COSEWIC
Assessment and Status Report

on the

Polar Bear
Ursus maritimus

in Canada

SPECIAL CONCERN
2018

COSEWIC
Committee on the Status of Endangered Wildlife in Canada

COSEPAC
Comité sur la situation des espèces en péril au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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COSEWIC. 2002. COSEWIC assessment and update status report on the polar bear *Ursus maritimus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa. vi + 29 pp.

Stirling, I., and M.K. Taylor. 1999. Update COSEWIC status report on the polar bear *Ursus maritimus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa. 27 pp.

Stirling, I. 1991. Update COSEWIC status report on the polar bear *Ursus maritimus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa. 24 pp.

Stirling, I. 1986. COSEWIC status report on the polar bear *Ursus maritimus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa. 20 pp.

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COSEWIC
Assessment Summary

Assessment Summary – November 2018

Common name
Polar Bear

Scientific name
Ursus maritimus

Status
Special Concern

Reason for designation
This apex predator depends on the availability of sea ice from which to hunt its preferred prey—ice-adapted seals. Reduction in the area and period of sea ice coverage due to climate warming in the Canadian Arctic, with consequent reductions in feeding opportunity, is the primary threat to the persistence of this species. However, the magnitude of the impact on population numbers is uncertain and will vary across the range. Population levels and trends are currently uncertain, as population estimates undertaken since the last COSEWIC assessment in 2008 exist for less than half the range and survey methodology has changed. This precludes the use of quantitative trend analysis for most of the Canadian population. The total population in Canada likely exceeds 10,000 mature individuals. ATK indicates stable or increasing populations in all 13 management units, while scientific knowledge suggests a decline associated with poorer body condition, decreasing productivity, and sea ice decline in three management units in the southern part of the range. The Canadian population is predicted to decline over the next three generations (35 years) due to a reduction in seasonal coverage of sea ice. This species may become Threatened in the future because the effects of sea ice loss on this species will be extensive and ongoing.

Occurrence
Yukon, Northwest Territories, Nunavut, Manitoba, Ontario, Québec, Newfoundland and Labrador, Arctic Ocean

Status history
Designated Not at Risk in April 1986. Status re-examined and designated Special Concern in April 1991. Status re-examined and confirmed in April 1999, November 2002, April 2008, and November 2018.

COSEWIC
Executive Summary

Polar Bear
Ursus maritimus

Wildlife Species Description and Significance

The Polar Bear (*Ursus maritimus*) is an apex carnivore found throughout the ice-covered coastal regions of the Arctic. Polar Bear are specifically adapted to the Arctic coastal marine environment and their life history is substantially dependent on sea-ice habitat. The Polar Bear is an icon of Canada's wildlife heritage, and of great cultural, spiritual, and economic significance to Canadians, especially northern Indigenous peoples. As a symbol of the Arctic environment, Polar Bear are viewed throughout the world as a barometer of important environmental issues, especially climate change and pollution.

Distribution

Polar Bear have a circumpolar Arctic distribution and are regularly found in Canada, USA, Russia, Svalbard (Norway), and Greenland. Worldwide, Polar Bear are delineated into 19 'subpopulations' (referred to as 'management units' in this report), of which 14 units occur wholly, or in part, in Canada. In Canada, their distribution encompasses the entire Arctic region: from Yukon to Newfoundland and Labrador, from Ellesmere Island to James Bay. Polar Bear distribution is closely linked to the presence, temporal duration, and quality of sea-ice habitat. As such, Polar Bear are not distributed evenly throughout their range: densities vary with sea-ice characteristics, ocean depth, and the availability of prey. Individual home range size is variable but tends to be very large (up to ca. 600,000 km^2), and may reflect habitat availability, habitat quality, geographic features, prey distribution, reproductive status (e.g., pregnant females or females with cubs-of-the-year), and individual foraging behaviour.

Habitat

Polar Bear require both marine (sea-ice) and terrestrial habitat. They are highly specialized carnivores and are strongly dependent on sea-ice to access marine mammal prey. Polar Bear may use terrestrial habitat seasonally and most females den on land. On the sea-ice, Polar Bear will use multi-year ice but are found in the greatest numbers on annual (i.e., first-year) sea-ice over the continental shelves and shallow (<300 m) basins where their prey, mainly species of seal, occur in the highest densities. Sea-ice concentration (area of sea-ice relative to the total ocean area of interest) is the most important factor affecting Polar Bear habitat selection. Habitat preferences vary seasonally, with strong selection for areas with approximately 85% ice concentration during peak foraging in spring, suggesting that a mix of ice and open water represents optimal habitat. Polar Bear typically move to land when ice concentration declines to 30-50%. On shore, bears often segregate by sex and reproductive status. In autumn, pregnant females excavate maternity dens in permafrost or snow.

Biology

The life history of the Polar Bear is characterized by slow growth and reproductive rates, a prolonged period of maternal care, and long lifespans. Maximum lifespan in the wild is generally between 25 and 30 years, with females living 1-3 years longer than males, on average. Female age at first reproduction is generally 4–5 years. Polar Bear are sexually dimorphic and most males enter the reproductive segment of the population at 8–10 years old when they have achieved the body size to compete for available mates. Females typically have litters of 1–2 cubs, which are weaned after 2.5 years. Generation time is estimated as 11.5 years. Total survival for mature-age bears often exceeds 90% per year.

Population Sizes and Trends

The global and Canadian population size is poorly known. Global population estimates of 20,000 – 26,000 have been made, but the authors of these reports recognize the limitations and do not support their use for population assessment. In Canada, of the 14 units, no surveys of one unit (Arctic Basin) exist, and surveys of the other 13 units vary in frequency and methodology. Many of the 14 management units have not been surveyed recently (i.e., in the last generation length period; 11.5 years), or data are unavailable. Survey data from 6 units are >17 years old and are not considered useful to provide a current population estimate. A population estimate of 10,448 bears (confidence intervals not available) of all ages is derived from the 7 management units with recent surveys. The total population is higher because the non-counted units comprise approximately 30% of the core of the Canadian range; surveys conducted only during the previous generation length period (1996 – 2007) totalled an additional 5,650 bears. The number of mature animals is unknown, but likely would exceed 10,000 animals because approximately 69% of the population are assumed to be adults (i.e*.*, 69% of both the 10,448 estimate and the bears in the remaining 30% of the range).

The population was impacted by overhunting for the fur trade before the 1970s but harvest management allowed subsequent recovery. A quantified population trend for the Canadian population in the last 1-3 generations cannot be determined because: 1) surveys are irregular and the entire population has never been surveyed in a similar time period; 2) almost half of the units have not been surveyed for >12-26 years (or, in the case of 5 units, surveys are completed, but data are unavailable); 3) wide confidence intervals; and 4) survey methods in some units have changed enough that comparisons between generations are not possible. In the previous status report (2008), population trends were used as a criterion for status assessment because a larger number of the units had been surveyed nearer to that assessment period.

Aboriginal traditional knowledge (ATK), Inuit traditional knowledge / Qaujimajatuqangit (ITK/IQ) (hereafter, 'ATK'), and local knowledge include observation of distribution, ecology, response to disturbances, and population trends over local and regional scales. Scientifically collected information typically includes aerial survey, mark-recapture, and genetic analyses. ATK and information from science sources run in parallel and often support each other on population trends, but they are not always in agreement.

Statements of population trend have been made for individual management units by the Polar Bear Technical Committee; in the last 15 years, all 13 managed units assessed are increasing or stable, when applying an ATK-based assessment.

Information from science sources is of limited use for range-wide population assessment. Only 1 of 14 management units has consistent methodology and recent surveys to permit calculation of a population trend using generation length periods. The Southern Beaufort Sea (SBS) unit declined 50% over 3 generations (from 1,800 to 900 bears), and declined 41% between 2006 and 2010 (half generation). The confidence intervals for these values do not overlap and these results suggest an actual decline. However, there is contention over using one particular estimate; if that estimate was not used, then population trend is unknown because of the lack of a recent estimate. The Western Hudson Bay (WHB), and Southern Hudson Bay (SHB) unit estimates are lower by 18% (depending on estimate used), and 17%, respectively, in the last half generation (5-6 years). However, a decline based solely on abundance is uncertain because confidence intervals overlap and the difference is not statistically significant. Indices of body condition and some demographic data do suggest a decline is occurring in these two units. The Polar Bear Technical Committee concludes that these 2 units, and the SBS unit, have 'likely declined' in the past 15 years, when applying a scientific assessment. The contribution of these units to the Canadian population is unknown because the entire population has never been surveyed in a short time period; assessing significance of trends within a single management unit requires a full survey in order to identify the proportion of each unit population as part of the national total.

Indices of population trend can be interpreted as evidence of decline or increase; for example, there is increasing human-bear conflict in 8 management units, which may suggest increased population size, or a shift in the existing population towards communities by bears not finding enough food on sea-ice. Some indices appear to indicate decreasing health, which may result in population decline; declines in female body condition have been observed in 5 management units and declines in reproduction have been observed in 4 management units, likely due to declines in sea-ice habitat. However, ATK indicates that Polar Bear health indices fluctuate with annual sea-ice conditions and that body condition is an incomplete indicator of population decline.

In summary, although a quantified population size and trend based on western science is unknown, ATK indicates that the population has been at least stable for the last generation. The lack of recent scientific data for many units makes it difficult to make conclusions on population trend using scientific data, at least based on comparing trend over 1-3 generations, as is done in COSEWIC status reports. Where recent scientific data do exist, the evidence indicates that these areas are in likely decline, in concordance with predictions on impacts of climate change. These three units (SHB, WHB, SBS) are in the southern range and likely are more representative of areas with greater effects of climate change than the rest of the range; the core of the range appears to be doing well and the majority of the population does not appear to be declining.

Threats and Limiting Factors

The Arctic is predicted to be mainly ice-free during summer by 2040 - 2060, although the timing of predictions varies widely. Scientific methods conclude that Polar Bear populations are predicted to decline due to decreasing sea-ice. A recent modelling exercise used 6 scenarios and concluded there was a median 71% probability (range 20-95%) of a >30% decline in three generations (35 years). However, there is uncertainty with this model because the relationship between bear populations and sea-ice is not well quantified. As such, the models are considered indicative of a general decline associated with climate change, rather than declines that can be readily quantified. Habitat loss driven by climate warming is the primary threat to the Polar Bear in Canada, although the severity is contested by some ATK that indicates Polar Bear are adaptable to change. In some units, generally in the southern parts of the range, declines in sea-ice have negatively affected Polar Bear body condition, adult and juvenile survival, reproduction, and abundance. Other threats include human-caused mortality (hunting and defence kills), pollutants, oil spills, displacement or disturbance by industrial development, and ship traffic (cargo and cruise). An important issue is whether Polar Bear are able to adapt to the predicted sea-ice loss by surviving on land. At present, empirically based analyses suggest that terrestrial foods are inadequate to replace the value of prey associated with sea-ice and that populations will decline with melting sea-ice. The Threats Assessment exercise suggested an impact threat of High-High, mainly due to the impact of human-induced climate change impact on sea-ice habitat. The Polar Bear Technical Committee listed 2 units as predicted to ‘likely decline’, 2 units as ‘uncertain/likely decline’, 6 units as ‘uncertain’, and 3 units as ‘likely stable’ for the next 10 years.

Protection, Status and Ranks

The Polar Bear has been designated by COSEWIC as Special Concern since 1991 and has been listed on Schedule 1 of SARA under the same designation since 2011. Between 2008 – 2016, Polar Bear were listed under various categories of endangerment; as a species of Special Concern under the Northwest Territories *Species at Risk (NWT) Act*, as a Threatened species under Ontario’s *Endangered Species Act* (2007) and in Manitoba under *The Endangered Species and Ecosystems Act*. Polar Bear are listed as Vulnerable in both Québec and Newfoundland and Labrador. Polar Bear are not listed in Nunavut, or Yukon. Polar Bear are considered Threatened worldwide under the USA *Endangered Species Act* and listed as a globally Vulnerable species under the IUCN Red List. International trade is restricted under Appendix II of CITES (Convention on International Trade in Endangered Species). Polar Bear removal (from hunting, defence kills, etc.) is regulated or managed based on scientific data and ATK at the unit level, generally through coordination of the Wildlife Management Boards and various governments.

TECHNICAL SUMMARY

Ursus maritimus

Polar Bear

Ours blanc

Range of occurrence in Canada: Yukon, Northwest Territories, Nunavut, Manitoba, Ontario, Québec, Newfoundland and Labrador, Arctic Ocean.

Demographic Information

Generation time Based on average age of females that produced the newborn cohort (i.e., females observed with cubs < 2 years old).	11.5 years (95% CI= 9.8, 13.6)
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? Uncertainty due to incomplete survey data and conflicting information from science and ATK sources. Observed and inferred likely decline in 3 units, based on science. Observed lack of decline, based on ATK. Inferred and projected decline associated with threat of sea-ice loss, with uncertainty due to conflicting information from different sources Scientific methods indicate populations in 3 management units, at the southern range likely have declined, compared to ATK information, which indicates 0 management units have declined. Potential projected decline of 30% for world population predicted in 3 generations but uncertainty exists about the model.	Uncertain
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations] ATK sources do not list % change but some concern or uncertainty exists for 8-10 units [PBTC 2018]; scientific methods not precise enough to determine % change in 2 generations.	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations]. Many units lack recent population estimates and total population size is unknown; thus, the proportion of units with data relative to total population unknown. ATK sources do not list % change	Unknown

[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations]. Projected reduction of 30% in 3 generations based on the global population, including Canada, but uncertainty exists about the model.	Unknown; reduction expected but uncertainty exists on quantifying the reduction
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future. See boxes #3- 5	Unknown
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. No; climate change unlikely to be reversed within 3 generations b. yes c. No
Are there extreme fluctuations in number of mature individuals?	no

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	8,700,000 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value). Value is a Biological Area of Occupancy not an Index of Occupancy based on 2x2 km grid; foraging area from mainland coastline (80 km buffer) and all of island archipelago.	5,600,000 km²
Is the population “severely fragmented” i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of “locations” Habitat deterioration from change in sea-ice condition will vary in severity and extent across range.	Many; . more than 10 locations

Is there an [observed, inferred, or projected] decline in extent of occurrence? Projected retraction in southern range due to habitat deterioration.	Yes
Is there an [observed, inferred, or projected] decline in index of area of occupancy? Projected retraction in southern range due to habitat deterioration.	Yes
Is there an [observed, inferred, or projected] decline in number of management units? Subpopulations are not well defined but ATK indicates northward movement of bears in Beaufort Sea. Projected retraction in southern range due to habitat deterioration may eventually extend to include the range of a management unit.	Projected, but timeline unknown
Is there an [observed, inferred, or projected] decline in number of “locations”*?	Yes, projected
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat? Predicted and observed loss of sea-ice due to climate change.	Yes, observed and projected
Are there extreme fluctuations in number of management units?	No
Are there extreme fluctuations in number of “locations”?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each management unit)

Management units (give plausible ranges)	**N Mature Individuals**
Total population size unknown because surveys of individual units not conducted recently, or at same time; recent (i.e., <1 generation length) available data for 7 (in bold) of 14 units suggests 10,448 bears, of all ages. The number of mature animals is unknown, but likely would exceed 10,000 animals because the minimum estimate derived from 7 units with recent surveys is approximately 7000, and inclusion of out-of-date estimates would increase the total to 11,000 mature animals with a level of uncertainty. These units do not meet the COSEWIC definition of subpopulation but there are demographic boundaries and the population likely contains subpopulations; further delineation is required.	Total and mature individual population size is unknown. Numbers in bold are estimates from recent surveys (i.e., in last generation): Best data for all ages (management unit/most recent survey year/estimate): Southern Beaufort Sea (2010); **900** (or 1526) Northern Beaufort Sea (2006); 980 Viscount Melville Sound (1992); 161 M'Clintock Channel (2000); 284 Gulf of Boothia (2000);1592 Lancaster Sound (1997); 2541 Norwegian Bay (1997); 203 Kane Basin (2014); **357** Baffin Bay (2013); **2826** Davis Strait (2009); **2158** Foxe Basin (2010); **2585** Western Hudson Bay (2016); **842** Southern Hudson Bay (2016); **780** Arctic Basin (no survey); ?
Total	Unknown, but likely exceed 10,000

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Unknown, PVA not conducted

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes; April 4, 2018

High Impact Threat

- Sea-ice habitat loss caused by human-induced climate change (and subsequent change in access to seal prey)

Low Impact Threats

- Human-caused mortality
- Pollution

Negligible Impact Threats

- Energy production and mining
- Shipping
- Tourism

What additional limiting factors are relevant? None; changes in seal prey considered to be a threat because of human-induced climate change.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	East Greenland – status unknown Southern Beaufort – declining (immigration from USA portion) Arctic Basin – status unknown (immigration from non-Canadian portion) Chukchi Sea – status stable
Is immigration known or possible?	Yes
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?	Yes
Are conditions for the source population deteriorating?	Yes
Is the Canadian population considered to be a sink?	No
Is rescue from outside populations likely? Canada presently contains a majority of the species' population and would likely be the core of a future population.	Not likely

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: Designated Not at Risk in April 1986. Status re-examined and designated Special Concern in April 1991. Status re-examined and confirmed in April 1999, November 2002, April 2008, and November 2018.

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric codes:** Not applicable
Reasons for designation: This apex predator depends on the availability of sea ice from which to hunt its preferred prey—ice-adapted seals. Reduction in the area and period of sea ice coverage due to climate warming in the Canadian Arctic, with consequent reductions in feeding opportunity, is the primary threat to the persistence of this species. However, the magnitude of the impact on population numbers is uncertain and will vary across the range. Population levels and trends are currently uncertain, as population estimates undertaken since the last COSEWIC assessment in 2008 exist for less than half the range and survey methodology has changed. This precludes the use of quantitative trend analysis for most of the Canadian population. The total population in Canada likely exceeds 10,000 mature individuals. ATK indicates stable or increasing populations in all 13 management units, while scientific knowledge suggests a decline associated with poorer body condition, decreasing productivity, and sea ice decline in three management units in the southern part of the range. The Canadian population is predicted to decline over the next three generations (35 years) due to a reduction in seasonal coverage of sea ice. This species may become Threatened in the future because the effects of sea ice loss on this species will be extensive and ongoing.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Population likely exceeds 10,000 mature animals. ATK indicates stable or increased population in all units. Population declines based on science likely for three southern management units, but evidence of decline >30% does not exist. A decline is projected due to loss of summer sea-ice in three generations but uncertainty exists over actual bear population response negates a quantification of that decline.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Range greatly exceeds thresholds, population is not fragmented and does not undergo extreme fluctuations. Decline is projected in quality of habitat and number of mature individuals.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. A continuing decline is projected and the population exists as one subpopulation but likely exceeds 10,000 mature bears, but unknown.
Criterion D (Very Small or Restricted Population): Not applicable. Population size and range exceed thresholds. Number of locations greater than 5.
Criterion E (Quantitative Analysis): Not applicable. Population viability analysis for the total population has not been conducted.

PREFACE

Since the publication of the 2008 COSEWIC status report (COSEWIC 2008), there is new scientific information, Aboriginal and Inuit Traditional Knowledge (hereafter 'ATK') and local knowledge available on Polar Bear movements, habitat selection, sea-ice trends, climate change effects, diet composition, contaminant loads, and abundance estimates. Gaps in knowledge persist about the abundance of Polar Bear in some parts of Canada (e.g., Norwegian Bay, Arctic Basin) and Polar Bear ecology. The estimated total Canadian population size remains unknown because many units have not been surveyed in a similar time period, or for many years.

Between 2008-2017, Polar Bear were listed as Special Concern in Northwest Territories, Threatened in Ontario and Manitoba, and Vulnerable in Québec. The Northwest Territories has a Polar Bear management plan recommended by the Inuvialuit, that the Yukon is party to, and other jurisdictions (Nunavut, Québec, Newfoundland and Labrador, and Manitoba) and Wildlife Management Boards are developing Polar Bear management or recovery plans and have identified sensitive or important Polar Bear habitat. Ontario developed a recovery strategy in 2016. Environment and Climate Change Canada is developing a federal addition to the National Polar Bear Management Plan to fulfill requirements under the *Species at Risk Act*. The Plan will be composed of federal and provincial/territorial recovery documents. Internationally, the Polar Bear was listed as a globally threatened species under the U.S.A. *Endangered Species Act* and as Vulnerable in Norway and Greenland. In 2015, the Polar Bear was re-listed as Vulnerable on the IUCN Red List.

COSEWIC would like to acknowledge Vicki Sahanatien, Andrew Derocher, and Gregory Thiemann for writing the status report on the Polar Bear, prepared under contract with Environment and Climate Change Canada. Modifications to the status report after acceptance of the provisional report were overseen by Graham Forbes, Co-chair of the COSEWIC Terrestrial Mammals Specialist Subcommittee (TMSSC), based on comments from jurisdictions, Wildlife Management Boards, researchers, the TMSSC, and COSEWIC Members.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2018)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada
Canadian Wildlife Service

Environnement et Changement climatique Canada
Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Class: Mammalia

Order: Carnivora

Family: Ursidae

Subfamily: Ursinae

Scientific name: *Ursus maritimus* Phipps (1774), no subspecies established.

Some common names: Polar Bear, Ours blanc, Ours polaire, Chelzhii, Nanuk, Nanuq, Wabusk.

Phipps (1774) was the first to describe the Polar Bear (*Ursus maritimus*) as its own species. Past generic names have included *Thalassarctos*, *Thalarctos*, and *Thalatarctos*; however, since the 1960s most authors have used the name *Ursus maritimus* (Wilson and Reader 2005). No subspecies are recognized by western science (Wilson and Reader 2005). One knowledge holder from Clyde River recognized two types of bear; 'Keewatin (Kivalliq) polar bears and Baffin bears are two different species. In the Kivalliq area the bears are …wilder, more remote. We see them more as sea creatures in the open water compared to the Keewatin bears which are more on land' (DFO 2011, p. 73). A similar recognition was made by an elder from Nunavik; 'the type that is always out on the ocean and never come ashore, and there are polar bears that come close to shore' (J. Oovaut, pers. comm. 2018). Two types have also been described based on body shape; one the 'weasel bear' has longer necks and are better at hunting seals at breathing holes, while the 'shovel bear' has wider paws (Slavik 2013; Joint Secretariat 2015). Further study is warranted but, at present, management by Wildlife Management Boards, such as the establishment of harvest quotas, is applied to a single unit and COSEWIC also recognizes one species.

Fossil evidence suggests that Polar Bear evolved from Brown Bear (*Ursus arctos*) some time within the last 400,000 years (Thenius 1953; Kurtén 1964). Genetic-based divergence estimates for the separation range from 0.34 - 5 million years ago (Hailer *et al.* 2012; Miller *et al.* 2012; Cahill *et al.* 2013; Cronin *et al.* 2014; Liu *et al.* 2014). Multiple historical hybridization events between Brown and Polar Bear (Edwards *et al.* 2011; Cahill *et al.* 2015) make definitive times of separation unclear. Modern hybridization events have also been recorded from the Northwest Territories over the last decade (Kelly *et al.* 2010; Pongracz *et al.* 2017). Fertile first- and second-generation Polar and Brown Bear hybrids in captivity have been known for many years (see review in Preuss *et al.* 2009). Notwithstanding these hybridization events, the Polar Bear is recognized as a distinct species.

