thiemann, Iverson et al. 2008; Thiemann, Iverson et al. 2011).

Subpopulations in different areas of the Arctic will experience different rates of change and timing of impacts. Within the foreseeable future, however, all ecoregions will be affected (Amstrup et al. 2008). In some locations where sea-ice already completely disappears in summer — for example, the Canadian Arctic islands, Svalbard, northern Alaska and Russian Chukotka — use of land by polar bears is already increasing (Schliebe, Evans et al. 2006). The amount of time on land is critical because polar bears are not able to capture normal prey and are more likely to be killed by human hunters. (Stirling and Derocher 2007; Stirling et al. 2011; Obbard 2008; Peacock et al. 2013; Rode et al. 2014;). Subpopulations not yet impacted by deteriorating ice conditions might become so in the future.

As changes in habitat become more severe and seasonal rates of change more rapid, larger-scale, catastrophic mortality events may occur; current observations of drownings and emaciated animals may be a prelude to such events. Drowning and starvation might increase if land-based bears are forced to swim in search of ice in key seasons, corresponding with longer open water periods (Monnett and Gleason 2006; Derocher et al. 2013).

3.3 Threats connected especially with migrations

Increasing activities of Arctic industries, such as petroleum or increased shipping activities have significant potential to place a further burden on subpopulations already weakened by the cumulative impacts of habitat destruction. As such, there is an urgent need to discuss mitigation of these impacts before they become entrenched and the solutions more difficult to find.

Some studies have predicted that two-thirds of polar bears will be gone by mid-century (Amstrup, Marcot et al. 2008; Amstrup, DeWeaver et al. 2010;). The decrease in polar bear habitat exacerbates all other potential threats to polar bears, putting additional physiological demands on animals. Individuals may be put at increased risk of disease

and epizootics (Burek, Gulland et al. 2008; Letcher, Bustnes et al. 2010; Sonne 2010; Sonne, Letcher et al. 2012). Ultimately, these interrelated factors may have cumulative or synergistic impacts and will result in range-wide subpopulation declines (Stirling and Derocher 2012). Some experts have concluded that many polar bear subpopulations will not survive in the long term due to the complete loss of summer sea-ice (Derocher, Lunn et al. 2004; Amstrup, Marcot et al. 2007; Stirling and Derocher 20012; Amstrup, Caswel et al. 2009).

Changes in polar bear migration routes or movement patterns will likely not be conclusively detected until ecological conditions, particularly the distribution and abundance of ice, change significantly (Laidre, Stirling et al. 2008), at which point there might be no ability to return to previous behaviours.

3.4 National and international utilization

Habitat destruction will exacerbate the impact of utilization and trade in several subpopulations (Aars, Lunn et al. 2005). As such the Range States have emphasized the importance of adaptive management strategies based on scientific and traditional knowledge to inform adjustment to harvest levels (see Declaration of the Responsible Ministers of the Polar Bear Range States, December 4, 2013). The Polar Bear Specialist Group, through resolution (IUCN Polar Bear Specialist Group 2006), urged that a precautionary approach be instituted when setting harvest limits in a warming Arctic environment urging that continued efforts are necessary to ensure that harvest or other forms of removal do not exceed sustainable levels.

3.4.1 Harvest

Polar bears are susceptible to over-harvest due to their life history characteristics. Historically, unregulated over-harvest resulted in the serious decline of many subpopulations (Prestrud and Stirling 1994). The Polar Bear Agreement, signed in 1973 by all five range States, restricted harvests to those “by local people using traditional methods in the exercise of their traditional rights” and “wherever polar bears have or might have been subject to taking by traditional means by its nationals”. However, the Agreement allows “skins and other items of value resulting from taking” to “be available for commercial purposes.”

In the Norwegian Arctic and Russia, polar bears are protected from all forms of harvest except problem or defence kills, although poaching is a significant conservation issue in Russia (Belikov, Boltunov et al. 2010).

There is legal harvest of polar bears in Greenland, the USA and Canada. In all three countries polar bears are harvested for subsistence purposes and the sale of handicrafts derived from these bears is permitted under national law. International trade in polar bear items (e.g. hides or scientific samples) is permitted under the Appendix II listing on the Convention on the International Trade in Endangered Species.

3.4.2 Live capture

The take of cubs is also prohibited through the range. A small number of orphaned cubs have been placed in public display facilities (Schliebe, Wiig et al. 2008).

3.4.3 Legal trade

The international trade in polar bear parts and derivatives is important culturally, socially and economically for Arctic communities. From 2005 to 2009, on average 400 bears entered trade annually. Items traded include carvings, skulls, skins and claws, with a proportion allocated to scientific samples collected from still-living bears (Shadbolt et al. 2012). CITES addresses issues related to international trade, and has also in 2014 initiated a Significant Trade Review Process. Any CMS Appendix listing of polar bear should seek to cooperate fully with this ongoing work.

3.4.4 Ecotourism

Public viewing and photography are another form of utilization and occur at Churchill, Canada, in Svalbard, Norway, and to a limited extent on the north coast of Alaska (Schliebe, Wiig et al. 2008).

Increasing levels of ecotourism may lead to greater impacts on polar bears, especially if the increase of exposure is related to changing sea-ice conditions and resulting changes to polar bear distribution and nutritional stress (Schliebe, Wiig et al. 2008; Vongraven and Peacock 2011). The number and range of cruise ships moving further north into areas used by polar bears may also increase. Potential effects of increased tourism include pollution, disturbance, and increased risk of defence kills (Lunn, Vongraven et al. 2010). During the 2009 meeting of the IUCN/Polar Bear Specialist Group, biologists requested the drafting of restrictive guidelines, deterrent training and

educational materials for the Arctic region to minimize tourism-related disturbance (Obbard et al. 2010). Current mitigation measures include the Association of Arctic Expedition Cruise Operator's rules for tour operators and visitors to maximize safety and minimize disturbances to the polar bears.

3.4.5 Human Caused Removals

Human- caused removals include harvested bears (based on legal Total Allowable Limits), bears killed in defense of life or property, bears killed during research activities, humane kills, accidental kills, etc. The 5 years mean of human-caused removals from the subpopulations presented clockwise from the Chukchi Sea, is as follows:

Chukchi Sea: Not known (PBSG 2013)
Laptev Sea: Not known (PBSG 2013)
Kara Sea: Not known (PBSG 2013)
Barents Sea: Not known (PBSG 2013)
East Greenland: 60 (PBSG 2013)
Davis Strait: 96 (PBSG 2013)
Baffin Bay: 156 (PBSG 2013)
Kane Basin: 11 (PBSG 2013)
Norwegian Bay: 4 (PBSG 2013)
Lancaster Sound: 85 (PBSG 2013)
Gulf of Boothia: 74 (PBSG 2013)
Foxe Basin: 109 (PBSG 2013)
Southern Hudson Bay: 45 (PBSG 2013)
Western Hudson Bay: 20 (PBSG 2013)
M'Clintock Channel: 3 (PBSG 2013)
Viscount Melville Sound: 7 (PBSG 2013)
Northern Beaufort Sea: 65 (PBSG 2013)
Southern Beaufort Sea: 76 (PBSG 2013)
Arctic Basin: Not known (PBSG 2013)

4. Protection status and needs

Most current information about polar bears has been derived from studies in the USA (Alaska), Canada, Greenland and Norway (Svalbard). Even so, large portions of the Arctic either have not been studied or have been the sites of less consistent efforts. These inequalities of available data create difficulties in drawing conclusions applicable over large regions of the Arctic. The greatest information gap is in the Russian Arctic (Vongraven and Peacock 2011).

4.1 The Arctic Council - Conservation of Arctic Flora and Fauna (CAFF)

The Conservation of Arctic Flora and Fauna (CAFF) is the biodiversity working group of the Arctic Council that consists of National Representatives assigned by each of the eight Arctic Council Member States, representatives of Indigenous Peoples' organizations that are Permanent Participants to the Council, and Arctic Council observer countries and organizations. CAFF's mandate is to address the conservation of Arctic biodiversity, and to communicate its findings to Governments and residents of the Arctic, helping to promote practices which ensure the sustainability of the Arctic's living resources. It does so through various monitoring, assessment and expert group activities.

The Arctic Biodiversity Assessment is CAFF's response to current global conservation needs. A full scientific assessment and suite of policy recommendations on the status and trends of Arctic biodiversity has been developed. The first deliverable of the Arctic Biodiversity Assessment was an overview report - *Arctic Biodiversity Trends 2010: Selected Indicators of Change* - released in May 2010, containing a preliminary assessment of status and trends in Arctic biodiversity and is based on a suite of 22 indicators developed by the Circumpolar Biodiversity Monitoring Program. The report identified seven key findings:

- Unique Arctic habitats for flora and fauna, including sea ice, tundra, thermokarst ponds and lakes, and permafrost peatlands have been disappearing over recent decades.
- Although the majority of Arctic species examined in this report are currently stable or increasing, some

species of importance to Arctic peoples or species of global significance are declining.

