NUNAVUT POLAR BEAR CO-MANAGEMENT PLAN

Government of Nunavut

NUNAVUT POLAR BEAR CO-MANAGEMENT PLAN

PREFACE

Management of polar bears (*Ursus maritimus)* in Canada is conducted at the territorial and provincial levels. Federal lands, such as Migratory Bird Sanctuaries, National Wildlife Areas and National Parks, are managed for conservation purposes and may include management measures for polar bears. In addition, there is recognition that management requires inter-jurisdictional coordination of efforts. In Nunavut, management of wildlife is governed by the *Nunavut Agreement*. The *Nunavut Agreement* recognizes Inuit harvesting rights and requires that Inuit play an effective role in all aspects of wildlife management. The management of polar bears shall acknowledge the best available scientific knowledge and Inuit Qaujimajatuqangit. The process for decision-making is clearly defined under the *Nunavut Agreement*.

The Nunavut Wildlife Management Board (NWMB) and Nunavut Minister of the Environment hold the primary and ultimate responsibility for wildlife management, respectively, under the *Nunavut Agreement*. The NWMB has the discretionary responsibility of approving management plans (*Nunavut Agreement*: Article 5 section 5.2.34 d(i)).

Successful management of polar bears depends on the commitment and cooperation of all co-management partners involved in implementing the directions set out in this management plan. The *Nunavut Polar Bear Co-Management Plan* has been prepared by the Government of Nunavut-Department of Environment (Department of Environment) in cooperation with Nunavut Tunngavik Inc. (NTI), Regional Wildlife Organizations (RWOs), Hunters and Trappers Organizations (HTOs), and Inuit community members from throughout Nunavut.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

EXECUTIVE SUMMARY

This management plan has been developed cooperatively by co-management partners to improve the existing polar bear management regime in Nunavut. It replaces the Memoranda of Understanding (MOUs) that have directed management efforts to date. These efforts have been instrumental in facilitating the recovery of polar bear populations from the lows of the1950s while maintaining traditional use by Inuit.

The Polar Bear was listed as a species of Special Concern under the federal *Species at Risk Act* (SARA) in 2011. A Special Concern designation is used for species that may become threatened or endangered because of a combination of biological characteristics and identified threats. While there are no associated implications on Inuit harvest or management actions, a management plan must be developed and published on the *Species at Risk Public Registry* for all species of Special Concern.

This management plan may be adopted—in whole or part—as the Nunavut territorial component of the national management plan under SARA while respecting the co-management process legislated by the *Nunavut Agreement*.

The intent of this management plan is (1) to identify goals and objectives for polar bear management; and (2) guide co-management partners in decision-making. Improved communications, co-management partner participation, and cooperation will be fundamental to the plan's success.

The previous management system relied heavily on scientific monitoring and modelling to determine sustainable harvest rates. This scientific approach has been effective and will continue, but the proposed *Nunavut Polar Bear Co-Management Plan* allows for full participation of Inuit. Improved collection and use of Inuit Qaujimajatuqangit and increased Inuit participation in all aspects of management are central to the goals of this plan.

Table of Contents

ACKNOWLEDGEMENTS

This management plan was developed by a co-management working group consisting of Gabriel Nirlungayuk and Paul Irngaut (NTI), Markus Dyck and Paul Frame (Government of Nunavut Department of Environment), James Qillaq (QWB), Attima Hadlari (KRWB), Ross Tatty (KWB), and Chris Hotson (Okalik Consulting). Additional review and drafting of text was provided by Lynda Orman (Department of Environment), Andrew Maher (PC), Peter Hale (ECCC), and David Lee (NTI). Leetia Janes, Lazarus Arreak, Gailene Pigalak, Jackie Price, Ema Qaggutaq, Leah M. Muckpah, and Jason Mikki assisted with community consultation.

1. INTRODUCTION

Nunavut is home to 12 of the world's 19 polar bear subpopulations, thus management actions by Nunavut are of paramount importance for ensuring the long-term persistence of the species. Management of polar bears in Nunavut predates the *Nunavut Agreement* by several decades. In the 1960s and 70s, harvest restrictions were placed on Inuit with little or no consultation. Restrictions (e.g., limiting the number of polar bears harvested per year per subpopulation) were the primary means of population recovery in regions where abundance was reduced as the result of unsustainable harvesting. Since then, implementation of the *Nunavut Agreement*, and improved research and understanding of polar bear biology has strengthened management and increased Inuit involvement. Over the last 50 years, polar bear management has focused on population recovery, which has mostly been achieved. Moving forward, the focus will be to manage polar bears sustainably, while allowing for flexibility to reduce numbers in areas where public safety is a concern and/or where there are detrimental effects on the ecosystem due to an increase in the number of polar bears. This plan has been developed to guide polar bear management in Nunavut through 2029 and explicitly recognizes the requirement to engage Inuit in polar bear management.

Inuit hunter observations indicate that polar bear numbers have increased from the population lows of the 1950s and 60s. This is confirmed by scientific studies on most Nunavut subpopulations. During the 50s and 60s, polar bears did not pose a serious threat to human safety; Inuit did not worry about going camping and families were safe in seasonal camps. Today's safety concerns are in part due to increased polar bear numbers in some Nunavut subpopulations and changes in the distribution of polar bears due to climate-driven changes in sea ice. Bears are forced to spend more time on land because the ice breaks up sooner in the spring and forms later in the fall.

Science and Inuit Qaujimajatuqangit indicate that polar bears have increased since the 1950s. However, differences exist between Inuit observations and public perspectives on the status of the species. Pressure to conserve and protect polar bears from national and international environmental and non-governmental organizations, climate change advocates, and the general public has created contention about the status of polar bear populations.

Inuit believe there are now so many bears that public safety has become a major concern. Public safety concerns, combined with the effects of polar bears on other species that Inuit and scientists are observing (*e.g.*, ringed seal and water fowl populations) suggest that in many Nunavut communities, the polar bear may have exceeded the co-existence threshold of Nunavummiut.

"…in my lifetime we have seen opposite ends of the spectrum where when I was a child we saw no bears, and now we can see 40 bears a year near town" Sandy Akavak, Elder, Kimmirut

In Canada, polar bears have been managed to increase populations since the 1970s, largely through sustainable hunting practices. Before the fur trade and whaling, polar bears were mainly harvested by indigenous peoples. The increase in whaling, sealing, fur trade and Arctic explorations during the late 1800s and early 1900s resulted in Arctic-wide increases in polar bear hunting by non-indigenous people. The five polar bear range states, Russia, Canada, the United States, Norway and Denmark (representing Greenland), agreed that the polar bear needed protection to prevent a further decline, and the *Agreement on the Conservation of Polar Bears* was signed in 1973. Management of polar bears has since evolved to include setting sustainable harvest levels, harvest monitoring and reporting, sex-selective harvesting, and other non-quota limitations (NQLs), such as the protection of family groups and the protection bears in dens. Although seen by some Inuit as restrictive, these NQLs are supported by the Nunavut Hunters and Trappers Organizations (HTOs).

Inuit generally support Nunavut's polar bear management efforts but have been directly affected by increased polar bear abundance from the standpoint of public safety and property damage (e.g., cabins and food caches). If not addressed, these concerns could undermine Inuit support for polar bear management; especially when the population is perceived to be high.

2. GUIDING PRINCIPLES

The following principles will guide conservation and management decisions within the framework of the *Nunavut Agreement*:

- Integrate Inuit societal values and traditional knowledge— collectively known as Inuit Qaujimajatuqangit—into polar bear management.
- *Use Inuit Qaujimajatuqangit* and scientific knowledge in decision-making.
- Consider public safety in all management actions and decisions.
- Consideration of the ongoing social, cultural, and economic value of polar bears during decision-making.
- Consider other components of the ecosystem when making decisions about polar bear conservation.

- Manage polar bears at the subpopulation level and regularly assess population status to ensure that information is available for timely conservation and long-term sustainability.
- Limit Inuit harvesting only to the extent necessary, and according to the principles of conservation, subject to the requirements of the *Nunavut Agreement*.

3. GOAL OF THE POLAR BEAR MANAGEMENT PLAN

To maintain viable and healthy polar bear subpopulations capable of sustaining harvesting needs for current and future generations, and to ensure that polar bears remain an integral and functioning part of the ecosystem while monitored, sustainable harvests occur.

4. SPECIES DESCRIPTION

Inuktut name – Nanuq, Nanuk
English name – Polar bear
French name – Ours blanc
Scientific name – *Ursus maritimus*

4.1 Status:

SARA Listing[1]: Schedule 1, Special Concern (2011)
COSEWIC Status[2]: Special Concern (2018)
IUCN Red List[3]: Vulnerable (2015)
CITES listing[4]: Appendix II (01/07/1975)
Nunavut Wildlife Act: Not assessed

4.2 General description

The polar bear is a member of the order *Carnivora* and the family Ursidae. It is the top terrestrial predator in the Arctic marine environment. Polar bear breeding biology is characterized by low reproductive rates, late sexual maturation and a long generation time.

[1] This is the legal status of the species on Schedule 1 of the federal *Species At Risk Act* (SARA)
[2] Status assessments are independent biological assessments by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)
[3] This is the global listing on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species
[4] CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival.

Webbed and enlarged front paws make the polar bear a strong swimmer and its curved claws are well-suited for “hooking” seals, their primary food source. Other adaptations to the Arctic environment include furred pads for improved insulation and traction on the paws, and black skin to absorb solar energy. Polar bear fur usually appears to be white, but it may also be yellowish or off-white, depending on the time of year and sex. Polar bears exhibit extraordinary strength when crushing through sea ice, digging into birth and haul-out lairs of seals, and moving large boulders to access meat caches. Adult males are larger (up to 300 cm long) and heavier (800-1000 kg) than adult females, which do not usually exceed 400 kg in weight and 250 cm in length.

4.3 Distribution

4.3.1 Global range

Polar bears occur in the Sub-Arctic and Arctic regions of the Northern Hemisphere. Satellite-telemetry studies and mark-recapture data have shown that polar bears do not wander throughout the Arctic, but rather show seasonal fidelity to local areas. Both science and Inuit *Qaujimajatuqangit* acknowledge that there is admixture between the subpopulations. Movements and distributions are determined by sea ice; a platform for feeding, mating, and denning. Globally, all polar bears are divided into 19 subpopulations. Fourteen subpopulations, including the Arctic Basin are in Canada or are shared between Canada and Greenland or the United States (Figure 1). The Global Population estimate is 26,000 with a lower confidence interval of 22,000 and an upper confidence interval of 31,000. Approximately 14,000 - 16,000 polar bears occur in Canada. Most of Canada’s polar bear subpopulations occur in Nunavut.

4.3.2 Nunavut range

As of 2019, there are 12 recognized subpopulations of polar bear within Nunavut (Baffin Bay, Davis Strait, Southern Hudson Bay, Western Hudson Bay, Foxe Basin, Kane Basin, Lancaster Sound, Norwegian Bay, Gulf of Boothia, M'Clintock Channel, Viscount Melville Sound, and Northern Beaufort Sea). Eight of these subpopulations are shared with other jurisdictions and user-groups and four are entirely within Nunavut (Figure 1). A more detailed background and description of Nunavut’s polar bear subpopulations, along with management recommendations are provided in Appendix A.

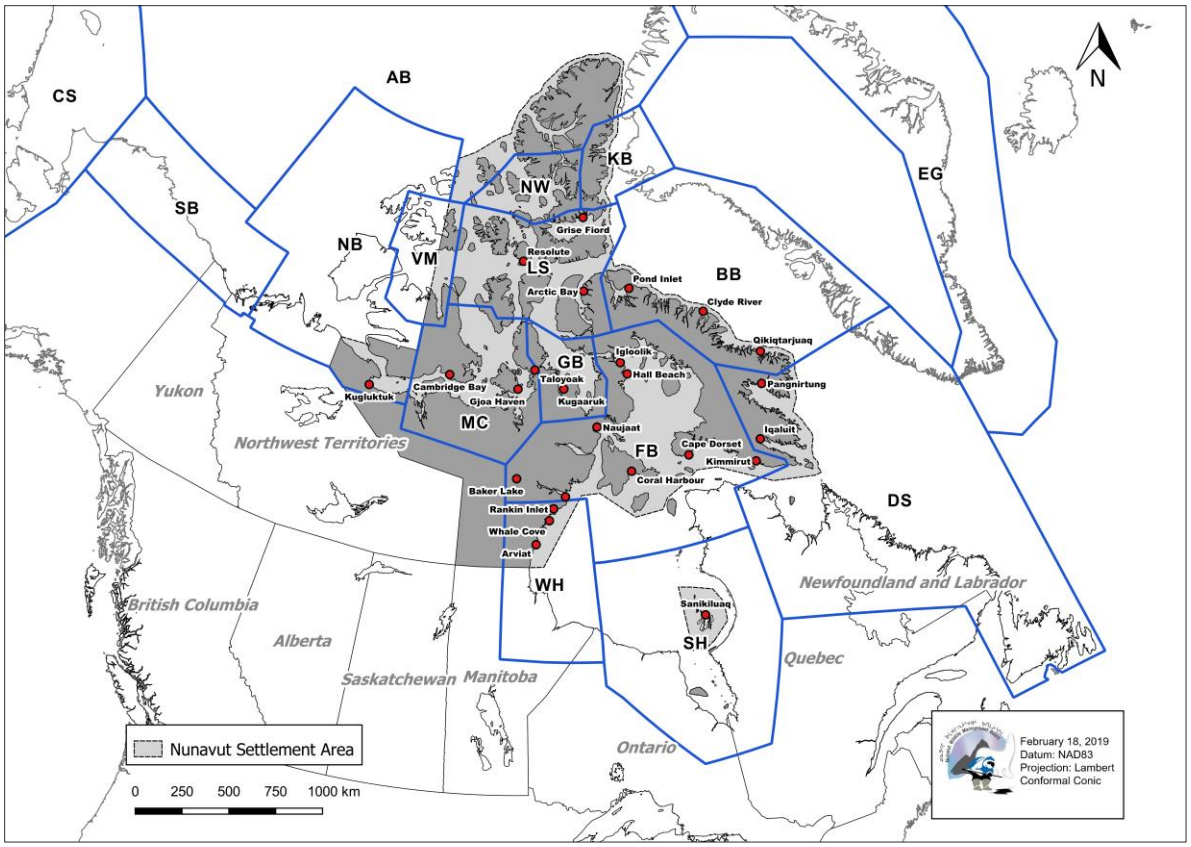

Figure 1. Canadian and Nunavut polar bear subpopulations [BB = Baffin Bay; DS = Davis Strait; SH = Southern Hudson Bay; WH = Western Hudson Bay; FB = Foxe Basin; GB = Gulf of Boothia; MC = M'Clintock Channel; LS = Lancaster Sound; KB = Kane Basin; NW = Norwegian Bay; VM = Viscount Melville Sound; NB = Northern Beaufort Sea; SB = Southern Beaufort Sea.