Morphological Description

Polar Bear are large mammals most comparable in size and shape to the Brown Bear. Polar Bear have a shoulder hump that is less developed than in Brown Bear, a narrower and less dish-shaped head, a longer rostrum, an elongated neck, and white pelage (DeMaster and Stirling 1981). The differences between Polar Bear and other bear species reflect adaptations to a more aquatic and ice-associated environment. An Inuit knowledge holder in Resolute described Polar Bear as a marine species, in the same category as seal (DFO 2011). Rapid evolution and adaptations to a semi-aquatic lifestyle and a carnivorous diet have resulted in cranial morphology poorly suited to processing the plant material common in the diet of the more omnivorous Brown Bear (Slater *et al.* 2010). Compared to Brown Bear, Polar Bear cheek teeth are reduced in size and surface area, and the carnassials are more pronounced, which reflects adaptations to a more carnivorous diet (Amstrup 2003; Sacco and Van Valkenburgh 2004; Figueirido *et al.* 2009). Polar Bear have enlarged forepaws, compared to other bears, which are useful for paddling in water, collapsing roofs of seal lairs, digging through or climbing on snow and ice, and subduing prey (DeMaster and Stirling 1981; Amstrup 2003). Unlike other bear species, the paws of the Polar Bear are extensively furred, which may function to insulate the feet or improve traction on ice and snow. Foot pads have a rough papillary surface that may provide additional traction (Manning *et al.* 1985). Translucent hair makes the pelage appear white, especially right after moulting, although it may appear yellow or off-white during summer (DeMaster and Stirling 1981). Pelage is more even over the body than other bear species and is thick with a dense underfur (Amstrup 2003).

Sexual size dimorphism is pronounced with males being longer and heavier than females (Derocher *et al.* 2010). Male Polar Bear can attain 800 kg in mass and 2.6 m in length (DeMaster and Stirling 1981; Derocher and Stirling 1998a). Females are smaller, usually not exceeding 400 kg and 2.5 m (Amstrup 2003). Both sexes undergo significant seasonal variation in mass (Ramsay and Stirling 1988; Pilfold *et al.* 2016a).

Population Spatial Structure and Variability

Polar Bear were once believed to occur as a single, homogeneous population that ranged throughout the circumpolar Arctic, with animals being carried passively on sea-ice by the predominant currents (Pedersen 1945). However, modern studies, based on satellite tracking, tag returns from hunters, and mark-recapture data demonstrate that Polar Bear show seasonal fidelity to local areas (Born *et al.* 1997; Mauritzen *et al.* 2001; Taylor *et al.* 2001; Amstrup *et al.* 2004; Cherry *et al.* 2013; McCall *et al.* 2015; Sahanatien *et al.* 2015) even though some movements may be exceptionally large (Durner and Amstrup 1995; Johnson *et al.* 2017) (**Dispersal** section).

The global population of Polar Bear is delineated into 19 subpopulations, of which 14 are partially, or entirely, within Canada (IUCN/SSC Polar Bear Specialist Group 2010; Figure 1). The subpopulations reflect local population dynamics and foraging behaviour that can be associated with local environmental conditions, harvest activity, and management. As such, they are considered in this status report to be management units, rather than discrete demographic entities.

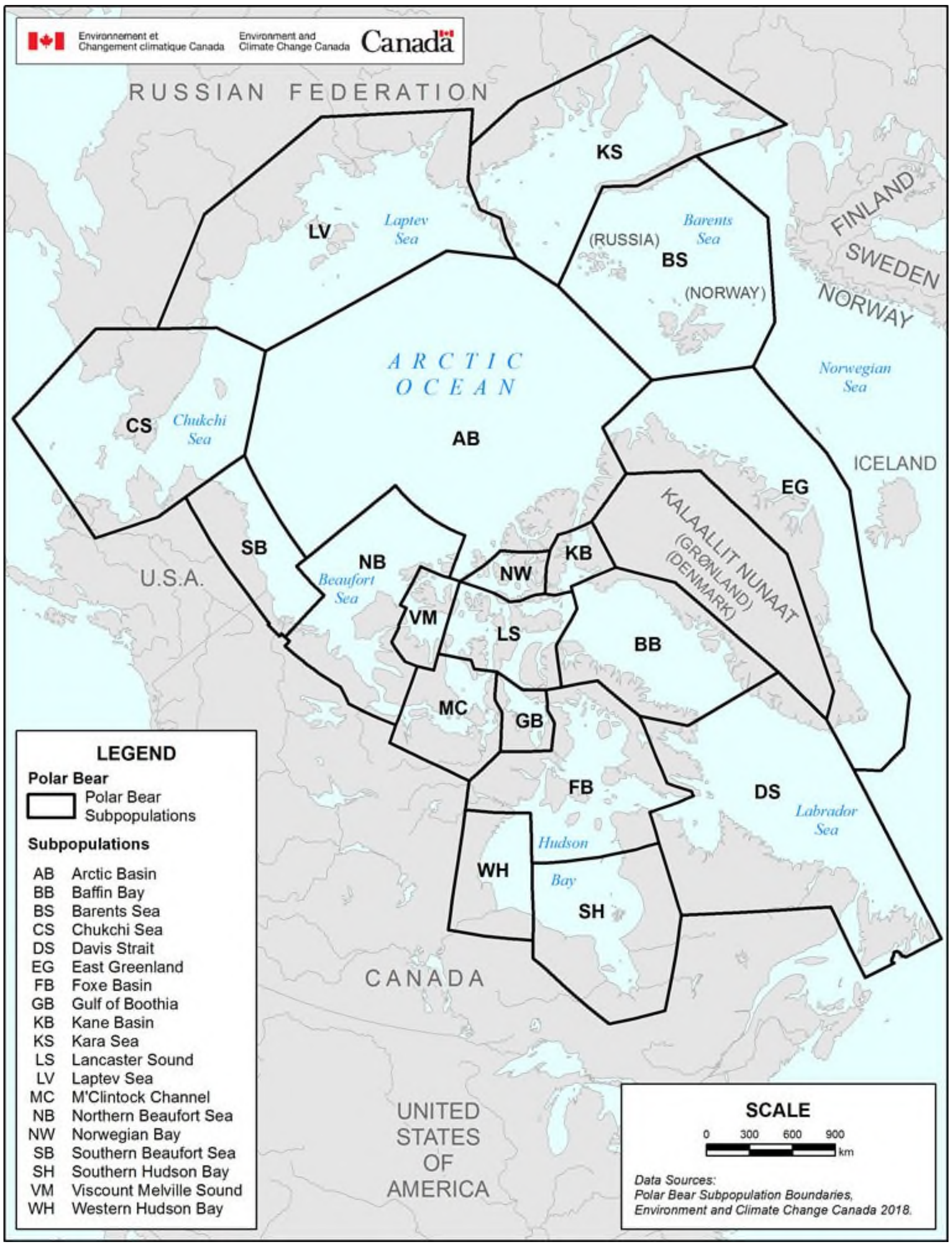

Figure 1. Global distribution of Polar Bears (*Ursus maritimus*) within 19 subpopulations, referred to as management units by COSEWIC. Fourteen management units are within or partially within Canada: The boundary between Southern and Northern Beaufort Sea used to be 200 km to the east, and is the boundary used in this report for population estimation (source: ECCC).

Delineation of actual subpopulations has not been accepted but work is underway, based, in part, on genetic structuring. Varying degrees of genetic structure have been identified both within (Crompton *et al.* 2008; 2014; Viengkone *et al.* 2016) and among Polar Bear management units (Paetkau *et al.* 1995, 1999; Campagna *et al.* 2013; Peacock *et al.* 2015; Malenfant *et al.* 2016b). Paetkau *et al.* (1999) performed a global analysis of microsatellite loci and identified four global clusters of Polar Bear: the Hudson Bay complex, including Davis Strait; the Canadian Arctic Archipelago; Norwegian Bay; and the perimeter Arctic Basin, including the Northern and Southern Beaufort Sea management units. The authors identified the Norwegian Bay management unit as showing a larger degree of genetic differentiation than any other management unit. However, the authors concluded there was no evidence of evolutionarily significant separation among genetic groups (Paetkau *et al.* 1999). More recent analyses of microsatellite data have largely confirmed the above-noted patterns of Polar Bear spatial structure. Peacock *et al.* (2015) identified four genetic clusters similar to the Paetkau *et al*. (1999) clusters. The analysis of Peacock *et al.* (2015) separated the Polar Basin cluster into eastern and western sections, combined Norwegian Bay with the Canadian Arctic Archipelago, and grouped Viscount Melville Sound with the Beaufort Sea cluster. In a re-analysis of the Peacock *et al.* (2015) data, Malenfant *et al.* (2016b) noted possible errors of interpretation in that study and instead identified six genetic clusters: Hudson Bay Complex, Western Canadian Arctic Archipelago, Eastern Canadian Arctic Archipelago, Western Polar Basin, Eastern Polar Basin, and Norwegian Bay. The confirmation of a genetically distinct Norwegian Bay unit may have conservation implications for this small (ca. 200 individuals, Taylor *et al.* 2008a) management unit. Similarly, Polar Bears in James Bay form a unique cluster, distinct from other genetic clusters in Hudson Bay (Peacock *et al.* 2015; Malenfant *et al*. 2016b; Viengkone *et al.* 2016). The genetic clusters identified within the Canadian range of Polar Bears closely matched those of Paetkau *et al.* (1999) and the proposed conservation units identified by Thiemann *et al.* (2008a).

Population spatial structure in the Polar Bear is produced by fidelity to feeding and denning areas, patterns of sea-ice formation and break-up, and barriers to movement, such as large land masses and areas of multi-year ice (Paetkau *et al.* 1999; Thiemann *et al.* 2008a; Peacock *et al.* 2015; Malenfant *et al*. 2016b). Although this spatial structure is detectable, genetic distances between clusters are considered small when compared to other North American carnivores. Ongoing changes in sea-ice habitat, including altered migration routes and loss of multi-year ice barriers, could change the rates and patterns of demographic exchange between management units in the future (Derocher *et al.* 2004). In addition, vagrants carried by sea-ice have potential to introduce genetic variability (Kutschera *et al*. 2016). At present, the species is generally considered a single evolutionary unit (Paetkau *et al.* 1999; Peacock *et al.* 2015). By COSEWIC standards, there is more than 1 subpopulation because of a degree of demographic structuring, but the number presently of true subpopulations is undetermined.

Designatable Units

Within the Canadian management units of Polar Bear, population dynamics appear to be largely determined from internal rates of birth and death, rather than from emigration and immigration (Taylor *et al.* 2001). However, demographic exchange among clusters and management units does occur.

Polar Bear inhabit a vast geographic range in Canada and are found in every region of the northern North American coastline. It is therefore likely that the species may face spatial differences in their conservation needs and status. COSEWIC recognizes potential designatable units (DU) within a taxonomic species when a single status designation is thought not to reflect the extent of evolutionarily significant diversity within a species. The following section compares the available evidence for Polar Bear in Canada to be recognized as a DU under COSEWIC guidelines (in italics):

<u>Criterion 1 – Subspecies or varieties</u>

Polar Bears do not have any named subspecies or varieties.

<u>Criterion 2 – Discrete and evolutionarily significant populations</u>

A population or group of populations may be recognized as a DU if it has attributes that make it "discrete" and evolutionarily "significant" relative to other populations.

Discreteness

1. Polar Bear in Canada exhibit *evidence of genetic distinctiveness* based on nuclear microsatellites and mitochondrial DNA (Paetkau *et al.* 1999; Malenfant *et al*. 2016b). Polar Bear thus meet this criterion for discreteness. The Polar Bear in Norwegian Bay and James Bay show high levels of discreteness and have been identified as genetically distinct units (Paetkau *et al.* 1999; Crompton *et al.* 2008, 2014; Malenfant *et al*. 2016b).

2. Polar Bear have a continuous distribution throughout the Canadian Arctic and thus do not meet the criterion of *natural disjunction between substantial portions of the species' geographic range*.

3. Documented genetic clusters of Polar Bear in Canada correspond closely with distinct sea-ice ecoregions (convergent, seasonal, archipelago; see Figure 3 for definitions) defined by Amstrup *et al.* (2008) that were based on temporal and spatial sea-ice melt patterns, ice movement, and forecasted changes in sea-ice. Thus, Polar Bear meet the criterion of *occupation of differing eco-geographic zones that are relevant to the species and reflect historical or genetic distinction*.

With evidence that Polar Bear management unit groups meet one or more of the criteria for *discreteness*, what follows is an examination of the evidence for *significance*:

Significance

1. The degree of genetic differentiation among Canadian Polar Bear is relatively low in comparison to other large North American carnivores, including Brown Bear and Gray Wolf (*Canis lupus*, see Paetkau *et al.* 1999). Thus, there is no conclusive evidence that any group of Polar Bear *differs markedly from others in genetic characteristics thought to reflect relatively deep intraspecific phylogenetic divergence*.

2. Given that Polar Bear are distributed throughout the coastal Arctic and subarctic regions of Canada, there is no evidence of *persistence of the discrete population or group of populations in an ecological setting unusual or unique to the species, such that it is likely or known to have given rise to local adaptations*. Norwegian Bay and James Bay units may be exceptions to the above generalization but insufficient information is available to assess the possibility of local adaptations.

3. The Polar Bear is distributed throughout the circumpolar Arctic and largely exists in its historical range. Thus, no group of Polar Bear *represents the only surviving natural occurrence of a species that is more abundant elsewhere as an introduced population outside of its historical range*.

4. The loss of the Archipelago cluster of Canadian management units (Paetkau *et al.* 1999; Peacock *et al.* 2015; Malenfant *et al*. 2016b) would create an expansive gap in the range of Polar Bear in Canada. However, the conservation concerns facing the species are more acute at the southern and western limits of the species' Canadian range (Bromaghin *et al.* 2015; Lunn *et al.* 2016). In contrast, the central Archipelago region is relatively secure for the foreseeable future (Amstrup *et al.* 2008; Hamilton *et al.* 2014). Thus, it seems unlikely that *loss of the discrete population or group of populations would result in an extensive disjunction in the range of the species in Canada*.

Thiemann *et al.* (2008a) argued that spatial and temporal differences in conservation threats warranted the assessment of Polar Bear as five genetically and biogeographically distinct DUs. However, that study was based on an earlier version of the DU criteria used by COSEWIC that based DUs, in part, on threats (see Green 2005).

In summary, current evidence suggests that genetic clusters of Polar Bear satisfy the criteria for *discreteness*. However, because the genetic differences among groups are small relative to other carnivores, and the species maintains a continuous distribution across its historical Canadian range, the genetic units do not meet the criteria for *significance*. Polar Bear in Canada constitute a single DU, as per current COSEWIC guidelines.

Special Significance

Polar Bear are specifically and intricately linked with the culture, traditions, spirituality, and economy of northern Indigenous peoples that have lived with and harvested the species for thousands of years. While this species has great symbolic significance for Canadians, the knowledge of Indigenous peoples provides unique perspectives and contributes to the overall understanding of this species. As the country with the greatest proportion of Polar Bear worldwide, Canada has national and international responsibilities to conserve Polar Bear.

Polar Bear are an economically important species for northern Canadians, especially Indigenous peoples, for both consumptive and non-consumptive uses (Dyck and Baydack 2004; Hart and Amos 2004a; Freeman and Wenzel 2006; Dowsley and Wenzel 2008; Lemelin *et al.* 2010b; Wenzel 2011; Tyrrell and Clark 2014; Joint Secretariat 2015). Polar Bear meat is consumed in many communities (Keith 2005; Inuuvik Community Corporation *et al.* 2006; Slavik 2010; Wenzel 2011; Zotor *et al.* 2012; Kolahdooz *et al.* 2014). Hides, teeth, claws, bones, and skulls from harvested bears are used for traditional purposes (e.g., clothing, household items, tools, and medicine) by Indigenous peoples, sold locally as artifacts and crafts, or enter the commercial fur trade (Keith 2005; Peacock *et al.* 2011; Kakekaspan *et al.* 2013; Kendrick 2013; Joint Secretariat 2015). Guided sport hunts occur in Nunavut and the Northwest Territories in association with the transfer of exclusive Inuit rights and are managed as part of the total allowable harvest and quota levels (Freeman and Wenzel 2006; Dowsley 2010; Wenzel 2011; Joint Secretariat 2015). A multi-million dollar tourism industry focused on Polar Bear has developed in Churchill, Manitoba (Lemelin *et al.* 2010a).

Concerns about safety around Polar Bear arise in many areas and communities that are on migration paths or staging areas where sea-ice forms earliest during freeze-up, and where attractants (e.g., dog food, harvested wildlife, garbage dumps) can result in human-bear conflicts (Stenhouse *et al.* 1988; Clark 2003; Stirling and Parkinson 2006; Clark *et al.* 2008; Towns *et al.* 2009; Henri 2012).

As a symbol of the Arctic environment, Polar Bear are seen throughout the world as a barometer of important environmental issues, especially climate change and pollution. Polar Bear evolved unique adaptations to hunt seals (DeMaster and Stirling 1981) and other ice-associated marine mammals from a sea-ice platform, and are therefore vulnerable to sea-ice loss (**Habitat**, **Threats** sections). They are considered a sentinel species for both environmental contaminants and ecosystem change (Houde *et al.* 2006; Moore 2008; Amstrup *et al.* 2010; Kirk *et al.* 2010; Knott *et al.* 2011). As an apex predator, Polar Bear may integrate and reflect changes in lower trophic levels that are otherwise difficult to detect. Thus, they have been considered as an indicator species for Arctic marine ecosystem change (e.g., Stirling and Derocher 1993; CAFF International Secretariat 2010; Pertoldi *et al.* 2012; Sonne *et al.* 2013).

DISTRIBUTION

Global Range

Polar Bear have a circumpolar Arctic distribution associated with the extent of suitable sea-ice (DeMaster and Stirling 1981). The species is found in Canada, U.S.A. (in Alaska), Russia, Norway (in Svalbard), and Greenland (Figure 1). Vagrants carried by drift ice occur in Iceland (Guthjonsson 2010). Since 2006, the global range of Polar Bears has been divided into 19 'subpopulations' (IUCN/SSC Polar Bear Specialist Group 2006) of which 14 units are entirely, or partially, within Canada (Figure 1).

Polar Bear distribution is closely linked to the presence, temporal duration, and quality of sea-ice habitat. As such, Polar Bear are not distributed evenly throughout their global range: their numbers and densities vary with sea-ice characteristics, ocean bathymetry, and availability of prey (Ferguson *et al.* 2000a; Durner *et al.* 2009; McCall *et al.* 2016). Polar Bear can move hundreds of kilometres in offshore areas to forage for seals on the Arctic sea-ice but they show strong preference for continental shelf areas (Amstrup *et al.* 2000; Mauritzen *et al.* 2003b; Wiig *et al.* 2003). In parts of their global range (e.g., Barents Sea and Beaufort Sea), some Polar Bear remain on the sea-ice year round foraging, breeding, denning, and rearing young (Amstrup 2003). However, in much of their range, sea-ice melts annually, creating an ice-free season that forces bears to move on land for part of the year. In regions with an ice-free season, female Polar Bear den on land, returning to the sea-ice with their cubs in the spring. Males, juveniles, family groups, and non-pregnant females leave land as soon as the new autumn sea-ice is safe for travel.

Changes in Polar Bear distribution are associated with loss and changes in sea-ice distribution. The prehistoric distribution of Polar Bear includes areas much further south in Denmark and Sweden (Ingølfsson and Wiig 2009) than their current distribution. Extirpation from these southern areas is thought to relate to loss of sea-ice.

On land, the distribution of Polar Bear is related to sea-ice distribution during break-up, pattern of freeze-up, and fidelity to individual terrestrial retreat, staging, and denning areas (Derocher and Stirling 1990; Zeyl *et al.* 2010; Cherry *et al.* 2013). Changes in seasonal distribution patterns have been observed throughout their range, with greater numbers of bears being observed on land and in new areas during the ice-free season. The Russian and Alaskan continental coasts, the islands off Russia and Norway, and coastal areas across the Canadian Arctic are receiving more bears in summer (Dowsley 2005; Ovsyanikov 2005; Kochnev 2006; Schliebe *et al.* 2008; Gleason and Rode 2009; Rogers *et al.* 2015; Pongracz and Derocher 2016).

Canadian Range

In Canada, Polar Bear are widely distributed throughout Arctic and subarctic regions. Bears are commonly found on landfast (ice attached to shoreline), offshore pack ice, and on the maritime coastlines of Labrador, Québec, Ontario, Manitoba, Nunavut, Northwest Territories, and Yukon. Canada has the most southerly breeding population of Polar Bear in the world, in James Bay, at 53°N.

During the ice season, local and regional Polar Bear distributions are related to the availability and density of their marine mammal prey. Historically (i.e., late 1700s-1800s), when sea-ice was more extensive, Polar Bear were regularly observed in southern Labrador and northern Newfoundland (Stirling and Kiliaan 1980) and possibly as vagrants in the Gulf of St. Lawrence (Harrison 1939; Jackson 1939). Today, extra-limital observations occur when Polar Bear drift south to Newfoundland on icebergs or pack ice carried southward with the Labrador Current. Occasionally, Polar Bear are observed long distances from the coast (Lemelin *et al.* 2010b). For example, in 1999, a bear was observed in Saskatchewan 420 km from Hudson Bay (Goodyear 2003) and in 2008, two observations were reported of bears in the Northwest Territories 320 km inland from the Beaufort Sea (Derocher 2012). These records are considered to be vagrants and are not included in the calculation of extent of occurrence (EOO).

Changes in sea-ice habitat have affected the ice-season distribution of bears in some parts of Canada. In Baffin Bay, sea-ice habitat has declined and changed such that the annual movements and distribution of Polar Bear shifted northward and landward, and their combined annual range declined from the 1990s and 2000s (SWG 2016; Laidre *et al*. 2017). In Davis Strait, Polar Bear can no longer stay on offshore pack ice for most of the year as they could in the 1970s and 1980s (Peacock *et al.* 2013), and it seems that 'Polar Bears are moving east to Newfoundland and Labrador…and Inuit in Nunavik know that Polar Bears will walk across the region from Hudson Bay to Ungava Bay, and vice versa' (J. Oovaut pers. comm. 2018). Kane Basin, Lancaster Sound, and other parts of the Archipelago are shifting to seasonal sea-ice systems, causing Polar Bear to use terrestrial habitat more frequently (Howell *et al.* 2009; Parkinson 2014; Stern and Laidre 2016).

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) of Polar Bears in Canada is approximately 8.7 million km^2 (Figure 2) and was mapped using the management unit boundaries and following the COSEWIC instructions.