- Climate change is emerging as the most far reaching and significant stressor on Arctic biodiversity. However, contaminants, habitat fragmentation, industrial development and unsustainable harvest levels continue to have impacts. Complex interactions between climate change and other factors have the potential to magnify impacts on biodiversity.
- Since 1991, the extent of protected areas in the Arctic has increased, although marine areas remain poorly represented.
- Changes in Arctic biodiversity are creating both challenges and opportunities for Arctic peoples.
- Long-term observations based on the best available traditional and scientific knowledge are required to identify changes in biodiversity, assess the implications of observed changes and develop adaptation strategies.
- Changes in Arctic biodiversity have global repercussions (Gill, Zöckler et al. 2010)

This foundation document has been further supported by the 2013 release of the *Arctic Biodiversity Assessment: Status and trends in Arctic biodiversity*, which confirms that the declining sea ice habitat is the greatest threat to polar bears. Springtime is an especially important period for several species because it coincides with critical reproduction periods or important feeding opportunities. Sea ice declines over the past several decades have been clearly documented, and the latest projections indicate an ice-free high Arctic in summer within three decades and that further polar bear habitat loss and habitat degradation can be expected. Declining sea ice habitat has been associated in some areas with declines in population abundance, declines in survival, declines in body condition, declines in recruitment and increased swimming. In general, scientists expect there will be large future reductions in most of the 19 subpopulations of polar bears. (Amstrup et al. 2008, Hamilton et al. in press). The *Arctic Biodiversity Assessment* recommends that the most urgent conservation need for ice-associated mammals, especially polar bear and pinnipeds, is a stabilization and reduction of greenhouse gases at the global scale, so that climate change can be slowed and limited in intensity world-wide (Reid, Berteaux, et al 2013).

4.2 Non-Arctic State interest in Arctic biodiversity

The Arctic Range States have mechanisms for the conservation of Arctic biodiversity through the Arctic Council and CAFF (Kattsov, Källén et al. 2005; Usher, Callaghan et al. 2005; Laidre,; Young 2009; Gerhardt, Steinberg et al. 2010; Gill, Zöckler et al. 2010; Kurvits, Alftan et al. 2010; Lunn, Vongraven et al. 2010; Cedar 2011), as is evidenced in the development of a pan-Arctic monitoring plan for polar bears (Vongraven and Peacock 2011). However, a number of impacts originate or are generated beyond the Arctic Circle and there is a need for a means to bring non-Arctic Governments to the policy discussions that have been generated and agreed through appropriate regional fora such as the Arctic Council and CAFF (Koivurova, Molenaar et al. 2009; Gerhardt, Steinberg et al. 2010).

Non-Arctic States are already seeking an enhanced role in the Arctic Council and asserting Arctic policy strategies of their own, as exemplified by the October 2008 Resolution of the European Parliament and the November 2008 Communication from the European Commission (European Parliament, 2008; European Commission, 2008). Also, the 1982 United Nations Convention on the Law of the Sea (UNCLOS) applies to the entire Arctic Basin (United Nations Convention on the Law of the Sea, 1982) and is in force for all Arctic rim states except the United States, which accepts the relevant provisions of UNCLOS as customary international law (Berkman and Young 2009). The International Maritime Organization adopted a set of voluntary 'Guidelines for Ships Operating in Ice-Covered Arctic Waters' in 2002 (Jensen, 2007) and the scope of some regional fisheries management organizations (RFMOs) created pursuant to UNCLOS Article 118 (e.g., the Northeast Atlantic Fisheries Commission) are broad enough to cover parts of the Arctic Basin (Molenaar and Corell 2009). The 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic, which focuses on pollution, is applicable to a significant segment of the Arctic Ocean (Convention for the Protection of the Marine Environment of the North-East Atlantic, 1992).

Success of science diplomacy in the Arctic will depend on knowledge-sharing and the steady generation of scientific findings (Berkman and Young 2009; Young 2009; Young 2012). However, detailed decision-making processes will also be needed to enable all Arctic and non-Arctic Governments to align their responses to agreed need. Like the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) addressing the detail of the regulation of trade in endangered species, CMS provides an appropriate mechanism to facilitate Arctic and non-Arctic States to discuss and agree on the detail of migratory species-related measures – especially those that should

be considered by non-Arctic States to complement those already in development in the Arctic region's processes. Such measured focus on the mitigation of impacts to CMS-listed species from climate change, pollution and shipping and marine industries, where those activities are under the jurisdictional control of non-Arctic States, should be a priority for CMS Parties.

4.3 National protection status

4.3.1 Canada (Manitoba, Newfoundland and Labrador, Northwest Territories, Nunavut, Ontario, Quebec, Yukon Territory)

The primary management responsibility for polar bears in Canada lies with the Provinces, Territories and wildlife management boards in which they occur. The overall management framework includes the legislation, research and management programs of each of these jurisdictions, along with the Species at Risk Act (SARA), 2002, and the Canadian Polar Bear Technical and Administrative Committees. The Species at Risk Act applies to all Federal lands in Canada; all wildlife species listed as being at risk; and their critical habitat (Species at Risk Act, 2002). Polar bears are listed under the Species at Risk as a species of 'Special Concern – Schedule 1' (Species at Risk Public Registry, 2012). In accordance with the Special Concern listing, Canada is developing a SARA Management Plan. The National Polar Bear Conservation Strategy (http://ec.gc.ca/nature/default.asp?lang=En&n=60D0FDBD-1#_004) was finalized in 2011 and will be integrated into SARA Management Plan. Polar bears are also listed under Provincial/Territorial legislation in Ontario (Threatened), Northwest Territories (Special Concern), Newfoundland and Labrador (Vulnerable), Manitoba (Threatened), Quebec (Vulnerable).

In 2008, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed the polar bear as a single overall population in accordance with criteria set in accordance with the Act. In its report, COSEWIC also reported trends by subpopulation. Population models project that four of 13 Canadian subpopulations have a high risk of declining by 30 percent or more over the next three bear generations (36 years). The 15th Meeting of the IUCN/SSC Polar Bear Specialist Group voiced concern about the COSEWIC assessment and recommended that:

1. due to the speed of current global warming the status of polar bears in Canada be re-assessed within 5 years of the last re-assessment rather than delaying to the normal 10-year cycle;
2. the status of polar bears in Canada be re-assessed within the context of ongoing and projected habitat losses; and
3. geographic variation in anticipated effects of global warming and other potential population stressors be included when re-assessing the status of polar bears in Canada (IUCN/SSC Polar Bear Specialist Group, 2009).

In Canada the hunting of polar bears is reserved for Aboriginal people or (should they decide to allocate some of their quota) to sport hunters accompanied by an Inuit guide using traditional means. All human caused mortality is applied to the legal quota within a given region. Much of the obligation to fund and conduct polar bear research and monitoring in Canada is at the regional level (Provinces and Territories), although significant financial resources are given annually to the jurisdictions from the Federal government to carry out this work. In addition the Federal government has also conducted long-term research of the Western Hudson Bay subpopulation and more sporadically in Davis Strait and the Beaufort Sea subpopulations (Vongraven and Peacock 2011).

In Canada, harvest quotas are typically established based upon both scientific data and Aboriginal Traditional Knowledge, and it is formally recognized that both sources of knowledge are essential for effective management. In more recent years, changes to harvest levels have been made in response to Local Ecological Knowledge suggesting that numbers of polar bears have increased. In some cases, such recommendations have been made in the face of data indicating the populations are not increasing and may be declining (Peacock et al. 2011).

4.3.2 Greenland

Greenland Self-Government Authorities exercise legislative and executive power for defined areas of responsibility (Government of Greenland 2009). The Greenlandic Government's Ministry of Fisheries, Hunting and Agriculture has established a polar bear quota system. National regulations for polar bear management are fixed by law in Executive Order no. 21 of 22 September 2005 on the Protection and Hunting of Polar Bears. Hunting is not prohibited. Only full-time hunters are allowed to go polar bear hunting within each relevant municipality or area. A license is required for hunting and there is a detailed reporting system for all hunters. Polar bear quotas were issued in 2006, 2009 and again in 2011 (Parties to the 1973 Agreement on the Conservation of Polar Bears, 2009b;

Greenland Ministry of Fisheries, Hunting and Agriculture 2009; Division on Wildlife Management, 2012). Prior to this the harvest of polar bears in Greenland was undertaken without quotas. In 2008 as a result of a Non-Detriment Finding (NDF) under CITES requirements, Greenland implemented a voluntary export ban on all polar bear products (Parties to the 1973 Agreement on the Conservation of Polar Bears 2011) which remains in effect today. The monitoring and research of polar bears in Greenland is primarily conducted by the Greenland Institute of Natural Resources and has been on-going since the 1980s. The Danish Environmental Research Institute also has monitoring programs in collaboration with the Greenland Institute of Natural Resources and international research agencies, specifically on the contaminants of polar bears (Greenland Ministry of Fisheries, Hunting and Agriculture 2009).