4.4 Biology

4.4.1 Life cycle and reproduction

Breeding occurs between March and June. Ovulation is induced by mating, but implantation of the fertilized egg is delayed until October. Female age at first reproduction ranges between four and seven years, with most females producing litters by age six. By age six, male polar bears are normally reproductively mature, however younger males often do not reproduce due to competition from older and bigger males. Most males enter the reproductive segment of the population between eight and ten years old.

Pregnant females prepare and enter maternity dens in late fall and the cubs—normally one or two—are born between November and early January. Inuit Qaujimajatuqangit suggests that the timing of birth is later in higher latitudes. In northern subpopulations dens are generally excavated in snow and are covered and closed by snowdrifts. They are frequently located on islands or land that is near the coast and adjacent to areas with high seal densities in spring. An anomaly to this

pattern of behaviour is the maternity dens for the Western Hudson Bay and Southern Hudson Bay polar bears, that can be located up to 120 km inland at traditional den sites and are initially dug in soil.

At birth, cubs weigh approximately 0.6 kg. They are nursed inside the den until sometime between the end of February and the middle of April. By this time, cubs weigh 10-12 kg. A new litter is produced after three years, making the average inter-litter interval approximately 3.6 years.

4.4.2 Natural mortality and survival

Other than humans, adult polar bears have no natural predators. Cubs less than one year old sometimes are prey to wolves and other carnivores. Walruses have also been reported to kill polar bears in self-defence, but this is infrequent. Polar bears have also been observed killing other polar bears. Each life-stage of a polar bear comes with different challenges, such as hunting success, hunting experience, and social status; therefore, the survival rates vary accordingly. Moreover, survival also varies among subpopulations because of differences in ecosystem productivity and seasonal ice duration.

Biologists recognize four important age categories: 1) cubs-of-the-year; 2) yearlings and sub-adults, 3) prime-age adults, and 4) senescent adults. These categories are also divided by sex because males generally have lower survival rates than females. In the wild, the maximum age is estimated to be 30 years.

4.4.3 Diet

Polar bears are carnivorous. Throughout their Nunavut range, ringed, bearded and harp seals make up most of the polar bear's diet. The abundance and population dynamics of polar bears is therefore, strongly connected to that of ringed, bearded and harp seals. Other species like harbour seals, walrus, beluga whale, narwhal, bowhead whale and birds are hunted opportunistically. Polar bears are also known to eat eggs, berries, and seaweed.

Polar bear diet varies throughout the year, and across its range. Primary feeding tends to be in spring when seal pups are abundant. However, polar bears will hunt and scavenge throughout the year, feeding opportunistically on vegetation, berries, eggs, and birds. Fish and ringed seals are also successfully hunted when there is little or no sea ice in summer.

Polar bears are well-adapted to times of food abundance and shortages. When food is in high abundance, they can increase their body mass significantly and when food becomes scarce or unavailable, they can live off their stored fat reserves.

4.4.4 Habitat

Polar bears can be found in all coastal and offshore areas of the Canadian SubArctic and Arctic. They hunt from sea ice to access their primary prey—seals. The condition and extent of sea ice is a key factor in determining the quality of the habitat. However, they seem to be adapted to all types of sea ice and are strong swimmers capable of traveling long distances in open water. Inuit have observed that bears can exist in open water and on sea ice for most of their lives (the Inuktitut term for this is *tulayuituq*). Access to land is essential during the ice-free periods, but also for mid-winter denning.

In Nunavut, polar bears den mostly on land. Denning sites are locations that have enough snow cover in early winter for the construction of the dens. Dens can also be found on moving multi-year ice and areas of annual rough ice. All maternity denning sites are important areas because they provide shelter for the mother and offspring. All maternity denning sites are protected under the Nunavut *Wildlife Act*. Maternal dens that occur inside protected areas are also protected by regulations governing such areas.

5. BACKGROUND ON POLAR BEAR MANAGEMENT

5.1 Historical perspective

The polar bear management system in Nunavut dates back to the Northwest Territories, when Nunavut was not yet a territory. This system includes setting of harvest limits (known as Total Allowable Harvest or TAH under the *Nunavut Agreement*), instituting harvest seasons, reporting harvests, and sample submission. After the creation of Nunavut, memoranda of understanding for each subpopulation were implemented between the Department of Environment and each RWO and HTO to guide harvest and management.

5.2 The Nunavut perspective

In the past, polar bear management in Nunavut has mainly focused on sustainable harvesting using population estimates derived from scientific studies. Although abundance in most subpopulations was low prior to the 1970s (the reason for the *Agreement on the Conservation of Polar Bears*), some populations have increased to greater densities than historically lower numbers. As of 2019, the statuses of the 12 subpopulations in Nunavut as determined by the Polar Bear Technical Committee (PBTC)[5] are: three uncertain, one likely decline, four likely stable, two stable, and two

[5] The Polar Bear Technical Committee (PBTC) was setup to support the Polar Bear Administrative Committee (PBAC) by reviewing scientific research and Indigenous Traditional Knowledge and providing the PBAC with an annual status assessment of the polar bear subpopulations in Canada

likely increase. Nunavummiut believe that polar bears have become less afraid of humans and more likely to damage property, as the result of an apparent increase in polar bears in some areas. In Nunavut, human safety and the right of Inuit to harvest are high priorities[6]. Increased interactions between humans and bears, and a right to protect human safety and property have led to an increase in defence kills. Considering all removals come off the TAH this can lead to a reduction in the community harvest, resulting in a loss of opportunity for traditional harvesting activities.

5.3 Legislative frameworks and agreements

In Nunavut, wildlife is managed according to Article 5 of the *Nunavut Agreement*. Article 5 recognizes the rights of Inuit to harvest polar bears and trade in polar bear products[7]. It also sets out the creation of the Nunavut Wildlife Management Board (NWMB), which is the primary instrument of wildlife management in Nunavut. It defines the roles of the NWMB, Department of Environment, RWOs and HTOs.

The Nunavut *Wildlife Act* (2015) sets out harvest management, licensing, reporting and sample submission. Further details on management, including research, harvest, and TAH determinations have been detailed in previous Memoranda of Understanding (MOUs) developed for all subpopulations (12) jointly with RWOs, HTOs and the Department of Environment. These MOUs shall be replaced with this management plan. Enforcement provisions are in place in regulations under the *Nunavut Wildlife Act*.

In Nunavut, each of the co-management partners fulfills its respective role as defined in the *Nunavut Agreement* (see Figure 2). This plan applies to the Nunavut Settlement Area as defined in Section 3.1.1 of the *Nunavut Agreement*.

The Polar Bear was listed as a species of Special Concern under SARA in 2011. A Special Concern designation is used for species that may become threatened or endangered because of a combination of biological characteristics and identified threats[8]. While there are no associated effects on Inuit harvest or management actions, a management plan must be developed and published on the *Species at Risk Public Registry* for all species of Special Concern.

This plan may be adopted—in whole or part—as the Nunavut territorial component of the national management plan under the federal *Species at Risk Act*, while respecting the co-management process legislated by the *Nunavut Agreement*.

In 1973, Canada was a signatory to the *Agreement on the Conservation of Polar*

[6] See Sections 5.1.2 and 5.6.1 of the Nunavut Agreement
[7] See Sections 5.6.1 of the Nunavut Agreement
[8] https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/glossary-terms.html

Bears. The *Agreement* holds member states accountable for acting to protect the ecosystems in which polar bears live, paying special attention to places where polar bears den, feed, and migrate. Range states also must manage polar bear populations in accordance with proper conservation practices, based on best available scientific data. Recently, range states have agreed to include Inuit Qaujimajatuqangit as part of the body of knowledge to be considered for polar bear conservation and management. There also exists inter-jurisdictional agreements between Canada and Greenland for the Davis Strait, Baffin Bay and Kane Basin subpopulations, and Canada and the United States for the Southern Beaufort Sea subpopulation.

6. POLAR BEAR CO-MANAGEMENT IN NUNAVUT

The *Nunavut Agreement* and *Nunavut Wildlife Act* provide the overarching criteria and principles under which Inuit harvesting of polar bears is managed.

6.1 Decision criteria

Conservation, public health and public safety are among the purposes for which Inuit harvesting of polar bears may be limited. Decisions made by the NWMB and Minister must limit Inuit harvesting only to the extent necessary.

6.2 Principles of conservation

Decisions made by the NWMB and Minister must apply the following principles:

- the maintenance of the natural balance of ecological systems within the Nunavut Settlement Area;
- the protection of wildlife habitat;
- the maintenance of vital, healthy, subpopulations capable of sustaining harvesting needs, and
- the restoration and revitalization of depleted subpopulations and wildlife habitat.

6.3 Co-Management partners

The following co-management partners participate in polar bear management; their roles are defined in detail in Section 5 of the *Nunavut Agreement*. A summary is provided below. Figure 2 details the partners and the decision-making process.

6.3.1 Nunavut Tunngavik Inc.

Nunavut Tunngavik Incorporated (NTI) represents all Inuit in the Nunavut Settlement Area, in line with the *Nunavut Agreement* that was signed in 1993 by the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada. The *Nunavut Agreement* supersedes legislation and is constitutionally protected under Canada's *Constitution Act* (1982).

6.3.2 NWMB

The roles of the NWMB are defined in the *Nunavut Agreement*, sections 5.2.33 and 5.2.34. These include, but are not limited to, setting TAH, Basic Needs Levels, and NQLs. In addition, the NWMB may approve management plans and the designation of rare and endangered species.

6.3.3 RWOs

The role of RWOs is defined in section 5.7.6 of the *Nunavut Agreement*. The role of the RWOs includes, but are not limited to, regulating the activities of HTOs in their regions, including allocating TAH among communities, and distributing any accumulated harvest credits (one unharvested bear equals one credit) as required to cover accidental, defence, or illegal kills. The RWOs may also return credits annually to augment a community's harvest. Credits may not be transferred between communities that share a subpopulation without the written consent of the community that accumulated the credit.

6.3.4 HTOs

The role of HTOs is defined in sections 5.7.2 and 5.7.3 of the *Nunavut Agreement*. The roles of HTOs include, but are not limited to, regulating the harvesting activities of their members, including all Inuit within the community. HTOs allocate tags within their respective communities for species with a TAH and set harvest seasons. As per the *Nunavut Agreement*, HTOs may develop rules for NQLs. HTOs may also open and close their polar bear hunting seasons to optimize hunting and may determine if sport hunts will be allowed in the community.

6.3.5 Government of Nunavut

The Nunavut Minister of Environment retains the ultimate authority over polar bear management in Nunavut as per the *Nunavut Agreement*. Department of Environment staff conduct research, record Inuit Qaujimajatuqangit, and make management recommendations to the NWMB for decision. Department of Environment Conservation Officers enforces the *Nunavut Wildlife Act* and its regulations. Department of Environment implemented new programs starting in 2013 to reduce human-bear conflicts and to reduce and compensate communities for damage to personal property by polar bears. The Government of Nunavut also works with the Government of Canada (Environment and Climate Change Canada) and the Government of Greenland to manage and conserve polar bears in the shared Kane Basin and Baffin Bay polar bear subpopulations.

6.3.6 Government of Canada

Under SARA, Environment and Climate Change Canada (ECCC) is responsible for completing a national management plan for polar bears and has responsibilities for

the management of listed species where they occur on federal lands. The Government of Canada is responsible for managing polar bears and their habitat on federal lands under the jurisdiction of the federal Minister of Environment (National Wildlife Areas, Migratory Bird Sanctuaries, National Parks, National Park Reserves, and National Historic Sites). The Government of Canada contributes to scientific knowledge of polar bears through research and helps to coordinate polar bear management across the country. Canada signs international agreements on behalf of all jurisdictions and has responsibilities to coordinate international management actions for polar bears, with the advice of the co-management boards and jurisdictions. It is involved in international polar bear management including the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the *1973 Agreement on the Conservation of Polar Bears.* When developing positions that relate to international agreements affecting Inuit harvesting rights in the Nunavut Settlement Area, the Government of Canada is required under the *Nunavut Agreement* to include Inuit in discussions.

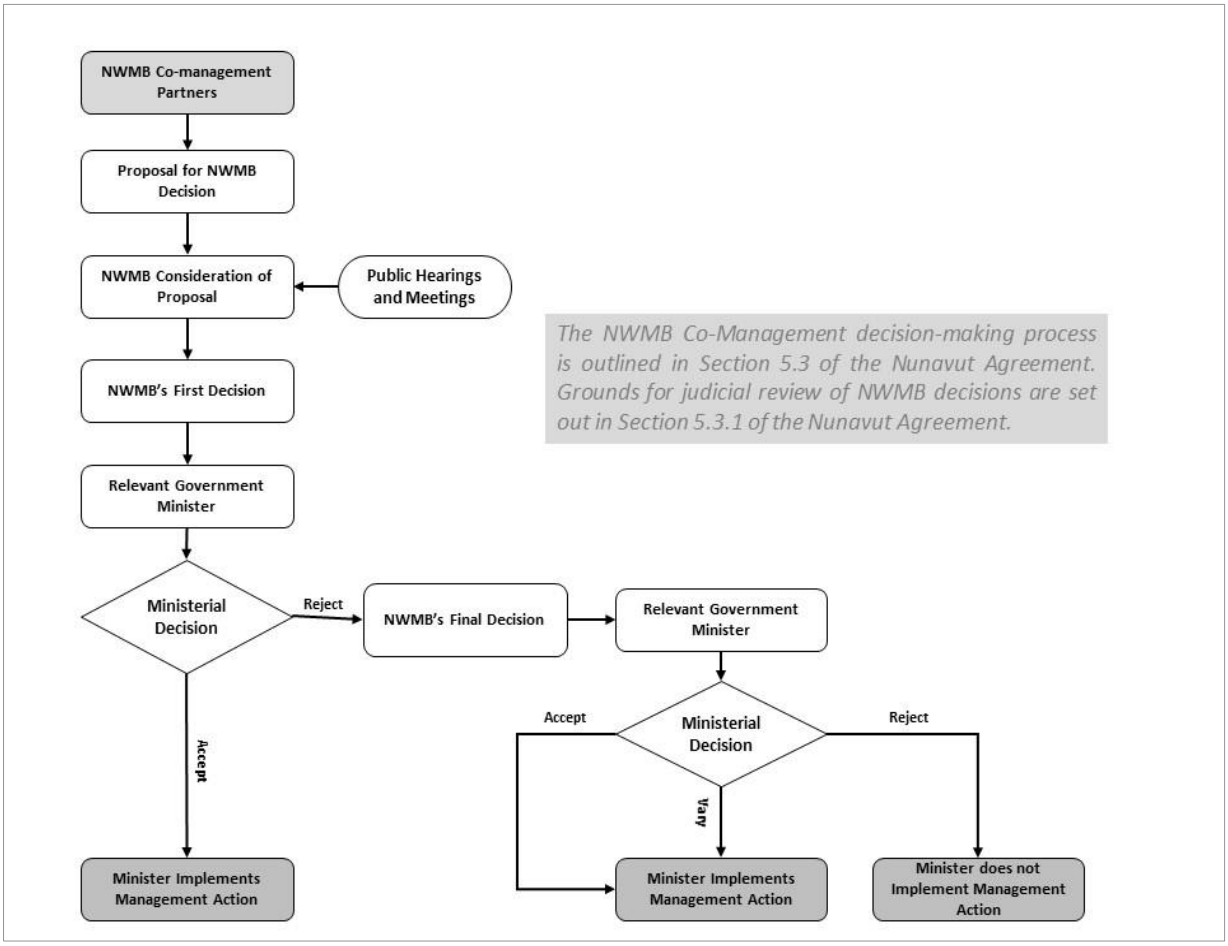

Figure 2. The Wildlife Co-management decision-making framework in Nunavut (NWMB 2019).