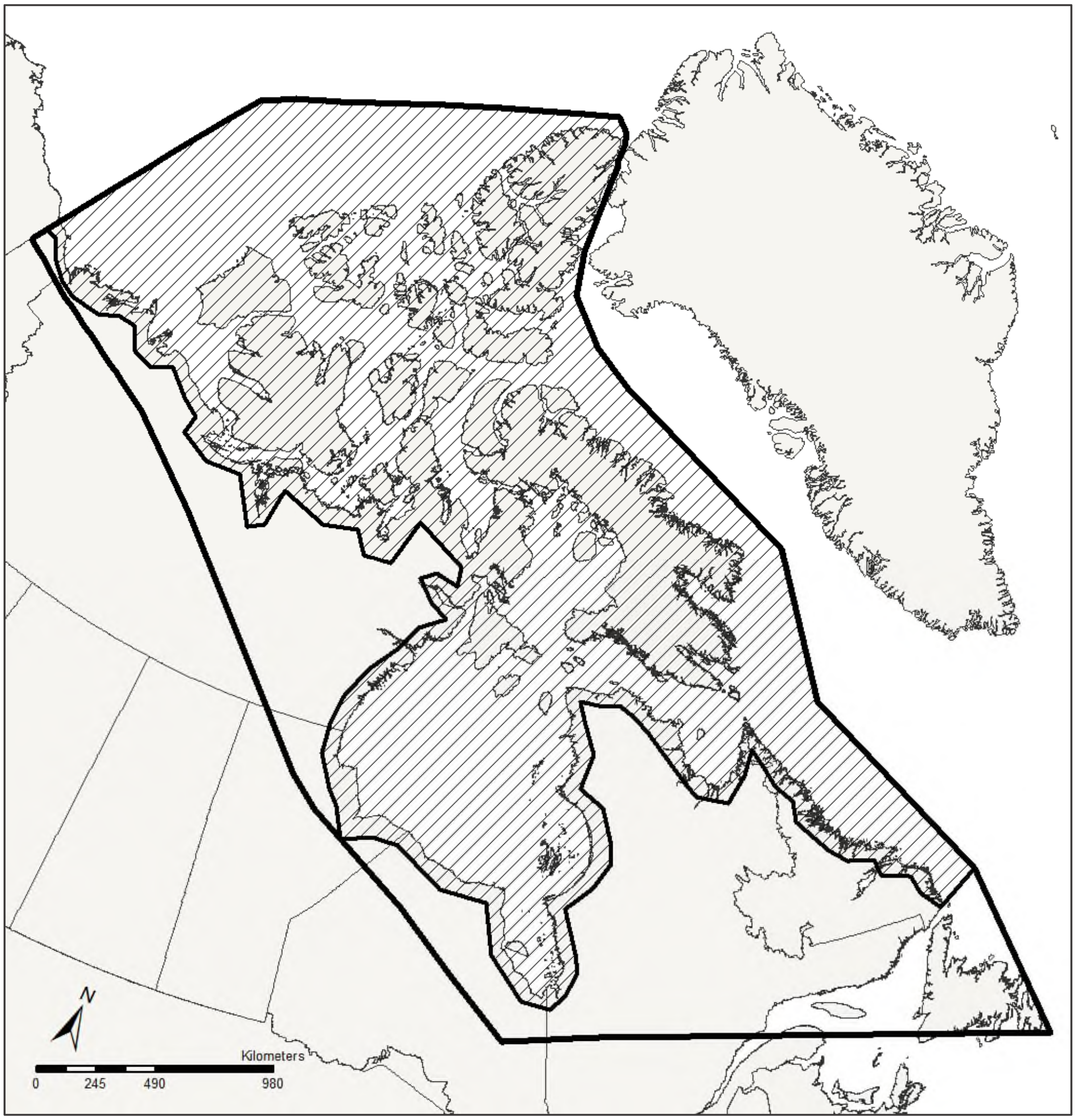

Figure 2. Extent of occurrence (EOO) (8.7 million km² area inside the polygon enclosed by a heavy black line) and biological area of occupancy (AOO) (5.6 million km² hashed area within the EOO, based on 80 km inland buffer) of Polar Bear in Canada (source: ECCC).

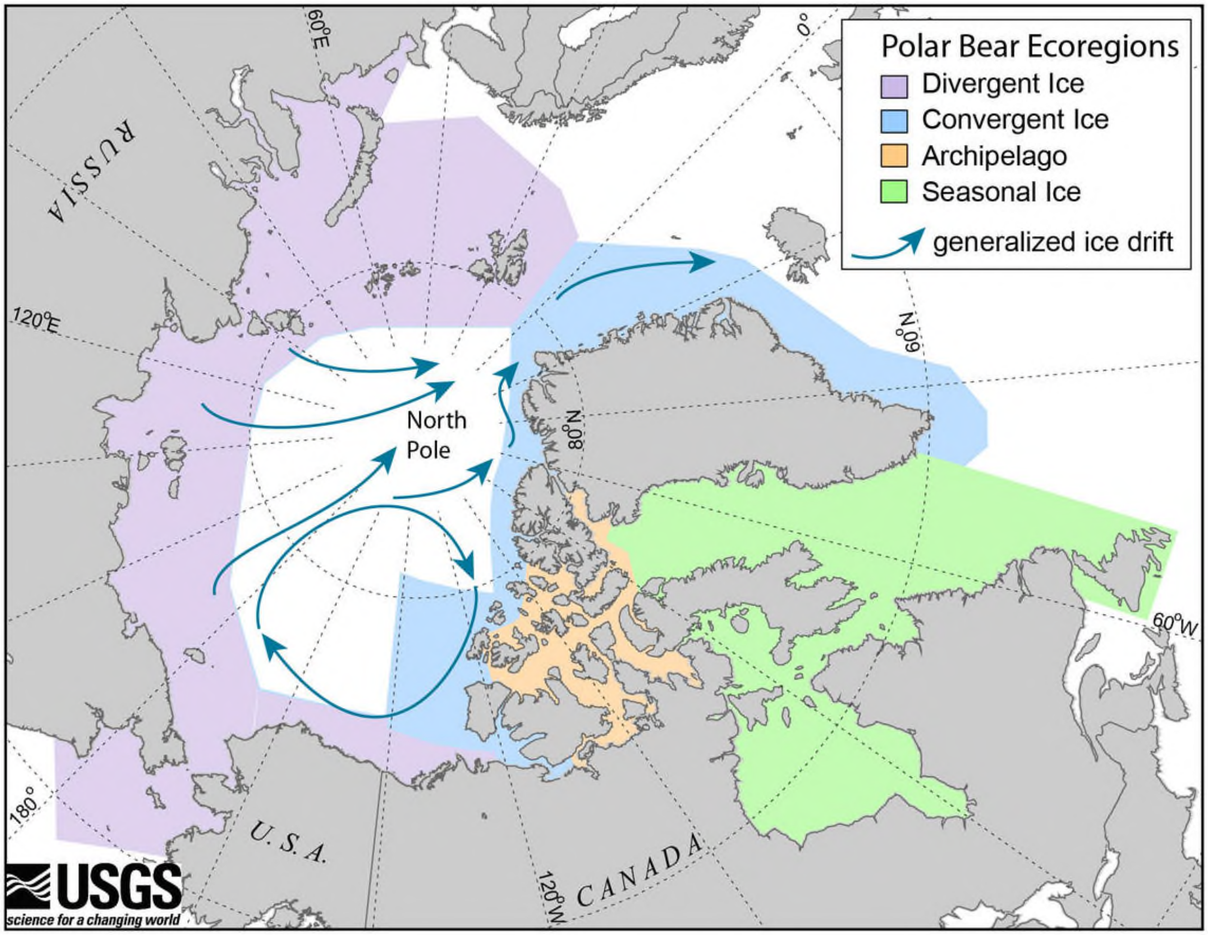

Figure 3. Polar Bear ecoregions based on ice habitat. In the Seasonal Ice Ecoregion, sea-ice melts completely in summer and polar bears move to land. In the Divergent Ice Ecoregion, sea-ice pulls away from the coast in summer, and Polar Bear must be on land or move with the ice as it recedes north. In the Convergent Ice and Archipelago Ecoregions, sea-ice is generally retained during the summer (source: USGS undated).

Denning sites are important habitat features that could be used to delineate area of occupancy (AOO). However, they are not used in this report; although there are concentrations of terrestrial denning areas in some regions, den site location can vary annually, and many dens are in ephemeral features, such as snow or ice **(Habitat** section). As well, the locations of the dens across the EOO are unknown and could not be mapped.

Instead, the report uses a biological AOO, based on the coastal and between island sea-ice environment where foraging occurs, and estimated as approximately 5.6 million km^2. Foraging mainly occurs on sea-ice and coastal areas. The southern boundary was mapped using a buffer of approximately 80 km along Canada's northern mainland coast (Figure 2). Where an ice-free season forces Polar Bears to migrate to land, they tend to remain within 50 km of the coast but can also be found further inland (up to 120 km) for denning, and crossing islands and peninsulas (Derocher and Stirling 1990; Obbard and Middel 2012). More Polar Bears are being observed and recorded on land for longer periods of time, in greater numbers, in new locations, and terrestrial distributions have shifted (Fischbach *et al.* 2007; McDonald *et al.* 1997; Dowsley and Wenzel 2008; Clark *et al.* 2010; Towns *et al.* 2010; Lemelin *et al.* 2010b; Cherry *et al.* 2013; Joint Secretariat 2015; SWG 2016; York *et al.* 2016).

Search Effort

ATK is based on a long history of observations and interactions between Indigenous peoples and Polar Bears (Henri *et al*. 2010). Indigenous peoples living in northern Canada can offer ecological observations about Polar Bear seasonal activities and habitat use, distributional shifts and population trends, as well as changes in body condition, behaviour, and habitat. Search effort by Indigenous peoples varies but often has a long timeframe (many generations), a smaller spatial coverage (local, seasonal hunting areas) compared to aerial surveys over the entire unit, and an association with subsistence and commercial (i.e., guided hunts) hunting activities. Polar Bear observations have been collected throughout the year but with more intensity during seasons when sea-ice conditions permit safe travel, daylight hours are longer, or when bears are on land. Performed at precise spatial and temporal scales, ATK can be combined with scientific knowledge to provide unique local scale expertise and historical baseline data, identify areas for further scientific data research, as well as monitor changes in Polar Bear ecology (reviewed in Henri 2010). The sources of the most recent available ATK used in the report are outlined in Table 1. Documented ATK is widespread but less is available for certain regions, such as the northern parts of Norwegian Bay, Kane Basin, and Viscount Melville units (Cardinal, undated). For ATK, methods focus on how well people know where the bears are, and secondly how well ATK is collected and documented (Species at Risk Committee 2012).

Table 1. Summary of information sources on ATK used in this report.

Management Unit	Interview Year	Example of Questions Asked	Approximate Time Period being Discussed	Citation	Other Citations with ATK collected during Meetings
Southern Beaufort	2010	Since you were young what changes have you observed[1]	1950/60/70/80s; and past 10-15 years	Joint Secretariat 2015	Slavik 2009, 2010; Parks Canada 2004;Species at Risk Com. 2012;
Northern Beaufort	2010	As above	same	same	Parks Canada 2004; Slavik 2009, 2010, 2013; Species at Risk Com. 2012
Viscount Melville	2010			same	
Davis Strait - Labrador	2012	What changes have you observed	10 - 30 - 40 years	York 2015	NMRMB 2018
Davis Strait - Nunavut	2007-2008	As above	greater abundance from 1960s-1990s	Kotierk 2010	CWS 2009; DFO 2011; Hotson 2014
Baffin Bay	2005	As above	10-15 years	Dowsley 2008	CWS 2009; DFO 2011; Hotson 2014
M'Clintock Channel	2002	Why has number of bears changed	30- 40 years	Keith 2005	CWS 2009; Atahak and Bianci 2001; Hotson 2014
Western Hudson Bay	1995	What changes have you observed	10-40 years	McDonald 1997	CWS 2009; Nirlungayuk and Lee 2009;

Management Unit	Interview Year	Example of Questions Asked	Approximate Time Period being Discussed	Citation	Other Citations with ATK collected during Meetings
Southern Hudson Bay	1995	As above	increase since 1960s	McDonald 1997	CWS 2009; DFO 2011; Hotson 2014; Laforest *et al*. 2018; NMRMB 2018
Foxe Basin	1995	As above	10-40 years	McDonald 1997	CWS 2009; DFO 2011; Hotson 2014

[1] This is one of numerous questions asked in the Joint Secretariat exercise.

Search effort, using scientific methods, has increased during the past 50 years. The effort has been spatially extensive and temporally intermittent in most jurisdictions as population estimates for harvest management are required every 10-15 years (e.g., *Polar Bear Management Memorandum of Understanding* for management units in Nunavut), and the actual interval has depended on research methods and requests for new abundance estimates from communities. Systematic population surveys (physical or genetic mark-recapture, and aerial) and satellite telemetry studies have occurred throughout the Canadian range of Polar Bear, except in the Arctic Basin. Timing of the studies has varied somewhat depending on the purpose of the survey or study, but most studies have occurred on the spring sea-ice in April-June, or on land in September-October. Onshore capture efforts in March-April have targeted females emerging from maternity dens. Polar Bear surveys and research efforts can be limited by budget (cost of logistics and aircraft), human resources, environmental conditions (weather, terrain), and lack of daylight in winter.

HABITAT

Habitat Requirements

<u>Sea-ice</u>

ATK on sea-ice use by bears is extensive; the NWT Status Report on Polar Bear, for example, contains detailed observations of Polar Bear use of sea-ice. It is recognized that their key habitat requirement is sea-ice, from which they hunt seals. Ideal habitat for hunting seals includes pressure ridges, open leads, and young or annual ice. Sea-ice is dynamic because it is influenced by wind and currents (Species at Risk Committee 2012). Bears use the sea-ice as the platform for finding and capturing marine mammal prey, and for maternity denning on multi-year ice in some regions. Polar Bear are sea-ice habitat specialists and their distribution is broadly coincident with the winter extent of sea-ice (DeMaster and Stirling 1981; Amstrup 2003). Polar Bear use both multi-year and seasonal sea-ice, and are found in greater numbers on the sea-ice over the continental shelves and shallow (<300 m) basins where their prey occur in higher density compared to over the deep oceanic waters, e.g., Arctic Ocean (Burns 1970; Frost *et al.* 2004).

Four ecoregions of Polar Bear sea-ice habitat have been identified (divergent, convergent, archipelago, and seasonal) based on ice composition, duration, ocean circulation, and how bears respond to sea-ice dynamics (Amstrup *et al.* 2008; Figure 3 contains definitions). Multi-year ice is generally considered to be poor habitat for Polar Bear (Stirling *et al.* 1993) due to the low abundance of prey (Kingsley *et al.* 1985; Joint Secretariat 2015) but it can be used for moving from one area to another by large older males and as a summer refuge habitat for both sexes (Joint Secretariat 2015; Pongracz and Derocher 2016). Inuvialuit note that bears are adjusting their range further north and further out on the multi-year ice in response to changes in ice conditions and distribution of seals related to climate change (Species at Risk Committee 2012). Scientific studies have focused on areas where there is a mixture of multi-year and annual sea-ice (Schweinsburg *et al.* 1982; Messier *et al.* 1992; Ferguson *et al.* 1999; Amstrup *et al.* 2000; Mauritzen *et al.* 2002; Durner *et al.* 2009; Wilson *et al.* 2014; Laidre *et al.* 2015). These studies were undertaken in the divergent, convergent, and archipelago ecoregions, which includes 9 of the 14 Polar Bear management units in Canada. The remaining five Canadian management units are found in the seasonal ice ecoregion where Polar Bear move to land each summer when the sea-ice melts (Ferguson *et al.* 2001; Parks *et al.* 2006; Obbard and Middel 2012; McCall *et al.* 2016).

Polar Bear move and forage on the sea-ice year-round unless in a maternity den (November-April) (Ramsay and Stirling 1988) or there is no available ice. Polar Bear travel over large areas relative to terrestrial mammals (Ferguson *et al.* 1999; McCall *et al.* 2015) although most studies are based only on adult females because adult males cannot be collared due to the size of their neck relative to their head. There has been some success tracking adult male bears using implanted satellite transmitters and satellite ear tags (Amstrup *et al.* 2001; Laidre *et al.* 2013); these studies found that male bear movements and space use are generally similar to females except during the spring mating season.

Home range size is variable within and between units, and is reflective of habitat availability, habitat quality, geographic features, and individual movement behaviour (Ferguson *et al.* 1999). Two patterns have been observed: bears that prefer the near shore, fiords and fast ice and which tend to have smaller home ranges, and bears that prefer the offshore pelagic and active floe ice, and which tend to have larger home range sizes (Amstrup *et al.* 2000; Mauritzen *et al.* 2001; Joint Secretariat 2015). On an annual basis, female bears have been recorded to move from 574 - 5,095 km and home range sizes vary from 940 - 596,800 km^2 (Amstrup *et al.* 2000; Mauritzen *et al.* 2001; Wiig *et al.* 2003; Parks *et al.* 2006; Andersen *et al.* 2008; McCall *et al.* 2015). Mean home range size was 19,400 km^2 in Kane Basin, and 228,300 km^2 in Davis Strait (Ferguson *et al*. 1999). Examination of home range sizes in Western Hudson Bay revealed no significant change between the 1990s and 2000s, with mean home ranges of ca. 264,000 km^2 and 354,000 km^2 in the two periods, respectively (McCall *et al.* 2015). Their large home ranges indicate Polar Bear require more space to obtain resources than terrestrial species of similar size (Auger-Méthé *et al.* 2016).

Polar Bear habitat selection studies have concluded that sea-ice concentration is the most important factor, followed by ice type, bathymetry, distance to ice edge, and distance to land (Arthur *et al.* 1996; Mauritzen *et al.* 2003a; Durner *et al.* 2009; Freitas *et al.* 2012; Joint Secretariat 2015; Laidre *et al.* 2015; McCall *et al.* 2016). Main ice types are: fast (attached to land); pack (continuous mass of floating ice); annual (forms each winter); and multi-year (has survived >1 melting season). There is less understanding of how ice structure (e.g., floes, leads, thickness, surface roughness, pressure ridges, polynyas [open water in ice-covered seas]) influences Polar Bear movements but it has been identified as important for both bears and their prey (Smith 1980; Hammill and Smith 1989; Kingsley and Stirling 1991; Stirling *et al.* 1993; McDonald *et al.* 1997; Stirling and Lunn 1997; Durner *et al.* 2004; Hart and Amos 2004a; Keith 2005; Slavik 2010; Brown and Fast 2012; Pilfold *et al.* 2014; Joint Secretariat 2015).

Bears show seasonal differences in habitat use. In summer and autumn, when sea-ice is at its minimum, bears select the highest concentration of available sea-ice (Ferguson *et al.* 2000a; Species at Risk Committee 2012; Wilson *et al.* 2014; McCall *et al.* 2016). In winter and spring when sea-ice is ubiquitous, there is strong selection for ~ 85% ice concentration (Durner *et al.* 2009; Pilfold *et al.* 2014), suggesting that this mix of ice and open water creates high quality habitat.

<u>Terrestrial Habitat</u>

Polar Bear move onto or retreat to land after sea-ice concentration drops to 30-50% (Stirling *et al.* 1999; Schliebe *et al.* 2008; Cherry *et al.* 2013; Atwood *et al.* 2016). The timing of movement to land varies with latitude and local oceanographic (e.g., currents) and environmental conditions (e.g., wind) having significant effects on the distribution and concentration of sea-ice. Fidelity to summer retreat habitat has been observed throughout the species' range (Schweinsburg and Lee 1982; Derocher and Stirling 1990; Amstrup *et al.* 2000; Cherry *et al.* 2013). It is unknown if Polar Bear select specific terrestrial habitat types except when denning, but they tend to remain on or near the coast during the ice-free season. Segregation by sex and reproductive status has been observed, where males occur on the coast and females with cubs at a distance (30-50 km) inland (Derocher and Stirling 1990; Stirling *et al*. 2004; Dyck *et al*. 2017). Polar Bear have been observed to use routes along coastlines (e.g., Western Hudson Bay, Foxe Basin, Northern Beaufort Sea) and to cut across peninsulas and islands (McDonald *et al.* 1997; Joint Secretariat 2015, V. Sahanatien pers. comm. 2017). Opportunistic foraging opportunities may affect some Polar Bears' use of terrestrial habitat (Rogers *et al.* 2015). Polar Bear are attracted to beached carcasses (e.g., whale) (Kalxdorff 1998; Herreman and Peacock 2013; Joint Secretariat 2015), garbage dumps (Lunn and Stirling 1985 York *et al.* 2015), Walrus (*Odobenus rosmarus*) haulouts (Stirling 1984; Ovsyanikov 1995), and seabird and goose colonies (Rockwell and Gormezano 2009; Iverson *et al.* 2014; Joint Secretariat 2015; Dey *et al.* 2016. Laforest *et al*. 2018).

Denning Habitat: Marine and Terrestrial

Most pregnant Polar Bear that den on land excavate snow dens during autumn or early winter (Harington 1968; Ramsay and Stirling 1990; Amstrup and Gardner 1994). The exception is in Western Hudson Bay and Southern Hudson Bay where females first excavate earthen dens into the permafrost of tundra ridges, hummocks, and stream or lake banks, then as snow accumulates extend dens into the snowdrifts (Jonkel *et al.* 1976; Kolenosky and Prevett 1983; Ramsay and Stirling 1990; Clark *et al.* 1997; Richardson *et al.* 2005). Terrestrial dens are often located in the leeward side of topographical features where sufficient snow accumulates by early autumn (Harington 1968; Durner *et al.* 2003; Van de Velde *et al.* 2003; Keith 2005; Richardson *et al.* 2005; Brown and Fast 2012; Joint Secretariat 2015; York *et al.* 2015).

Terrestrial denning habitat is diverse: from the rugged mountains and fiords of eastern Baffin Island to low elevation riverbanks and beach ridges of the Beaufort Sea and Hudson Bay. Dens are usually located near the coastline (< 25 km) but in Ontario and Manitoba, Polar Bear may den up to 120 km inland at traditional denning areas (Stirling *et al.* 1977; Kolenosky and Prevett 1983; Ramsay and Stirling 1990; Richardson *et al.* 2005). Dens are often located adjacent to areas with high seal densities in spring (Harington 1968; Stirling and Andriashek 1992; Messier *et al.* 1994; Van de Velde *et al.* 2003; Andersen *et al.* 2012).

Concentrated terrestrial denning areas have been identified in the Southern Beaufort Sea, Northern Beaufort Sea, Western Hudson Bay, Southern Hudson Bay, Foxe Basin, M'Clintock Channel, and Gulf of Boothia (Harington 1968; Kolenosky and Prevett 1983; Ramsay and Stirling 1990; Stirling and Andriashek 1992; Amstrup and Gardner 1994; McDonald *et al.* 1997; Scott and Stirling 2002; Van de Velde *et al.* 2003; Keith 2005; Community of Aklavik *et al.* 2008; Community of Tuktoyaktuk *et al.* 2008; Ghazal 2013; Joint Secretariat 2015), but in much of Canada, Polar Bear dens are scattered over the coastal landscape at low density (e.g., Schweinsburg *et al.* 1984; York *et al.* 2015). Denning habitat is widespread and abundant (Species at Risk Committee 2012; Joint Secretariat 2015).