4.3.3 Norway (including Svalbard)

There has been no legal harvest of polar bears in Norway since 1973, but numbers and characteristics of defence kills are monitored, as well as human-bear interactions, especially in relation to tourism in Svalbard (Government of Norway, 2001). In 1927, the use of poison to hunt polar bears was prohibited. In 1939, an important denning area in Kongsøya was declared closed to hunting. In 1965, cubs and females with cubs were protected. In 1973, Norway prohibited the hunting of polar bears in Svalbard, except in cases of scientific or other special purposes. Approximately 65 percent of the land area of Svalbard is protected, including all major regions of denning by female polar bears. In 2001, the Norwegian Parliament passed a new Environmental Act for Svalbard. This act was designed to ensure that wildlife, including polar bears, is protected, although hunting of some species is allowed. The only permitted take of polar bears is for defense of life and property. In 2003, Svalbard designated six new protected areas, including the main polar bear denning area at Kong Karls Land (Norwegian Directorate for Nature Management 2009). Recent developments include work on management plans for protected areas important for polar bear denning and an agreement with Russia in 2010 on delineation of the border between Norway and Russia in the Barents Sea (Parties to the 1973 Agreement on the Conservation of Polar Bears 2011). Long term research conducted by the Norwegian Government (Norwegian Polar Institute) has resulted in extensive information on population ecology, movement, denning behaviour and contaminant load of polar bears on Svalbard and in the Barents Sea. There is at present considerable effort being put into investigating cost-efficient monitoring schemes for polar bears in the Barents Sea. This work is lead by the Norwegian Polar Institute, and a long term monitoring scheme of polar bear reproductive parameters as it relates to sea ice change has been established (Vongraven and Peacock 2011).

4.3.4 Russian Federation (North European Russia, Siberia, Chukotka, Sakha (Yakutia), Krasnoyarsk)

Restrictions on polar bear hunting began as early as 1938 in Russia with the prohibition on hunting from ships and hydro-meteorological stations. In the 1950s, polar bear hunting was further limited in the Soviet Arctic. In 1956 the decree On Protection of Arctic Animals was adopted forbidding all hunting of polar bears whether on shore, islands or in the water. This decree remains in force, although polar bears have been illegally hunted in Russia for some time. The polar bear was listed as a “Red List species” in 1978 (Government of the Russian Federation 2009; Parties to the 1973 Agreement on the Conservation of Polar Bears, 2009b). A recent agreement between the Russian Federation and the United States allows for legalized hunting by native peoples in the Russian Federation, although to date no such hunting has been allowed as Russia has imposed its own zero quota on such take. There are a number of protected areas (wildlife refuges, parks, sanctuaries and reserves) that serve to protect polar bear habitat. The Strategy for Polar Bear Conservation in the Russian Federation was approved by the Ministry of Natural Resources and Environment of the Russian Federation, Decree No. 26-r in 2010 (Parties to the 1973 Agreement on the Conservation of Polar Bears 2011). The Russian Academy of Sciences has collaborated with US Fish and Wildlife Service and US Geological Survey scientists to study the sea ice habitats of their shared polar bear population. Russian scientists have developed collaborations with Norwegian biologists in research on the population status of the Barents Sea subpopulations and with American researchers to study the Chukchi Sea subpopulation. Coastal monitoring programs have been developed across the Russian Arctic by local residents, in collaboration with non-governmental organizations, to increase deterrence activities, monitor poaching activities and to collect monitoring data. Since 1990, there has been a research and monitoring project on polar bear behaviour, condition, demography and denning on Wrangel Island in the Chukchi Sea (Vongraven and Peacock 2011).

4.3.5 United States of America (Alaska)

Polar bears are managed under the Marine Mammal Protection Act of 1972. All imports of polar bears and their products were banned under this act, with limited exceptions for science, conservation enhancement, public display, and, until recently, sport-hunted trophies. In May 2008, polar bears were listed as threatened under the Endangered

Species Act; as a consequence, only imports for science and conservation enhancement are still allowed. Indigenous people in Alaska are allowed to hunt polar bears, only for the purpose of traditional use. The US Fish and Wildlife Service has general responsibilities for conservation and management of polar bears, in partnership with the State of Alaska, the Alaska Nanuuq Commission and the North Slope Borough (Parties to the 1973 Agreement on the Conservation of Polar Bears, 2009b; United States Fish and Wildlife Service 2009). The Endangered Species Act listing still allows Alaska Native handicrafts (not including hides or rugs) to be exported for non-commercial purposes and allows marine mammal parts to be exported for cultural exchanges among Natives of Alaska, Russia, Canada, and Greenland (United States Fish and Wildlife Service 2009).

Research, monitoring, and management of polar bears are conducted largely by the US Federal government. Additional research is conducted by the North Slope Borough, and there are auxiliary studies on disease, contaminants and foraging ecology by universities in conjunction with Federal research. Habitat and demographic studies in the southern Beaufort Sea have been long term and often performed in cooperation with Canadian scientists. There have also been collaborative research efforts with Russia in the Chukchi Sea. The funding and human capacity for the study and management of polar bears in the United States is extensive (Vongraven and Peacock 2011).

4.4 International protection status

4.4.1 Coherence with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

The polar bear is listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) under the higher taxon listing of Ursidae. All range States are Parties to CITES and none has taken a reservation on this species listing. CITES appropriately addresses issues related to international trade, and any CMS Appendix listing of polar bear should seek to cooperate fully with this ongoing work.

4.4.2 Coherence with the Agreement on the Conservation of Polar Bears (ACPB)

The circumpolar Agreement on the Conservation of Polar Bears (ACPB) was signed in 1973 between the Governments of Canada, Denmark (Greenland), Norway, the Union of Soviet Socialist Republics (Russian Federation) and the United States of America, recognizing that the polar bear is a significant resource of the Arctic Region which requires additional protection. It prohibits the taking of polar bears except as provided in Article III, which includes the exercise of traditional rights in accordance with the laws of each Signatory Government. The 1973 Polar Bear Agreement requires that all Parties take appropriate action to protect the ecosystem of which polar bears are a part, with special attention to habitat 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 scientific data. During their 2009 meeting, the ACPB Parties reinforced the importance of habitat protection as a means of implementing Article II of the Agreement on protection of ecosystems of which polar bears are a part, recognizing that the expansion of protected areas can potentially reduce the vulnerability of polar bear populations and their ecosystems, and that protected areas should be designed with consideration of long-term shifts in sea ice conditions that will result from climate change and the overall integrity of habitats critical to polar bear survival (Parties to the 1973 Agreement on the Conservation of Polar Bears, 2009, 2009b). Since the 2009 Meeting of the Parties, the Range States have been developing a Circumpolar Action Plan for the species. This comprehensive plan includes an assessment of all threats that face the polar bear, under the advice of the IUCN/SSC PBSG, as well as how to mitigate them – including through the adoption of Best Management Practices (BMP's). Any CMS listing of polar bear should seek to support and integrate with this work. Non-range states Parties to CMS can engage in polar bear conservation by adopting relevant BMP's where appropriate (e.g. BMP for marine shipping and cruise ship operation). The Circumpolar Action Plan is expected to be finalized at the 2015 Meeting of the Parties.

4.4.3 Coherence with the Inuvialuit - Inupiat Polar Bear Management Agreement

In 2000, a bilateral Inuvialuit - Inupiat Polar Bear Management Agreement in the Southern Beaufort Sea was signed between the Inuvialuit of Canada and the Inupiat of the United States - groups that both harvest polar bears for cultural and subsistence purposes (Brower, Carpenter et al. 2002). This agreement, based on the understanding that the two groups harvested animals from a single population shared across the international boundary, provides a joint responsibility for conservation and harvest practices. Provisions of the agreement include annual quotas, hunting seasons, and protection of females, cubs and dens (United States Fish and Wildlife Service 2009; Brower et al.

2002). The Commissioners meet annually to decide on quotas and discuss population status and trends.

4.4.4 Coherence with the USA and Canadian Memorandum of Understanding

In 2008 a Memorandum of Understanding was signed between the USA and Canada, to facilitate and enhance coordination and cooperation for the conservation and management of polar bears between the two countries. The Memorandum of Understanding establishes the Bilateral Oversight Group in recognition of the need to leverage rather than duplicate the polar bear expertise and management experience of agency and Alaska Native/aboriginal people of both countries. The Memorandum of Understanding also identifies the need to establish a Scientific Working Group to assess the available information and aboriginal traditional knowledge of North American polar bear populations, and the establishment of other working groups as necessary to advise Environment Canada and the US Department of the Interior on polar bear management and conservation (United States Fish and Wildlife Service 2009).