7. CONSERVATION THREATS AND CHALLENGES

7.1 Threats

In Nunavut's adaptive co-management system, any threat can be identified and responded to relatively quickly. For example, if a significant reduction in the body condition, recruitment, or overall abundance of a subpopulation is detected and attributed to a threat, the appropriate conservation measures will be implemented to stop or mitigate the observed threat. The following are current threats, or threats expected to occur within the 10-year life of this plan.

7.1.1 Sea-ice habitat loss and alteration due to climate change

Climate change is affecting terrestrial and marine environments in Nunavut. It is projected that increasing Arctic warming will lead to a decrease in the extent and thickness of multi-year sea ice, and the duration and thickness of annual sea ice. These changes will affect polar bear sea-ice habitat, the availability and abundance of prey species, and the ability of polar bears to access prey. While no subpopulation declines have been attributed to climate change, there is growing scientific evidence linking the impacts of climate change to current and future declines in body conditions, cub survival, and subpopulation sizes. Inuit Qaujimajatuqangit agrees that polar bears are exposed to the effects of climate change but suggest that they are adaptable.

"..people (in the south) think climate change will hurt polar bears , but the bears will adapt, and there will always be an Arctic and ice".
Leopa Akpalialuk*, Pangnirtung HTO Board Member*

It is challenging to predict and mitigate the effects of climate change on the polar bears' sea-ice habitat. Adaptive management and frequent subpopulation assessments will allow for more responsive decision-making in response to climate change. The loss of annual sea ice in southern subpopulations may be offset by improvements to heavy multi-year ice in other portions of the range. Subpopulation boundaries may shift as polar bears adapt to changes in their environment.

7.1.2 Denning habitat alteration due to climate change

Other important habitat includes denning and coastal areas used as summer retreat areas during ice-free periods. In Nunavut, most polar bears den on land, either along the slopes of fiords, on peninsulas or islands. All maternity denning sites are important areas because they provide shelter for the mother and offspring and contribute to the growth of the population. There are concerns that current and future changes in climatic conditions (e.g. winds, storm surges, flooding and shoreline erosion, and insufficient snow accumulation) and increasing anthropogenic activities may alter maternal denning habitat or render previously important denning sites unsuitable or inaccessible.

A significant amount of polar bear habitat, including known denning areas, occur within the boundaries of National Parks, Territorial Parks, or other protected areas, such as Migratory Bird Sanctuaries and National Wildlife Areas. Protected areas will, therefore, play an increasingly important role in the face of increasing human activities in the Arctic.

7.1.2 Industrial activity

In Nunavut, there are several active and proposed mines, and other industrial pursuits, that could affect polar bears directly, or indirectly through increased shipping traffic and pollution. Noise and disturbance from humans or exploration activity in any form near dens could cause disturbance, the abandonment of offspring, or the displacement of denning bears if it is not carefully planned and controlled. Any shipping activities through feeding areas may lead to disturbance and reduce the hunting success of polar bears. These activities could also increase the abandonment of seal dens. If industrial activities (e.g., oil or gas exploration and development, shipping, mining exploration and operations) lead to an oil spill in sea-ice habitat, polar bears and seals will be directly exposed to oil, with effects ranging from ingestion of oil, hair loss, kidney failure to ultimately death. Increasing industrial activities may cause an increase in the local human population (both the indigenous population and non-indigenous people), as well as the amount of refuse and other wildlife attractants. Consequently, polar bear-human encounters are also likely to increase, leading to a potential increase in conflicts between polar bears and humans.

7.1.3 Pollution/contaminants

Polar bears are at the top of the Arctic food chain, and as such accumulate high levels of various environmental pollutants through the food they ingest. Most of these polluting compounds, namely organochlorines, reach the Arctic via wind and ocean currents from industrialized areas. Environmental pollutants bioaccumulate through the food chain and have been found in polar bear tissue, particularly in males. In females, it has been demonstrated that contaminants can be transferred to the offspring via their mother's milk.

How these pollutants and chemical compounds will affect polar bear health and fitness over the long-term is not well known. It has been suggested that high concentrations of contaminants could adversely impact immune and reproductive systems. A combined and persistent response to these stressors is anticipated.

7.1.4 Tourism

Interest in Arctic tourism has grown because of easier access to remote destinations across the Arctic. Any increase in tourism activity or the cumulative impacts of several negative human stressors (e.g. tourism, mining, shipping and contaminants) can have unintended impacts on polar bear health, reproduction and mortality. Unlike Manitoba—

that has a tourism industry focused on polar bears — Nunavut does not have a polar bear tourism industry. However, various locations in Nunavut offer similar opportunities and could become focal points for intense polar bear viewing. Some Inuit have expressed concerns that tourism and research related to polar bear handling and habituation, such as in Churchill, Manitoba, is the reason polar bears have lost their fear of humans and tend to come into communities. The impacts of tourism can be limited by proper policies and management.

7.2 Challenges

7.2.1 Subpopulation boundaries

The division of polar bears into subpopulations is based on movement patterns estimated from satellite telemetry data, and ear tags returned from harvested bears. Although boundaries are accepted for management purposes, it is understood that bears occasionally move across these management boundaries. It is important to recognize that these boundaries have formed the basis for management actions for over four decades and have been relied on by managers to set harvest levels and by researchers focusing their subpopulation assessment studies.

Inuit believe that polar bears regularly travel among different geographic areas of Nunavut and that there may be fewer than 13 subpopulations in Canada. As the understanding of the structure of polar bear populations improves, there will be an ongoing need to review current subpopulation delineation. Ongoing studies using satellite telemetry collars in the Western Hudson Bay subpopulation by ECCC researchers may provide information that could result in boundary changes. It will remain a challenge to balance Inuit perspective on population structure with current subpopulation designations. Maintaining Inuit support for subpopulation boundaries is fundamental to the success of polar bear management in Nunavut. Reconciling Inuit Qaujimajatuqangit with scientific knowledge as it evolves will be a necessary, but considerable challenge.

7.2.2 Polar bears and people

Inuit and their ancestors have lived in proximity to polar bears for thousands of years. The human population in Nunavut is currently higher than it has ever been and continues to grow. At the same time, it is recognized that, in many areas across Nunavut, there are more polar bears now than 40 or 50 years ago. Human-bear interactions have increased and have led to an increase in polar bear mortality in defence of life and property.

These Defence of Life and Property Kills (DLPKs) are included in the TAH and reduce Inuit harvesting opportunities. DLPKs occur in communities, on the land, and in hunting

and fishing camps. Inuit have stored meat for centuries in traditional meat caches, both within small traditional camps on the land, and within communities. The loss of nutritious food due to polar bear depredation is a significant cost to Inuit. In addition to polar bear mortality associated with DLPKs, human-bear interactions can also lead to damage, including damage to cabins and bear destruction of meat caches.

Reduced hunting opportunities and associated loss of meat and hide are only part of the impact Inuit feel from harvest restrictions. There is also an impact on the transfer of Inuit knowledge and culture over time when restrictions are in place.

"…it is like ripples in a pond, we lose the hide and the meat and the hunt, but there is also a loss of culture and knowledge. We no longer travel to the areas we used to hunt polar bears, so a generation has no knowledge of the land and traditional camping areas, we no longer have sport hunters so we no longer keep dog teams, and we cannot pass on that knowledge, we no longer have skins to handle and women cannot pass on the skills to prepare and sew."
David Irqiut, HTO Director and Elder, Taloyoak

7.2.3 Inter-jurisdictional considerations

In Nunavut, eight of 12 polar bear subpopulations are shared with other jurisdictions. The shared populations are Northern Beaufort Sea and Viscount Melville Sound (shared with NWT*), Foxe Basin (shared with Quebec*), Southern Hudson Bay (shared with Ontario* and Quebec*), Western Hudson Bay (shared with Manitoba*), Davis Strait (shard with Labrador*, Quebec* and Greenland*), and Baffin Bay and Kane Basin (shared with Greenland). Cooperative efforts on research and consultation between jurisdictions should be encouraged as part of these efforts. Current jurisdictional efforts to consider combined total allowable removal levels between jurisdictions are a positive step for cooperative management. However, this remains a significant challenge due to the complexities of multiple jurisdictions and land claims.

(*This denotes a simplified relationship between jurisdictions and does not reflect the respective sub-jurisdictional entities and their respective stakeholders and Boards).

7.2.4 Trade

The CITES Convention of 1973 has been in effect in Canada since July 1975. Polar bears are listed in *Appendix II* to the Convention and trade is allowed under strict conditions — including that it must be non-detrimental to the species and CITES permits are required.

As the responsible authority for the implementation of CITES, ECCC must determine if the export or import of a species would be detrimental to the survival of that species.

Such “non-detrimental findings” (NDFs) are a requirement of the Convention. The international export of polar bears from Canada is currently considered non-detrimental.

Given the shared jurisdiction for wildlife in Canada, coordination among provincial and territorial jurisdictions is required to ensure that total removals among jurisdictions within shared subpopulations is sustainable and defendable at the national and international levels.

Ongoing domestic and international export of polar bear parts, such as hides, depends on sound harvest reporting and sustainable harvest levels. Communities have unanimously supported efforts to maintain international trade of polar bear specimens as an important component of community economic development. The listing of polar bears on CITES *Appendix I* would have a negative impact on conservation efforts as the economic benefit to communities will be reduced, and the incentive to manage for abundant populations will be lost. In September 2015, the Animal Committee of CITES determined that the current trade in polar bear hides and parts is not detrimental to the survival of the species in the wild.

8. MANAGEMENT PLAN OBJECTIVES

The following five main components are considered important for co-management partners to achieve the goal of the management plan:

- Harvest management (*Angujaujunnaqtunik Aulattiniq*)
- Information and knowledge gathering (*Qanuqtuurniq*)
- Habitat management and environmental stewardship (*Avatitinnik Kamatsiarniq*)
- People and bears (*Inuillu Nanuillu*)
- Working together (*Piliriqatiginniiq*)

8.1 Harvest management and objectives (Angujaujunnaqtunik Aulattiniq)

8.1.1 Harvest management

Legislated harvest restrictions have been the primary management tool used to facilitate the recovery of polar bear subpopulations throughout Nunavut. As new information becomes available, co-management partners work together to consider or review a TAH for each polar bear subpopulation. The TAH represents the total number of polar bears that can be harvested according to the management objective of the subpopulation. These numbers are based on detailed scientific data, population trends, Inuit Qaujimajatuqangit, and harvest history.

Where a TAH is established, HTOs have the choice to harvest the set number of bears for their own needs or to allocate a portion of the TAH for guided sport hunts. All bears harvested, whether for subsistence purposes, sport hunts, or in defence of life and

property, are accounted for and subtracted from the annual TAH of the nearest community. If human-caused mortality exceeds the annual community TAH, additional tags will be issued and will be counted as part of the following year's TAH. Any portion of the TAH that goes unused will be counted as credits, which can then be used in subsequent years. Unused credits are zeroed, when a new subpopulation estimate is generated and a new TAH is established. This accounting regime is known as the Flexible Quota System[9].

While the TAH for each polar bear subpopulation is subject to change, the following harvest restrictions have been established by the NWMB for enactment in the *Nunavut Wildlife Act* and do not vary according to subpopulation dynamics or annual removals:

1. No person shall harvest a polar bear that is under three years of age unless
    a. It appears to be abandoned by its mother; or
    b. Its mother was killed or harvested as an emergency kill in accordance with section 97 of the Act and there is little likelihood of it surviving.
2. No person shall harvest a female polar bear that is accompanied by a bear that is or appears to be under three years of age (A polar bear is deemed to be three years old on the first day of the January that follows the third summer after its birth).
3. No person shall harvest a female polar bear that is in a den or that is constructing a den.

The use of NQLs, including seasonal harvest restrictions and the protection of family groups are also important components of Nunavut's polar bear harvest management regime.

8.1.2 Selective harvesting

Selective harvesting of wildlife populations is a common management practise whereby individuals of a certain age, sex or body size are selectively harvested to achieve a specific management goal. In Nunavut, age- and sex-selective harvesting have been used to recover polar bear populations, while maximizing harvest opportunities for Inuit.

Sex-Selective Harvesting

Polar bears are a polygynous species, which means that one male often mates with multiple females during a single breeding season. Accordingly, a few male bears can sire many offspring. Females generally only mate once every 2-4 years because they must give birth and raise their young alone. Therefore, the number of females in a given

[9] The flexible quota system is used in Nunavut to administer the portion of the Total Allowable Harvest allocated to a given community. The system allows for credits to be accumulated when the annual allocation is under-harvested and for over-harvested bears to be subtracted from the next year's base allocation.

population is the most important factor affecting the future abundance and population growth. Scientific modelling has shown that harvesting two males for every female is the best way to increase/maintain polar bear populations, while simultaneously maximizing the harvest.

The two males for every female harvest ratio has been instrumental to the conservation management of polar bears in Nunavut. However, communities throughout Nunavut have expressed concerns about the difficulties in the administration of the sex-selective harvesting and the excessive penalizations that occur when females are over-harvested.