In the Southern Beaufort Sea, M'Clintock Channel, and likely in the high latitude areas of the Arctic Archipelago, some female Polar Bear den on multi-year sea-ice (Lentfer 1975; Amstrup *et al.* 1986; Amstrup and Gardner 1994; Keith and Arqviq 2006 Fischbach *et al.* 2007; Joint Secretariat 2015). Multi-year, drifting or landfast ice that is stable (sufficient area, concentration, and thickness) and has sufficient topography (pressure ridges) to catch snow and create drifts is required for sea-ice dens (Lentfer 1975). The ice needs to be stable for 81-164 days for successful denning (Amstrup and Gardner 1994).

Polar Bear show selection and fidelity to denning substrate: if they den on sea-ice they tend to return to sea-ice, similarly for terrestrial substrate (Amstrup and Gardner 1994; Fischbach *et al.* 2007). Access to suitable maternity den areas by pregnant females in the autumn or early winter is essential for reproduction. Similarly, family groups require access to sea-ice upon emergence from dens in spring.

Habitat Trends

<u>Sea-ice Trends</u>

Additional information is presented in the **Threats** section. ATK holders are concerned about deterioration of sea-ice conditions (Atatahak and Banci 2001; Dowsley 2005; Keith *et al.* 2005; NTI 2005; Nirlungayuk 2008, cited in COSEWIC 2008; Species at Risk Committee 2012; Joint Secretariat 2015). These conditions include the disappearance of multi-year ice and icebergs, which Polar Bear use for travel, feeding, and resting platforms. Other changes include thinner ice, more rough ice, and earlier spring break-up, which may reduce Polar Bear hunting efficiency (Species at Risk Committee 2012). Some Inuvialuit hunters have stated that break-up occurs a month earlier (Joint Secretariat 2015). On the eastern section of SHB, Cree and Inuit members from three communities report significant changes in length of the sea-ice season, with earlier melting and later freeze-up, compared to 20 years prior (Laforest *et al*. 2018).

An accumulation of greenhouse gases has caused increased sea surface temperatures and ocean water temperatures that affect the development and retention of sea-ice (IPCC 2013; Vaughan *et al.* 2013; Notz and Stroeve 2016). More open water during spring and summer enhances the positive ice-albedo feedback; low albedo of open water absorbs solar energy, and the additional heat stored in the ocean increases melting of remaining sea-ice and delays the onset of freeze-up in autumn (Stroeve *et al.* 2012).

The duration of the sea-ice season has declined in the last few decades throughout the Polar Bear's global range (Table 2, Figure 4) (Dowsley 2005; Serreve *et al*. 2007; Born *et al.* 2011; Kotierk 2010; Slavik 2010; Parkinson 2014; York *et al.* 2015; Regehr *et al.* 2016; Stern and Laidre 2016). Knowledge holders from Banks Island and coastal Labrador have noted that summers are longer and winters shorter (Slavik 2013; York *et al*., 2015). Duration of sea-ice cover is declining globally between 6.8 to 44.6 days/decade and in Canada, between 6.8 days/decade in Southern Hudson Bay, 19.8 days/decade in Baffin Bay, and to 29.3 days/decade in the Arctic Basin (Stern and Laidre 2016). Model predictions are difficult because of complex interactions among radiation budgets, albedo, cloud cover, and stochastic events but many models predict much of the Arctic will be ice-free during summer by 2040 or 2060 (Overland and Wang 2013). Overland and Wang (2013) used three common methods to predict summer ice loss: (1) extrapolation of sea-ice volume data, (2) assuming several more rapid loss events such as 2007 and 2012, and (3) climate model projections; they predicted nearly sea-ice-free summer for these three approaches as 2020 or earlier, 2030 ± 10 years, and 2040 or later.

Table 2. Sea-ice habitat trends (1979-2014) for the high quality (productive, shallow waters, ≤ 300 m) Polar Bear habitat portions by management units: trend in date of spring sea-ice retreat or break-up (days decade[1]); trend in date of fall sea-ice advance or freeze-up (days decade[1]); trend in number of ice-covered days (days decade[1]); and projected loss of ice-covered days in 2050 – approximately 3 Polar Bear generations (3 x 11.5 y/generation) into the future, from 2014. Statistical significance noted by asterisks.

Management Unit	Spring Trend (d/decade) [1]	Fall Trend (d/decade) [1]	Decline in # of Ice-covered Days (d/decade) [1]	Projected Loss in # of Ice-covered Days by 2050 [2]
Arctic Basin	-9.4**	16.8**	29.3**	105
Southern Beaufort Sea	-7.3**	8.6**	15.5**	86
Northern Beaufort Sea	-5.6	3.5**	8.5*	31
Viscount Melville Sound	-4.3	6.9	11.7**	42
M'Clintock Channel	-4.1**	5.8**	11.0**	40
Gulf of Boothia	-8.6**	7.6**	18.8**	68
Lancaster Sound	-7.6**	4.6**	11.2**	40
Norwegian Bay	-1.3	4.2	7.0*	25
Kane Basin	-9.7**	5.5**	15.1**	54
Baffin Bay	-8.4**	9.7**	19.8**	71
Davis Strait	-6.9**	8.0**	14.7**	53
Foxe Basin	-5.2**	5.6**	11.3**	41
Western Hudson Bay	-5.1**	3.5**	8.6**	31
Southern Hudson Bay	-3.0*	3.6*	6.8**	25

[1] From Stern and Laidre (2016): statistical significance *95% and ** 99% for two-sided F test and all quantities are computed from the total marine area of each management unit for the period 1979-2014.

[2] Multiplication of values in column 3 by 3.6, based on 36 years from 2017 to 2050 and assuming constant rate.

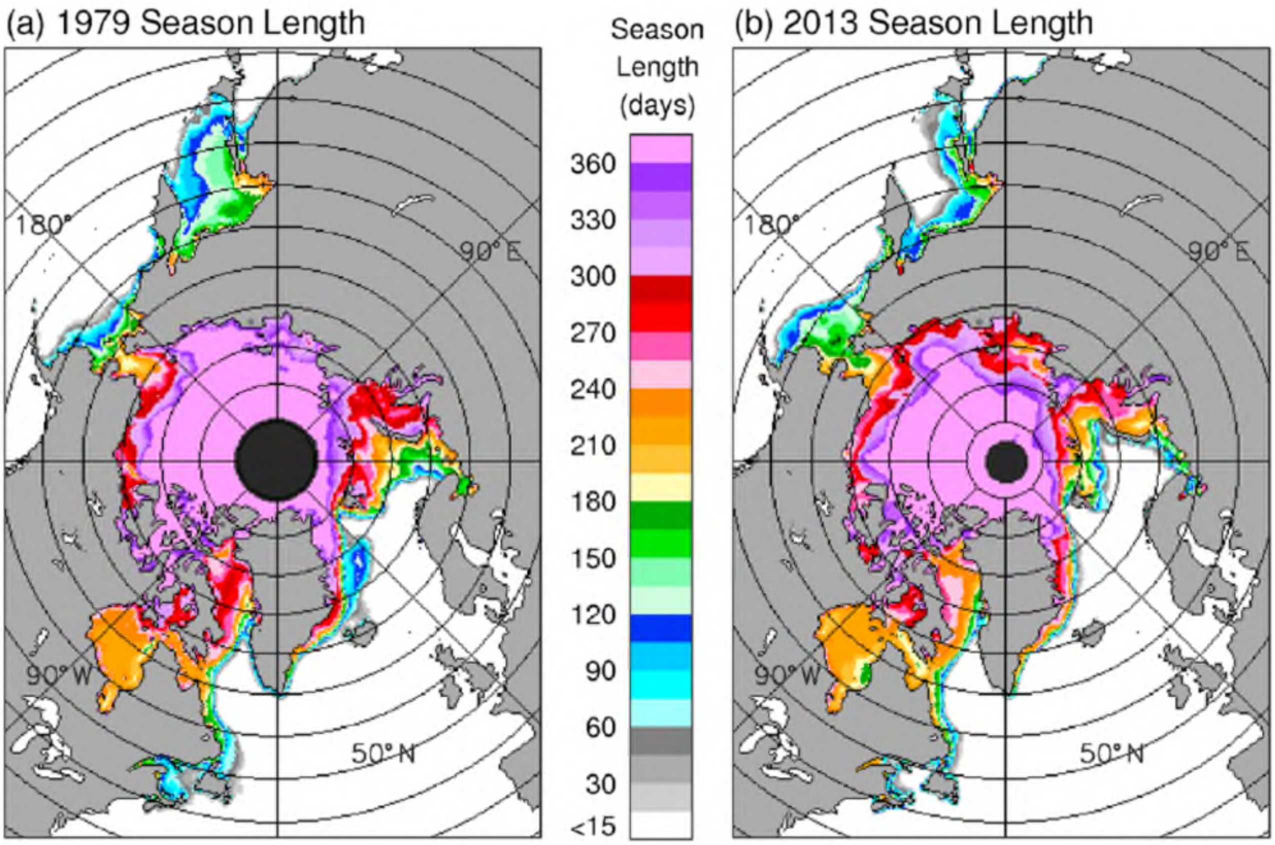

Figure 4. Length of sea-ice season for (a) 1979 and (b) 2013. Calculated by counting the number of days each pixel (25 x 25 km) had an ice concentration ≥ 15% using SSMR, SSMI, and SSMIS satellite data (source: Parkinson 2014).

Currently in the Arctic, at high latitudes, some multi-year ice remains but there has been a rapid decline in multi-year sea-ice over the past 10 years (Dowsley 2005; Keith and Arqviq 2006; Kwok *et al.* 2009; Stroeve *et al.* 2012; Meier *et al.* 2014; Joint Secretariat 2015). Multi-year sea-ice cover in the Arctic Ocean has declined from 75% in the mid-1980s to 45% in 2011, and the oldest ice types (>5 yr old) have declined from 50% of the multi-year ice pack to 10% in the Arctic Ocean and Arctic Archipelago (Maslanik *et al.* 2011; Stroeve *et al.* 2012). Projections suggest it is very likely that there will be no multi-year sea-ice by 2040 (Stroeve *et al.* 2007; Sou and Flato 2009). Annual, or first-year sea-ice now constitutes the dominant form of Arctic ice over winter and in spring (Stroeve *et al.* 2012). Annual ice is actually 11-25% thinner than the value used in models, suggesting melting rates are faster than had been predicted (Nandan *et al*. 2017). Climate change has affected seasonal sea-ice by reducing its extent, distribution, thickness, duration of coverage, and timing of phenological events (Stroeve *et al.* 2012; Vaughan *et al.* 2013).

Sea-ice habitat is declining at significant rates throughout the Canadian range of Polar Bears and rates differ regionally. The ice-free season has increased from 6 – 30 days/decade since the 1980s (Figure 5), with sea-ice break-up occurring earlier and freeze-up occurring later (Table 2) (Stern and Laidre 2016). Summer (June-October) ice concentration has also decreased by 2- 9%/decade. Regional scale analyses (Parkinson and Cavalieri 2002; Saucier *et al.* 2004; Gagnon and Gough 2005; Stirling and Parkinson 2006; Howell *et al.* 2009; Hochheim and Barber 2010; Sahanatien and Derocher 2012) of historical changes in sea-ice are in agreement with Stern and Laidre's (2016) global results.

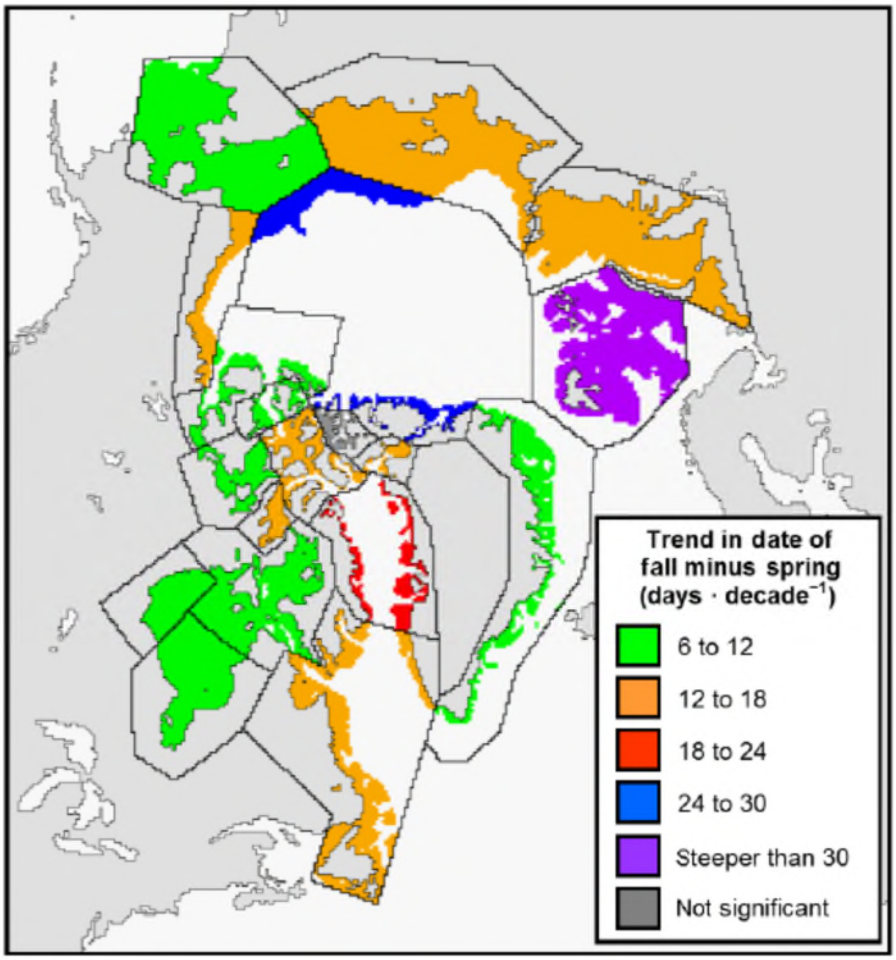

Figure 5. Map of global Polar Bear management units indicating areas of increased length of the open water (summer) season from 1979-2014 in the high quality Polar Bear habitat (i.e., productive, shallow waters, ≤300m). For example, green illustrates where the summer season has increased by 6-12 days each decade between 1979 and 2014 (source: Stern and Laidre 2016).

Changes in sea-ice are accompanied by ecosystem changes that span all trophic levels. Earlier onset of the annual phytoplankton bloom has caused mismatched availability of prey for some species, increased marine productivity in some areas, northward range expansions of subarctic and temperate species, and changes in species assemblages and community structure as some benthic systems become more pelagic (Gaston *et al.* 2005;

Grebmeier *et al.* 2006; Higdon and Ferguson 2009; Wassmann *et al.* 2011; Post *et al.* 2013; Bhatt *et al.* 2014; Arrigo and van Dijken 2015).

Terrestrial Habitat Trends

No trends in terrestrial Polar Bear habitat have been measured. There may be a small reduction in available habitat due to human activities: increasing footprints of coastal communities and more mining and tourism infrastructure. However, it is clear that terrestrial habitat is becoming more important to Polar Bears as summer sea-ice continues to decline. If the predictions are correct and summer sea-ice will no longer exist by mid-century, there will be large changes in Polar Bear terrestrial distribution and abundance.

Denning Habitat Trends: Marine and Terrestrial

Declining sea-ice is predicted to cause more bears to den on land. Durner *et al*. (2003) predicted that the reduction in the stability and availability of sea-ice in the Beaufort Sea would cause an increase in terrestrial denning on the coast. The prediction was supported by Fischbach *et al*. (2007) who recorded that the proportion of females in Southern Beaufort Sea that denned on the pack ice declined from 62% in 1985-1994 to 37% in 1998-2004. There are no similar denning datasets within Canada.

In Western and Southern Hudson Bay, and James Bay, permafrost degradation caused by warming climate may affect den integrity (cause den collapse) and Polar Bear survivorship (Derocher *et al.* 2004; Stirling and Derocher 2012). The overall quality of terrestrial denning habitat is dependent on the timing and volume of snowfall. Climate change is anticipated to affect snowfall but the effects over the Polar Bear range will be variable and regional. Nunavut and NWT ATK have reported that there is less snow accumulation in recent memory and this may affect denning (KAVIK-AXYS Inc. 2012; Dowsley 2005; Joint Secretariat 2015). In Baffin Bay, female bears are denning at higher altitude in the 2000s, compared to the 1990s, which may be related to changes in snow conditions in the autumn (SWG 2016). Unseasonable rain-on-snow events may also pose challenges for denning females through den collapse (Clarkson and Irish 1991) although the importance of this issue is unclear. Reduced spatiotemporal availability of sea-ice, specifically delayed fall freeze-up, may also make it more difficult for pregnant Polar Bears to reach traditional denning areas on land, especially near the southern limit of the species' range (Derocher *et al.* 2011).

BIOLOGY

Life Cycle and Reproduction

The Polar Bear life cycle is typical of a large carnivore, with slow growth and reproductive rates, a prolonged period of maternal care, and long life span (Bunnell and Tait 1981). Survival and reproductive rates of Polar Bears vary among management units. Lifespan in the wild is typically up to 30 years, although females have been known to live into their early 30s (Amstrup 2003). Adult survival tends to decline beyond 20 years (Obbard *et al.* 2007; Regehr *et al.* 2007; Taylor *et al.* 2008b).

Age at first reproduction is generally 4-5 years (DeMaster and Stirling 1981; Ramsay 1988 Ramsay and Stirling 1988), with most management units having females producing litters by 6 years old (Taylor *et al.* 2005, 2008a,b, 2009). The latest age at first reproduction is near the northern extent of the species' range in Kane Basin (6 years; Taylor *et al.* 2008a) and Norwegian Bay (7 years; Taylor *et al.* 2008b).

Male Polar Bears become physiologically mature at 5–6 years of age. Fully formed spermatozoa appear in low concentrations in testes of bears aged 2–4 years; concentrations asymptote at 5.8 years of age (Rosing-Asvid *et al.* 2002). Despite physiological maturity, younger males are unlikely to reproduce because of competition with older, larger-bodied males (Derocher *et al.* 2010). It appears that most males do not enter the reproductive segment of the population until they are 8–10 years old, when sexual dimorphism is greatest and males have achieved the body size to compete for available mates (Ramsay and Stirling 1986; Derocher and Wiig 2002; Derocher *et al.* 2005, 2010). The evolution of pronounced sexual size dimorphism in Polar Bears is consistent with intense intrasexual competition for females (Ramsay and Stirling 1986; Derocher *et al.* 2010).

Females enter estrus in March, which lasts until June and peaks in late April and early May (Palmer *et al.* 1988; Stirling *et al.* 2016). Males can travel more during the mating period, as they search for receptive females (Keith and Arqviq 2006; Slavik 2010; Joint Secretariat 2015). Females may mate with multiple males in a single season (Ramsay and Stirling 1986; Wiig *et al.* 1992) and multiple paternities in a single litter can occur (Zeyl *et al.* 2009).

Both ATK (Slavik 2010, Joint Secretariat 2015) and scientific research (Lønø 1970; Derocher *et al.* 1992; McDonald *et al.* 1997; Derocher and Stirling 1998b; Lunn *et al.* 2004) indicate that pregnant females enter maternity dens in late October and the young (normally 1–2; less often triplets), are born between November and early January. Pregnancy rates (based on having no cubs or cubs that are about to be weaned in one year, then producing cubs the following year) vary from as few as 50% of adult females (e.g., Kane Basin; Taylor *et al.* 2008a) to as many as 100% (e.g., Western Hudson Bay, Derocher *et al.* 1992; Baffin Bay, Taylor *et al.* 2005).

Polar Bears use maternity dens for protection and insulation during gestation, birth, and initial lactation (Denning Habitat section). Cubs are nursed inside the den until the family group emerges, typically between late February and mid-April (Ramsay and Stirling 1988; Ferguson *et al.* 2000b) when the cubs weigh 10–15 kg (DeMaster and Stirling 1981). Average litter size at den emergence is roughly 1.7 (Lønø 1970; DeMaster and Stirling 1981) and varies little across management units or latitude (Derocher 1999).

Cubs are usually weaned at 2.5 years of age (Stirling *et al.* 1975). However, in especially productive populations (e.g., Western Hudson Bay in the early 1980s) a substantial proportion of cubs were weaned as yearlings (Ramsay and Stirling 1988).

Conversely, in less productive circumstances family groups may remain together until the cubs are 3 years old (Stirling *et al.* 1975). Females become available for breeding in the same season the cubs are weaned (Stirling *et al.* 2016), which yields a typical interbirth interval of 3 – 3.5 years (Lentfer *et al.* 1980; Taylor *et al.* 1987; Derocher and Stirling 1995b). In Western Hudson Bay, the proportion of yearling bears independent of their mothers declined after 1986, increasing the interbirth interval from 2.1 years to 2.9 years by the early 1990s (Derocher and Stirling 1995b).

Natal dispersal in Polar Bear is poorly understood, at least partly because of the difficulty of tracking the movements of adult male and juvenile Polar Bears. Recent genetic analyses in Western Hudson Bay have shown that breeding among close relatives is exceptionally rare (one case among 382 mating events and no cases of first-degree relatives mating), likely due to dispersal and interbreeding among adjacent management units (Malenfant *et al.* 2016a).

Generation length for Polar Bear, defined as the "average age of parents of the current cohort (i.e., of newborn individuals in the population)", was estimated based on the age of adult females with cubs or yearlings in 11 management units (8 in Canada). Mean generation length ranged from 9.6 (East Greenland) to 13.7 years (Western Hudson Bay). The mean generation length across all management units was 11.5 years (95% CI = 9.8, 13.6) (Regehr *et al.* 2016). Male bears were not used because paternity rates are poorly known; however, recent work using male-based data suggests the length would only increase slightly if males were included (Marks 2017).

Polar Bear have high survival rates, and survival varies by age or life history stage. Researchers typically assess survival rates separately for cubs-of-the-year (COYs), yearlings and subadults (ages 1 – 4), prime-age adults (ages 5 – 20), and senescent adults (ages 21+). The general pattern is for COYs and yearlings to exhibit survival rates that are lower than subadults and prime adults, and senescent adults have lower survival rates than prime adults. Some juvenile Polar Bear are killed by conspecific adult males (Taylor *et al.* 1985; Amstrup *et al.* 2006; Stone and Derocher 2007; Slavik 2010; Stirling and Ross 2011; Joint Secretariat 2015) although the importance of this mortality source is poorly understood. Total survival rates (i.e., including mortality from harvest) are determined from natural survival rates, which are computed by considering the fates of bears that die only from natural causes. Total survival for prime-age bears often exceeds 90% (Regehr *et al.* 2007; Taylor *et al.* 2008b; Regehr *et al.* 2010). Males generally have lower total survival rates than females, due in part to harvest selection for large animals (which often are males) (Taylor *et al*. 2002; Taylor *et al*. 2006a, 2009).