4.4.5 Coherence with the Alaska-Chukotka Polar Bear Agreement

A bilateral Agreement between the Government of the United States of America and the Government of the Russian Federation on the conservation and management of the Alaska-Chukotka polar bear population was also signed in 2000 and implemented in 2007. The agreement provides oversight by a joint commission (two members/jurisdiction one Native and one Federal); sets harvest limits; has authority to enforce regulations and for monitoring and reporting; and develops research priorities in cooperation with native organizations. The Agreement commits the parties to the conservation of important polar bear habitats. The first meeting of the USA-Russia Polar Bear Commission took place in Moscow on 23-25 September 2009. The Commission developed the structure of a Scientific Working Group, which is to assist the Commission in resolving questions pertaining to the protection and management of the Alaska-Chukotka polar bear population (United States Fish and Wildlife Service 2009).

4.4.6 Coherence with the Canada, Nunavut and Greenland Polar Bear Agreement

A trilateral Memorandum of Understanding for polar bear conservation and management was signed in 2009 between the Governments of Canada, Nunavut and Greenland. It established a joint commission that will recommend combined total allowable harvest and a fair division of the shared harvest (Environment Canada, 2009b). It also established Scientific and Aboriginal Traditional Knowledge Working Groups that provide expertise to the Joint Commission. Since meeting in 2010, the Scientific Working Group developed a research program to update population estimates for the Kane Basin and Baffin Bay subpopulations. The field work was concluded in the spring of 2014 and new estimates will be available in the spring of 2015.

4.4.7 Coherence with the United Nations Convention on the Law of the Sea (UNCLOS)

The UNCLOS, adopted by the Third UN Conference on the Law of the Sea on December 10, 1982 entered into force in November 16, 1994. It established a modern framework for ocean governance, specifying rights of access and duties to conserve living resources and protect and preserve the marine environment. UNCLOS therefore provides that States are to prevent, reduce and control pollution of the marine environment. A number of polar bear conservation measures could be implemented through UNCLOS in collaboration with the CMS.

4.4.8 Coherence with CMS

There is a long standing mandate for appropriate CMS involvement in polar bear conservation emanating from: CMS considering the impact of climate change on the Arctic; the request for the CMS to identify Arctic species for listing on the CMS Appendices; and the specific identification during CMS CoP10 of polar bears as a species that will be seriously impacted by climate change and should be considered for listing. There is also a mandate for CMS to play a useful role in facilitating greater international cooperation for migratory species conservation.

In 1997, *CMS Recommendation 5.5: Climate Change and its Implications for the Bonn Convention* first requested the establishment of a working group to formulate CMS's response to the impacts of climate change (CMS 1997).

In 2005, *CMS Resolution 8.11: Cooperation with other Conventions* requested the examination of options for a flexible framework between all relevant actors, such as a global partnership on biodiversity, in order to enhance international implementation of migratory species conservation through improved cooperation. During the same CMS CoP, *Resolution 8.13: Climate Change and Migratory Species*, was also passed, recognising that climate change might significantly affect the behaviour, distribution and abundance of migratory species and might change

the ecological character of their habitats. Resolution 8.13 established a high priority programme of work for the CMS Secretariat and Scientific Council to pursue in this area (CMS, 2005; CMS 2005b).

In 2008, *CMS Resolution 9.6: Cooperation with other Bodies* was passed, reaffirming the importance for CMS of continuing to develop effective and practical cooperation with other biodiversity instruments and international organisations and for the CMS Secretariat, CMS daughter agreements and the Scientific Council to enhance engagement with IUCN expert committees. The 9th CMS CoP also passed *Resolution 9.7: Climate Change Impacts on Migratory Species*, which urged Parties to identify which migratory species are most likely to be directly or indirectly threatened or impacted by climate change and for the Scientific Council to prioritise climate change adaptation concerning migratory species in its future work programme; as well as for the various CMS bodies, other biodiversity organizations and biodiversity related bodies to produce scientific and technical advice to assist CMS Parties introduce adaptation measures to counteract the effects of climate change on migratory species (CMS, 2008; CMS 2008b). *CMS Resolution 9.9: Migratory Marine Species* drew specific attention to the major and accelerating changes to Arctic regions due to climate change and the consequences for migratory marine mammals specifically in these regions. The resolution directed the Scientific Council and the CMS Secretariat to identify priority issues, species and habitats in the marine sphere requiring intervention by CMS in the next decade, while specifically requesting that CMS seek avenues for research and dialogue on issues of common interest with the Arctic Council (in particular CAFF) regarding Arctic migratory marine species. Resolution 9.9 also requested that the Scientific Council should advise which additional Arctic migratory marine species might warrant listing on the CMS appendices (CMS, 2008c).

During CMS CoP10 in 2011, Parties extended the call for greater coordination and facilitation through *Resolution 10.21: Synergies and Partnerships* reiterating the importance of cooperation and synergies with other bodies. It requested the Secretariat to continue developing effective and practical cooperation with relevant stakeholders including other biodiversity instruments and international organizations. In particular Resolution 10.21 suggested that the CMS and Convention on Biological Diversity (CBD) Secretariat as well as the Secretariats of other relevant Multilateral Environmental Agreements (MEAs) could advise on ways and means of more coherently addressing the conservation and sustainable use of animal species in CBD processes. This would include ways and means in relation to the implementation by biodiversity-related conventions of the Strategic Plan for Biodiversity 2011-2020 and its Aichi Targets adopted by CBD CoP10 (Decision X/2). The Resolution also urged Parties to facilitate cooperation among international organizations and to promote the integration of biodiversity concerns related to migratory species into all relevant sectors by coordinating their national positions among the various conventions and other international fora in which they are involved (CMS, 2011c).

Also during CMS CoP10 *Resolution 10.3: The Role of Ecological Networks in the Conservation of Migratory Species* recognized that habitat destruction and fragmentation are among the primary threats to migratory species, and that the identification and conservation of habitats of appropriate quality, extent, distribution and connectivity are of paramount importance for the conservation of migratory species in both the terrestrial and marine environments. It also recognized that migratory species merit particular attention when designing and implementing initiatives aimed at promoting ecological networks in order to ensure that the areas selected are sufficient to meet the needs of these species throughout their life cycles and migratory ranges. Resolution 10.3 requested that the Secretariat work with Parties, the Scientific Council and other international and regional organizations, including CBD, to organize regional and sub-regional workshops to promote the conservation and management of critical sites and ecological networks among Parties (CMS, 2011).

Most importantly, the CMS Scientific Council Working Group on Climate Change presented the outcomes of a workshop - *The Impact of Climate Change on Migratory Species: the current status and avenues for action* - that collected research priorities and policy recommendations for inclusion in CMS's climate change policy and its climate change resolution (CMS, 2011d). Consequently, *Resolution 10.19: Migratory Species Conservation in the Light of Climate Change*, as drafted by the Working Group on Climate Change, was passed. It urged Parties, the Scientific Council, conservation stakeholders and relevant organizations to improve the resilience of migratory species and their habitats to climate change, by reducing other threats in order to maintain or increase population size and genetic diversity. When implementing Resolution 10.3 on ecological networks, Resolution 10.19 asks the Secretariat and the Scientific Council to examine whether provisions of the Convention, including the terms "range" and "historic coverage" in Article I, might benefit from a new interpretation that takes account of the requirements of species in response to climate change. This is in view of the fact that climate change was not explicitly considered

when the Convention text was signed in 1979. Resolution 10.19 also requests the Secretariat to strengthen synergies with the Secretariats of other international instruments, in order to address more effectively the threats that climate change poses to biodiversity, whilst recognizing the distinct mandates and independent legal status of each treaty. Finally, Resolution 10.19 requests Parties, the Scientific Council, and the scientific community (including IUCN and other relevant organizations) to identify Appendix I and II listed species, as well as other migratory species on the IUCN Red List, that are most susceptible to climate change and specifically to consider the listing of polar bear on the CMS appendices (CMS, 2011b).

4.5 Additional protection needs

The majority of policy and legislative effort to date has focused on the regulation of harvest and trade and the development of conservation management plans by Arctic Range States. However, although there are regulatory mechanisms for managing many of the threats to polar bears in each of the polar bear Range States, as well as among range countries through bilateral and multilateral agreements, there are no known regulatory mechanisms that are directly and effectively addressing reductions in sea ice habitat at this time.

As stated in previous sections, one study has predicted a two-thirds decline of polar bears by mid-century (Amstrup et al. 2008), changes in polar bear migration routes or movement patterns will likely not be conclusively detected until ecological conditions, particularly the distribution and abundance of ice, change significantly, at which point there might be no ability to return to previous behaviours.