The current management system adopts a one male to one female harvest ratio for all Nunavut subpopulations, until there is new information from science or Inuit Qaujimajatuqangit showing that there has been a decrease in a subpopulation's size or the survival of females, and there is a conservation concern. In this new system, the overharvest of females will be penalised by removing the same number of females from the following year's allocation.

Age-Selective harvesting

As noted above, only those bears that are three years of age and older can be harvested. This is meant to ensure polar bear populations remain stable via the recruitment of new cubs.

8.1.3 Harvest reporting and monitoring

Timely harvest reporting and sample collection are essential components of any wildlife management system. They provide invaluable information about population health and are required to maintain international trade in polar bear specimens. The following body parts and measurements shall be collected from each polar bear that is harvested in Nunavut:

(a) lower jaw, as proof of species

(b) baculum (penis bone), as proof of sex in the case of males

(c) ear tags, if present

(d) straight line body length and chest girth

(e) other samples or measurements, as required (e.g., liver, body condition, body size, etc.).

It is recognized that consultation and training may be required before additional information can be collected. Hunters will be paid for samples at a rate determined by the Department of Environment. In the event of a defence of life or property kill (DLPK), the Superintendent of Wildlife (Department of Environment) may authorize

payment for samples collected by HTOs or individuals on behalf of the Department if there is no Conservation Officer in the community.

8.1.4 Potential harvest management actions and scenarios

1) *If a decline in a subpopulation's size is noted by science/* Inuit Qaujimajatuqangit, *and the objective is to increase or maintain the subpopulation's size, actions may include:*
    - Switch to a two male for every female sex-selective harvest ratio if female or cub survival is low;
    - Reduce the TAH or institute a moratorium until the desired target number is reached.
2) *If an increase in a subpopulation's size is noted by science/* Inuit Qaujimajatuqangit *and the objective is to decrease or maintain the population size, actions may include:*
    - Increase or maintain the TAH. If the TAH is increased, appropriate monitoring must be conducted as a follow-up to measure the success of the management action;
3) *If a subpopulation's size is determined to be stable by science/*Inuit Qaujimajatuqangit *and the objective is to maintain the population at the current level, actions may include:*
    - Maintain the current harvest conditions unless there is evidence of declining body condition or recruitment.

8.2 Information and knowledge gathering (*Qanuqtuurniq*) and objectives

8.2.1 Gaining knowledge

To date, most polar bear research has focused on the estimation of population abundance and trends, and the delineation of population boundaries using physical mark-recapture and telemetry collars. Inuit resistance to polar bear handling resulted in a shift to less invasive methods, including genetic mark-recapture studies and aerial surveys. These new methods do not require the handling of bears but require more frequent surveys and do not provide the same degree of detailed information that can be obtained from mark-recapture and telemetry studies.

Due to the Department of Environment's shift to less invasive research methods, a variety of information that biologists previously obtained through physical mark-recapture and telemetry is no longer available. With proper training, communities and harvesters can voluntarily collect some of this information from the bears they harvest

or observe (e.g., body condition, bears with single cubs, twins and triplets, etc.). This will aid in understanding polar bear biology and ecology more broadly.

In addition to ongoing scientific research and monitoring, improvements are being made in the collection of Inuit Qaujimajatuqangit for use in decision-making. Inuit observe bears year-round and provide current and historical knowledge relevant to decision-making. Harvester observations of body condition can be used to help infer health, as can observations of reproductive success, such as bears with single cubs, twins and triplets. Additionally, Inuit have repeatedly expressed the view that polar bears appear to move between subpopulations and there may be an increased role for Inuit Qaujimajatuqangit to play in the ongoing identification and characterization of subpopulations.

The following objectives are aimed at providing information that will help in making decisions:

- Increase the frequency of population surveys and monitoring;
- Continue to improve Inuit involvement and participation in research;
- Improve and continue gathering and archiving Inuit Qaujimajatuqangit in relation to polar bears and their habitat;
- Improve and continue to collect supplementary information of harvested bears by hunters;
- Continue to develop and evaluate new and less invasive methods of research;
- Consider not only the effects of ecosystem changes on polar bears but also how polar bears affect other species, specifically ringed seals and eider ducks;
- Continue genetic research and collaring to clarify potential boundary changes if needed and supported by communities;
- Review existing management boundaries;
- Improve information collection and reporting related to polar bears and bear-human interactions;
- Improve the analysis of bear-human interactions to determine causes and potential mitigation measures;
- Continue traditional mark-recapture and delineation studies using collars where needed and supported by communities.

8.2.2 Research

The Department of Environment intends to conduct population inventories of each subpopulation on average every ten years (depending on the monitoring techniques applied). Harvest statistics and sample collection will continue to support

management decisions. When possible, a concurrent Inuit Qaujimajatuqangit study will be conducted to complement the population inventory. A schedule of subpopulation inventories and Inuit Qaujimajatuqangit studies is found in Appendix C.

Community residents (with priority to HTO members) shall have the opportunity to participate in polar bear research projects. HTOs will have input into the proposed studies, and Inuit Qaujimajatuqangit will be used to guide research efforts.

In addition to the ongoing population monitoring conducted by the Department of Environment, other partner organizations and individuals conduct research on polar bears throughout Nunavut. Some of these initiatives include research examining the impacts of contaminants and climate change on polar bear populations, ecological studies, feeding studies and many others. The information gathered through these projects will be considered in management decisions as well.

While the Government of Nunavut has invested considerable effort into the development and use of less invasive research methods to study polar bears, there may be instances when collaring and physical mark-recapture studies are needed to collect more detailed information. The Government of Nunavut will seek the support of HTOs prior to implementing studies that use these methodologies.

Physical mark-recapture and collaring studies require researchers to use immobilizing drugs to safely handle polar bears. When a bear has been immobilized within one year of the date of harvest, $1000.00 compensation will be paid to the hunter who harvested the polar bear. HTOs will be consulted and informed of all research initiatives involving the use of chemical immobilization; harvesters can consult their local conservation officer to determine whether a bear has been previously immobilized. Any damage to the hide from research activities will be compensated for based on the reduced amount of the hide's market value. Also, when a bear is destroyed during Department of Environment's polar bear research activities, the nearest community HTO will provide a tag and will be paid $5,000.00 in compensation from the appropriate government authority. These compensation amounts will be reviewed during the 5 and 10-year reviews of the plan. Environment and Climate Change Canada and Parks Canada Agency also have guidelines for research-related polar bear mortality. HTOs are encouraged to negotiate compensation packages with other researchers or companies that may destroy a bear in defence of life and property when the community reviews the respective research or development permits.

8.3 Habitat management and environmental stewardship (*Avatitinnik Kamatsiarniq*) objectives

Polar bears use most parts of the Arctic and SubArctic habitat in which they live.

Polar bears are highly mobile and may be found on annual and multi-year ice, land, or in open water. It will take significant effort to ensure that polar bear habitat remains available and usable because of the vastness of the Arctic and the fact that many threats originate elsewhere or are global in nature. Stewardship can be partially achieved through regulatory processes that occur within Nunavut. However, contaminants that are brought north by wind and ocean currents and habitat changes due to climate change are issues that occur far beyond Nunavut and will require global action to address.

Current habitat stewardship is further supported by the existing parks and protected areas in Nunavut, including National Parks, Territorial Parks, Migratory Bird Sanctuaries, and National Wildlife Areas.

Objectives that promote stewardship and protect habitat must be local and consider the broader causes and issues. These objectives include:

- Ensure that stakeholders have the resources and information to participate effectively in regulatory reviews, such as Environmental Impact Assessments;
- Improve monitoring for contaminants and diseases to respond to potential health concerns resulting from human consumption;
- Consider how increasing shipping and resource development activities may affect polar bears at the individual and subpopulation level;
- Improve understanding of the negative and positive impacts of climate change on polar bear ecology;
- Identify important habitats for polar bears and implement appropriate habitat protection measures through cooperation with appropriate partners and jurisdictions;
- Consider the creation of special management areas, parks, and other land use designations for additional habitat protection and stewardship.
- Generally, assist Canada to meet its obligation under Article II of the *International Agreement on Conservation of Polar Bears* i.e. to “take appropriate action to protect the ecosystems of which polar bears are a part, with special attention to habitat components such as denning and feeding sites and migration patterns.”

8.4 People and bears (*Inuillu Nanuillu*); objectives

The polar bear maintains a position of significant cultural importance to Inuit. Harvesting polar bears for meat, tradition, and economic benefit is still very important, and the harvest of one’s first bear is a significant milestone in a hunter’s life. Minimizing DLPKs and maintaining the traditional harvest are important to all

communities in Nunavut.

When a DLPK occurs, the hide, meat, and other parts of harvested polar bears are turned over to the local HTO after the conservation officer has determined that it is a legitimate DLPK. When there is an irregular or illegal kill, the conservation officer will seize the parts of the bear necessary to complete the investigation. The samples of the killed bear are collected as normal. When it has been determined that the kill was accidental or a DLPK, the conservation officer shall ensure that all seized parts from the kill are turned over to the local HTO. The cleaning and drying of the hide is the responsibility of the HTO because the HTO retains the hide. In all cases, the hides in question must be properly stored, preserved, and returned to the HTO as soon as possible to prevent damage and loss of economic revenue.

If there is any dispute about the distribution of the hide, meat, or parts of the bear from a DLPK, the decision is deferred to the appropriate RWO. There is no payment to the HTO or the hunter for samples, or for cleaning and drying the hide of a bear taken illegally. As per the *Nunavut Wildlife Act*, all seized parts from bears taken illegally are disposed of as directed by the judicial authority.

The following objectives are aimed at reducing bear-human conflict, and reducing human injury and mortality:

- Continue to support communities in the development and implementation of polar bear monitoring and safety plans;
- Hire, train, and equip more community polar bear monitors;
- Continue to develop and improve methods for protecting people, property, and meat caches;
- Ensure that the Department of Environment Wildlife Damage Compensation and Wildlife Damage Prevention Programs are functional and accessible to all communities;
- Enhance communication and information sharing with communities about public safety, polar bear deterrence, and available compensation programs;
- Develop and deliver education programs in schools and communities on methods to protect people while polar bears are on land;
- Work with communities and HTOs to improve local storage for meat in camps and communities as part of the bear-human conflict prevention program.

8.5 Working together (*Piliriqatiginniiq*); objectives

8.5.1 Within Nunavut

This plan was developed with the direction of a co-management working group and the participation of all HTOs and communities. This is a positive step in improved cooperative management, and the following objectives will help to further improve co-management within Nunavut:

- Involve Inuit in research, including project design, field surveys, analysis, and reporting;
- Improve on the documentation of Inuit Qaujimajatuqangit about polar bears so that it is accessible for use in management decision-making.

8.5.2 Between jurisdictions

Working together should also take place at the inter-jurisdictional level. Polar bear inter-jurisdictional agreements should be developed for all subpopulations that are shared with Nunavut. Such agreements already exist between Canada, Nunavut, and Greenland (Kane Basin, Davis Strait, and Baffin Bay subpopulations). User-to-user groups should also pursue agreements on shared populations; one such agreement already exists in the western portion of the Kitikmeot and the Inuvialuit in NWT for the Northern Beaufort Sea and Viscount Melville Sound subpopulations.

The following objectives will help to foster improved inter-jurisdictional cooperation:

- Foster user-to-user agreements between Inuit organizations and other jurisdictions;
- Work toward developing compatible management regimes for shared populations;
- Build cooperative research programs in areas such as population monitoring, contaminants monitoring, and Inuit Qaujimajatuqangit studies;
- Continue to improve coordination between different levels of government and partners. Environment and Climate Change Canada, Parks Canada Agency, Department of Environment, RWOs and HTOs all have a role and an interest in implementation of this plan and the sustainable management of polar bears;
- Work with other jurisdictions in Canada to address public safety concerns and formulate coordinated responses;
- Work toward joint decision-making processes involving all the co-management boards linked to a shared subpopulation.

8.5.3 Sharing information and knowledge

Ensuring that knowledge and information are shared will help all co-management partners to make better informed decisions. Currently, information flow is sporadic,

and all parties need to make improvements. This is best done by formalizing information sharing through communications and outreach, including:

- Develop a communications strategy for sharing information;
- Develop data sharing agreements with other agencies and jurisdictions;
- Ensure that the results of studies, both scientific and Inuit Qaujimajatuqangit, are shared with all co-management partners;
- Continue to contribute to the Polar Bear-Human Interaction Management System, work with the human-bear conflict subcommittee of the Range States and outside organizations to quantify and characterize successful polar bear deterrent measures.

9. IMPLEMENTATION OF THE PLAN

Achieving the objectives identified in section 8 will require cooperation of co-management partners, jurisdictions, and significant investment of financial and human resources. New information will be presented to the NWMB when available, along with a review of the management objective(s) for the subpopulation and a review of any new scientific or Inuit Qaujimajatuqangit information. When new information is available, a change to the TAH will be recommended that is consistent with the subpopulation management objective and the objectives of this plan.

The co-management structure in Nunavut requires an NWMB decision for any changes to TAHs, management objectives, or NQLs. It is difficult to predetermine which action(s) will be undertaken within the co-management framework and the NWMB decision-making process, as each individual scenario will have its own set of circumstances. The management objectives, Inuit Qaujimajatuqangit, population size and trend, and population projections under differing harvest scenarios, will vary by subpopulation. This does not mean that action will not be taken, as the goal of the management plan is *"To maintain viable and healthy polar bear subpopulations capable of sustaining harvesting needs for current and future generations, and to ensure that polar bears remain an integral and functioning part of the ecosystem while monitored, sustainable harvests occur."*. In that context, the following are examples identified by co-management partners of what actions should be taken to implement this plan. It is important to note that appropriate consultation and dialogue with co-management partners will be carried out before any action is taken.

Prior to action being taken, there will be appropriate consultation and neighbouring jurisdictions.