Physiology and Adaptability

Additional information is presented in the **Threats** section. Polar Bear are highly specialized apex carnivores that depend on annual sea-ice habitat, and ice-associated marine mammal prey, to fulfill their life history requirements. Polar Bears have evolved important physiological, behavioural, and morphological adaptations to their Arctic environment, where the distribution of resources is highly seasonal and dynamic (Ramsay and Stirling 1988; Stirling 2002; Joint Secretariat 2015). Polar Bear have the ability to facultatively switch to a metabolic fasting state (i.e., lipid is metabolized for energy and protein is spared) when food is unavailable, even while actively foraging on the sea-ice (Derocher *et al.* 1990; Ramsay *et al.* 1991; Cherry *et al.* 2009; Whiteman *et al.* 2015).

In the parts of their range where the summer sea-ice melts completely (areas which account for 50–60% of bears in Canada), Polar Bear move to land during the summer and autumn ice-free seasons. Without access to their marine mammal prey, bears rely primarily on stored energy reserves (Ramsay and Hobson 1991; Derocher *et al.* 1993a; Atkinson and Ramsay 1995). The timing of migration, and the length of the onshore fast-ice, is thus directly related to sea-ice conditions (Stirling *et al.* 1999; Cherry *et al.* 2013, 2016). While on land bears reduce their activity and conserve energy (Knudsen 1978; Lunn and Stirling 1985). The onshore period poses the greatest physiological challenge for juvenile, subadult, and senescent bears which, as a consequence of health, hunting ability, or body size, may not have sufficient fat stores to survive a prolonged fasting period (Regehr *et al.* 2007).

While most bears return to the sea-ice when the ice re-forms in autumn, pregnant females enter maternity dens where they will remain until their cubs are born and are old enough to be moved from the den (Stirling *et al.* 1977). Thus, pregnant females may fast for up to 8 months, while having to meet the energetic demands of gestation and lactation (Watts and Hansen 1987; Atkinson and Ramsay 1995; Robbins *et al.* 2012). Adult Polar Bear lose about 1 kg of body mass per day during ice-free season fasts (Derocher and Stirling 1995b; Polischuk *et al.* 2002; Pilfold *et al.* 2016a) and pregnant females may lose as much as 43% of their body mass (Atkinson and Ramsay 1995). Offspring survival is largely predicted by offspring body mass, which is closely tied to maternal body mass (Derocher and Stirling 1996, 1998b). Thus, reproductive success, and ultimately population recruitment and abundance, will be dependent on the ability of adult female Polar Bear to acquire sufficient fat stores to cover the energetic costs of fasting, gestation, and lactation.

The issue of adaptability of Polar Bear to decreasing summer period and multi-year ice is critical to assessing the threat of sea-ice loss on Polar Bear. Two hypotheses are in play: 1) bears will be able to adapt by feeding on terrestrial food resources and thus loss of sea-ice does not affect viability; and 2) individual bears will decline in body condition, and the population will eventually decline if bears do not have access to seals, which are captured from ice. The ability to consume a wide variety of food items is established; while on shore, ATK and science indicates that Polar Bear consume many terrestrial foods, including plants, animals, and anthropogenic sources (Russell 1975; Derocher *et al.* 1993b; McDonald *et al.* 1997; Shannon and Freeman 2009; Lemelin *et al.* 2010b; Slavik 2010; Gormezano and Rockwell 2013; Joint Secretariat 2015; York *et al.* 2015). Declines in sea-ice habitat could drive Polar Bear toward increased use of terrestrial foods, but the issue is whether that food will sustain bears (Hart and Amos 2004a; Dowsley 2005; Keith and Arqviq 2006; Canadian Wildlife Service 2009; Dyck and Kebreab 2009; Kotierk 2010; Rockwell *et al.* 2011; Slavik 2013; Gormezano and Rockwell 2015; Joint Secretariat 2015; York *et al.* 2015).

ATK presents mixed views regarding the current and future contribution of terrestrial food sources to Polar Bear. Some ATK suggests that bears will quickly adapt (Canadian Wildlife Service 2009; Joint Secretariat 2015); for example, a Labrador Inuit hunter noted that “Nanuk can adapt. If they find dead seal or minke whale or anything dead they’ll eat them. They’ll eat grass or berries or fish. They’ll eat that. I’ve seen them having char before. They’re very adaptable” (York 2014, p. 185). A survey of knowledge holders on Baffin Island showed that people were not worried about the bears’ future, in part because they do not live exclusively on ice (Kotierk 2010); “they will go without seal meat for a long time during the summertime. What they usually do in summer is walk along the shore and look for drifted up seal or whale...and sometimes they will eat seaweed” (Joint Secretariat 2015, p. 101). In the Northern Eeyou Marine Region (the eastern shore of the Southern Hudson Bay unit), one-third of survey participants believed the bears will adapt because they can catch seals in open water, and eat a variety of terrestrial food (Laforest *et al*. 2018). Other ATK suggest that bears will not adapt quickly because bears rely on seal blubber (Kotierk 2010; Slavik 2013; Joint Secretariat 2015; York *et al.* 2016); for example, a knowledge holder from Aklavik stated that “they have to have ice – the polar bear. They can’t live without ice. The way they hunt that seal. The seal won’t go to them. They have to go after the seal to get it. In order to get it, they’ve got to have ice. No ice: no food” (Joint Secretariat 2015, p. 53). And for Gjoa Haven, a hunter commented that “years ago there was icebergs and multi-year and annual ice all mixed together. Today all there is annual ice. Bears hunt for seals around icebergs and on the edge of multi-year ice. Now in the past few years it is all annual ice. The ice every year disappears more. And the bears do not stay in the water. This is the reason that they have declined in this area” (Atahaki and Banci 2001, p. 8).

Despite the dietary breadth of Polar Bear, empirical evidence from scientific studies suggests that Polar Bear will have difficulty relying on only terrestrial food sources (Ramsay and Hobson 1991; Hobson and Stirling 1997; Hobson *et al.* 2009). Recent science evidence suggests that Polar Bear have only a limited ability to alter their feeding habits (Thiemann *et al.* 2008b) or habitat selection (Wilson *et al.* 2016) in response to environmental change. Polar Bear appear to be highly specialized predators of marine mammals and their demography is tightly coupled to that of their prey (Stirling and Øritsland 1995; Stirling and Lunn 1997; Pilfold *et al.* 2015). Swimming Polar Bear have been observed killing seals in open water, but this event is not common (Furnell and Oolooyuk 1980; Joint Secretariat 2015). In areas where whale, seal, and Walrus hunting regularly occur, beached carcasses are sought out by Polar Bear and can contribute to individual bears’ caloric intake during the ice-free season (Miller *et al.* 2006; Schliebe *et al.* 2008) but stable isotope and fatty acid research shows only a small proportion of bears have access to whales and Walrus (Iverson *et al.* 2006; Thiemann *et al.* 2008b, 2011; Galicia *et al.* 2015). In areas where sea-ice habitat (and thus access to seals) has declined, there is no science-based evidence to date that Polar Bear has been able to offset lost foraging opportunities with increased use of terrestrial food (Rode *et al.* 2015; Sciullo *et al.* 2016). ATK has mixed results on the severity of bears relying on terrestrial food but numerous sources note that Polar Bear are very adaptable and terrestrial food is valuable (**Threats** section).

As curious animals with highly developed olfactory senses, Polar Bear may be attracted to human activities, and associated anthropogenic food sources, at any time of year (Wilder *et al*. 2017). Where Polar Bear spend the ice-free season on land, spatial proximity may increase the likelihood of human-Polar Bear interactions. The frequency, circumstances, and outcomes of human-Polar Bear interactions are poorly documented, or out of date in most of the species' range (Stenhouse *et al.* 1988; Clark 2003; Dyck 2006). A total of 73 attacks on humans by Polar Bear have been recorded and increases in conflicts may increase with nutritionally stressed bears spending more time on land near humans (Wilder *et al*. 2017). Nutritionally stressed adult males were found to be the most likely to threaten humans (Wilder *et al.* 2017). Data from dedicated monitoring and management programs near Churchill, MB suggest that the frequency of interaction/conflict is related to environmental conditions and, specifically, the length of the ice-free period (Towns *et al.* 2009). ATK indicates bears in some areas are closer to land because of less sea-ice, or the location of floe edges and other important features; for example, one Labrador Inuit hunter observes "the bear, he is going to come closer to the land obviously looking for food. He's going to be spending more time on land, than say we were living in the 1960s or 1970s. He would probably be 50 miles offshores" (York *et al*. 2015, p. 53). With continued changes in sea-ice conditions, and likely increases in human activity and population density in the North, the frequency of human-Polar Bear interactions may increase in the future.

A shift of range northward has been noted by knowledge holders in the Beaufort Sea and Banks Island areas (Slavik 2013). This response is seen as an adaptation to prey availability and ice conditions, but also could be interpreted as an eventual loss of range along southern parts of the range, if it continues.

Dispersal and Migration

Migration may be directed toward specific locations during summer (Schweinsburg 1979; Derocher and Stirling 1990), to maternity denning habitat in autumn (Ramsay and Stirling 1990; Lone *et al.* 2012) and along shorelines to areas with early freeze-up, or to seasonal foraging areas (Lemelin *et al.* 2010b; Fisheries and Oceans Canada 2011; Joint Secretariat 2015; York *et al.* 2015). Seasonal distribution is affected by sea-ice freeze and thaw cycles (Ferguson *et al.* 1998; Mauritzen *et al.* 2003a; Schliebe *et al.* 2008). Migratory and movement patterns in Polar Bear are largely tied to patterns of sea-ice formation and melt (Durner *et al.* 2009; Cherry *et al.* 2013, 2016; Sahanatien *et al.* 2015; Pongracz and Derocher 2016, NMRWB 2018). Factors affecting movement are associated with polynyas, large landmasses, ice types, distribution of prey, presence of humans, site fidelity, and distribution of maternity denning areas (Paetkau *et al.* 1999).

Long distance migrations are common in populations where Polar Bear migrate to offshore multi-year sea-ice (Durner *et al.* 2009), whereas migrations are of shorter distance when bears summer on land (Cherry *et al.* 2013). In regions where sea-ice melts on an annual cycle, bears spend up to several months on land while waiting for freeze-up. This is most marked at the southern range of the Polar Bear in Canada, especially Hudson Bay and James Bay (Stirling *et al.* 1977; Derocher and Stirling 1990), Foxe Basin and Hudson Strait (Sahanatien and Derocher 2012; Stapleton *et al.* 2016), eastern Baffin Island (Stirling *et al.* 1980; Ferguson *et al.* 1997), and Davis Strait (Peacock *et al.* 2013, NMRWB 2018). Once on shore for summer, bears generally spend most of their time resting or, if pregnant, investigating areas for potential den sites (Knudsen 1978; Ferguson *et al.* 1997; Lunn *et al.* 2004).

Dispersal in Polar Bear is poorly understood largely because subadult bears have rarely been tracked by telemetry. Movement across management unit boundaries is commonly noted from different methods, including capture-recapture, harvest records, and satellite telemetry studies (Taylor and Lee 1995; Bethke *et al.* 1996; Amstrup *et al.* 2005). Genetic analyses provide some insights on dispersal patterns. Gene flow between adjacent areas suggests that long-distance movements occur (Paetkau *et al.* 1995; Crompton 2005, 2014; Kutschera *et al*. 2016) (**Population Spatial Structure and Variability** section).

Interspecific Interactions

Polar Bear are predators of ice-associated marine mammals. Although their diet composition varies temporally and spatially according to prey availability (Thiemann *et al.* 2008b; Galicia *et al.* 2015), Polar Bear throughout their circumpolar range depend largely on Ringed (*Pusa hispida*), Bearded (*Erignathus barbatus*), and Harp (*Pagophilus groenlandicus*) seals as prey (Stirling and Archibald 1977; Smith 1980; Derocher *et al.* 2002; Thiemann *et al.* 2008b). The abundance and population dynamics of Polar Bear is strongly connected to that of Ringed Seal (Stirling and Øritsland 1995; Hart and Amos 2004b; Keith 2005; Joint Secretariat 2015; York *et al.* 2015). Where environmental conditions have negatively affected the productivity of Ringed Seal, Polar Bear foraging success, natality, and survival have also declined (Stirling and Lunn 1997; Stirling 2002; Pilfold *et al.* 2015). The demographic connection between the species is at least partly a consequence of bears feeding heavily on newly weaned seal pups during the spring period of bear hyperphagia (Stirling and Archibald 1977). However, Polar Bear feed on seals of all age classes (Pilfold *et al.* 2012).

Participants of ATK exercises in Gjoa Haven, Cambridge Bay, and Taloyoak communicated that Polar Bear readily adapt their movements to environmental conditions and availability of prey species (Atatahak and Banci 2001; Keith *et al.* 2005).

Besides Ringed Seal and Bearded Seal, Polar Bear in parts of their Canadian range will feed on Harp Seal and Harbour Seal (*Phoca vitulina*), Walrus, Beluga (*Delphinapterus leucas*), and Narwhal (*Monodon monoceros*); see Thiemann *et al.* 2008b and references therein). Harp Seal are especially important and may represent the dominant prey item in terms of biomass for bears around Labrador and southeastern Baffin Island (Thiemann *et al.* 2008b; Galicia *et al.* 2016). Some individual Polar Bear in the western Arctic (Southern Beaufort Sea) supplement their diet by feeding on the carcasses of Bowhead Whale (*Balaena mysticetus*) taken by Inupiat subsistence hunters in Alaska (Bentzen *et al.* 2007; Herreman and Peacock 2013; Rode *et al.* 2014).

Arctic Fox (*Vulpes lagopus*), wolves, Wolverine (*Gulo gulo*), Raven (*Corvus corax*), Ivory Gull (*Pagophila eburnea*), and potentially other species benefit from Polar Bears' behaviour of feeding preferentially on seal blubber and leaving behind carcasses (Stirling and McEwan 1975; Andriashek *et al.* 1985; Smith 1980; Derocher *et al.* 2002; Roth 2003; Keith and Arqviq 2006; Joint Secretariat 2015).

Adult Polar Bear are not typically preyed upon, other than by humans. A small number of newborn cubs may be taken by wolves near terrestrial denning areas (Ramsay and Stirling 1984; Derocher and Stirling 1996; Richardson and Andriashek 2006), but this is unlikely to have substantive demographic consequences. ATK records at least two cases of Brown Bear killing Polar Bear in the Northern Beaufort unit (Joint Secretariat 2015), and mortality from Walrus (DFO 2011).

Climate-driven changes in sea-ice may alter the abundance and spatiotemporal distribution of potentially interacting species. For instance, earlier break-up of sea-ice and a longer ice-free season can cause greater temporal overlap between Polar Bear and ground-nesting birds. By depredating nests, a relatively small number of bears can have severe reproductive and demographic impacts on a bird colony (Keith 2005; Rockwell and Gormezano 2009; Smith *et al.* 2010; Fisheries and Oceans Canada 2011; Hotson 2014; Iverson *et al.* 2014; Prop *et al.* 2015).

The removal of sea-ice barriers can also facilitate the arrival of new top predators in the Arctic. There is evidence of indirect interactions between Polar Bear and Killer Whale (*Orcinus orca*) in the Canadian Arctic (Galicia et al. 2016). Specifically, Bowhead Whale carcasses that remain after Killer Whale depredation events may provide an opportunistic supplemental food source for Polar Bear in northern Foxe Basin (Galicia *et al.* 2016). Future food web changes associated with climate warming are difficult to predict.

Brown Bear distribution overlaps with that of Polar Bear in the Northwest Territories, Kitikmeot Region of Nunavut, and in Manitoba (Doupe *et al.* 2007; Rockwell *et al*. 2008), creating potential for interaction in spring on the landfast sea-ice and during the ice-free season along the coastlines. Brown Bear have been observed on the sea-ice in the Southern Beaufort Sea unit hunting seal pups and patrolling the coastline in summer scavenging on marine mammal carcasses (Joint Secretariat 2015; Miller *et al.* 2015). Most direct interactions have been observed during summer when both species are scavenging on the same carcass; behaviours documented include tolerance, competitive, displacement, aggressive, and attack (Joint Secretariat 2015; Miller *et al.* 2015).

Climate change in the Arctic has the potential to reduce or eliminate long-standing biophysical barriers (e.g., multi-year sea-ice) and alter the distribution of both Arctic and near-Arctic species. Such changes can potentially promote hybridization between previously allopatric species (Kelly *et al.* 2010). Polar Bear and Brown Bear produce fertile offspring (Preuss *et al.* 2009), thus the potential exists for biodiversity loss related to genetic introgression (Pongracz *et al.* 2017). Brown Bear were not recorded between 1965 and 1996, sporadically reported until 2005 and are annually recorded in Wapusk National Park (located in Western Hudson Bay Polar Bear unit) (Rockwell *et al*. 2008; M. Gibbons, pers. comm. 2018). Recent evidence (e.g., Doupe *et al.* 2007; Pongracz *et al.* 2017) suggests that barren ground Brown Bear may be expanding their range to offshore Arctic islands. However, the two species share an ancient history of producing hybrid individuals (Edwards *et al.* 2011; Cahill *et al.* 2015) and there is currently no scientific evidence that hybrids are becoming more common or that hybridization poses a substantive risk to the conservation of either species. Recent observations of eight Polar Bear X Brown Bear hybrids in Canada were determined to be the result of a single female Polar Bear mating with two different Brown Bears (Pongracz *et al*. 2017); hybridization appears to be very rare (Joint Secretariat 2015).

The main internal parasite in Polar Bear is *Trichinella spiralis* (or more likely *T. nativa*; J. Carney, pers. comm. 2018), which are gained from consuming seals (DeMaster and Stirling 1981). Various pathogens, such as *Brucella* spp., *Coxiella burnetii*, *Toxoplasma gondii, Francisella tularensis*, and *Neospora caninum* were recorded in bears from the Southern Beaufort Sea unit but it is unclear if some of these represent new species or native species not previously detected (Atwood *et al*. 2017).

POPULATION SIZE AND TRENDS

Sampling Effort and Methods

Information on abundance and trend are derived from two main sources, ATK, and scientific sources (**Search Effort** section).

ATK/ITK and local information has provided insights into Polar Bear population abundance by reporting qualitative evaluations of local and regional Polar Bear densities based on individual or collective experiences of their communities, hunting and travel areas (e.g., Henri *et al*. 2010). ATK has informed managers of changes in abundance in advance of the periodic scientific surveys, through harvest reporting which provides data and biological samples, and has been important in informing survey design (e.g., aerial survey stratification) (Taylor *et al.* 2009; Peacock *et al.* 2012; Stapleton *et al.* 2016; SWG 2016; Dyck *et al.* 2017). ATK recognizes that time-coincident environmental conditions should be considered when interpreting abundance estimates because Polar Bear numbers vary annually with ice conditions and seal abundance (e.g., Joint Secretariat 2015; York *et al.* 2016). Trends reported by ATK holders are relative to the lifetime(s) and hunting areas of the observer(s), and the collective observations that span multiple generations.

Total Polar Bear abundance estimates to date have been generated from scientific methods for individual management units, rather than for the entire Canadian population (Table 3). Sampling effort and methods have varied and reflect the management framework of each province and territory. Within management units, different methods have been used over time, making it difficult to assess abundance trends. Additional factors that have influenced the occurrence of abundance estimates include shared jurisdiction of a management unit, data requirements to support a non-detrimental finding for international trade (i.e., CITES), local attitudes about physical handling of bears, and the use of new technologies (e.g., genetic analyses for mark-recapture) and analytical methods. Types of data that have been used to estimate Polar Bear abundance include telemetry, physical mark-recapture, genetic mark-recapture, aerial survey/distance sampling, and harvest records. Each data source and associated analytical methods have their strengths and weaknesses for estimating abundance, assessing trends, and population status.

Table 3. Population abundance trends for the fourteen Polar Bear management units in Canada relative to population estimates at 1-3 generation length periods.

Management Unit	3 Generation (=1982) abundance estimate (95% CI)[1] [year of survey]	2 Generation (=1994) abundance estimate (95% CI) [year of survey]	1 Generation (= 2006) abundance estimate (95% CI) [year of survey]	Recent [2] abundance estimate (95% CI) [year of survey]	Percent change (by COSEWIC generation length)	Survey Method (PMR=physical mark recapture; GMR=genetic mark recapture)
Arctic Basin	No data[3]	No data	No data	No data	n/a[4]	none
Southern Beaufort Sea	1800 (1300-2500) [1983]	No data	1526 (1211-1841) [2006; but data from 2001-2006]	~900 (606-1212) [2010; but data from 2001-2010]	- 50 (3 gen.) - 41 (1/2 gen.) Or, ‘n/a’ if 2010 survey not used	PMR; surveys are comparable
Northern Beaufort Sea	867 (726-1008) [1986]	No data	980 (825-1135) [2006; but data from 2000-2006]	No data	n/a	Both PMR
Viscount Melville Sound	No data	161 (93-229) [1992]	No data	No data	n/a	PMR
M’Clintock Channel	700 [1978]	No data	284 (166-402) [2000]	No data	n/a	PMR
Gulf of Boothia	No data	No data	1592 (870-2314) [2000]	No data	n/a	PMR
Lancaster Sound	1031 (795-1267) [1979]	2541 (1759-3323) [1997]	No data	No data	n/a	PMR; no data and not comparable due to study area change
Norwegian Bay	No data	203 (115-291) [1997]	No data	No data	n/a	PMR
Kane Basin	No data	224 (94-234) [1995-1997]		357 (221-493) [2014]	n/a	1st estimate = PMR, 2nd est. = PMR & GMR; SWG (2014) state that est. not comparable due to different sampling protocols
Baffin Bay	No data	2173 (1252-2093) [1997]	2047 (1542-2606) [2005]	2826 (2059-3593) [2013]	n/a	1st est. = PMR, 2nd est. = genetic MR & PMR, 3rd est. = GMR; differences in sampling design, spatial coverage & environmental conditions

Management Unit	3 Generation (=1982) abundance estimate (95% CI)[1] [year of survey]	2 Generation (=1994) abundance estimate (95% CI) [year of survey]	1 Generation (= 2006) abundance estimate (95% CI) [year of survey]	Recent [2] abundance estimate (95% CI) [year of survey]	Percent change (by COSEWIC generation length)	Survey Method (PMR=physical mark recapture; GMR=genetic mark recapture)
Davis Strait	900 [1980]	No data	No data	2158 (1833-2542) [2007]	n/a	2nd est. = PMR; 1st est. = PMR but a sum of 2 separate efforts; data not comparable
Foxe Basin	No data	2197 (SE=260) [1994]	2300 (1780-2820) [2004]	2585 (2096-3189) [2010]	n/a	1st est.= MR (using tetracycline biomarker), 2nd est. based on ATK 3rd est. = aerial survey; studies not comparable (all different methods)
Western Hudson Bay	1194 (1020-1368) [1987]	1233 (823-1643) [1994]	935 (794-1076) [2005]	842 (562-1121) [2016] In 2011 aerial survey est. 1030 (745-1406) Additional 2011 estimates of 949 and 806 (see text)	n/a ? (change of -18, -11, +4% for 1/2 gen. but confidence limits overlap)	1st three est. based on PMR; 4th est. = aerial survey. Last study not comparable with 1-3; different method and study areas. 2011 vs 2016 is comparable
Southern Hudson Bay	641 (401-881) [1986]	No data	681 (401-961) [2005]	780 (590-1029) [2016] In 2012 aerial survey est. 943 (658-1350)	n/a ? (-17 for 1/2 gen. but confidence limits overlap)	First two studies PMR and last two aerial survey; 3rd and 4th est. not comparable with 1st & 2nd, 2012 vs 2016 is comparable
MINIMUM ABUNDANCE (range)[5] {# of units}[6]	7133 (5842-8624) {7}	8732 (6073-10339) {7}	12503 (9422-15295) {9}	10448 (7967-13177) {7}	n/a	

1. Information on data sources are presented in the Abundance and Trends by Management Unit section.

2. 'Recent' equates to surveys conducted within the last generation length period (11.5 years; >2007).