The IUCN/SSC Polar Bear Specialist Group *Resolution 1-2009: Effects of global warming on polar bears* recognized that sea ice is essential to the continued survival of polar bears and that human-produced greenhouse gases are playing a significant forcing role in global warming, they recommended that urgent global action to significantly reduce atmospheric greenhouse gas concentrations (IUCN Polar Bear Specialist Group. 2009).

There is an urgent need focused, international attention on the impacts of the global community on polar bear habitat and ensuring that seasonal polar bear migrations are as un-impeded as possible, including through the restriction of activities that may involve non-Arctic States, such as petroleum exploration, petroleum extraction and shipping. It is appropriate for CMS to facilitate this attention.

5. Range States

Canada (Manitoba, Newfoundland and Labrador, Northwest Territories, Nunavut, Ontario, Quebec, Yukon Territory), DENMARK/Greenland, NORWAY (including Svalbard), Russian Federation (North European Russia, Siberia, Chukotka, Sakha (Yakutia), Krasnoyarsk), United States of America (Alaska). Vagrants occasionally reach Iceland.

6. Comments from Range States

Canada has contributed with factual information in August 2014, which has to a large degree been included.

7. Additional remarks

[to follow]

8. References

Aars, J., N. Lunn, et al. (2005). Polar Bears: Proceedings of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group. Seattle, Washington, USA.

ACIA (2004). Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge, Cambridge

- University Press.
- AMAP (1997). Persistent Organic Pollutants. Arctic Pollution Issues: A State of the Arctic Environment Report. Oslo, Arctic Council, Arctic Monitoring and Assessment Programme.
- Amstrup, S. (2003). The Polar Bear — *Ursus maritimus*: Biology, Management, and Conservation. Wild Mammals of North America. G. Feldhamer, B. Thompson and J. Chapman. Baltimore, Johns Hopkins University Press.
- Amstrup SC, Marcot BG, Douglas DC (2008) A Bayesian network modeling approach to forecasting the 21st century worldwide status of polar bears. In: Arctic Sea Ice Decline: Observations, Projections, Mechanisms, and Implications, Geophysical Monograph Series vol. 180 (eds DeWeaver ET, Bitz CM, Tremblay LB), pp. 213–268.
- Amstrup, S., E. DeWeaver, et al. (2010). "Greenhouse gas mitigation can reduce sea ice loss and increase polar bear persistence." Nature **468**: 955-960.
- Amstrup, S., G. Durner, et al. (2000). "Movements and distribution of polar bears in the Beaufort Sea." Canadian Journal of Zoology **78**(6): 948-966.
- Amstrup, S., H. Caswel, et al. (2009). "Rebuttal of 'Polar Bear Population Forecasts: A Public-Policy Forecasting Audit' " Interfaces **39**(4): 353-369.
- Amstrup, S., I. Stirling, et al. (2006). "Recent observations of intraspecific predation and cannibalism among polar bears in the southern Beaufort Sea." Polar Biology **29**(11): 997-1002.
- Atkinson, S. and M. Ramsay (1995). "The Effects of Prolonged Fasting of the Body Composition and Reproductive Success of Female Polar Bears (*Ursus maritimus*)." Functional Ecology **9**(4): 559-567.
- Belikov, S. E., Y. A. Gorbunov, V. I. Shilnikov, and A. V. Yablokov (1984), Distribution and migration of certain pinnipedes, whales and the polar bear in the seas of the eastern Arctic. Marine mammals: 233-252.
- Belikov, S. E., and Y. A. Gorbunov (1991), Distribution and migrations of the polar bear in the Soviet Arctic in relation to ice conditions, Occasional Papers of the IUCN Species Survival Commission, 70-74.
- Belikov, S., A. Boltunov, and Y. Gorbunov (1996), Distribution and migration of polar bears, Pacific walrus and gray whales depending on ice conditions in the Russian Arctic, Proceedings of the NIPR Symposium on Polar Biology, 9, 263-274.
- Belikov, S., A. Boltunov, et al. (2010). Strategy for Polar Bear conservation in the Russian Federation, Ministry of Natural Resources and Environment of the Russian Federation.
- Bentzen, T., E. Follmann, et al. (2008). "Dietary biomagnification of organochlorine contaminants in Alaskan polar bears." Canadian Journal of Zoology **86**(3): 177-191.
- Bergen, S., G. Durner, et al. (2007). Predicting Movements of Female Polar Bears between Summer Sea Ice Foraging Habitats and Terrestrial Denning Habitats of Alaska in the 21st Century: Proposed Methodology and Pilot Assessment. Reston, U.S. Geological Survey.
- Berkman, P. and O. Young (2009). "Science and government. Governance and environmental change in the Arctic Ocean." Science **17**(324(5925)): 339-340.
- Bernhoft, A., J. Skaare, et al. (2000). "Possible immunotoxic effects of organochlorines in polar bears (*Ursus maritimus*) at Svalbard." J. Toxicol. Env. Health **A**(59): 561–574.
- Brower, C., A. Carpenter, et al. (2002). "The Polar Bear Management Agreement for the Southern Beaufort Sea: An Evaluation of the First Ten Years of a Unique Conservation Agreement." Arctic **55**(4): 362-372.
- Braathen, M., M. Haave, G. H. Olsen, A. E. Derocher, J. U. Skaare, E. Ropstad, O. Wiig, E. G. Sormo, and B. M. Jenssen (2000), PCB contamination in relation to levels of thyroid hormones and progesterone, and migration patterns in polar bears (*Ursus maritimus*), Organohalogen Compounds, 49, 438-441.
- Burek, K., F. Gulland, et al. (2008). "Effects of Climate Change on Arctic Marine Mammal Health." Ecological Applications **18**(2): S126-S134.
- Castro de la Guardia, L., Derocher, A. E., Myers, P. G., Terwisscha van Scheltinga, A. D. and Lunn, N. J. (2013), "Future sea ice conditions in Western Hudson Bay and consequences for polar bears in the 21st century." Global Change Biology, **19**: 2675–2687
- CBC News. (April 11th, 2011). Demand for polar bear hides soars: auction house. CBC News. Toronto, CBC/Radio-Canada.
- CBC News. (April 1st 2011). Quebec hunters kill 12 times more polar bears. CBC News. Toronto, CBC/Radio-Canada.
- Cedar, O. (2011). "The Arctic Council: Gatekeeper or Doormat to the World's Next Major Resource Battle?" Sustainable Development Law & Policy **12**(1): 40, 51, 66-67.
- Cherry, S., A. Derocher, et al. (2008). "Fasting physiology of polar bears in relation to environmental change and