9.1 Harvest Management

Management Action	Priority	Timeline
Undertake a review of the sustainable removal rates for females for all subpopulations in Nunavut.	High	3 years
Revise the Flexible Quota System to accommodate the switch from two male for every female to one male for every female sex-selective harvest ratio.	High	1 year
Monitor and evaluate the implementation of the one male for every female (1:1) sex-selective harvest ratio within the Flexible Quota System, including any impact on abundance, cub and female survival.	High	2 years
Expand and increase harvest sample collection and reporting upon peer review of research objectives.	High	5 years
Improve handling of hides taken from bears killed in defense of life and property to ensure no loss in hide value.	High	Ongoing
Ensure harvest reporting and sample submission is adequate to address research and management needs.	High	Ongoing
Develop a community program to train Inuit to effectively collect biological data on polar bear and harvest efforts.	Medium	5 years

9.2 Information and Knowledge Gathering (Qanuqtuurniq): Actions

Habitat Management and Environmental Stewardship (*Avatitinnik Kamatsiarniq*): Actions

Management Action	Priority	Timeline
Develop a knowledge and information sharing framework for co-management partners.	High	2 years
Document Inuit Qaujimajatuqangit about polar bear health, abundance, and distribution to support management decisions.	High	Ongoing
Use available Inuit Qaujimajatuqangit to support polar bear science research and formulation of management objectives.	High	Ongoing
Strive for meaningful involvement of Inuit in all aspects of polar bear research and decision-making.	High	Ongoing
Conduct population assessments as per the	High	Ongoing

inventory schedule and make the results publicly available on time.		
Continue to develop, evaluate, and apply research techniques that will provide the essential information with minimal impacts on polar bears.	Medium	Ongoing
Develop a twenty-five-year research strategy for polar bear ecosystem-based monitoring identifying and prioritizing research gaps.	Medium	2019
Build partnerships with external researchers and governments to increase Department of Environment's capacity for both science and Inuit Qaujimajatuqangit towards the implementation of the twenty-five-year research strategy.	Medium	Ongoing
Work with relevant partners to improve knowledge of the distribution and abundance polar bear prey species (mainly ringed seal and bearded seal).	Medium	5 years

9.3 Habitat Management and Environmental Stewardship (*Avatitinnik Kamatsiarniq*) Actions

Management Action	Priority	Timeline
Seek to build capacity in all co-management organizations to better participate in regulatory review processes.	Medium	Ongoing
Continue to participate in the contaminants monitoring program for polar bears.	Medium	Ongoing
Study effects of marine shipping and develop of mitigation measures.	Medium	10 years
Develop and circulate best management practices to reduce the impacts of human activities, such as tourism and mineral exploration, within polar bear habitat.	Medium	Ongoing
In general, work closely with relevant partners to reduce the impacts of climate change on polar bear habitat.	Low	10 years

9.4 People and Bears (*Inuillu Nanuillu*) Actions

Management Action	Priority	Timeline
Seek program funding to train and equip bear guards.	High	Ongoing
Develop educational material (e.g., posters, fact	High	Within 2 years

sheets, website material) for communities, tourists, mining camps, etc., on best practices to minimize human-bear interactions.		
Develop, adopt, and implement community bear management plans and community human-bear-interaction protocols.	High	Within 3 years
Encourage community-level participation to address public safety concerns using non-lethal polar bear deterrents methods such as bear guards, auditory/pyrotechnic deterrents, and fortification of meat caches.	High	Ongoing
Develop a communications plan and education materials for bear safety.	Medium	Within 3 years
Conduct a review of Damage Compensation and Damage Prevention Programs.	Medium	Within 3 years

1045

1046 ### 9.5 Working Together (*Piliriqatiginniiq*) Actions

Management Action	Priority	Timeline
Seek cooperative research partners to build further capacity in Inuit Qaujimajatuqangit studies and scientific research.	High	Ongoing
Build capacity in HTOs to provide support and participation in research projects.	High	Within 3 years
Develop a knowledge and information sharing framework for co-management partners.	High	2 years
Identify inter-jurisdictional agreements near completion and ensure resources are available to finalize.	High	Ongoing
Explore frameworks for coordinated responses with other jurisdictions in Canada regarding human safety.	Medium	2 years
Identify inter-jurisdictional agreements that need to be pursued and ensure resources are available to initiate.	Medium	3 years
Explore research agreements with neighboring jurisdictions for shared populations.	Medium	5 years
Improve cooperation with federal agencies such as Parks Canada Agency and Canadian Wildlife Service so that their land management efforts also support this plan.	Medium	5 years

10. PLAN REVIEW

This management plan is meant to be a dynamic, living document and is expected to be revised as new science and Inuit Qaujimajatuqangit becomes available to ensure that the goal and objectives are met. A co-management working group will conduct a review of objectives with respect to progress made every five years. Where objectives have been met, they will be revised according to current needs. Where objectives have not been met, additional actions and new timelines may be identified. Co-management is an ongoing effort that evolves in line with available knowledge and information. The review will consider the number of polar bears in each subpopulation, their health, trends (population, reproduction, survival rates etc.), conservation of habitat (largely the sea ice, but also denning areas), reduction of human-bear conflict occurrences and resulting decrease in DLPKs, and the incorporation of Inuit Qaujimajatuqangit.

11. APPENDICES

Appendix A – Subpopulations and Status

Globally, polar bears are divided into 19 subpopulations for management purposes. This is based on movement patterns estimated from satellite telemetry data, and ear tags returned from harvested bears. The eleven subpopulations that occur in Nunavut (wholly or in-part) are presented here along with a brief characterization of their population history, status, and proposed management recommendation(s). Although these boundaries are accepted for management purposes, frequent movement of bears occur between subpopulations and both scientists and Inuit Qaujimajatuqangit believe these subpopulations are not isolated. For underlying details of estimates and trend, consult the most recent PBTC status table[10].

Appendix A I – Baffin Bay (BB) subpopulation status

Brief history

The Baffin Bay subpopulation is shared between Canada (Nunavut) and Greenland. The Canada-Greenland Joint Commission was established in 2009 with the signing of a *Memorandum of Understanding between Canada, Nunavut, and Greenland to conserve and managed shared polar bear populations*. This subpopulation shares its boundaries with Kane Basin, Lancaster Sound, Foxe Basin, and Davis Strait. A study using microsatellite markers found no significant genetic differences between polar bears in the Baffin Bay and Kane Basin, but there was significant genetic variation between Baffin Bay and Davis Strait. Studies conducted between 1994 and 1997 produced a Baffin Bay subpopulation abundance estimate of 2,074 polar bears. A 3-year genetic mark-recapture survey (via biopsy darting) completed in 2014 produced a subpopulation estimate of 2,826 polar bears (range: 2,059-3,593). The trade ban placed on the subpopulation in 2010 because of perceived over-harvesting was lifted in 2016.

Status: 2,826 bears (2016)
Science – Stable

[10] The status table presents the population status and trends of all polar bear subpopulations in Canada. It is reviewed annually by the Polar Bear Technical Committee (PBTC) and presented to the Polar Bear Administrative Committee (PBAC) to support management decision making.

Inuit Qaujimajatuqangit – Increased
Current TAH (2018) – Nunavut 80
– Greenland 80

Management recommendations:

- Maintain current population abundance and review management objective(s) and TAH when new Inuit Qaujimajatuqangit or scientific knowledge becomes available.
- Consider adaptively managing the subpopulation for a decrease if there is evidence (Inuit Qaujimajatuqangit or scientific knowledge) that the subpopulation size is stable or increasing and public safety becomes a major concern.
- Explore the possibility to re-assess the subpopulation boundary between Baffin Bay and Kane Basin.
- Increase cooperation with the Government of Greenland to ensure a sustainable harvest.

Appendix A II – Davis Strait (DS) subpopulation status

Brief history

The Davis Strait subpopulation is shared with Greenland, Newfoundland and Labrador, and Quebec. Studies have shown that polar bears from the northern portions of Davis Strait and those from Foxe Basin are closely related. The current abundance estimate of 2,158 bears (range: 1,833–2,542) is based on physical mark-recapture data collected in 1974–2004 and 2005–2007, and harvest data from 1974–2009. The population is characterized by low recruitment rates and high population density where sea-ice conditions are deteriorating and variable. Previously the subpopulation abundance was estimated at 900 polar bears. This estimate was based on the sum of separate estimates from southeast Baffin Island and Labrador in the 1980s. In 1993, the estimate was revised to 1,400 bears and then to 1,650 in 2005. These increases were to account for the offshore bears not surveyed, and to include Inuit Qaujimajatuqangit that suggested more bears had been seen over the last 20 years. In 2017 and 2018, a genetic mark-recapture survey of the Davis Strait subpopulation was conducted collaboratively by Nunavut, Newfoundland and Labrador, and Quebec. Concurrently, Inuit Qaujimajatuqangit studies in Nunavut, Nunavik, and Nunatsiavut are ongoing.

Status: 2,158 bears (2007)

Science – Stable
Inuit Qaujimajatuqangit – Increasing
Current TAH – Nunavut = 61
– Nunavik = 32
– Nunatsiavut = 12
– Greenland = 3
– Greenland = 3

Management recommendations:

- Maintain current population abundance and review management objective(s) and TAH when new Inuit Qaujimajatuqangit or scientific knowledge becomes available.
- Consider adaptively managing the subpopulation for a decrease if there is evidence (Inuit Qaujimajatuqangit or scientific knowledge) that the subpopulation size is stable or increasing and public safety becomes a major concern.
- Explore the possibility to re-assess the boundary between Foxe Basin and Davis Strait near Kimmirut.
- Increase cooperation among all jurisdictions that share this subpopulation to ensure a sustainable harvest.
- Hold joint co-management board public hearings to consider management options.
- Encourage inter-jurisdictional discussions between user groups to identify appropriate quota allocation between regions.

Appendix A III – Southern Hudson Bay (SH) subpopulation status

Brief history

The range of the Southern Hudson Bay subpopulation includes the Nunavik and Eeyou Marine regions and the coastline of Ontario and Québec. Polar bears in the Southern Hudson Bay, Davis Strait, and Foxe Basin subpopulation experience a seasonally ice-free environment, which forces the bears onto shore during late summer, where they remain for several months while awaiting freeze-up. Mark-recapture studies conducted 1984–86 and 2003–05 and an intensive aerial survey conducted 2011–12 suggested abundance was unchanged since the mid-1980s. A recent mark-recapture study suggested that the abundance declined by 17% from 943 bears (range: 658–1350) in 2011/2012 to 780 bears (range: 590–1029) in 2016. A concurrent Inuit knowledge study concluded that the abundance of Southern

Hudson Bay polar bears has increased relative to the 1970s and that most bears are in good body condition. An inter-jurisdictional Southern Hudson Bay Polar Bear Management Advisory Committee was established in 2018 to develop and recommend sustainable management options using best available Inuit Qaujimajatuqangit and scientific knowledge. These studies and more recent telemetry data show seasonal fidelity to the Ontario coast during the ice-free season, and some mixing with the Western Hudson Bay and Foxe Basin subpopulations during winter months.

Status: 780 bears (2016)

Science – likely decline
Inuit Qaujimajatuqangit – increased
Current TAH – Nunavut = 25 (Voluntary agreement reduced it to 20; expired 2016)
– Ontario = 3
– Nunavik = 23

Management recommendations:

- Maintain current population abundance and review management objective(s) and TAH when new Inuit Qaujimajatuqangit or scientific knowledge becomes available.
- Increase cooperation among all jurisdictions that share this population to ensure a sustainable harvest.
- Continue with inter-jurisdictional user-to-user discussions to ensure agreement on the fair allocation of the TAH.

Appendix A IV – Western Hudson Bay (WH) subpopulation status

Brief history

The Western Hudson Bay subpopulation is shared with Manitoba. This subpopulation shares its boundaries with Foxe Basin and Southern Hudson Bay. Mapping of satellite telemetry data indicates substantial range overlap in the winter when bears are on the sea ice. Inuit Qaujimajatuqangit indicates that the subpopulation's abundance has increased when compared to historic levels in the 1950s and 1970s. The 2016 aerial survey resulted in an abundance estimate of 842 bears (range: 562–1121). This estimate was not statistically different from the 2011 aerial survey estimate of 1030 bears, that used similar survey methods and was considered broadly consistent with Environment and Climate Change Canada's 2011 estimate of 806 polar bears—based on analysis of long-term capture and harvest data. All three studies combined suggest that the abundance remained stable during the past 10 years. However, like observations from the 2011 survey, cubs-of-the-year

and yearlings comprised a small proportion of the sample size in 2016, a possible indication of low recruitment.

Status: 842 bears (2016)
Science – likely declined
Inuit Qaujimajatuqangit – increased
current TAH – Nunavut = 38
– Manitoba = 4

Management recommendations:

- Maintain current population abundance and review management objective(s) and TAH when new Inuit Qaujimajatuqangit or scientific knowledge becomes available.
- Consider adaptively managing the subpopulation for a decrease if there is evidence (Inuit Qaujimajatuqangit or scientific knowledge) that the subpopulation size is stable or increasing and public safety becomes a major concern.
- Increase cooperation with Manitoba especially in the areas of tourism, polar bear deterrence and public safety.
- Explore the possibility to re-assess the management boundaries between Western Hudson Bay and Foxe Basin/Southern Hudson Bay subpopulations.
- Encourage knowledge exchange between Inuit and researchers.

Appendix A V – Foxe Basin (FB) subpopulation status

Brief history

The Foxe Basin polar bear subpopulation is shared between Nunavut and Quebec. The 2009–2010 aerial surveys produced a subpopulation estimate of 2,580 polar bears (range: 2096-3189). This estimate was not statistically different from the 1994 abundance estimate of 2,197 polar bears, derived from a tetracycline biomarking study, indicating a stable population. Inuit Qaujimajatuqangit maintains that the number bears in the subpopulation has increased. The winter home range of the Foxe Basin subpopulation overlaps with that of the Western Hudson Bay and Davis Strait. The coverage and quality of sea-ice habitat has declined substantially over the last several decades and is predicted to continue to decline. However, there is no evidence to suggest that polar bears have been negatively affected.

Status: 2,580 bears
Science – stable
Inuit Qaujimajatuqangit – increased
Current TAH – Nunavut = 123
– Nunavik = 7

Management recommendations :

- Maintain current population abundance and review management objective(s) and TAH when new Inuit Qaujimajatuqangit or Scientific knowledge becomes available.
- Consider adaptively managing the subpopulation for a decrease if there is evidence (Inuit Qaujimajatuqangit or scientific knowledge) that the subpopulation size is stable or increasing and public safety becomes a major concern.
- Increase cooperation with Nunavik to ensure sustainable harvesting.
- Hold joint board hearings and meetings with Nunavik Marine Region Wildlife Board (NMRWB).

Appendix A VI – Gulf of Boothia (GB) subpopulation status

Brief history

Based on Inuit Qaujimajatuqangit, a recognition of sampling deficiencies, and polar bear densities in other areas, an interim subpopulation estimate of 900 was established in the 1990s. A physical mark-recapture study from 1976–2000 produced an abundance estimate of 1,592 polar bears range (1231–1953). This study also suggested that recruitment levels are high and the population is stable or increasing. A new three-year subpopulation abundance study that began in 2015 was finalised in 2017. Results of the abundance estimate are expected in 2019.