3. Survey results not available, or survey not conducted near (i.e., within 7 years of) the generation time year period.

4. Percent population change compares most recent estimate to estimates for previous generations, if data are available or survey methodology is comparable (see text for details).

5. Range is not the confidence interval for the total, but is the sum of individual standard error or confidence interval data.

6. Total number of units with data available during each generation period.

Population trends based on ATK, local knowledge, or scientific methods often vary (see management unit section below; Table 4). For example, Inuit reported higher abundance of Polar Bear in Baffin Bay in the 2000s than was reported from scientific assessments. Information from three Baffin Bay communities (Pond Inlet, Clyde River and Qikiqtarjuaq) indicates that hunters and residents recorded more Polar Bear on the land and around communities in the early 2000s, compared to 10–15 years earlier (Dowsley 2005). Bear encounters have increased, especially in Pond Inlet and Clyde River, as have concerns about safety and property damage (Dowsley and Taylor 2006). In response to community ATK that Polar Bear increased in abundance, for example, the Government of Nunavut increased its quota in Baffin Bay from 64 to 105 bears in December of 2004 and again later to 178. An increased population estimate in 2013 resulted in a harvest rate of 160.

Table 4. Indices of population trend and reported trend during the last generation length period (approximately 11.5 years) for the 14 Polar Bear management units in Canada. Information to right of column lines is only from the Polar Bear Technical Committee (2018).

Management unit	Body Condition Trend [1,2]	Reproduction Trend [1,2]	Human-Bear Conflict Trend [1,2]		Historical Trend (since 1973)[3]	ATK (TEK) Trend [4]	Reported Recent Trend (last 15 years)[5]
Arctic Basin	no data	no data	no data		no data	no data	no data
Southern Beaufort Sea	D	D	I		U	S	LD
Northern Beaufort Sea	U	S	I		LS	S	LS
Viscount Melville Sound	U	U	U		LR	I	U
M'Clintock Channel	U	U	U		LR	S	U
Gulf of Boothia	U	U	U		LS	I	U
Lancaster Sound	U	U	I		LS	I	U
Norwegian Bay	U	U	U		U	S	U
Kane Basin	I	S	U		LR	I	I
Baffin Bay	D	D	I		U	S	LS
Davis Strait	D	D	I		LI	I	LI
Foxe Basin	U	S	I		S	I	S
Western Hudson Bay	D	D	I		LR	I	LD
Southern Hudson Bay	D	S	I		LR	I, S	LD

Trend for columns to left of double line: Decline (D); Stable (S); Increase (I); Unknown. Trends for columns to right of double line: Uncertain (U); Reduced (R); Likely Reduced (LR); Likely Declined (LD; = LR); Stable (S); Likely Stable (LS); Likely Increased (LI); Increased (L)

[1.] Sources for trends in Body Condition, Reproduction, Human-Bear Conflict and Reported Trend from the following:

Southern Beaufort Sea: Regehr *et al.* (2007), Hunter *et al.* (2010), Bromaghin *et al.* (2015);

Northern Beaufort Sea: Stirling *et al.* (2011);

Viscount Melville Sound: Taylor *et al.* (2002);

M'Clintock Channel: Taylor *et al.* (2006a);

Gulf of Boothia: Taylor *et al.* (2009);

Lancaster Sound: Taylor *et al.* (2008b);

Norwegian Bay: Taylor *et al.* (2008b);

Kane Basin: Scientific Working Group to the Canada-Greenland Joint Commission on Polar Bear (2016);

Baffin Bay: Scientific Working Group to the Canada-Greenland Joint Commission on Polar Bear (2016);

Davis Strait: Peacock *et al.* (2013);

Fox Basin: Stapleton *et al.* (2015);

Western Hudson Bay: Dyck *et al*. (2017), Towns *et al.* (2009);

Southern Hudson Bay: Obbard *et al.* (2006, 2015, 2017).

2. Sources for trends in Body Condition, Reproduction, Human-Bear Conflict, and ATK from the following:

Southern Beaufort Sea: Hart and Amos (2004), Slavik *et al.* (2009), Canadian Wildlife Service (2010), Joint Secretariat (2015);

Northern Beaufort Sea: Slavik *et al.* (2009), Canadian Wildlife Service (2010), Joint Secretariat (2015);

Viscount Melville Sound: Canadian Wildlife Service (2010), Joint Secretariat (2015);

M'Clintock Channel: Atatahak and Banci (2001), Keith *et al.* (2005);

Lancaster Sound: Canadian Wildlife Service (2009), Fisheries and Oceans Canada (2001);

Baffin Bay: Dowsley (2005, 2007), Fisheries and Oceans Canada (2011), Brown and Fast (2012);

Davis Strait: Katavik Regional Government (2010), Kotierk (2010), Fisheries and Oceans Canada (2011), Brown and Fast (2012), York *et al.* (2015);

Foxe Basin: McDonald *et al.* (1997), Fisheries and Ocean Canada (2011);

Western Hudson Bay: McDonald *et al.* (1997), Nirlungayak and Lee (2009), Fisheries and Oceans Canada (2011), Brown and Fast (2012), Dyck *et al*. (2017);

Southern Hudson Bay: McDonald *et al.* (1997), Makavik Corporation (2001), Kativak Regional Government (2010), Fisheries and Oceans Canada (2011), York (2014), NMRWB (2018).

3. Historical Trend is based on an amalgamation of ATK and population estimates since the signing of the International Agreement on the Conservation of Polar bears (1973). Notations 3-7

are sourced from Polar Bear Technical Committee 2018 Report.

4. ATK Trend is based on an amalgamation of human-bear conflict, condition, and observation indices, within the last 15 years, and as such reflects a 1-generation trend.

5. Reported Trend (also termed 'scientific') is based on amalgamation of recent population estimates (Table 3), condition and reproductive indices, reported over varying time periods but generally within the last 15 years, and as such reflects a 1-generation trend.

6. Future Trend is an assessment of anticipated direction of abundance from the present (2017) to 10 years into the future.

7. 'Likely Decline' based on science; 'Uncertain' based on Traditional Ecological Knowledge.

In ATK studies over the past few decades knowledge holders have reported increases in Polar Bear sightings and encounters. While a portion of these reports are clearly attributed to increased Polar Bear abundance some may be more nuanced, and it is also possible that some may indicate distribution changes resulting in increased localized sightings or abundance. Local observations of increased abundance may be due to greater numbers of bears, or observer bias if people are travelling further, or bears spend more time near communities. Movement of bears inland during summer has increased in some areas (Keith and Arqviq 2006; Lemelin *et al.* 2010b; Slavik 2010; York *et al.* 2015). For example, Inuit have reported that during the open-water season bears can be found much farther into Eclipse Sound, up the fiords and inlets where they did not previously occur (Dowsley 2005; York *et al.* 2015). Further, all three Baffin Bay communities have reported climate change impacts on the sea-ice, such as less shore-fast ice, fewer icebergs and thinner ice, which some people (5 of 12 people who discussed the idea) thought might contribute to changes in Polar Bear distribution (Dowsley 2005; Dowsley and Taylor 2006). ATK suggested that the population in Foxe Basin management unit increased (McDonald *et al.* 1997). For example, at Southampton Island, it was common for hunters to fill their quota in a matter of days (McDonald *et al.* 1997). One untested hypothesis proposed to explain this observation is that ocean currents in the region are now weaker, allowing bears to become more evenly distributed on the ice during mid-winter, rather than congregating at the mouth of Hudson Strait (McDonald *et al.* 1997). Inuit hunters and residents interviewed in Igloolik attributed increases in Polar Bear sightings to an increase in the population (Henri 2012).

The efficacy of either ATK or scientific methods is difficult to measure but some studies have tried to assess both sources of knowledge. In the Western Hudson Bay unit, Regehr *et al.* (2007) concluded that a decline in bears had occurred in the Manitoba section, but local knowledge holders suggested that the bears had shifted range northward along the Kivalliq coast, Nunavut (Peacock and Taylor 2007). To address the discrepancy, the Government of Nunavut conducted a mark-recapture survey of bears over a larger area (from Churchill to Chesterfield Inlet) to determine whether there were large numbers of bears along the Kivalliq coast during the summer (Peacock and Taylor 2007). A total of 25 bears were captured during the 3-day survey, a result similar to the density estimate from Regehr *et al*. (2007). Subsequent aerial surveys have reconfirmed that a shift has not occurred and that most of the summertime bears (approximately 95%) are in Manitoba and not along the Nunavut coast (Dyck *et al*. 2017). However, the local knowledge did result in a more complete survey of the distribution, and a better understanding of relative abundance.

In summary, there is a lack of consensus between ATK and science on whether increasing observations of bears indicate an increasing bear population.

Abundance, Fluctuations, and Trends

Abundance and Trends by Management Unit

Population trends in each management unit are presented separately because all surveys, research, and management (e.g., harvest quotas) exist at the unit scale. The extent to which data from these separate units reflects trends in the Canadian population is uncertain because many units lack data for the last 1-2 generations, and when surveys are available, they often cannot be compared across generations because of different methodologies. Summaries of total abundance and trends follow the section on individual units.

Arctic Basin

There is no abundance information for this management unit. The density of bears is thought to be low and that most bears are transient (COSEWIC 2008; IUCN/SSC Polar Bear Specialist Group 2010) but no estimate has been made in reports by IUCN or the Polar Bear Specialist Group.

Southern Beaufort Sea

Polar Bear inhabiting the Southern Beaufort Sea management unit are shared between Canada and Alaska. A boundary shift was made in 2013/2014 that moved the eastern boundary 200 km westward (Figure 1). The shift was made because ATK indicated mixing of bears (Joint Secretariat 2015; 2017), which was supported by analysis of satellite telemetry data on adult females collected in 1985–2003 that showed 50% of female bears near Tuktoyaktuq were from the Southern Beaufort Sea management unit and 50% from the Northern Beaufort Sea unit (Armstrup *et al*. 2005; Stirling *et al.* 2011).

As a result of the boundary shift, two population estimates exist. The estimate for the original boundary is 900 bears (90% CI: 606-1,212) for 2010, based on analyses of physical mark-recapture data from 2001-2010 (Bromaghin *et al.* 2015). There were concerns that the 2010 estimate was lower due to annual variability in ice conditions, which results in changes in density, and that bears are shifting to the Northern Beaufort Sea unit because of ice conditions (PBTC 2018). Based on these concerns, a second estimate of 1,215 bears (no C.I.) was derived using a re-analyses of physical mark-recapture data from 2001–2006, and applying that data to the new boundary (Griswold *et al.* 2010). A total of 311 bears were removed from the Southern Beaufort unit estimate and added to the Northern Beaufort unit estimate (Joint Secretariat 2017).

In Canada, the historical harvest of bears in this unit has been relatively light. There was an increase in hunting activity in the late 1950s due to an increase in fur prices; however, by the mid-1970s Polar Bear were only killed by Aklavik and Inuvik hunters opportunistically during hunts for other species (Usher 1976). Hunters from Tuktoyaktuq recall hunting Polar Bear during this time in the Cape Bathurst area. Some hunters in Tuktoyaktuq and Aklavik report seeing fewer bears and some report seeing the same numbers as in the past. The total allowable harvest is 56 bears/year (21 in Canada and 35 in USA), and removal in 2016-2017 was 18 bears (Table 5).

Table 5. Annual removal of Polar Bear due to mortality from harvest, defence kills, research or toxins, as well as maximum potential removals allowed under various harvest systems. Source: PBTC (2018).

Management Unit	Annual Removal (5 year mean)	Removal (2016-2017)	Maximum Potential Removal (2016-2017)[1]
Southern Beaufort Sea	28.6	18	21
Northern Beaufort Sea	41.2	40	70
Viscount Melville	4.4	3	7
M'Clintock Channel	6.4	10	12
Gulf of Boothia	62	61	74
Lancaster Sound	85	78	85
Norwegian Bay	2	1	4
Kane Basin	5.6	5	5

Management Unit	Annual Removal (5 year mean)	Removal (2016-2017)	Maximum Potential Removal (2016-2017)[1]
Baffin Bay	130.4	138	65 (+67 in Greenland)
Davis Strait	96.6	74 [2]	73 [2]
Foxe Basin	103.4	99 [2]	123 [2]
Western Hudson Bay	27.2	21 [3]	28 [3]
Southern Hudson Bay	41.6	27 [2,4]	43 [2,4]
Total		575 [2,3,4]	610 [2,3,4]

1. Some units share harvest with other countries; only the Canadian segment is shown
2. Does not include unknown number of harvest or defence kills in Québec.
3. Does not include unknown number of defence kills in Manitoba.
4. Does not include unknown number of harvest or defence kills in Ontario.

This status report only uses estimates that cover the same survey area over time. Based on surveys by Armstrup *et al*. (1986), Regehr *et al*. (2007) and Bromaghin *et al*. (2015), and COSEWIC use of generation length periods as a basis for population trend, survey data suggests that the population is in decline. Earlier abundance estimates for this management unit were: 1,800 in 1983 (95% CI; 1,300–2,500) (Amstrup *et al.* 1986) and 1,526 (95% CI: 1,211–1,841) in 2006 (Regehr *et al.* 2007), while a more recent estimate was 900 (95% CI:606 – 1,212) in 2010 (Bromaghin *et al*. 2015). This suggests a 50% decline over 3 generations (1983 vs 2010) and a 41% decline over a half generation (2006 vs 2010). These estimates were based on physical mark-recapture data, which were also used in past surveys and are comparable over time. Bromaghin *et al.* (2015) found a declining trend in abundance from 2001–2006 that stabilized during 2008–2010. This study found low survival in 2004–2006, resulting in a 25–50% decline in population abundance but with wide confidence interval in the estimates of population decline. Adult female survival, breeding probabilities, and abundance were observed to decline with increasing numbers of ice-free days from 2001–2005 (Hunter *et al.* 2010; Regehr *et al.* 2007). Stochastic modelling conducted for this unit predicted declines in bears (Hunter *et al*. 2010). Body condition and reproduction indices were in 'decline' and human-bear conflict trend was 'increasing' (Table 4).

Criticism of the estimates in Bromaghin *et al*. (2015) is such that they are not included in some reports (i.e., Joint Secretariat 2017), or both estimates are presented (i.e., PBTC 2018). If Bromahgin *et al*. (2015) is not used in calculating trend using generation length, then the only comparable surveys are 1,800 bears in 1983 (95% CI; 1,300–2,500) (Amstrup *et al.* 1986) and 1,526 bears (95% CI: 1,211–1,841) in 2006 (Regehr *et al.* 2007); this is a decline of 15% over 2 generations (1983 – 2006) but the confidence intervals overlap and the difference is not statistically significant. Also, to be consistent throughout the status report, the estimate is from data beyond 1 generation length and thus the trend is unknown. The Griswold *et al*. (2010) estimate cannot be used because it covers a different survey area.

The consensus among harvesters is that Polar Bear abundance in this management unit is stable (Slavik *et al.* 2009; Joint Secretariat 2015; PBTC 2018). The PBTC (2018) lists the historical trend (i.e., since 1973) as 'uncertain', the ATK assessment as 'stable', recent scientific trend as 'likely declined', and the future trend (i.e., next 10 years) as 'likely decline'.

In summary, the COSEWIC report applies both estimates; a 50% decline in 3 generations, and a 41% decline in half a generation when using Bromaghin *et al*. (2015), or that a recent trend cannot be calculated, based on scientific methods, and 'uncertain' or stable, based on ATK.

Northern Beaufort Sea

The Northern Beaufort unit mean abundance estimate is 980 bears (95% CI: 825–1,135) based on physical mark-recapture data collected in 2000–2006 (Stirling *et al.* 2011). This estimate is not considered recent in this status assessment because it is >1 generation length old.

Re-analyses of the mark-recapture data from 1972–2006 found no change in the mean abundance by decade: the 1972–1979 estimate was 867 ± 494 (95% CI), the 1985–1989 estimate was 857 ± 482, and the 2006 estimate was 1,004 ± 504 (Stirling *et al*. 1988; Stirling *et al*. 2011). The first abundance estimate for management purposes was 1,200 bears (Amstrup *et al.* 1986; Stirling 2002). This management unit had an increasing trend in abundance in the 1970s as it recovered from overharvest in the 1960s (Stirling *et al.* 2011). From the 1980s-2000s, the population in this management unit continued to slowly increase and may now be stable (Canadian Wildlife Service 2009; Joint Secretariat 2015; Griswold *et al.* 2017). Stirling *et al.* (2011) indicated that the population would eventually decline with a continuous trend of climate warming. In a 2001 interview for the Paulatuuq Oral History project, an elder stated that the population in the area had been stable from the 1970s to 2000s (Parks Canada 2004). More recent local knowledge suggests that this management unit remains stable and may be increasing (Slavik *et al*. 2009; Joint Secretariat 2015). The lack of population data since 2006 negates a trend assessment based on science. The total allowable harvest is 77 bears/year, under the new management unit boundary, and 40 bears were removed in 2016-2017 (PBTC 2018).

The Polar Bear Technical Committee (2016) reported an abundance estimate of 1,291 (no CI) for harvest management based on the 2014/2015 change in the management unit boundary and a re-analyses of physical mark-recapture data from 1971–2006 (Griswold *et al.* 2010), which added 311 bears to the unit. The estimate used for management is 1,710 bears, based on concerns that northern parts of the unit are under-surveyed (Joint Secretariat 2017).

A population trend based on generation length is not possible because of the lack of recent data. The PBTC (2018) lists historical trend as 'likely stable', ATK assessment as 'stable', and the recent scientific and future trends as 'likely stable' (Table 4). Indices for body condition are 'unknown', reproductive trend is 'stable', and human-bear conflict is 'increasing' (Table 4).

Viscount Melville Sound

There are no recent scientific data available for the Viscount Melville Sound Polar Bear management unit; the most recent estimate is 26 years old. An old estimate of abundance is 161 (95% CI: 93-229), based on physical mark-recapture data collected from 1974–1992 (Taylor *et al.* 2002). A 3-year (2012-2014) physical mark-recapture study was completed but the updated abundance estimate is not yet available.

In the 1970s, the abundance and productivity of the Viscount Melville Sound Polar Bears were overestimated, resulting in substantial over-harvest of bears during the 1980s and early 1990s (e.g., 1985–1990 mean harvest rate 19.6 bears/year) (Kingsley *et al.* 1985). Polar Bear density is considered to be low in this management unit relative to others because of the predominance of multi-year ice habitat and low densities of Ringed Seals (Furnell and Schweinsburg 1984). Controls on hunting (1994–1999) and conservative total allowable harvests (4 bears/year from 1999–2004; 7 bears/year, since 2014; PBTC 2018) may have allowed an increase in abundance (Joint Secretariat 2015). The total allowable harvest is 7 bears/year and 3 bears were removed in 2016-2017 (Table 5).

A population estimate based on generation length is not possible because of the lack of recent data. ATK indicates that the population in this management unit is stable, and may be increasing (Canadian Wildlife Service 2010; Joint Secretariat 2015). The PBTC (2018) lists historical trend as 'likely reduced', ATK assessment as 'increased', and the recent scientific and future trends as 'uncertain' (Table 4). Indices for body condition, reproductive trend and human-bear conflict are all 'unknown', because of limited data (Table 4).

M'Clintock Channel

There are no recent scientific data available for the M'Clintock Channel management unit; the most recent estimate is 18 years old. An old abundance estimate is 284 (95% CI: 166–402), based on an 8-year physical mark-recapture study using data from 1992 – 2000 (Taylor *et al.* 2006a). A 3-year genetic mark-recapture study was completed in 2016 but the updated abundance estimate is not available.

A population trend based on scientific knowledge cannot be quantified because of the lack of recent data. In the mid-1970s, a 6-year physical mark-recapture study covering most of M'Clintock Channel and Gulf of Boothia estimated the total study area abundance of 1,100 bears (Furnell and Schweinsburg 1984; Taylor *et al.* 2006a). This study estimated 900 bears for M'Clintock Channel unit, which was lowered to 700 bears because Inuit hunters thought the estimate of 900 animals was too high and the harvest (mean 34 bears/year from 1976–1999) not sustainable (Atatahak and Banci 2001; Keith 2005).

M’Clintock Channel and Gulf of Boothia management units were later delineated as individual management units based on movements of satellite radio-collared adult female bears, tag returns of harvested bears, and ATK about how local conditions influenced movements (Taylor and Lee 1995; Taylor *et al*. 2001).

Taylor *et al*. (2006a) reported that the management unit had declined (growth rate 0.946 ± 0.038) and a moratorium on hunting was put in place for 2001-2002 (Taylor *et al.* 2006a). Hunting resumed in 2004–2005, with a total allowable harvest of 3 bears/year. In 2015, the total allowable harvest was increased to 12 bears/year for the 2015/16 harvest season (Polar Bear Technical Committee 2016) and 10 bears were removed in 2016-2017 (Table 5).

Documented ATK has the same findings as the scientific data that indicated low abundance due to over-harvest. Gjoa Haven hunters reported that bear numbers near their community had declined over the 30 years prior to the 2000s (Keith *et al.* 2005). Other areas where decreased numbers of Polar Bears have been reported include the Royal Geographical Society Islands, Paisley Bay, northern King William Island, Gateshead Island, Larsen Sound, and the M’Clintock Channel itself (Atatahak and Banci 2001). Inuit suggest that Polar Bears were no longer present in the Queen Maud Gulf area (Keith *et al.* 2005). Inuit hunters also reported a decline in the number of adult male bears in M’Clintock Channel but that large males can be found further to the north (Atatahak and Banci 2001; Keith *et al.* 2005).

A population estimate based on generation length is not possible because of the lack of recent data. The PBTC (2018) lists the ATK assessment as stable, recent scientific trend as uncertain, and future trend (10 years) as uncertain (Table 4). Indices for body condition, reproductive trend and human-bear conflict are all ‘unknown’, because of limited data (Table 4).

Gulf of Boothia

No recent scientific population estimate is available for the Gulf of Boothia management unit; the most recent estimate is 18 years old. An old abundance estimate of 1,592 bears (95% CI: 870–2314) is based on a physical mark-recapture study from 1976–2000; recruitment and survival rates were estimated to be relatively high (Taylor *et al.* 2009). A three-year genetic mark-recapture study is underway but presently is not available.