- breeding behavior in the Beaufort Sea." *Polar Biology* **32**(3): 383-391.
- Cherry, S. G., A. E. Derocher, G. W. Thiemann, and N. J. Lunn (2013), Migration phenology and seasonal fidelity of an Arctic marine predator in relation to sea ice dynamics, *J. Anim. Ecol.*, **82**, 912-921, doi:10.1111/1365-2656.12050.
- Clarkson, P., and D. Irish. (1991). Den collapse kills female polar bear and two newborn cubs. *Arctic* **44**: 83-84.
- CMS (1997). Recommendation 5.5: Climate Change and its Implications for the Bonn Convention, 5th Conference of the Parties to the Convention on Migratory Species of Wild Animals, Geneva
- CMS (2005). Resolution 8.11: Cooperation with other Conventions, 8th Conference of the Parties to the Convention on Migratory Species of Wild Animals, Nairobi
- CMS (2005b). Resolution 8.13: Climate Change and Migratory Species, 8th Conference of the Parties to the Convention on Migratory Species of Wild Animals, Nairobi
- CMS (2008). Resolution 9.6: Cooperation with other Bodies, 8th Conference of the Parties to the Convention on Migratory Species of Wild Animals, Rome
- CMS (2008b). Resolution 9.7: Climate Change Impacts on Migratory Species, 8th Conference of the Parties to the Convention on Migratory Species of Wild Animals, Rome
- CMS (2008c). Resolution 9.9: Migratory Marine Species, 8th Conference of the Parties to the Convention on Migratory Species of Wild Animals, Rome
- CMS (2011). Resolution 10.3: The Role of Ecological Networks in the Conservation of Migratory Species, 10th Conference of the Parties to the Convention on Migratory Species of Wild Animals, Bergen
- CMS (2011b). Resolution 10.19: Migratory Species Conservation in the Light of Climate Change, 10th Conference of the Parties to the Convention on Migratory Species of Wild Animals, Bergen
- CMS (2011c). Resolution 10.21: Synergies and Partnerships, 10th Conference of the Parties to the Convention on Migratory Species of Wild Animals, Bergen
- CMS (2011d). Conf 10.40: Impact of Climate Change on Migratory Species: The Current Status and Avenues for Action, 10th Conference of the Parties to the Convention on Migratory Species of Wild Animals, Bergen, at: http://www.cms.int/bodies/COP/cop10/docs_and_inf_docs/doc_40_climate_change_e.pdf (downloaded 14th April 2012)
- Convention for the Protection of the Marine Environment of the North-East Atlantic, 1992, (OJ L104) Paris, at: http://www.ospar.org/html_documents/ospar/html/ospar_convention_e_updated_text_2007.pdf (accessed 10th April 2012)
- Derocher, A.E. (2012). *Polar Bears: A Complete Guide to their Biology and Behavior*. Johns Hopkins University Press, 264 pp.
- Derocher, A., M. Andersen, et al. (2011). "Sea ice and polar bear den ecology at Hopen Island, Svalbard." *Marine Ecology Progress Series* (441): 273-279.
- Derocher, A., N. Lunn, et al. (2004). "Polar Bears in a Warming Climate." *Integrative and Comparative Biology* **44**(2): 163-176.
- Dietz, R., R. Bossi, et al. (2008). "Increasing Perfluoroalkyl Contaminants in East Greenland Polar Bears (*Ursus maritimus*): A New Toxic Threat to the Arctic Bears." *Environmental Science & Technology* **42**(7): 2701-2707.
- Division on Wildlife Management (2012). Marine animal quotas, Ministry of Fisheries, Hunting and Agriculture, Government of Greenland, at: http://uk.nanoq.gl/Emner/Government/Departments/ministry_of_fisheries/Division%20on%20Wildlife%20Management/Quotas.aspx (downloaded 10th April 2012)
- Douglas, D. (2010). Arctic Sea Ice Decline: Projected Changes in Timing and Extent of Sea Ice in the Bering and Chukchi Seas, U.S. Geological Survey Open-File Report. **2010-1176**.
- Durner, G., D. Douglas, et al. (2007). Predicting the Future Distribution of Polar Bear Habitat in the Polar Basin from Resource Selection Functions Applied to 21st Century General Circulation Model Projections of Sea Ice. Reston, Virginia, U.S. Geological Survey
- Durner, G., D. Douglas, et al. (2009). "Predicting 21st-century polar bear habitat distribution from global climate models." *Ecological Monographs* **79**: 25-58.
- Durner, G., J. Whiteman, et al. (2011). "Consequences of long-distance swimming and travel over deep-water pack ice for a female polar bear during a year of extreme sea ice retreat." *Polar Biology* **34**(7): 975-984.
- Durner, G., S. Amstrup, et al. (2006). "Polar Bear Maternal Den Habitat in the Arctic National Wildlife Refuge, Alaska." *Arctic* **59**(1): 31-36.
- Environment Canada (2009). Polar Bears in Canada: Conservation, Management and Research, Meeting of the Parties to the Agreement on the Conservation of Polar Bears; Tromsø, Norway, at:

- <http://www.polarbearmeeting.org/content.ap?thisId=500038377> (downloaded 14th April 2012)
- Environment Canada (2009b). Canada Takes Another Major Step Forward on Polar Bear Conservation, Press Statement (October 30th, 2009), at: <http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=CB28FD19-07D9-446E-8DD9-899E38E8F5C5> (accessed at 16th April 2012)
- European Commission (2008). European Commission Communication on the European Union and the Arctic Region European Union (EU), at: http://eeas.europa.eu/arctic_region/docs/com_08_763_en.pdf (accessed 10th April 2012)
- European Parliament (2008). European Parliament Resolution on Arctic Governance, European Union (EU), Brussels, at <http://www.europarl.europa.eu/sides/getDoc.do?type=TA&reference=P6-TA-2008-0474&language=EN> (accessed 10th April 2012)
- Ferguson, S., M. Taylor, et al. (1997). "Space use by polar bears in and around Auyuittuq National Park, Northwest Territories, during the ice-free period." *Canadian Journal of Zoology* **75**(10): 1585-1594.
- Ferguson, S., M. Taylor, et al. (2000). "Influence of Sea Ice Dynamics on Habitat Selections by Polar Bears." *Ecology* **81**(3): 761-772.
- Fischbach, A., S. Amstrup, et al. (2007). "Landward and eastward shift of Alaskan polar bear denning associated with recent sea ice changes." *Polar Biology* **30**(11): 1395-1405.
- Flyger, V., and M. R. Townsend (1968), The migration of polar bears, *Sci. Am.*, 218, 108-116.
- Freeman, M. and G. Wenzel (2006). "The Nature and Significance of Polar Bear Conservation Hunting in the Canadian Arctic." *Arctic* **59**(1): 21-30.
- Freeman, M. and L. Foote (2010). "Inuit, Polar Bears, and Sustainable Use: Local National and International Perspectives." *Human Ecology* **38**: 463-465.
- Gerhardt, H., P. Steinberg, et al. (2010). "Contested Sovereignty in a Changing Arctic." *Annals of the Association of American Geographers* **100**(4 (Special Issue: Climate Change): 992-1002.
- Gill, M., C. Zöckler, et al. (2010). The Arctic Species Trend Index. *Arctic Biodiversity Trends - 2010: Selected Indicators of Change*. Akureyri, Iceland, CAFF International Secretariat.
- Gleason, J. and K. Rode (2009). "Polar Bear Distribution and Habitat Association Reflect Long-Term Changes in Fall Sea Ice Conditions in the Alaskan Beaufort Sea." *Arctic* **62**(4): 405-417.
- Government of Greenland (2009). Act on Greenland Self-Government (Act no. 473 of 12 June 2009), Government of Greenland, at: <http://uk.nanoq.gl/Emner/~media/6CF403B6DD954B77BC2C33E9F02E3947.ashx> (accessed 10th April 2012)
- Government of Norway (2001). Svalbard Environmental Protection Act (No.79 Relating to the Protection of the Environment in Svalbard), Government of Norway at: <http://www.regjeringen.no/en/doc/Laws/Acts/Svalbard-Environmental-Protection-Act.html?id=173945> (accessed 12th April 2012)
- Government of the Russian Federation (2009). Protection and Management of Polar Bear Populations in Russia, Meeting of the Parties to the Agreement on the Conservation of Polar Bears; Tromsø, Norway, at: <http://www.polarbearmeeting.org/content.ap?thisId=500038377> (accessed 14th April 2012)
- Greenland Ministry of Fisheries, Hunting and Agriculture (2009). Polar Bear Management in Greenland, Meeting of the Parties to the Agreement on the Conservation of Polar Bears; Tromsø, Norway, at: <http://www.polarbearmeeting.org/content.ap?thisId=500038377> (accessed 14th April 2012)
- Hamilton, S.G., de la Guardia, L.C., Derocher, A.E., Sahanatian, V., Tremblay, B. and Huard, D. in press. Projected polar bear sea ice habitat in the Canadian Arctic Archipelago. *Plos One*.
- Hansson, R. (1991), Summary of polar bear migration studies in southern Svalbard 1987, Occasional Papers of the IUCN Species Survival Commission, 34-35.
- Hunter, C., H. Caswell, et al. (2010). "Climate change threatens polar bear populations: a stochastic demographic analysis." *Ecology* **91**: 2883-2897.
- IUCN Polar Bear Specialist Group. (2005). Resolution 1-2005: A precautionary approach when setting catch levels in a warming Arctic. Seattle, USA, 14th meeting of the PBSG.
- IUCN Polar Bear Specialist Group. (2009). Resolution 1-2009: Effects of global warming on polar bears. Copenhagen, Denmark, 15th meeting of the PBSG.
- IUCN (2001). IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. at: http://www.iucnredlist.org/apps/redlist/static/categories_criteria_3_1 (accessed 24th April 2012)
- IUCN/SSC Polar Bear Specialist Group. (2009). Resolution 3-2009: On the 2008 status report on polar bear by the Canadian Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Copenhagen,