Status: 1,592 bears (2000)
Science –uncertain
Inuit Qaujimajatuqangit – increased
Current TAH – Nunavut = 74

Management recommendations:

- Maintain current population abundance and review management objective(s) and TAH when new Inuit Qaujimajatuqangit or Scientific knowledge becomes available.

Appendix A VII – M'Clintock Channel (MC) subpopulation status

Brief history

An estimate of 900 bears was derived from a six-year study undertaken in the mid-1970s. Following the completion of a mark-recapture inventory in the spring of 2000, the subpopulation was estimated to number 284 (range: 166-402). A moratorium was put in place, followed by a significantly reduced harvest that was in place until 2015/16 when the TAH was increased. The management objective for this population is an increase in the abundance for recovery. Inuit suggest that there has been a recovery in the number of bears in the subpopulation. They also consider the current population estimate of 900 bears to be "about right". The Department of Environment conducted a genetic mark-recapture study from 2014-2017; results are expected in 2019.

Status: 284 bears (2000)
Science – uncertain, but likely increasing
Inuit Qaujimajatuqangit – increased
Current TAH – Nunavut = 12

Management recommendations:

- Maintain current population abundance and review management objective(s) and TAH when new Inuit Qaujimajatuqangit or scientific knowledge becomes available.

Appendix A VIII – Lancaster Sound (LS) subpopulation status

Brief history

Information from satellite radio-collars, and physical and genetic mark-recapture show that this subpopulation is distinct from the adjoining Viscount Melville Sound, M'Clintock Channel, Gulf of Boothia, Baffin Bay, and Norwegian Bay subpopulations. The subpopulation estimate of 2,541 (range: 2932–2150) was based on an analysis of both historical and current mark-recapture data up to 1997. This estimate is considerably larger than a previous estimate of 1,675 that included Norwegian Bay. Currently, there are no data available to assess the population size.

Status: 2,541 bears (1998)
Science – uncertain, likely stable
Inuit Qaujimajatuqangit – increased
Current TAH – Nunavut = 85

Management recommendations:

- Maintain current population abundance and review management objective(s) and TAH when new Inuit Qaujimajatuqangit or scientific knowledge becomes available.

Appendix A IX – Kane Basin (KB) subpopulation status

Brief history

The Kane Basin polar bear subpopulation is inter-jurisdictional and internationally shared between Canada (Nunavut) and Greenland. Like Baffin Bay, management of the Kane Basin polar bears is coordinated by the Canada-Greenland Joint Commission. Kane Basin polar bears are not genetically different from those in the adjacent Baffin Bay subpopulation. A two-year (2013–2014) collaborative study between Greenland and Nunavut estimated that there are 357 bears in the Kane Basin subpopulation (range: 221–493. This estimate is higher than the 1997 estimate of 164 polar bears and when taken together with survival rates and body conditions, suggests an increase in numbers. The study, and a subsequent Harvest Risk Assessment showed that there are fewer males than females in the subpopulation, male survival is lower than female survival, and found no evidence that Kane Basin polar bears have been negatively affected by a decrease in sea ice extent over the past several decades.

Status: 357 bears (2014)
Science – increased
Inuit Qaujimajatuqangit – increased
Current TAH – Nunavut = 5
Greenland = 9

Management recommendations:

- Maintain current population abundance and review management objective(s) and TAH when new Inuit Qaujimajatuqangit or scientific knowledge becomes available.
- Explore the possibility to re-assess the population boundary between Baffin Bay and Kane Basin.
- Work closely with Greenland to ensure that a sustainable harvest occurs.

Appendix A X – Norwegian Bay (NW) subpopulation status

Brief history

The current (1993–97) estimate is 203 (range: 159–247). Data collected during mark-recapture studies and from satellite radio tracking of adult female polar

bears indicate that most of the polar bears in this subpopulation are concentrated along the coastal tide cracks and ridges along the north, east, and southern boundaries of the management unit. Science research suggests that the low polar bear abundance may be due to low ringed seal productivity in the central and western areas of Norwegian Bay—a result of prevailing multi-year ice[11]. This subpopulation is genetically distinct compared to other polar bear subpopulations.

Status: 203 bears (1998)
Science – uncertain
Inuit Qaujimajatuqangit – stable
current TAH – Nunavut = 4

Management recommendations:

- Maintain current population abundance and review management objective(s) and TAH when new Inuit Qaujimajatuqangit or scientific knowledge becomes available.

Appendix A XI – Viscount Melville Sound (VM) subpopulation status

Brief history

The Viscount Melville Sound subpopulation is shared with the Inuvialuit Settlement Region, in the Northwest Territories. The current subpopulation estimate of 161 polar bears was based on a mark-recapture survey completed in 1992. Results of a mark-recapture study conducted by the Government of Northwest Territories are expected in 2019.

Status: 161 bears (1992)
Science – uncertain
Inuit Qaujimajatuqangit – increasing
Current TAH – Nunavut = 3
– Northwest Territories = 4

[11] Kingsley, M. C. S., Stirling, I., Calvert, W. 1985. The distribution and abundance of seals in the Canadian High Arctic, 1980–82. *Can. J. Fish. Aquat. Sci.* **42:** 1189-1210, pp 1207.
McLoughlin, P. D., Taylor, M. K., Dowsley, M. 2007. Update, COSEWIC status report on the polar bear (Ursus maritimus) prepared for the Committee on the Status of Endangered Wildlife in Canada. Government of Nunavut, Department of Environment, Status report: **32**, Iqaluit, pp 20.

Management recommendations:

- Maintain current population abundance and review management objective(s) and TAH when new Inuit Qaujimajatuqangit or scientific knowledge becomes available.
- Increase cooperation with the Inuvialuit Settlement Region and the Government of Northwest Territories to ensure a sustainable harvest.

Appendix A XII – Northern Beaufort Sea (NB) subpopulation status

Brief history

It is currently recognised that the 2006 estimate of 980 bears was biased low because of changes in distribution. The subpopulation estimates of 1200-1300 in 2004 and 2005 appears to more accurately reflect the current number of bears in the population, suggesting that the population is increasing. The Inuvialuit Settlement Region adopts a subpopulation estimate of 1,710, for management purposes.

Status: 980 bears (2006)
Science – stable
Inuit Qaujimajatuqangit – stable
current TAH – Nunavut = 6
– NWT = 71

Management recommendations:

- Maintain current population abundance and review management objective(s) and TAH when new Inuit Qaujimajatuqangit or scientific knowledge becomes available.
- Increase cooperation with the Inuvialuit Settlement Region and the Government of Northwest Territories to ensure a sustainable harvest.

Appendix B – Research Schedule

Proposed schedule to conduct studies to update the status of the population, using scientific Inuit Qaujimajatuqangit, as of December 2018. This schedule is tentative and assumes full availability of funds and human resources. The priorities and needs may shift over the coming years, which will affect timing of this schedule. TBD-To be determined

Subpopulation	Previous survey year and method	Next survey year and method	Previous IQ survey	Proposed IQ survey
Baffin Bay	2011–2013 Genetic mark-recapture	2021 To be determined	2015	2022
Davis Strait	2005–2007 Mark- recapture	2017–18 Genetic mark-recapture	2007-2008	2018
Foxe Basin	2010–2011 Aerial survey	2020 Aerial survey	2008-2009	2020
Gulf of Boothia	1998–2000 Mark -recapture	2015–2017 Genetic mark-recapture	n/a	TBD
Kane Basin	2012–2014 Genetic mark recapture and aerial survey	2021 To be determined	n/a	2024
Lancaster Sound	1997 Mark-recapture	2019–2021 To be determined	n/a	2020
M'Clintock Channel	1998-2000 Mark-recapture	2014-2017 Genetic mark recapture	2002-2006	TBD
Northern Beaufort Sea	2006 Mark-recapture	2019	n/a	TBD
Norwegian Bay	1998 Mark-recapture	2019–2021 To be determined	n/a	2020
Southern Hudson Bay	2016 Aerial survey	2021	2013	TBD
Viscount Melville	2012–2014 Mark-recapture	TBD	n/a	TBD
Western Hudson Bay and Southern Hudson Bay	2016 Aerial survey	2021 Aerial survey	2011-2012	2021

Appendix C – Literature Reviewed

Amstrup, S. C. 1993. Human disturbances of denning polar bears in Alaska. *Arctic*, **46:** 246-250.

Amstrup, S. C. 2003. Polar bear. Pp. 587–610 in Wild mammals of North America: biology, management, and conservation. 2nd Edition. G.A. Feldhamer, B.C. Thompson, and J.A. Chapman (eds). John Hopkins University Press, Baltimore, MD.
biology, management, and conservation. 2nd Edition. G. A.

Amstrup, S. C., Durner, G. M., McDonald, T. L., Johnson, W. R. 2006. Estimating potential effect of hypothetical oil spills on polar bears. US Geological Survey, US Department of the Interior. 55 pp.

Atkinson, S. N., Nelson, R. A., Ramsay, M. A. 1996. Changes in the body composition of fasting polar bears (*Ursus maritimus*): the effect of relative fatness on protein conservation. *Physiol. Zool.* **69:** 304-316.

Atkinson, S., Garshelis, D., Stapleton, S., Hedman, D. 2012. Western Hudson Bay polar bear aerial survey, 2011. Government of Nunavut, Final Report, Igloolik, Nunavut. 56 pp.

Best, R. C. 1984. Digestibility of ringed seals by the polar bear. *Can. J. Zool.* **63:** 1033-1036.

Bethke, R., Taylor, M. K., Amstrup, S., Messier, F. 1996. Population delineation of polar bears using satellite collar data. *Ecol. Appl.* **6:** 311-317.

Blix, A. S., Lentfer, J. W. 1979. Modes of thermal protection in polar bear cubs – at birth and on emergence from their den. *Am. J. Physiol.* **236:** R67-R74.

Brice-Bennett, C. 1977. Land Use in the Nain and Hopedale Regions. Pp 97-203 *in* Our footprints are everywhere, Inuit land use and occupancy in Labrador. C. Brice-Bennett (ed.). Labrador Inuit Association, Nain, Greenland.

Bytingsvik, J., Lie, E., Aars, J., Derocher, A. E., Wiig, Ø., Jenssen, B. M. 2012. PCBs and OH-PCBs in polar bear mother-cub pairs : a comparative study based on plasma levels in 1998 and 2008. *Sci. Total Env*. DOI: 10.1016/j.scitotenv.2011.12.033.

Campagna, L., Van Coeverden de Groot, P.J., Saunders, B., Atkinson, S., Weber, D., Dyck, M.G., Boag, P.T., Lougheed, S.C. 2013. Extensive sampling of polar bears (*Ursus maritimus*) in the Northwest Passage (Canadian Arctic Archipelago) reveals population differentiation across multiple spatial and temporal scales. *Ecol. Evol.* **3:** 3152-3165.

Clark, D. A., Stirling, I., Calvert, W. 1997. Distribution, characteristics, and use of earth dens and related excavations by polar bears on the western Hudson Bay Lowlands. *Arctic,* **50:** 158-166.

Colborn, T., vom Saal, F. A., Soto, A. M. 1993. Developmental effects of endocrine-disrupting chemicals in wildlife and humans. *Environ. Health Perspect*. **101:** 378-384.

Comiso, J. C., Nishio, F. 2008. Trends in sea ice cover using enhanced and compatible AMSR-E, SSM/I, and SMMR data. *J. Geophys. Res.-Oceans* **113:** C020507.

Damstra, T., Barlow, S. Bergman, A., Kavlock, R., Kraak, G. V. D. 2002. Global Assessment of the state-of-the-science of endocrine disruptors. Geneva: World Health Organization.

de March, B. G. E., de Wit, C., Muir, D. C. G., Braune, B., Gregor, D. J., Norstrom, R. J. 1998. Persistent organic pollutants. Pp. 183-372 in AMAP Assessment Report: Arctic Pollution Issues. Oslo: Arctic Monitoring Assessment Programme.

DeMaster, D. P., Stirling, I. 1981. *Ursus maritimus*. Polar bear. *Mammal. Spec.* **145:** 1-7.

Department of Environment. 2014. Summary of Community Consultations on the draft Nunavut Polar Bear Management Plan development and process. Government of Nunavut, Iqaluit, Nunavut.

Derocher, A. E., Stirling, I., Andriashek, D. 1992. Pregnancy rates and serum progesterone levels of polar bears in western Hudson Bay. *Can. J. Zool.* **70:** 561-566.

Derocher, A. E., Andriashek, D., Stirling, I. 1993. Terrestrial foraging by polar bears during the ice-free period in western Hudson Bay. *Arctic,* **46:** 251-254.

Derocher, A. E., Stirling, I. 1995. Temporal variation in reproduction and body mass of polar bears in western Hudson Bay. *Can. J. Zool.* **73:** 1657-1665.

Derocher, A. E., Stirling, I. 1998. Geographic variation in growth of polar bears (*Ursus maritimus*). *J. Zool. (Lond.)* **245:** 65-72.

Derocher, A. E., Stirling, I. 1998. Maternal investment and factors affecting offspring size in polar bears (*Ursus maritimus*). *J. Zool. (Lond.)* **245:** 253-260.

Derocher, A. E., Wiig, Ø. 1999. Infanticide and cannibalism of juvenile polar bears (*Ursus maritimus*) in Svalbard. *Arctic,* **52:** 307–310.

Derocher, A. E., Wiig, Ø., Bangjord, G. 2000. Predation of Svalbard reindeer by polar bears. *Polar Biol.* **23:** 675-678.

Derocher, A. E., Wolkers, H., Colborn, T., Schlabach, M., Larsen, T. S. & Wiig, O. 2003. Contaminants in Svalbard polar bear samples archived since 1967 and possible population level effects. *Sci. Total Environ*. **301:** 163-174.

Donaldson, G. M., Chapdelaine, G., Andrews, J. D. 1995. Predation of thick-billed murres, *Uria lomvia*, at two breeding colonies by polar bears, *Ursus maritimus*, and walruses, *Odobenus rosmarus*. *Can. Field-Nat.* **109:** 112-114.

Dowsley, M., Wenzel, G. W. 2008. ‘‘The time of the most polar bears’’: A co-management conflict in Nunavut. *Arctic*, **61:** 177–189.

Durner, G. M., D. C. Douglas, R. M. Nielson, et al. 2009. Predicting 21st-century polar bear habitat distribution from global climate models. *Ecological Monographs*, **79:** 25–58.

Dyck, M. G., Daley, K. 2002. Cannibalism of a yearling polar bear (*Ursus maritimus*) at Churchill, Canada. *Arctic,* **55:** 190-192.