In the mid-1970s, a 6-year mark-recapture study that covered most of M’Clintock Channel and Gulf of Boothia estimated the study area abundance to be 1,100 bears (Furnell and Schweinsburg 1984). From this research, an estimate of 300 bears for Gulf of Boothia was derived (Taylor *et al.* 2009). Managers agreed with Inuit hunters that the abundance estimate was too low and increased it to 900 bears in the 1990s. In the late 1990s, the Gulf of Boothia management unit was delineated as a separate management unit from M’Clintock Channel, based on movements of satellite radio-collared adult female bears, tag returns of harvested bears, and ATK about how local conditions influenced movements (Taylor and Lee 1995; Taylor *et al*. 2001). In 2005, the management unit was thought to be increasing and the total allowable harvest was increased to 74 bears/year, where it remains (Table 5).

A population trend based on generation length is not possible because of the lack of recent data. The PBTC (2018) lists historical trend as 'likely stable', ATK assessment as 'increased', and recent scientific and future trends as 'uncertain' (Table 4). Indices for body condition, reproductive trend and human-bear conflict are all 'unknown', because of limited data (Table 4).

Lancaster Sound

No recent abundance estimate is available for Lancaster Sound management unit. An old estimate of 2,541 bears (95% CI: 1,759–3,323) exists and is based on physical mark-recapture data collected from 1972–1985 and 1989–1997 (Schweinsburg *et al.* 1982; Taylor *et al.* 2008b). While this is higher than the 1979 estimate of 1,031 ± 236 (95% CI) bears, which was also based on physical mark recapture (1970–1979) (Taylor *et al.* 2008b), there were substantial differences in study area boundaries. The Schweinsburg *et al.* (1982) study area was smaller and extended into northern Baffin Bay and the Taylor *et al.* (2008b) study area reflects the current Lancaster Sound management unit boundary. Documented ATK from Lancaster Sound area reports increased bear abundance in this management unit, based on increased human-bear conflict (Canadian Wildlife Service 2009; Fisheries and Oceans Canada 2011). The 2018 allowable harvest is 85 bears/year and 78 bears were removed in 2016 - 2017 (Table 5).

A population trend based on generation length is not possible because of the lack of recent data, and changing study boundaries in past estimates. The PBTC (2018) lists historical trend as 'likely stable', ATK assessment as 'increased', and recent scientific and future trends as 'uncertain' (Table 4). Indices for body condition and reproductive trend are 'unknown', and human-bear conflict is 'increasing' (Table 4).

Norwegian Bay

No recent scientific population estimate is available for the Norwegian Bay management unit; the most recent estimate is 21 years old. An old estimate is 203 (95% CI: 115–291), based on physical mark-recapture data collected from 1995–1997 (Taylor *et al.* 2008b). Taylor *et al.* (2008b) reported that the risk of decline was high for this management unit because of a low rate of reproduction and population growth rate, and low abundance. The total allowable harvest for the Norwegian Bay management unit was reduced to 4 bears/year in 1996 and remains remained at this level; 1 bear was removed in 2016 - 2017 (Table 5).

A population trend based on generation length is not possible because of the lack of recent data. The PBTC (2018) lists historical trend as ‘uncertain’, ATK assessment as ‘stable’, and recent scientific and future trends as ‘uncertain’ (Table 4). Indices for body condition, reproductive trend, and human-bear conflict is ‘unknown’ due to limited data (Table 4).

Kane Basin

The Kane Basin Polar Bear abundance estimate is 357 Polar Bears (95% CI: 221–493) for 2013–2014 (SWG 2016). This estimate was based on physical and genetic mark-recapture data collected during 2012–2014.

A population trend using COSEWIC methods of generation length is not possible because methodology was not consistent over time. Previous estimates were based on only physical mark-recapture methods; Taylor *et al.* (2008a) estimated 164 bears (95% CI: 94–234) from 1994 – 1997 data, and the Scientific Working Group to the Canada-Greenland Joint Commission on Polar Bear (SWG) estimated 224 bears (95% CI: 145–303) for 1995–1997, based on 1992–1997 data. The SWG (2016) concluded that there is evidence for stable to increasing numbers of bears in Kane Basin but recommended caution for such a conclusion because there were differences in sampling protocols between the 1990s and 2000s. ATK indicated more bears in eastern Kane Basin during 2012–2014 than during the 1994–1997 surveys (Born *et al.* 2011; SWG 2016).

Historically, Greenland hunters took the majority of bears out of Kane Basin (~10 bears/year in 1999-2004) but the actual number is uncertain (Taylor *et al.* 2008a). The SWG (2016) expressed concern that the total Kane Basin harvest was unsustainable because they found a declining population trend and it appeared that over-harvesting had occurred during 1992–1997, but there was uncertainty because emigration and sea-ice habitat quality may have been contributing factors. The total allowable harvest in 2018 is 11 bears/year (Canada 5; Greenland 6), and 5 were removed (Table 5).

The PBTC (2018) lists historical trend as ‘likely reduced’, ATK assessment as ‘increased’, recent scientific trend as ‘increased’, and future trends as ‘likely stable’ (Table 4). Indices for body condition are ‘increasing’, ‘stable’ for reproductive trend, and ‘unknown’ for human-bear conflict (Table 4).

Baffin Bay

The Baffin Bay management unit Polar Bear abundance estimate is 2,826 (95% CI: 2,059–3,593) for 2012–2013 and was based on genetic mark-recapture data collected during 2011–2013 (SWG 2016). The 2005 Baffin Bay abundance estimate using the 1990s physical and genetic mark-recapture data from (1993–1997) was similar, at 2,047 (95% CI: 1,542–2,606) (Taylor *et al.* 2005).

The SWG (2016) re-calculated the mean estimate of total abundance for 1994 -1997 to be 2,173 (95% CI: 1,252–3,093) based on genetic data collected during the 1993–1995 and 1997 physical mark-recapture study.

The SWG (2016) concluded that it is not possible to draw conclusions about population trends in Baffin Bay from 1990s and 2000s because of differences in sampling designs, spatial coverage, and environmental conditions. In addition, they expressed concern about the status of Baffin Bay because the estimates of total survival for males and independent females were too low to support a stable population. The decline in survival rates was also detected in an analysis of the harvest data (1979–2009) and physical capture data (1979-1997) and correlated with sea-ice habitat changes (Peacock *et al.* 2013). Estimated annual recruitment (calculated as the number of yearlings per adult female in the MR sample) for Baffin Bay during 1993-2013 ranged from 0.24 to 0.51. This level of cub production and survival suggests that the unit has enough reproductive capacity, at the present time, to function as a viable population (SWG 2016).

The bears in this unit are managed with Greenland. The number of bears from the Baffin Bay management unit hunted by Greenlanders between 1993–2005 ranged from 72 to 206/year (Born *et al.* 2011), and no harvest limit was in place for harvesters from Greenland. In January 2006, Greenland introduced a quota limitation for Baffin Bay unit bears that varied by year from 73–79 bears/year. The total allowable harvest as of July 2018 is 132 bears/year (Canada 65; Greenland 67), and 138 bears were removed in 2016 – 2017 (Table 5).

A population trend based on generation length is not possible because of changing methodologies between surveys. The PBTC (2018) lists historical trend as ‘uncertain’, ATK assessment as ‘stable’, recent scientific trend as ‘likely stable’, and future trend as ‘uncertain’ (Table 4). In the early 2000s, hunters and residents from three Baffin Bay communities (Pond Inlet, Clyde River, and Qikiqtarjuaq) had observed more Polar Bear on land, around communities, and in some areas, such as Home Bay (Dowsley 2005, 2007; Fisheries and Oceans Canada 2011; Brown and Fast 2012). Indices for body condition and reproductive trend are ‘decreasing’, and ‘increasing’ for human-bear conflict (Table 4).

Davis Strait

The Davis Strait unit abundance estimate in 2007 was 2,158 bears (95% CI: 1,833–2,542) based on physical mark-recapture data collected during the fall from 1974–2004 and 2005–2007, and harvest data from 1974–2009 (Peacock *et al.* 2013). A genetic mark -recapture survey of the DS subpopulation has been conducted in 2017 and 2018 with a new population estimate expected in 2019. The survey was collaboratively conducted by Nunavut, Newfoundland and Labrador, Québec, and Labrador Indigenous groups.

The previous Davis Strait abundance estimate was 900 bears and was based on the sum of separate estimates from southeast Baffin Island (Stirling *et al.* 1980) and Labrador (Stirling and Kiliaan 1980). In 1993, the abundance estimate was increased to 1,400 bears to account for the offshore bears not surveyed. Peacock *et al.* (2013) did not compare the 1970s and 2000s estimates for evidence of a trend because of the differences in sampling protocols: the earlier data were collected during the spring when a portion of bears were offshore on pack ice and unavailable for capture, and later data were collected in the fall (ice-free season) when most bears are on shore and available for capture. The numbers of bears hunted by Greenlanders from the Davis Strait management unit between 1993–2008 was 0–22 bears/year (Born *et al.* 2011). In 2006, Greenland introduced a quota limitation for Davis Strait that varied from 2–3 bears/year. The total allowable harvest in 2016 is 76 bears/year (Nunavut 61; Nunatsiavut 12; Greenland 3), but does not include removal by Québec residents; a minimum of 74 bears were removed in 2016-2017 (Table 5).

All Davis Strait communities reported increased Polar Bear abundance over the past 40 years (Kativik Regional Government 2010; Kotierk 2010; Fisheries and Oceans Canada 2011; Brown and Fast 2012; York *et al.* 2016). Qualitative observations from elders with considerable knowledge of Polar Bears in Nain, Labrador indicated that abundance in Davis Strait was higher now than in the past (Nunatsiavut Government 2006). The elders also reported that Polar Bear distribution has changed from primarily outer coast and offshore areas to now including the inner bays (which freeze first), and farther inland than previously.

A population trend based on generation length is not possible because of changing methodologies between surveys. The PBTC (2018) lists historical trend as 'likely increased', ATK assessment as 'increased', recent scientific trend as 'likely stable', and future trend as 'uncertain' (Table 4). Indices for body condition and reproductive trend are 'decreasing', and 'increasing' for human-bear conflict (Table 4).

Foxe Basin

The mean abundance of the Foxe Basin management unit is estimated to be 2,585 (95% CI: 2,096-3,189) based on two years of aerial survey data (2009 and 2010) (Stapleton *et al.* 2016).

The earliest estimate for Foxe Basin was 1,820 bears, based on sea-ice habitat area and bear density per 1000 km² (Taylor and Lee 1995), but this estimate was based on the assumption that Foxe Basin bears were primarily found in northern Hudson Bay; a satellite telemetry study (2007–2011) found that bears were actually distributed throughout the management unit (Sahanatien *et al.* 2015).

A more accurate estimate of 2,197 (SE: 260) was made for 1994, based on a 1989-1994 mark-recapture data set that used using tetracycline biomarkers (Taylor *et al.* 2006b). Stapleton *et al.* (2016) suggested that the Foxe Basin management unit population was stable. As of 1997, local knowledge had documented an increase in some parts of the management unit and a decrease in others (McDonald *et al.* 1997). In 2004, after consultations with Inuit communities, the total allowable harvest was increased to 109 bears/year to reflect the updated abundance estimate of 2,300 bears. Based on the abundance estimate in Stapleton *et al*. (2015), the total allowable harvest was increased to 123 bears/year, but this does not include harvest levels from Québec; a minimum of 99 bears were removed in 2016 - 2017 (Table 5).

A population trend based on generation length is not possible because of changing methodologies between surveys. The PBTC (2018) lists historical trend as 'stable', ATK assessment as 'increased', recent scientific trend as 'stable', and future trend as 'likely stable' (Table 4). Indices for body condition are 'unknown', 'stable' for reproductive trend, and 'increasing' for human-bear conflict (Table 4).

Western Hudson Bay

The most recent mean abundance of this management unit is estimated to be 842 (95% CI: 562-1121) based on an aerial survey conducted in 2016 (Dyck *et al.* 2017).

Population trends suggest a period of increase, then stability, and possibly decline. Aerial surveys indicated that populations increased after the 1960s when the fur-trading post at York Factory closed and Manitoba closed hunting (Stirling *et al.* 1977; Derocher and Stirling 1995a), which is in agreement with ATK summarized by Nirlungayuk (2008; cited in COSEWIC 2008) which indicated that bear abundance in the areas of Western Hudson Bay in the 2000s were considerably higher than historically (>50 years ago).

Mark-recapture analysis of data from 1978 – 1992 suggested a mean abundance estimate of 1,000 (95% CI: 537-1,268) (Derocher and Stirling 1995a). This estimate was increased to 1,200 for management purposes because the study area did not cover the entire unit (i.e., areas to the north of Churchill and areas east of the Nelson River). The 1987 estimate was 1194 bears (95% CI: 1020-1368). A 1994 estimate of 1,233 bears (95% CI: 823–1,643) was based on physical mark-recapture data collected between 1984–1995 (Lunn *et al.* 1997). This estimate included data from the most southerly part of the management unit. Regehr *et al.* (2007) found declining abundance between 1987 and 2004, from 1,194 (95% CI: 1,020–1,368) to 935 (95% CI: 794 -1,076). Data from long-term monitoring from Churchill River to Nelson River (which includes the core denning area) indicated a long-term decline (>30%) from 1,185 bears (Bayesian credibility intervals: 993–1,411) in 1987, to 806 bears in 2011 (Bayesian credibility intervals: 653–984) (Lunn *et al.* 2016), with a likely period of population stability during 2001-2010, possibly due to a temporary period of stability in sea-ice conditions.

Repeated surveys and different methodologies have produced several more recent estimates for bears in this unit. An aerial survey of the entire summer range of the WH population was conducted by the governments of Nunavut and Manitoba in 2011. Few (5.3%) of the summer observations were in Nunavut (Dyck *et al.* 2017). The survey estimated the population size as 1030 bears (95% CI: 754 – 1406) (Stapleton *et al*. 2014; Dyck *et al*. 2017). Another estimate for 2011 was derived from analyses of mark-recapture data from 1984–2011 for the core and main denning area, resulting in an estimate of 806 bears (95% CI: 653–984) (Lunn *et al.* 2016*).* A third estimate for the 2011 survey was derived from applying 2011 data to the same analytical methods used in the 2016 estimate; this analysis resulted in an estimate of 949 bears (95% CI: 618–1280) (Dyck *et al*. 2018). The 2016 estimate of 842 bears (95% CI: 562-1121) is an 18% decline compared to the original government estimate, an 11% decline compared to the third estimate, and a 4% increase when comparing to the mark-recapture method. Confidence limits overlap in most of these estimates and any differences are not statistically significant.

Population trends can also be derived from other indices. Survey results from both 2011 and 2016 indicate poorer reproductive performance in this unit compared to any other unit in the Hudson Bay complex. Dyck *et al.* (2017) and Stapleton *et al.* (2014) recorded lower mean litter sizes and the proportion of COYs and yearlings, compared to nearby management units (Regehr *et al*. 2007). Female growth rate appeared to have been stable for the period 1991-2011, at 2% annually (Lambda = 1.02; 95% CI: 0.98-1.06) (NWMB 2018), but adult females with offspring went from stable to decreasing between 2011 and 2016 (Dyck *et al*. 2017). The low % yearling abundance (3%) suggests that recruitment rates are currently very low in this unit (Obbard *et al*. 2016).

The suspected decline in the last 30 years conflicts with local knowledge from Arviat, Whale Cove, Rankin Inlet, and Chesterfield Inlet where greater numbers of Polar Bears have been reported near and in communities during the ice-free season, and which has been interpreted as evidence of an increasing population (Obbard *et al.* 2015; Nirlungayuk and Lee 2009; Brown and Fast 2012).

The 2018 total allowable harvest is 28 bears/year, which is allocated to Nunavut hunters. Defence kills and potentially live removals to zoos in Manitoba are additive to the harvest rate, although these are infrequent occurrences. Removal in 2016-2017 was 21 bears (Table 5).

A population trend based on generation length is possible only for the 2011 versus 2016 estimates because they are based on the same methodology. This half generation length difference was a decline of 18% but the confidence intervals overlap and the difference is not statistically significant. The PBTC (2018) lists historical trend as ‘likely reduced’, ATK assessment as ‘increased’, recent scientific trend as ‘likely declined’, and future trend as ‘likely decline’, based on science, and ‘uncertain’, based on ATK (Table 4). Indices for body condition and reproductive trend are ‘declining’, and ‘increasing’ for human-bear conflict (Table 4). In summary, the scientific knowledge indicates a possible decline, and ATK indicates increase or uncertainty.

Southern Hudson Bay

The most recent (2016) abundance of Polar Bears in Southern Hudson Bay is estimated to be 780 (95% CI: 590-1,027) (PBTC 2018). The estimate from 2011-2012 was 943 (95% CI: 658-1,350) based on an aerial surveys conducted (Obbard *et al.* 2015). The entire Québec coastline from James Bay to the Southern Hudson Bay/Foxe Basin management unit boundary was surveyed and 0 or only a few Polar Bear were recorded in

2012 and 2016, respectively (Obbard *et al.* 2015, 2018). Most bears recorded in 2016 were along the coast near Wapusk, Akimiski Island, Belcher Islands, and offshore of Ungava Peninsula (Obbard *et al*. 2018).

Surveys suggest evidence of an increase in abundance from the 1960s to 1990s, and then stability in the 2000s. Coastal aerial survey data showed an increase in the number of bears from mid-1960s until the mid-1990s (Stirling *et al.* 2004). A re-analysis of physical mark-recapture data (1984–1986 and 1999–2005) found the abundance of Polar Bears in Southern Hudson Bay had not changed over that time period: 641 bears (95% CI: 401–881) in 1986 and 681 (95% CI: 401–961) in 2005 (Obbard *et al.* 2007). The survey results in the last generation length period suggest a 17% decline in estimated population size from 2011-2012 to 2016 but the confidence intervals overlap and a decline is not statistically significant (Table 3). Decreasing body size and condition, and lower yearling abundance (i.e., 12% of total population in 2011, versus 5% in 2016) suggest a declining population (Obbard *et al*. 2018). The low % yearling abundance suggests that recruitment rates are currently very low in this unit (Obbard *et al*. 2016). The 2018 total allowable harvest is 43 bears/year, but does not include removal by Québec or Ontario residents (Table 5).

Documented ATK from communities in this unit reported increased Polar Bear abundance since the 1960s along the coasts and near communities (COSEWIC 2008; Laforest *et al*. 2018; NMRWB 2018). Inuit hunters reported an increase in the number of bears between more recent times and historically; 50 years ago there were no bears on the offshore islands and bears were rare around Inukjuak, only appearing at the time of the study, 20 years ago (McDonald *et al.* 1997). Similarly, in Sanikiluaq, it was rare to kill a Polar Bear in the 1960s but by the 2000s the community's annual quota was filled in approximately 3 weeks, with increased observations of bears coming into the community (personal communication of Arragutainaq [2006], cited in COSEWIC 2008). In 1986, relatively high numbers of bears were observed near Twin Islands in James Bay during the ice-free season (Crête *et al.* 1991). Coastal Cree of western James Bay report increased aggressiveness among bears and an increase in litter size in a 20-year study (McDonald *et al.* 1997). Recent ATK indicates that the population in the James Bay and southern Hudson Bay region is still increasing (Laforest *et al*. 2018; NMRWB 2018).

A population trend based on generation length is possible only for the 2012 versus 2016 estimates because they are based on the same methodology. This half generation length difference was a decline of 17% but the confidence intervals overlap and the difference is not statistically significant. The PBTC (2018) lists historical trend as 'likely reduced', ATK assessment as 'stable' in the James Bay area and 'likely increased' in the east Hudson Bay area, recent scientific trend as 'likely declined', and future trend as 'likely decline', based on science, and 'uncertain', based on ATK (Table 4; NMRWB 2018). Indices for body condition are 'declining', 'stable' for reproduction trend, and 'increasing' for human-bear conflict (Table 4). In summary, the scientific knowledge indicates a possible decline, and ATK indicates increase or uncertainty.

Total Abundance

Although estimates exist, it is not possible to rigorously estimate the number of Polar Bears globally, or in Canada. The global and Canadian population size is unknown because of irregular surveys, large confidence intervals on surveys, and because many surveys are >10 years old, or have not been done. Global population estimates of 20,000 (IUCN/SSC Polar Bear Specialist Group 2010), 26,000 (Wiig *et al*. 2015), and 23,315 (range 15,973 - 31,212) (Hamilton and Derocher 2018) have been made but these authors do not support use of these estimates for population assessment. The problem is well known and improvements in survey frequency, consistency, and completeness are required (Hamilton and Derocher 2018). The global estimate in Wiig *et al*. (2015) was based on separate surveys in 19 subpopulations; however 7 of 19 surveys were conducted over a generation ago. A tally of only Canadian units in Wiig *et al.* (2015) results in an estimate of 15,641 (95% CI not possible due to missing data) but this value includes data from 7 of 13 units (approximately 43% of the total estimate) with surveys older than 1 generation. If valid, the Canadian population comprises approximately 60% of the global population. A similar tally of most recent estimates from this report results in 16,209 bears (95% CI not available) but, again 6 of 13 units (36% of the total) have data older than 1 generation. Approximately 30% of the Canadian range, mainly in the central coast and central Arctic islands region, has not been surveyed for at least 17 years (Table 3, Figure 1). As well, the estimate would likely be an overestimate because four management units include an unknown number of animals from outside Canada; the estimates for three management units (Kane Basin [n=357], Baffin Bay [2,826], Davis Strait [2,158]) include coastal bears occurring in western Greenland. The estimate for Southern Beaufort unit (900) includes Polar Bears from the north shore of Alaska. No surveys have been conducted in the Canadian portion of the Arctic Basin that includes part of the Canadian Archipelago (i.e., Polar Bear habitat off northern Ellesmere Island, northern Melville Island, northern Prince Patrick Island). Surveys have been conducted in the last few years for Southern Beaufort Sea, Viscount Melville, M’Clintock Channel, and Gulf of Boothia units but data have not been released. For the purposes of status assessment, this report derived a minimum estimate of 10,448 bears (of all ages) based on only using estimates from units with data collected in the last generation (Table 4).