- Denmark, 5th Meeting of the PBSG.
- Jensen, Ø., (2007). The IMO Guidelines for Ships Operating in Arctic Ice-Covered Waters, Fridtjof Nansen Institute, Lysaker, Norway
- Jensen, S. K., Aars, J., Lydersen, C., Kovacs, K. M., & Åsbakk, K. (2010). "The prevalence of *Toxoplasma gondii* in polar bears and their marine mammal prey: evidence for a marine transmission pathway?." *Polar biology*, **33**(5), 599-606.
- Johannessen, O. (2008). "Decreasing Arctic Sea Ice Mirrors Increasing CO₂ on Decadal Time Scale." *Atmospheric and Oceanic Science Letters* **1**(1): 51-56.
- Kattsov, V., E. Källén, et al. (2005). Future Climate Change: Modeling and Scenarios for the Arctic. *Arctic Climate Impact Assessment*. ACIA. Cambridge, Cambridge University Press.
- Kinnard, C., C. Zdanowicz, et al. (2011). "Reconstructed changes in Arctic sea ice over the past 1,450 years." *Nature* **479**(7374): 509-512.
- Kirk, C., S. Amstrup, et al. (2010). "Hematology of Southern Beaufort Sea Polar Bears (2005–2007): Biomarker for an Arctic Ecosystem Health Sentinel." *EcoHealth* **9th July 2010**.
- Koivurova, T., E. Molenaar, et al. (2009). "Canada, the EU, and Arctic Ocean Governance: A Tangled and Shifting Seascape and Future Directions." *Journal of Transnational Law & Policy* **18**(274).
- Kurvits, T., B. Alfthan, et al., Eds. (2010). *Arctic Biodiversity Trends 2010: Selected indicators of change*. Akureyri, Iceland, CAFF International Secretariat.
- Laidre, K. L., I. Stirling, L. F. Lowry, Ø. Wiig, M. P. Heide-Jorgensen, and S. H. Ferguson (2008), Quantifying the sensitivity of arctic marine mammals to climate-induced habitat change, *Ecol. Appl.*, **18**(2), S97-S125.
- Laidre, K., I. Stirling, et al. (2008). "Quantifying the sensitivity of Arctic marine mammals to climate-induced habitat change." *Ecological Applications* **18**(2): S97–S125.
- Letcher, R., J. Bustnes, et al. (2010). "Exposure and effects assessment of persistent organohalogen contaminants in arctic wildlife and fish." *Science of The Total Environment* **408**(15): 2995-3043.
- Loeng, H., K. Brander, et al. (2005). Marine Systems. *Arctic Climate Impact Assessment*. ACIA. Cambridge, Cambridge University Press.
- Lunn, N., D. Vongraven, et al. (2010). Indicator #01 Polar bears. *Arctic Biodiversity Trends 2010: Selected indicators of change*. T. Kurvits, B. Alfthan and E. Mork. Akureyri, Iceland, CAFF International Secretariat.
- Lunn, N., I. Stirling, et al. (1997). "Re-Estimating the Size of the Polar Bear Population in Western Hudson Bay." *Arctic* **50**(3): 234-240.
- Mauritzen, M., A. E. Derocher, and Ø. Wiig (2001), Space-use strategies of female polar bears in a dynamic sea ice habitat, *Can. J. Zool.*, **79**(9), 1704-1713.
- Mauritzen, M., A. Derocher, et al. (2001). "Space-use strategies of female polar bears in a dynamic sea ice habitat " *Canadian Journal of Zoology* **79**(9): 1704-1713.
- Mauritzen, M., A. E. Derocher, Ø. Wiig, S. E. Belikov, A. N. Boltunov, E. Hansen, and G. W. Garner (2002), Using satellite telemetry to define spatial population structure in polar bears in the Norwegian and western Russian Arctic, *J. Appl. Ecol.*, **39**(1), 79-90.
- Mauritzen, M., A. Derocher, et al. (2003). "Female polar bears, *Ursus maritimus*, on the Barents Sea drift ice: walking the treadmill." *Animal Behaviour* **66**(1): 107-113.
- McBean, G., G. Alekseev, et al. (2005). Arctic Climate: Past and Present. *Arctic Climate Impact Assessment*. ACIA. Cambridge, Cambridge University Press.
- McKinney, M., R. Letcher, et al. (2011). "Flame retardants and legacy contaminants in polar bears from Alaska, Canada, East Greenland and Svalbard, 2005–2008." *Environment International* **37**(2): 365–374.
- McKinney, M., R. Letcher, et al. (2011). "Regional Contamination versus Regional Dietary Differences: Understanding Geographic Variation in Brominated and Chlorinated Contaminant Levels in Polar Bears." *Environmental Science and Technology* **45**(3): 896–902.
- Minister of Justice, 2003, Species at Risk Act (S.C. 2002, c. 29), Government of Canada, at: <http://laws-lois.justice.gc.ca> (accessed 10th April 2012)
- Molenaar, E. and R. Corell (2009). Arctic Fisheries: Background Paper, Arctic TRANSFORM project of the European Commission
- Moline, M., N. Karnovsky, et al. (2008). "High Latitude Changes in Ice Dynamics and Their Impact on Polar Marine Ecosystems." *Annals of the New York Academy of Sciences* **1134**(1): 267-319.
- Molnár, P., A. Derocher, et al. (2010). "Predicting survival, reproduction and abundance of polar bears under climate change." *Biological Conservation* **143**: 1612–1622.
- Molnár, P., A. Derocher, et al. (2011). "Predicting climate change impacts on polar bear litter size." *Nature*

- Communications **2**(186).
- Monnett, C. and J. Gleason (2006). "Observations of mortality associated with extended open-water swimming by polar bears in the Alaskan Beaufort Sea." *Polar Biology* **29**(8): 681-687.
- Muir, D., S. Backus, et al. (2005). "Brominated Flame Retardants in Polar Bears (*Ursus maritimus*) from Alaska, the Canadian Arctic, East Greenland, and Svalbard." *Environmental Science and Technology* **40**(2): 449-455.
- NOAA Fisheries (2012). NOAA lists ringed and bearded ice seal populations under the Endangered Species Act:: NOAA Fisheries at:
http://www.nmfs.noaa.gov/mediacenter/2012/12/21_noaa_lists_ringed_and_bearded_ice_seal_populations_under_the_endangered_species_act2.html (accessed 13th March 2014)
- Norstrom, R., S. Belikov, et al. (1998). "Chlorinated hydrocarbon contaminants in polar bears from eastern Russia, North America, Greenland and Svalbard." *Arch. Environ. Con. Tox.* **35**: 354-367.
- Norwegian Directorate for Nature Management (2009). Report on polar bear conservation and implementation of 1973 Polar Bear Agreement, Meeting of the Parties to the Agreement on the Conservation of Polar Bears; Tromsø, Norway, at: <http://www.polarbearmeeting.org/content.ap?thisId=500038377> (accessed 14th April 2012)
- O'Neill, S., T. Osborn, et al. (2008). "Using expert knowledge to assess uncertainties in future polar bear populations under climate change." *Journal of Applied Ecology* **45**: 1649-1659.
- Obbard, M., T. McDonald, et al. (2007). Polar Bear Population Status in Southern Hudson Bay, Canada. Reston, Virginia, U.S. Geological Survey.
- Obbard, M., G. Thiemann, et al. (2010). Proceedings of the 15th Working Meeting of the IUCN/SSC Polar Bear Specialist Group. Occasional Paper No. 43. Gland, Switzerland and Cambridge, IUCN Species Survival Commission.
- Obbard, M.E., G.W. Thiemann, E. Peacock and T.D. DeBruyn (eds) (2010). Polar bears: Proceedings of the 15th working meeting of the IUCN/SSC Polar Bear Specialist Group, 29 June-3 July 2009, Copenhagen, Denmark. Occasional Paper of the IUCN Species Survival Commission, No. 43. International Union for Conservation of Nature, Gland, Switzerland and Cambridge, UK.
- Pachauri, R. and A. Reisinger (2007). Climate change 2007: Synthesis report. Contribution of Working Groups I, II and III to the Fourth Assessment Report on the Intergovernmental Panel on Climate Change. Geneva, IPCC (Intergovernmental Panel on Climate Change).
- Parks, E., A. Derocher, et al. (2006). "Seasonal and annual movement patterns of polar bears on the sea ice of Hudson Bay" *Canadian Journal of Zoology* **84**(9): 1281-1294.
- Parsons, E. and L. Cornick (2011). "Sweeping scientific data under a polar bear skin rug: The IUCN and the proposed listing of polar bears under CITES Appendix I." *Marine Policy* **35**: 729-731.
- Parties to the 1973 Agreement on the Conservation of Polar Bears, (2009). Outcomes of the Meeting, Meeting of the Parties to the Agreement on the Conservation of Polar Bears; Tromsø, Norway, at:
<http://www.polarbearmeeting.org/home> (accessed 14th April 2012)
- Parties to the 1973 Agreement on the Conservation of Polar Bears, (2009b). Meeting Report, Meeting of the Parties to the Agreement on the Conservation of Polar Bears; Tromsø, Norway, at:
<http://www.polarbearmeeting.org/home> (accessed 14th April 2012)
- Parties to the 1973 Agreement on the Conservation of Polar Bears (2011). Outcomes of the Meeting, Meeting of the Parties to the Agreement on the Conservation of Polar Bears, Nunavut, Canada, at:
<http://www.polarbearmeeting.org/home> (accessed 14th April 2012)
- Peacock, E., A. Derocher, et al. (2011). "Conservation and management of Canada's polar bears (*Ursus maritimus*) in a changing Arctic." *Canadian Journal of Zoology* **89**(5): 371-385.
- Polar Bear Specialist Group. (2012). "Polar bear hunting, harvesting and over-harvesting." IUCN/SSC Polar Bear Specialist Group, at: <http://pbsg.npolar.no/en/issues/threats/over-harvest.html> (downloaded 10th April 2012)
- Polar Bear Specialist Group. (2013). "Summary of polar bear population status as per 2013". IUCN/SSC Polar Bear Specialist Group, at: <http://pbsg.npolar.no/en/status/status-table.html> (accessed 23rd February 2014)
- Regehr, E., C. Hunter, et al. (2009). "Survival and breeding of polar bears in the southern Beaufort Sea in relation to sea ice." *Journal of Animal Ecology* **79**(1): 117-127.
- Regehr, E., N. Lunn, et al. (2007). "Effects of Earlier Sea Ice Breakup on Survival and Population Size of Polar Bears in Western Hudson Bay." *The Journal of Wildlife Management* **71**: 2673-2683.
- Reid, D., D. Berteaux, et al. (2013), "Mammals" in Meltotte, H. (ed.) Arctic Biodiversity Assessment: Status and trends in Arctic biodiversity, Conservation of Arctic Flora and Fauna, Akureyri
- Rengifo-Herrera, C., Ortega-Mora, L. M., Álvarez-García, G., Gómez-Bautista, M., García-Párraga, D., García-Peña, F. J., & Pedraza-Díaz, S. (2012). "Detection of *Toxoplasma gondii* antibodies in Antarctic