Dyck, M. G. Baydack, R. K. 2004. Vigilance behaviour of polar bears in the context of wildlife-viewing activities at Churchill, Manitoba, Canada. *Biol. Cons*. **116:** 343-350.

Dyck, M. G. 2006. Characteristics of polar bears killed in defence of life and property in Nunavut, Canada, 1970-2000. *Ursus,* **17:** 52-62.

Dyck, M. G., Baydack, R. K. 2006. Human activities associated with polar bear viewing near Churchill, Manitoba, Canada. *Human Dimensions of Wildlife*, **11:** 143-145.

Dyck, M. G., Romberg, S. 2007. Observations of a wild polar bear (*Ursus maritimus*) successfully fishing Arctic charr (*Salvelinus alpinus*) and fourhorn sculpin (*Myoxocephalus quadricornis*). *Polar Biol.* **30:** 1625-1628.

Dyck, M. G., Morin, P. 2011. In vivo digestibility trials of a captive polar bear (*Ursus maritimus*) feeding on harp seal (*Pagophilus groenlandicus*) and Arctic charr **(***Salvelinus alpinus*). *Pakistan J. Zool.* **43:** 759-767.

Feldhamer, G. A., Thompson, B. C., Chapman, J. A. (eds). Wild mammals of North America. John Hopkins University Press, Baltimore, MD.

Ferguson, S. H., Taylor, M. K., Messier, F. 2000. Influence of sea ice dynamics on habitat selection by polar bears. *Ecology,* **81:** 761-772.

Ferguson, S. H., Taylor, M. K., Rosing-Asvid, A., Born, E. W., Messier, F. 2000. Relationships between denning of polar bears and conditions of sea ice. *J. Mammal.* **81:** 1118-1127.

Fikkan, A., Osherenko, G., and Arikainen, A. 1993. Polar bears: the importance of simplicity. Pp. 96-151 *in* Young, O. R., and Osherenko, G. (eds). Polar politics: creating international environmental regimes. Ithaca, NY: Cornell University Press.

Freeman, Milton M.R. and Lee Foote, 2009. Inuit, Polar Bears and Sustainable Use. Edmonton, CCI Press, 252 pages.

Freeman, M. M. R. 2001. Culture, commerce and international co-operation in the global recovery of polar bears. *Pacific Conservation Biology* **7:** 161– 168.

Freeman, M. M. R., and Wenzel, G. 2006. The nature and significance of polar bear conservation hunting in the Canadian Arctic. Arctic 59:21-30.

Furnell, D. J., Oolooyuk, D. 1980. Polar bear predation on ringed seals in ice-free water. *Can. Field-Nat*. **94:** 88-89.

Furnell, D.J., Schweinsburg, R.E. 1984. Population dynamics of central Arctic polar bears. *J. Wildl. Manage.* **48:** 722-728.

Gentry, A. 2001. Nomenclatural notes: the authorship and date of the specific name of *Ursus* or *Thalarctos maritimus*, the polar bear, is Phipps (1774) and not Linnaeus (1758). *Bull. Zool. Nomen*. **58**: Part 4.

Gough, W. A., Cornwell, A. R., Tsuji, L. J. S. 2004. Trends in seasonal sea-ice duration in southwestern Hudson Bay. *Arctic*, **57:** 299-305.

Hamilton, S.G., Castro de la Guardia, L., Derocher, A.E., Sahanatien, V., Tremblay, B., et al. 2014. Projected polar bear sea ice habitat in the Canadian Arctic Archipelago. PLoS ONE 9: e113746. doi:10.1371/journal.pone.0113746

Hannah, C.G., Dupont, F., and Dunphy, M. 2009. Polynyas and tidal currents in the Canadian Arctic Archipelago. *Arctic*, **62:** 83-95.

Harington, C. R. 1968. Denning habits of the polar bear (*Ursus maritimus* Phipps). *Can. Wildl. Serv. Report Series* **No. 5.** 30 pp.

Hobson, K. A., Stirling, I. 1997. Low variation in blood $\delta^{13}C$ among Hudson Bay polar bears: implications for metabolism and tracing terrestrial foraging. *Mar. Mammal Sci.* **13:** 359-367.

Hobson, K. A., Stirling, I., Andriashek, D. S. 2009. Isotopic homogeneity of breadth CO_2 from fasting and berry-eating polar bears: implications for tracing reliance on terrestrial foods in a changing Arctic. *Can. J. Zool.* **87:** 50-55.

Honderich, J. E. 2001. Wildlife as a hazardous resource: an analysis of the historical interaction of humans and polar bears in the Canadian Arctic 2000 B.C. to 1935 A.D. M. A. thesis, University of Waterloo, ON, Waterloo. 193 pp.

Howell-Skalla, L. A., Cattet, M. R. L., Ramsay, M. A., Bahr, J. M. 2002. Seasonal changes in testicular size and serum LH, prolactin and testosterone concentrations in male polar bears (*Ursus maritimus*). *Reproduction,* **123:** 729-733.

IPCC (Intergovernmental Panel on Climate Change). 2001. Third Assessment Report: Climate Change 2001 (TAR). Accessible at: http://www.ipcc.ch.

IPCC (Intergovernmental Panel on Climate Change). 2007. Fourth Assessment Report: Climate Change 2007 (AR4). Accessible at: http://www.ipcc.ch.

Iverson, S. J., Stirling, I., Lang, S. L. C. 2006. Spatial and temporal variation in the diets of polar bears across the Canadian Arctic: indicators of changes in prey populations and environment. Pages 98-117 in I.L. Boyd, S. Wanless, C. J. Camphuysen (eds.). Top predators in marine ecosystems. Cambridge University Press, New York, New York, USA.

Kalxdorff, S. B. 1997. Collection of local knowledge regarding polar bear habitat use in Alaska. Marine Mammals Management, Fish and Wildlife Service, Region 7, Alaska. USFWS Technical Report MMM 97-2. U.S. Department of the Interior. 71 pp.

Kingsley, M. C. S., Stirling, I., Calvert, W. 1985. The distribution and abundance of seals in the Canadian High Arctic, 1980–82. *Can. J. Fish. Aquat. Sci.* **42:** 1189-1210.

Kolenosky, G. B., Prevett, J. P. 1983. Productivity and maternity denning of polar bears in Ontario. *Int. Conf. Bear Res. Manage.* **5:** 238-245.

Kurtén, B. 1964. The evolution of the polar bear, *Ursus maritimus* Phipps. *Acta Zool. Fenn*. **108**: 130.

Laidre, K. L. et al. 2015. Arctic marine mammal population status, sea ice habitat loss, and conservation recommendations for the 21st century. *Conservation Biology*, DOI: 10.1111/cobi.12474.

Laidre, K. L., Stirling, I., Lowry, L. F., Wiig, Ø., Heide-Jorgensen, M. P., Ferguson, S. H. 2008. Quantifying the sensitivity of Arctic marine mammals to climate-induced habitat change. *Ecol. Appl.* **18:** S97-S125.

Lewis, A., Doidge, W., Suppa, S. 2006. Update of traditional knowledge on polar bears at Inukjuak and Puvirnutuq, Nunavik. Report 12-493 submitted to Aboriginal Species at Risk Fund, Environment and Climate Change Canada, Québec Region. Nunavik Research Centre, Makivik Corporation, Kuujjuaq, QC.

Letcher, R. J., Bustnes, J. O., Dietz, R., Jenssen, B. M., Jørgensen, E. H., Sonne, C., Verrault, J., Vijayan, M. M., Gabrielsen, G. W. 2010. Exposure and effects assessment of persistent organohalogen contaminants in Arctic wildlife and fish. *Sci Total Environ.* **408:** 2995-3043.

Lie, E., Bernhoft, A., Riget, F., Belikov, S. E., Boltunov, A. N., Derocher, A. E.,

Garner, G. W., Wiig, O., & Skaare, J. U. 2003. Geographical distribution of organochlorine pesticides (OCPs) in polar bears (*Ursus maritimus*) in the Norwegian and Russian Arctic. *Sci. Total Environ*. **306:** 159-170.

Linnaeus, C. 1758. *Systema Naturae*, Ed. 10, Vol. 1. 824 pp. Salvii, Holmiae.

Lunn, N. J., Stirling, I., Andriashek, D., Richardson, E. 2004. Selection of maternity dens by female polar bears in western Hudson Bay. *Polar Biol.* **27:** 350–356.

Lunn, N. J., Stenhouse, G. B. 1985. An observation of possible cannibalism by polar bears (*Ursus maritimus*). *Can. J. Zool.* **63:** 1516–1517.

Markus, T., Stroeve, J. C. and Miller J. 2009. Recent changes in Arctic sea ice melt onset, freezeup, and melt season length. J. Geophys. Res. 114:C12024, doi:10.1029/2009JC005436.

Maslanik, J., Stroeve, J., Fowler, C. and Emery W. 2011. Distribution and trends in Arctic sea ice through spring 2011. Geophys. Res. Letters 38:L13502, doi:10.1029/2011GL047735.

Mauritzen, M. et al. 2003. Functional responses in polar bear habitat selection. *Oikos,* **100:** 112–124.

McLoughlin, P. D., Taylor, M. K., Messier, F. 2005. Conservation risks of male-selective harvest for mammals with low reproductive potential. *J. Wildl. Manage*. **69:** 1592-1600.

McLoughlin, P. D., Taylor, M. K., Dowsley, M. 2007. Update, COSEWIC status report on the polar bear (*Ursus maritimus*) prepared for the Committee on the Status of Endangered Wildlife in Canada. Government of Nunavut, Department of Environment, Status report: 32, Iqaluit, 59 pp.

McKinney, M. A., Peacock, E., Letcher, R. 2009. Sea ice-associated diet change increases the levels of chlorinated and brominated contaminants in polar bears. *Environ. Sci. Technol.* **43:** 4334-4339.

Malenfant, R.M., Davis, C.S., Cullingham, C.I., Coltman, D.W. 2016 Circumpolar genetic structure and recent gene flow of polar bears: a reanalysis. PLoS ONE 11(3): e0148967. doi:10.1371/journal. pone.0148967

Messier, F., Taylor, M. K., Ramsay, M. A. 1994. Denning ecology of polar bears in the Canadian Arctic Archipelago. *J. Mammal.* **75:** 420-430.

Molnár, P. K., Lewis, M. A. and Derocher, A. E. 2014. Estimating allee dynamics before they can be observed: polar bears as a case study. PLos One **9(1):** e85410.
DOI:10.1371/journal.pone.0085410.

Muir, D., Braune, B., DeMarch, B, Norstrom, R., Wagemann, R., Lockhart, L., Hargrave, B., Bright, D., Addison, R., Payne, J., Reimer, K. 1999. Spatial and temporal trends and effects of contaminants in the Canadian Arctic marine ecosystem: A review. *Sci*. *Total Environ.* **230:** 83–144.

Muir, D., Backus, S., Derocher, A. E., Dietz, R., Evans, T. J., Gabrielsen, G. W., Nagy, J., Norstrom, R. J., Sonne, C., Stirling, I., Taylor, M. K., Letcher, R. J. 2006. Brominated flame retardants in polar bears (*Ursus maritimus*) from Alaska, the Canadian Arctic, East Greenland, and Svalbard. *Environ. Sci. & Technol*. **40:** 449–455.

Norstrom, R. J., Belikov, S. E., Born, E. W., Garner, G. W., Malone, B., Olpinski, S., Ramsay, M. A., Schliebe, S., Stirling, I., Stishov, M. S., Taylor, M. K., Wiig, Ø. 1998. Chlorinated hydrocarbon contaminants in polar bears from eastern Russia, North America, Greenland and Svalbard. *Arch. Environ. Contam. Toxicol*. **35:** 354–367.

Obbard, M. E., Cattet, M. R. L., Moody, T., Walton, L. R., Potter, D., Inglis, J., Chenier, C. 2006. Temporal trends in the body condition of Southern Hudson Bay polar bears. Climate Change Research Information Note, No. 3. Ontario Ministry of Natural Resources, Applied Research and Development Branch, Sault Ste. Marie, ON, 8 pp.

Obbard, M. E. 2008. Southern Hudson Bay polar bear project: Final Report. Ontario Ministry of Natural Resources, Peterborough, Ontario. 64 pp.

Obbard, M. E., Thiemann, G. W., Peacock, E., DeBruyn, T. D. (eds) (2010). *Polar Bears: Proceedings of the 15th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Copenhagen,Denmark, 29 June–3 July 2009.* Gland, Switzerland and Cambridge, UK: IUCN. vii + 235 pp.

Obbard, M.E., Middel, K.R., Stapleton, S., Thibault, I., Brodeur, V., and Jutras, C. 2013. Estimating abundance of the Southern Hudson Bay polar bear subpopulation using aerial surveys, 2011 and 2012. Ontario Ministry of Natural Resources, Science, and Research Branch, Wildlife Research Series 2013-01.33 pp.

Øritsland, N. A., Engelhardt, F. R., Juck, F. A., Hurst, R. J., Watts, P. D. 1981. Effect of crude oil on polar bears. Indian and Northern Affairs Canada, Environmental Studies No. 24.

Ovsyanikov, N. G. 1996. Interactions of polar bears with other large mammals, including man. *J. Wildl, Res.* **1:** 254-289.

Palmer, S. S., Nelson, R. A., Ramsey, M. A., Stirling, I., Bahr, J. M. 1988. Annual changes in serum sex steroids in male and female black (*Ursus americanus*) and polar (*Ursus maritimus*) bears. *Biol. Repr.* **38:** 1044-1050.

Peacock, E., Taylor, M. K., Laake, J., Stirling, I. 2013. Population ecology of polar bears in Davis Strait, Canada and Greenland. *J. Wildl. Manage.* DOI: 10.1002./jwm.489.

Pedersen, A. 1945. Der Eisbär: Verbreitung and Lebensweise. E. Bruun, Copenhagen.

Perovich, D. K., Richter-Menge, J. A. 2009. Loss of ice in the Arctic. *Ann. Rev. Mar. Sci*. **1:** 417-441.

Phipps, C. J. 1774. A voyage towards the North Pole undertaken by His Majesty's Command,1773. viii, 253 pp., 14 pls. Nourse, London.

Pilfold, N. W., Derocher, A. E., Stirling, I., Richardson, E., Andriashek, D. 2012. Age and sex composition of seals killed by polar bears in the eastern Beaufort Sea. PLos ONE; DOI: 10.1371/journal.pone.0041429

Polischuk, S. C., Letcher, R. J., Norstrom, R. J., Ramsay, M. A. 1995. Preliminary results of fasting on the kinetics of organochlorines in polar bears (*Ursus maritimus*). *Sci*. *Total Environ*. **160-161:** 465-472.