- pinnipeds." *Veterinary parasitology* **190**(1), 259-262.
- Rockwell, R. and L. Gormezano (2008). "The early bear gets the goose: climate change, polar bears and lesser snow geese in western Hudson Bay." *Polar Biology* **32**(4): 539-547.
- Rode, K., E. Peacock, et al. (2011). "A tale of two polar bear populations: ice habitat, harvest, and body condition." *Population Ecology* **54**(1): 3-18.
- Rode, K., S. Amstrup, et al. (2010). "Reduced body size and cub recruitment in polar bears associated with sea ice decline." *Ecological Applications* **20**(3): 768-782.
- Schliebe, S., K. Rode, et al. (2008). "Effects of sea ice extent and food availability on spatial and temporal distribution of polar bears during the fall open-water period in the Southern Beaufort Sea." *Polar Biology* **31**(8): 999-1010.
- Schliebe, S., Ø. Wiig, et al. (2008). IUCN Red List Assessment: *Ursus maritimus*, IUCN Red List of Threatened Species. Version 2011.2.
- Schliebe, S., T. Evans, et al. (2006). Range Wide Status Review of the Polar Bear (*Ursus maritimus*). Alaska, U.S. Fish and Wildlife Service.
- Shadbolt, T., G. York and E.W.T. Cooper (2012). Icon on Ice: International Trade and Management of Polar Bears. TRAFFIC, North America and WWF-Canada. Vancouver, B.C.
- Smithwick, M., S. Mabury, et al. (2005). "Circumpolar Study of Perfluoroalkyl Contaminants in Polar Bears (*Ursus maritimus*)." *Environmental Science and Technology* **39**(15): 5517-5523.
- Sonne, C. (2010). "Health effects from long-range transported contaminants in Arctic top predators: An integrated review based on studies of polar bears and relevant model species." *Environment International* **36**(5): 461-491.
- Sonne, C., R. Letcher, et al. (2012). "Two decades of biomonitoring polar bear health in Greenland: a review." *Acta Veterinaria Scandinavica* **54**(0): 1-7.
- Species at Risk Public Registry (2012). Species at Risk Act Schedule 1: List of Wildlife Species at Risk, Government of Canada, at: http://www.sararegistry.gc.ca/sar/listing/schedules_e.cfm?id=1 (accessed 10th April 2012)
- Stirling, I. and Derocher, A.E. (1993). "Possible impacts of climatic warming on polar bears." *Arctic* **46**:240-245.
- Stirling, I., and Derocher, A.E. (2012). "Effects of Climate Warming on Polar Bears: A Review of the Evidence." (invited review) *Global Climate Biology* **18**:2694-2706.
- Stirling, I. and C. Parkinson (2006). "Possible Effects of Climate Warming on Selected Populations of Polar Bears (*Ursus maritimus*) in the Canadian Arctic." *Arctic* **59**(3): 261-275.
- Stirling, I., and Ross, J.E. (2011). "Observations of cannibalism by polar bears (*Ursus maritimus*) on summer and autumn sea ice at Svalbard, Norway." *Arctic* **64**:478-482.
- Stirling, I. and Smith, T.G. (2004). "Implications of Warm Temperatures and an Unusual Rain Event on the survival of Ringed Seals on the Coast of Southeastern Baffin Island." *Arctic* **57**:59-67.
- Stirling, I., D. Andriasheka, et al. (1993). "Habitat preferences of polar bears in the western Canadian Arctic in late winter and spring." *Polar Record* **29**: 13-24.
- Stirling, I., E. Richardson, et al. (2008). "Unusual Predation Attempts of Polar Bears on Ringed Seals in the Southern Beaufort Sea: Possible Significance of Changing Spring Ice Conditions." *Arctic* **61**(1): 14-22.
- Stirling, I., Lunn, N.J., and Iacozza, J. 1999. Long-term trends in the population ecology of polar bears in western Hudson Bay in relation to climatic change. *Arctic* **52**:294-306.
- Stirling, I., N. Lunn, et al. (2004). "Polar Bear Distribution and Abundance on the Southwestern Hudson Bay Coast during Open Water Season, in Relation to Population Trends and Annual Ice Patterns." *Arctic* **57**(1): 15-26.
- Stirling, I., T. McDonald, et al. (2011). "Polar bear population status in the northern Beaufort Sea, Canada, 1971-2006." *Ecological Applications* **21**(3): 859-876.
- Stroeve, J., M. Serreze, et al. (2012). "The Arctic's rapidly shrinking sea ice cover: a research synthesis." *Climatic Change* **110**(3): 1005-1027.
- Thiemann, G., S. Iverson, et al. (2008). "Polar bear diets and arctic marine food webs: insights from fatty acid analysis." *Ecological Monographs* **78**(4): 591-613.
- Thiemann, G., S. Iverson, et al. (2011). "Individual patterns of prey selection and dietary specialization in an Arctic marine carnivore." *Oikos* **120**(10): 1469-1478.
- UNEP-WCMC (2012). UNEP-WCMC Species Database: CITES-Listed Species at: <http://www.cites.org/eng/resources/species.html> (downloaded 30th April, 2012)
- United Nations Convention on the Law of the Sea (1982). (Reg I-31363, UNTS 1833) Montego Bay, at: <http://treaties.un.org/Pages/showDetails.aspx?objid=0800000280043ad5> (accessed 10th April 2012)
- United States Fish and Wildlife Service (2009). Polar Bear Management in the United States, Meeting of the Parties

- to the Agreement on the Conservation of Polar Bears; Tromsø, Norway, at:
<http://www.polarbearmeeting.org/content.ap?thisId=500038377> (accessed 14th April 2012)
- Usher, M., T. Callaghan, et al. (2005). Principles of Conserving the Arctic's Biodiversity. Arctic Climate Impact Assessment. Cambridge, Cambridge University Press.
- Verreault, J., G. Gabrielsen, et al. (2005). "Flame retardants and methoxylated and hydroxylated polybrominated diphenyl ethers in two Norwegian Arctic top predators: Glaucous gulls and polar bears." Environ. Sci. Techno **I**(39): 6021-6028.
- Vongraven, D. and E. Peacock (2011). Development of a pan-Arctic monitoring plan for polar bears: background paper. Circumpolar Biodiversity Monitoring Programme, CAFF Monitoring Series Report No.1.. Akureyri, Iceland, CAFF International Secretariat.
- Wiig, Ø. (1995), Distribution of polar bears (*Ursus maritimus*) in the Svalbard area, *J. Zool.*, 237, 515-529.
- Wiig, Ø., E. Born, et al. (2003). "Movements of female polar bears (*Ursus maritimus*) in the East Greenland pack ice." Polar Biology **26**(8): 509-516.
- Wiig, Ø., J. Aars, et al. (2008). "Effects of climate change on polar bears " Science Progress **91**(2): 151-173.
- York, G., (ed) (2010). Strategy for Polar Bear Conservation in the Russian Federation, Russian Ministry of Natural Resources.
- Young, O. (2009). "Whither the Arctic? Conflict or cooperation in the circumpolar north." Polar Record **45**: 73-82.
- Young, O. (2012). "Arctic Tipping Points: Governance in Turbulent Times." AMBIO: A Journal of the Human Environment **41**(1): 75-84.
- Zeyl, E., J. Aars, D. Ehrlich, and O. Wiig (2009), Families in space: relatedness in the Barents Sea population of polar bears (*Ursus maritimus*), *Mol. Ecol.*, 18(4), 735-749, doi:10.1111/j.1365-294X.2008.04049.x.