Polischuk, S. C., Norstrom, R. J. Ramsay, M. A. 2002. Body burdens and tissue concentrations of organochlorines in polar bears vary during seasonal fasts.

Environ. *Pollut*. **118:** 29-39.

Prestrud, P., and Stirling, I. 1994. The international polar bear agreement and the current status of polar bear conservation. *Aquatic Mammals* **20:** 113-124.

Ramsay, M. A., and Dunbrack, R. L. 1986. Physiological constraints on life history phenomena: The example of small bear cubs at birth. *Am. Nat*. **127:** 735-743.

Ramsay, M.A., Stirling, I. 1988. Reproductive biology and ecology of female polar bears (*Ursus maritimus*). *J. Zool. (Lond.)* **214:** 601-634.

Ramsay, M. A., Stirling, I. 1990. Fidelity of female polar bears to winter den sites. *J. Mammal.* **71:** 233-236.

Ramsay, M. A., Hobson, K. A. 1991. Polar bears make little use of terrestrial food webs: evidence from stable-carbon isotope analysis. *Oecologia,* **86:** 598-600.

Regehr, E. V., Amstrup, S. C., Stirling, I. 2006. Polar bear population status in the southern Beaufort Sea: U.S. Geological Survey Open-File Report 2006-1337, 20 pp.

Regehr, E. V., Lunn, N. J., Amstrup, S. C., Stirling, I. 2007. Effects of earlier sea ice breakup on survival and population size of polar bears in western Hudson Bay. *J. Wildl. Manage*. **71:** 2673-2683.

Regehr, E. V., Hunter, C. M., Caswell, H., Amstrup, S.C. Stirling, I. 2010. Survival and breeding of polar bears in the southern Beaufort Sea in relation to sea ice. *J. Anim. Ecol.* **79:** 117-127.

Richardson, E., Stirling, I., Hik, D. S. 2005. Polar bear (*Ursus maritimus*) maternity denning habitat in western Hudson Bay: A bottom-up approach to resource selection functions. *Can*. *J. Zool.* **83:** 860-870.

Rockwell, R. F., Gormezano, L. J. 2009. The early bear gets the goose: climate change, polar bears and lesser snow geese in western Hudson Bay. *Polar Biol*. **32:** 539-547.

Rode, K.D., Amstrup, S.C. and Regehr, E.V. 2010. Reduced body size and cub recruitment in polar bears associated with sea ice decline. *Ecol. Appl.* **20:** 768-782.

Rode, K. D., Peacock, E., Taylor, M., Stirling, I., Born, E. W., Laidre, K. L., Wiig, Ø. 2012. A tale of two polar bear populations: ice habitat, harvest, and body condition. *Popul. Ecol.* **54:** 3-18.

Rosing-Asvid, A., Born, E. W., Kingsley, M. C. S. 2002. Age at sexual maturity of males and timing of the mating season of polar bears (*Ursus maritimus*) in Greenland. *Polar Biol.* **25:** 878-883.

Russell, R. H. 1975. The food habits of polar bears of James Bay and southwest Hudson Bay in summer and autumn. *Arctic,* **28:** 117-129.

Sahanatien, V., Peacock, E., and A. E. Derocher. 2015. Population substructure and space use of Foxe Basin polar bears. *Ecology and Evolution*, **5:** 2851-2864.

Sahanatien, V., Derocher, A. E. 2012. Monitoring sea ice habitat fragmentation for polar bear conservation. *Animal Cons*. DOI : 10.1111/j.1469-1795.2012.00529

Saunders, B. L. 2005. The mating system of polar bears in the central Canadian Arctic. M.Sc. Thesis, Queen's University, Kingston, Ontario.

Serreze, M. C., M. M. Holland, and J. Stroeve. 2007. Perspectives on the Arctic's shrinking sea ice cover. *Science* **315:** 1533–1536

Sonne, C., Dyck, M., Riget, F., Bech-Jensen, J.E., Hyldstrup, L., Letcher, R., Gustavson, K., Gilbert, T., and Dietz, R. 2015. Globally used chemicals and penile density in Canadian and Greenland polar bears. *Environmental Research* **137**: 287-291.

Sonne, C., Riget, F. F., Dietz, R., Kirkegaard, M., Born, E. W., Letcher, R., Muir, D. C. G. 2005. Trends in fluctuating asymmetry in East Greenland polar bears (*Ursus maritimus*) from 1892 to 2002 in relation to organohalogen pollution. *Sci. Total Environ*. **341:** 81-96.

Sonne, C., Leifson, P. S., Dietz, R., Born, E. W., Letcher, R. J., Hyldstrup, L., Riget, F. F., Kirkegaard, M., Muir, D. C. G. 2006. Xenoendocrine pollutants may reduce size of sexual organs in East Greenland polar bears (*Ursus maritimus*). *Environ. Sci Technol* **40:** 5668-5674.3

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. *Environ Int*. **36:** 461–491.

Sou, T. and Flato G. 2009. Sea ice in the Canadian Arctic Archipelago: modeling the past (1950-2004) and the future (2041-60). *J. Climate* **22:** 2181-2198.

Smithwick, M., Mabury, S. A., Solomon, K. R., Sonne, C., Martin, J. W., Born, E. W., Dietz, R., Derocher, A. E., Letcher, R. J., Evans, T. J., Gabrielsen, G. W., Nagy, J., Stirling, I., Taylor, M. K., Muir, D. C. G. 2005. Circumpolar study of perfluoroalkyl contaminants in polar bears (*Ursus maritimus*). *Environ. Sci. & Technol*. **39:** 5517–5523.

Stapleton, S., Peacock, E., and Garshelis, D. 2016. Aerial surveys suggest long-term stability in the seasonally ice-free Foxe Basin (Nunavut) polar bear population. *Marine Mammal Science*, **32:** 181-201.

Stapleton, S., Peacock, E., Garshelis, D., Atkinson, S. 2012. Foxe Basin polar bear aerial survey, 2009 and 2010: Final Report, Government of Nunavut, Iqaluit, Nunavut.

Stapleton, S., Atkinson, S., Hedman, D., and Garshelis, D. 2014. Revisiting Western Hudson Bay: using aerial surveys to update polar bear abundance in a sentinel population. Biol. Cons. **170:** 38-47.

Stempniewicz, L. 2006. Polar bear predatory behavior toward molting Barnacle geese and nesting Glaucus gulls on Spitzbergen. *Arctic,* **59:** 247-251.

Stirling, I., McEwan, E. H. 1975. The caloric value of whole tinged seals (*Phoca hispida*) in relation to polar bear ecology and hunting behavior. *Can. J. Zool.* **53:** 1021-1027

Stirling, I., Archibald, W. R. 1977. Aspects of predation of seals by polar bears. *J. Fish. Res. Board Can.* **34:** 1126-1129

Stirling, I., Calvert, W., Cleator, H. 1982. Underwater vocalizations as a tool for studying the distribution and relative abundance of wintering pinnipeds in the High Arctic. *Arctic,* **36:** 262-274.

Stirling, I. 1988. Attraction of polar bears *Ursus maritimus* to off-shore drilling sites in the eastern Beaufort Sea. *Polar Rec.* **24:** 1-8.

Stirling, I., Andriashek, D. 1992. Terrestrial denning of polar bears in the eastern Beaufort Sea area. *Arctic,* **45:** 363-366.

Stirling, I., Derocher, A. E. 1993. Possible impacts of climatic warming on polar bears. *Arctic,* **46:** 240-245.

Stirling, I., Andriashek, D. A., Calvert, W. 1993. Habitat preferences of polar bears in the western Canadian Arctic in late winter and spring. *Polar Rec.* **29:** 13-24.

Stirling, I., Lunn, N. J., 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., Parkinson, C. L. 2006. Possible effects of climate warming on selected populations of polar bears (*Ursus maritimus*) in the Canadian Arctic. *Arctic*, **59:** 261-275.

Stroeve, J., Holland, M. M., Meier, W., Scambos, T., Serreze, M. 2007. Arctic sea ice decline: faster than forecast. *Geophys. Res. Lett.* **34:** L09501.

Taylor, M., Larsen, T., Schweinsburg, R. E. 1985. Observations of intraspecific aggression and cannibalism in polar bears (*Ursus maritimus*). *Arctic,* **38:** 303–309.

Taylor, M. K., Lee, L. J. 1995. Distribution and abundance of Canadian polar bear populations: a management perspective. *Arctic,* **48:** 147–154.

Taylor, M. K., Akeeagok, S., Andriashek, D., Barbour, W., Born, E. W., Calvert, W., Cluff, H. D., Ferguson, S., Laake, J., Rosing-Asvid, A., Stirling, I., Messier, F. 2001. Delineating Canadian and Greenland polar bear (*Ursus maritimus*) populations by cluster analysis of movements. *Can. J. Zool.* **79:** 690–709.

Taylor, M. K., Laake, J., Cluff, H. D., Ramsay, M. A., Messier, F. 2002. Managing the risk from hunting for the Viscount Melville Sound polar bear population. *Ursus,* **13:** 185–202.

Taylor, M.K., Laake, J. L., McLoughlin, P. D., Born, E. W., Cluff, H. D., Ferguson, S. F., Rosing-Asvid, A., Schweinsburg, R., Messier, F. 2005. Demography and viability of a hunted population of polar bears. *Arctic,* **58:** 203–214.

Taylor, M.K., Laake, J.L., McLoughlin, P.D., Cluff, H.D., Messier, F. 2006. Demographic parameters and harvest-explicit population viability analysis for polar bears in M'Clintock Channel, Nunavut. *J. Wildl. Manage*. **70:** 1667–1673.

Taylor, M.K., Laake, J. L., McLoughlin, P. D., Cluff, H. D., Born, E. W., Rosing-Asvid, A., Messier, F. 2008a. Population parameters and harvest risks for polar bears (*Ursus maritimus*) in Kane Basin, Nunavut and Greenland. *Polar Biol*. **31:** 491-499.

Taylor, M. K., P. D. McLoughlin, and F. Messier. 2008b. Sex-selective harvesting of polar bears *Ursus maritimus*. Wildlife Biology 14:52-60.

Taylor, M.K., Laake, J. L., McLoughlin, P. D., Cluff, H. D., Messier, F. 2009. Demography and population viability of polar bears in the Gulf of Boothia, Nunavut. *Mar. Mammal Sci*. **25:** 778-796.

Thiemann, G. W., Iverson, S., Stirling, I. 2008. Polar bear diets and Arctic marine food webs: insights from fatty acid analysis. *Ecol. Monogr*. **78:** 591-613.

Thenius, E. 1953. Concerning the analysis of the teeth of polar bears. *Mammal. Bull.* **1:** 14-20.

Tyrrell, M. 2006. More bears, less bears: Inuit and scientific perceptions of polar bear populations on the west coast of Hudson Bay. *Inuit Studies*, **30:** 191–208.

Van de Velde, F., Stirling, I., Richardson, E. 2003. Polar bear (*Ursus maritimus*) denning in the area of the Simpson Peninsula, Nunavut. *Arctic,* **56:** 191–197.

Verreault, J., Gabrielsen, G. W., Chu, S. G., Muir, D. C. G., Andersen, M., Hamaed, A., Letcher, R. J. 2005a. Flame retardants and methoxylated and hydroxylated polybrominated diphenyl ethers in two Norwegian Arctic top predators: Glaucous gulls and polar bears. *Environ. Sci. & Technol*. **39:** 6021-6028.

Verreault, J., Muir, D. C. G., Norstrom, R. J., Stirling, I., Fisk, A. T., Gabrielsen, G. W., Derocher, A. E., Evans, T. J., Dietz, R., Sonne, C., Sandala, G. M., Gebbink, W., Riget, F. F., Born, E. W., Taylor, M. K., Nagy, J., Letcher, R. J. 2005b. Chlorinated hydrocarbon contaminants and metabolites in polar bears (*Ursus maritimus*) from Alaska, Canada, East Greenland, and Svalbard: 1996-

2002. *Sci. Total Environ*. **351:** 369-390.

Verreault, J., Norstrom, R. J., Ramsay, M. A., Mulvihill, M., Letcher, R. J. 2006. Composition of chlorinated hydrocarbon contaminants among major adipose tissue depots of polar bears (*Ursus maritimus*) from the Canadian high Arctic. *Sci. Total Environ*. **370:** 580-587.

Verreault, J., Dietz, R., Sonne, C., Gebbink, W. A., Shamiri, S., Letcher, R. J. 2008. Comparative toxokinetics of organohalogen ontaminants in two top Greenland carnivores: Captive sledge dogs (*Canis familiaris*) and wild polar bear (*Ursus maritimus*). *Comp. Biochem. Physiol*., Part C **147:** 306–315.

Vongraven, D., Peacock, E. 2011. Development of a pan-Arctic monitoring plan for polar bears: background paper. Circumpolar Biodiversity Monitoring Programme*,* CAFF Monitoring Series Report No.1, January 2011, CAFF International Secretariat,
Akureyri, Iceland.

Vongraven, D. et al. 2012. A circumpolar monitoring framework for polar bears. *Ursus Monogr. Ser*. 5.

Wang, M., Overland, J. E. E. 2012. A sea ice free summer Arctic within 30 years-an update from CMIP5 models, *Geophys. Res. Lett.*, DOI:10.1029/2012GL052868.

Watts, P. D., Hansen, S. E. 1987. Cyclic starvation as a reproductive strategy in the polar bear. *Symp. Zool. Soc. (Lond.)* **57:** 305-318.

Wenzel, G. 1983. Inuit and polar bears: observations from a hunt near Resolute Bay, N.W.T. *Arctic* **38:** 90-94.

Wenzel, G. 1995. Ningiqtuq: Inuit resource sharing and generalized reciprocity in Clyde River, Nunavut. *Arctic Anthropology* **32:** 43-60.

Wenzel, G. 2004. Polar bear as a resource: an overview. Third northern research forum open meeting position paper. URL: http://www.nrf.is/open_meetings_files/ Yellowknife_2004/Wenzel.pdf.

Wiig, Ø., Amstrup, S., Atwood, T., Laidre, K., Lunn, N., Obbard, M., Regehr, E., and Thiemann, G. 2015. *Ursus maritimus*. The IUCN Red List of Threatened Species 2015: e.T22823A14871490.

2046 Wimsatt, W. A. 1963. Delayed implantation in the Ursidae, with particular
2047 reference to the black bear (Ursus americanus Pallas). Pp. 49-76 in Delayed
2048 implantation. A.C. Enders (ed.). University of Chicago Press, Chicago, IL.