Polar Bear population estimates have been reported as total bears and this typically includes all age classes, whereas the COSEWIC assessment only considers adult individuals. Determining the proportion for adults can be challenging as age classes used in surveys have shifted over time. In general, all surveys report the proportion of cubs (age 0) and the proportion of yearlings observed with the mother (age 1). However, some surveys combine yearlings with sub-adults (ages 1-4; Taylor *et al*. 2005). Sub-adult age class also varies among publications (ages 1-4; 2-5) leaving adult age class to also vary (ages 5-6 to senescence). Sub-adults should be included as “mature” individuals because they can be sexually mature and able to reproduce in some circumstances (e.g., during abundant resources for females and lack of competition for males) at earlier ages (5% of 4 yr-old females in 1970-1980s Western Hudson Bay unit [Ramsay and Stirling 1988[). Also, there may be bias in capture probability of the proportion of adults that contribute to the variation in the reported proportion; for example, from 38% (captured animals from 1968 - 1979 on the coast of SE Baffin Island; Stirling *et al*. 1980) to 78% (capture-mark-recapture of Davis Straight subpopulation; Peacock *et al*. 2013). However, the larger challenge is that for most publications the proportions of adults is not reported whereas the proportion of COY and yearlings is regularly reported. Where adult proportions are reported it is often difficult to determine if the proportion of adults being reported is for the entire observed bears or only the unencumbered bears (missing females with COY or yearlings). Because of the uncertainty and variability, this status report uses a mean value from two recent studies. Peacock *et al*. (2013) reports adults as 79%, 65%, and 67% over three consecutive years (2005, 2006, 2007) for Davis Strait, and Atkinson *et al*. (2012) reports 64% and 69% (2011 from 2 surveys routes) for Western Hudson Bay, for a combined average of 69% adult bears. The minimum estimate of 10,448 bears in Canada would equate to approximately 7209 adult bears. Including the bear population from the central Canadian range, which is approximately 30% of core range, would likely exceed 10,000 adult bears.

Fluctuations

There are few data to suggest that populations of Polar Bear fluctuate markedly. In the Beaufort Sea there have been observations that decadal-scale sea-ice conditions influence Ringed Seal production resulting in changes in Polar Bear reproduction (Stirling and Lunn 1997; Tynan and DeMaster 1997; Stirling 2002; Joint Secretariat 2015). Overall, it does not seem that Polar Bear populations undergo significant population change over large areas, but there are changes in local distribution that could be interpreted as local population change (Laforest *et al*. 2018; NMRWB 2018).

Summary of Population Trend over Last Three Generations

The Arctic Basin management unit is not considered in this status report because neither scientific research, nor ATK is available. Population trend based on science for the remaining 13 units cannot be determined because of incomplete or sporadic survey data, wide confidence intervals, and different interpretations of information from ATK and scientific methods.

ATK recognizes that Polar Bear abundance trends vary by management unit but generally people have observed increasing or stable trends across the Canadian Arctic (Table 4). Increasing numbers of bears have been observed in some management units during the ice-free season, suggesting changes in distribution and/or abundance (for example, Keith and Arqviq 2006; Lemelin *et al.* 2010b; Dowsley 2005; Kotierk 2010 Joint Secretariat 2015; York *et al.* 2015; York *et al.* 2016). Territorial and provincial harvest management, voluntary agreements with traditional stewardship practices, the *Agreement on the Conservation of Polar Bears* (1973) and the *Convention on International Trade in Endangered Species of Wildlife Flora and Fauna* contributed to the recovery of the management units by the 1980s that had been depleted by the 1940-1960s fur trade, and this is reflected in ATK (e.g., Hart and Amos 2004a; McDonald et al. 1997; Dowsley 2005).

Long-term scientific studies in the Southern Beaufort and Western Hudson Bay units have documented declines (>25%) in Polar Bear abundance over parts of the last 3 generations (35 years), but with periods of stabilization (Bromaghin *et al.* 2015; Lunn *et al.* 2016). Historically, there was trend of 'likely reduced' since 1973 for the Southern Hudson Bay, Western Hudson Bay, Kane Basin, Viscount Melville Sound, and M'Clintock Channel units (Table 4).

Based on scientific methods used in COSEWIC status assessments, as of 2018, declines of 50% have occurred over 3 generations for the Southern Beaufort unit (or, trend is unknown; see Southern Beaufort unit), and possibly by 17-18% in the Western Hudson Bay and Southern Hudson Bay units in the last ½ generation (Table 3). Indices of body condition and some demographic data suggest a decline is occurring in these two units. The Polar Bear Technical Committee (PBTC) concludes that these 2 units, and the Southern Beaufort unit, have 'likely declined' in the past 15 years, when applying a scientific assessment, and are 'likely reduced' in the Western Hudson Bay and Southern Hudson Bay units, and 'uncertain' for the Southern Beaufort unit, when applying a 'historical trend (i.e., since 1973). The proportion of these subpopulations to the Canadian population is unknown because the entire population has not been surveyed within a similar time period; assessing significance of trends within a single management unit requires a full survey in order to identify the proportion of each unit population as part of the national total. The PBTC similarly notes that the recent trend is 'uncertain' for 5 units (Table 4).

Other indices about the Canadian Polar Bear population provide additional evidence about status (Table 4). Declines in female body condition had been recorded in five management units: Southern Beaufort, Baffin Bay, Davis Strait, Western Hudson Bay, and Southern Hudson Bay. Declines in reproduction have been observed in four management units: Southern Beaufort, Baffin Bay, Davis Strait, and Western Hudson Bay. These indices are important because there is evidence that decreasing body condition preceded population decline (Obbard *et al*. 2018). Some ATK indicates that Polar Bear health indices fluctuate with annual sea-ice conditions (Species at Risk Committee 2012; Joint Secretariat 2015) and that indices change over time. There is increasing human-bear conflict in eight management units. Declines in sea-ice habitat have been observed in all Canadian Polar Bear management units (Table 2).

The 2008 COSEWIC report estimated that approximately 28% of the population (4 management units; Western Hudson Bay, Southern Beaufort, Baffin Bay, and Kane Basin) had declined. A percentage of the population could be calculated then because all 13 units had abundance data available within 1 generation of the 2008 status report, compared to only 6 of 13 units having data available in this report. Based on science, the Southern Beaufort unit population continues to decline and concern remains about populations in the Western Hudson Bay and Southern Hudson Bay (Table 4). A trend based on generation length is not possible for the Kane Basin and Baffin Bay units because of inconsistent methodology, but ATK indicates that the population is likely stable or has increased (Table 4).

In summary, based on scientific methods using estimates and indices comparing trend over 1-3 generations, as is done in COSEWIC status reports, it is not possible to state population trend for the Canadian population. Within the population, declines in 1 management unit likely have occurred, and possibly occurred in 2 more units. These 3 units are well studied, frequently surveyed, and occur in the southern range; they likely are representative of areas where climate change may be negatively affecting the suitability of the habitat, rather than the majority of the population range. Trend cannot be rigorously assessed for the other units and some have indices suggesting decline while others suggest a healthy population. Based on ATK, some areas are recognized as having limited data and trends are uncertain, but the overall consensus from ATK is that the population is stable or increasing.

Projected Trend

The IUCN listed Polar Bear as Vulnerable, based mainly on a projection of future sea-ice loss. This model (Wiig *et al*. 2015) and the IUCN Supplemental Material (IUCN 2015), was based on available data until 2014, and predicted a significant global decline in Polar Bear within three generations. The model is discussed at length here because it is widely cited but only partially supported in this status report. Their analysis estimated generation length (11.5 years) and then predicted future population decline over three generations (to approximately 2050) based on assumed and estimated relationships between bear abundance and sea-ice concentration. The relationship between population trend and sea-ice concentration is not well known and the authors used three approaches. Approach 1 assumed a one-to-one proportional relationship between the sea-ice metric (*ice*) and Polar Bear abundance (N) for each subpopulation. For example, a 10% decline in ice would equate to a 10% decline in N. Approach 2 used the same linear relationship but then used it as a function of predicted global scale sea-ice conditions, and based it on a reduced dataset of management units for which there were two survey periods. This approach assumes that Polar Bears exhibit broadly similar ecological and numerical responses to changing sea-ice conditions throughout their range. Approach 3 estimated a separate ice-N relationship for each Polar Bear ice-type ecoregion using a dataset that was similar to approach 2 but included longer time series of N available for four units (i.e., NBS, SBS, WHB, SHB) (Sea-ice Habitat section; Figure 3). Approaches 2 and 3 were expected to produce a wide range of probabilities; they are characterized by large uncertainty because of sparse data and large sampling error in abundance estimates for most subpopulations. Results were summarized for 6 variations (the mean-, and 95th percentile-generation length, for each of Approaches 1-3) for the projected decline to 2050, and the probability of a decline relative to the thresholds for categories under criterion A3 of the IUCN Red List (i.e., >0%, 30%, 50%, and 80% declines) (IUCN 2014). Under the scenario of a direct relationship of sea-ice decline to bear population (Approach 1), the median % population decline was 30% (C.I. = -35%, -25%), with a 56% probability of decline >30%. Under the scenario of a reduced data set and a global ice model (Approach 2), the median decline was 4% (-62%, +50%) with a 20% probability of decline >30%. Under the scenario of regional sea-ice ecoregions (Approach 3), the median decline was 43% (-76%, -20%) with an 86% probability of decline >30%.

The application of these results to this status report is somewhat uncertain because the relationship of bear populations to sea-ice change has not been numerically quantified. In the Wiig *et al*. (2015) analyses, the latter uncertainty was partially addressed by using three scenarios but the baseline relationship exists in all scenarios. Results from Approach 2 were limited by a lack of sensitivity to different spatial patterns in habitat use. Results from Approach 3 were limited by the overweighting of SBS, NBS, SHB, and WHB management units. The IUCN document used a median value from the six scenarios to address the uncertainty of any one scenario; the median probability of a reduction in the mean global population size >30% was approximately 71% (range 20-95%). The median probability of a reduction >50% was approximately 0.07% (range 0-35%), and the probability of a reduction greater than 80% was negligible (IUCN 2015).

Other models have suggested a decline is likely. Amstrup *et al*. (2007) used a deterministic model on sea-ice and carrying capacity of Polar Bear to predict a 10-22% reduction in global carrying capacity after 45 years, with greatest declines in the Divergent and Seasonal ecoregions. Later analyses found that by 2050, the global population could be reduced by 66%, with extirpation or severe depletion of Polar Bear from the Baffin Bay, Davis Strait, Foxe Basin, Western Hudson Bay, Southern Hudson Bay, and Southern Beaufort Sea management units (Amstrup *et al.* 2008). Schliebe *et al*. (2008) predicted a >30% population reduction within 45 years based on predicted declines in area of occupancy, extent of occurrence, and habitat quality. Atwood *et al*. (2016) suggested that Polar Bear could significantly decline in the Divergent ecoregion by 2030 and in the Seasonal and Convergent ecoregions by 2055, with less change in the Archipelago ecoregion. A survey by O'Neill *et al*. (2008) recorded that half of the respondents expected a >30% decline in the global population by 2050.

In summary, there is general support in scientific literature, and some ATK, that a decline in sea-ice will decrease Polar Bear populations but there is uncertainty in quantifying the projected decline in Polar Bear populations associated with decreasing sea-ice. There also is some ATK stating that Polar Bear will adapt to sea-ice loss (**Physiology and Adaptability**, **Threats** sections).

Rescue Effect

There is potential for Polar Bear to move into Canada if there is connectivity provided by sea-ice for part of the year with adjacent populations in the USA, Russia, Greenland, and Norway (e.g., Durner and Amstrup 1995; Johnson *et al.* 2017). In the long term, within the context of climate change and sea-ice loss, it has been proposed that the Canadian Archipelago may serve as a refuge where some summer sea-ice remains and the annual ice season is of sufficient duration to support Polar Bear (Peacock *et al.* 2015). There is significant movement of Polar Bear between Canada and U.S.A. as well as between Canada and Greenland within the shared management units and there may be evidence of gene flow from south to north (Peacock *et al.* 2011, but see Malenfant *et al*. 2016b). There has been no research investigating Polar Bear management units as sources or sinks. It is possible that past hunting pressure in Greenland created sinks in Kane Basin and Baffin Bay until quotas were imposed.

THREATS AND LIMITING FACTORS

Limiting Factors

Predation by non-humans on adult Polar Bear is unlikely (**Interspecific Interactions** section) and therefore the main limiting factor would be the availability of food, which is mainly comprised of several species of seal (**Physiology and Adaptation** section). However, changes in prey availability is considered a threat and not a limiting factor because human-caused climate change will impact seal populations (Reduced Prey – **Threats** section).

Threats

ATK and scientific knowledge are in agreement on the primary threats to Polar Bear in Canada, although there are diverse views on the threat level and ultimate impacts, such as whether bears can adapt to sea-ice habitat loss by eating more terrestrial prey (Canadian Wildlife Service 2009; Kotierk 2010; Slavik 2013; Joint Secretariat 2015, 2017; Species at Risk Committee 2012; York *et al.* 2016; **Habitat Trends** section). The primary threats to the Polar Bear population in Canada are climate change causing sea-ice habitat loss, and lower impact threats from human-caused mortality (overhunting and defence kills), contaminants, displacement or disturbance by increasing industrial development (mining, oil/gas exploration) and recreation, and ship traffic (cargo and cruise) (Stirling and Derocher 1993; Tonge and Pulfer 2011; Vongraven *et al.* 2012; Patyk *et al.* 2015; Wiig *et al.* 2015). An assessment in 2015 was made for four units contained in the Inuvialuit Settlement Region for the next 10 years, with a high/medium concern listed for climate change in the Southern Beaufort unit, and medium concern for pollution across all four units; most threats were considered to be ‘low’ for the Northern Beaufort, Viscount Melville, and Arctic Basin units (Joint Secretariat 2017; Table 6). There has been no assessment of the cumulative effects of threats to the Polar Bear population.

Table 6. Summary of level of concern for threats associated with four management units in the Inuvialuit Settlement Region, for a 10-year period, beginning in 2015. Summary is based on input from numerous wildlife management councils, and territorial and federal jurisdictions (Source: Joint Secretariat 2017).

Threat	Southern Beaufort	Northern Beaufort	Viscount Melville	Arctic Basin
Climate change (warming and ice reduction)	High/Medium	Low	Low	Low
Increased shipping (includes oil and gas development, tourism, commercial shipping)	Medium/Low	Low	Low	Low
Human-caused mortality in excess of total allowable harvest	Low	Low	Low	Low
Pollution and contamination	Medium	Medium	Medium	Medium

Threat	Southern Beaufort	Northern Beaufort	Viscount Melville	Arctic Basin
Research impacts	Medium/Low	Low	Low	Low
Disease and parasites	Medium	Low	Low	Low
Competition	Low	Low	Low	Low

In its assessment of anticipated future trend (present to 10 years in the future), the Polar Bear Technical Committee listed 2 units as 'likely decline', 2 units as 'uncertain/likely decline', 6 units as 'uncertain', and 3 units as 'likely stable' (PBTC 2018). PBTC does not assess the Arctic Basin unit. A threats calculator exercise was conducted and concluded an overall threat risk of High-High, mainly due to the concerns over the impacts of changing sea-ice habitat. The exercise included a large group of >50 experts from diverse backgrounds, who concluded that declining sea-ice would likely affect 71-100% of the Polar Bear in Canada, and this would have Serious (i.e., 31-70%) effects on the population. The threats are presented in categories derived from the Threats Calculator exercise. Some impact threats were categorized as low or negligible impact threat based on existing information; future investigations may establish that these are more serious threats. Concerns over changes in marine coastal ice conditions and their impact on bears have been associated with outflow volumes from hydroelectric dams in northern Quebec (Laforest *et al*. 2018, NMRWB 2018) but this threat is limited to a small part of Canadian Polar Bear range.

High Impact Threat Categories

Climate Change - IUCN 11.1 Habitat Shifting and Alteration

Climate Change Causing Sea-ice Habitat Loss

Sea-ice habitat loss is the main threat to the Canadian and global Polar Bear population. The future amount of sea-ice cover is discussed in the **Sea-ice Trends** section. Global greenhouse gas emissions are causing increases in atmospheric temperature (Tynan and DeMaster 1997; Derocher *et al.* 2004; Laidre *et al.* 2008; Kovacs *et al.* 2010; IPCC 2013) and projections indicate that the Arctic will be ice free in summer by 2060, and possibly by 2040 (**Habitat Trends** section). Because greenhouse gas emissions continue to increase it is expected that sea-ice habitat will continue to decline (Stern and Laidre 2016; Wiig *et al.* 2015; Figure 4) and there will be virtually no usable marine habitat for Polar Bear in their southern range because the ice season is too short, and bears will be relegated to the Arctic Archipelago and western Greenland (Amstrup *et al.* 2008; Durner *et al.* 2009; Castro de la Guardia *et al.* 2013; Hamilton *et al.* 2014; **Threats** section).

Loss of sea-ice habitat has already affected ice-dependent species (e.g., Ringed Seal) but the magnitude of effects on Polar Bear body condition, reproduction, abundance, and distribution varies by region (Dowsley 2005; Keith 2005; Laidre *et al.* 2008; Gilg *et al.* 2012; Stirling and Derocher 2012; Rode *et al.* 2014; Crawford *et al.* 2015; Harwood *et al.* 2015; Obbard *et al.* 2016). Sea-ice loss was not the only factor explaining Polar Bear short-term population demographics in the Southern Beaufort unit; other factors, such as disease and competition also are influences (Bromaghin *et al.* 2015).

Sea-ice habitat loss can negatively affect Polar Bear body condition, adult and cub survival, reproduction, prey species distribution and abundance, and causes habitat fragmentation. Negative effects have been observed in the management units of Western Hudson Bay, Southern Hudson Bay, Baffin Bay, Davis Strait, and the Southern Beaufort Sea (see **Habitat Trends**, and **Population Size and Trends** sections). A decline of 30% in the global Polar Bear population is predicted by 2050, although there is some uncertainty about this model (**Projected Trends** section). The following sections detail the relationship of sea-ice to Polar Bear survival, productivity, and ecology.

Reduced Body Condition and Size

Body condition is calculated as an index of expected combined mass of fat and skeletal muscle relative to body length (e.g., Obbard *et al*. 2016). It is essential for Polar Bears to build up fat reserves to carry them through the ice-free season fasting period and for pregnant females to be of sufficient body condition for successful winter denning and lactation (Ramsay and Stirling 1988; Derocher *et al.* 1993a; Atkinson and Ramsay 1995; Derocher and Stirling 1995b; Atkinson *et al.* 1996; Polischuk *et al.* 2002). Polar Bear weight loss during the ice-free season varies by sex, age, and reproductive status (Pilfold *et al.* 2016a); median weight loss averaged about 1 kg/day during the ice-free season (Stirling and Derocher 2012; Pilfold *et al.* 2016a). Reduced foraging time and success due to sea-ice habitat loss contributes to declines in body condition, which in turn affects survivorship, reproduction and abundance (Stirling and Archibald 1977; Stirling and Øritsland 1995; Stirling *et al.* 1999). Polar Bears heavily use sea-ice for foraging and the spring hyperphagic (excessive food consumption) period is particularly important for increasing and maintaining body condition (Molnár *et al.* 2010,2014; Pilfold *et al.* 2016a). Models have projected that if the duration of ice-free fasting season increased to 120 days (i.e., in a summer ice-free scenario), then about 2-3% of adult males would die of starvation, with about 9-21% dying at 180, and at 210 days, 29-48% of adult males would die (Molnár *et al*. 2010, 2014). Subadults were thought to be more vulnerable to prolonged fasting with 56-63% dying of starvation with a fasting period of 180 days (Pilfold *et al.* 2016a).

Declines in Polar Bear body condition and body size have been observed in the Southern Beaufort Sea (Stirling *et al.* 1999; Regehr *et al.* 2007; Regehr *et al.* 2010; Rode *et al.* 2014), M'Clintock Channel (Keith and Arqviq, 2006; Canadian Wildlife Service 2009), Foxe Basin (McDonald *et al.* 1997), Western Hudson Bay (Stirling *et al.* 1999; Sciullo *et al.* 2016), Southern Hudson Bay (Obbard *et al.* 2016; Rode *et al.* 2012), Baffin Bay (Dowsley and Wenzel 2008; Rode *et al.* 2012; SWG 2016), and Davis Strait (Rode *et al.* 2012). Timing of break-up, duration of ice-free season, and sea-ice concentration were factors associated with decline in body condition (e.g., Rode *et al.* 2014). Body condition trends of adults, cubs, males, and females within management units varied. ATK from the Southern Beaufort unit indicate body condition has remained stable over time (Species at Risk Committee 2012; Joint Secretariat 2017). In the Chukchi Sea (the management unit adjacent to the Southern Beaufort unit), an area largely over the continental shelf with high ocean biological productivity and prey abundance, the declines in sea-ice have not affected body condition and size of Polar Bears (Rode *et al.* 2014).

ATK presents a varied message on the impacts of sea-ice loss on Polar Bears (**Physiology and Adaptability** section), and it is recognized that the issue is complex (Joint Secretariat 2015); however, recent consensus is that, “For the Inuvialuit, the future cannot be predicted; it could be good or bad as far as Polar Bears are concerned. However, the consensus among workshop participants was that Polar Bears are highly intelligent animals that can adapt to climate change because they have been adapting to many things for thousands of years” (Joint Secretariat 2015, p.196). Traditional knowledge holders in the Beaufort Sea units confirm that sea-ice is changing but note that ice conditions have always been highly variable (Joint Secretariat 2015).

Reduced Reproduction

The loss of snow for denning is considered to be a significant threat (J. Oovaut, pers. comm. 2018) but data on population effects are limited and most concern at present relates to fecundity. Females in better body condition have been shown to have larger litters and heavier cubs (Derocher and Stirling 1994; Molnár *et al.* 2011; Joint Secretariat 2015). Mating and the litter size of Polar Bear can be affected by changes in sea-ice condition. Searching success or encounter rate by males for females could be reduced as sea-ice declines and this would affect mating probability (Derocher and Stirling 1995b). In Western Hudson Bay, an energy budget model was used to predict that litter size will decline as spring sea-ice break-up occurs earlier, for example, if spring break-up occurs 1 month earlier than during the 1990s, 40–79% of females might not reproduce (Molnár *et al.* 2011). The Western Hudson Bay unit has lower mean litter size than the adjacent Foxe Basin and Southern Hudson Bay management units (Stapleton *et al.* 2014; Dyck *et al.* 2017). Triplets were more common in the past; the last triplet litter handled by the ECCC Polar Bear program in Western Hudson Bay was in 1996 (N.J. Lunn, pers. comm.). The observed lower reproductive rates of Polar Bear in Davis Strait were likely a result of sea-ice habitat changes and/or Polar Bear density (Rode *et al.* 2012; Peacock *et al.* 2013). Reduced litter size mass was related to sea-ice habitat availability in the Southern Beaufort Sea (Rode *et al.* 2010a).

Adult and Cub Survival

Observations of declining survival in some management units over the past decade have been attributed to the effects of deteriorating sea-ice habitat (Regehr *et al.* 2007; Bromaghin *et al.* 2015). Although juvenile, subadult, and senescent bears are probably most vulnerable to habitat-mediated changes in food availability (Regehr *et al.* 2007), recent studies have found the survival of adult male and female Polar Bear also declined during a period of unfavourable sea-ice conditions or low prey abundance in the Southern Beaufort Sea (Regehr *et al.* 2010; Bromaghin *et al.* 2015). In the Western Hudson Bay management unit, short periods of improvement or stability in sea-ice resulted in improved survival (Lunn *et al.* 2016).

There is some variation in survival rates related to sea-ice. In Western Hudson Bay the survival rate for female bears of all age classes was correlated with sea-ice break-up and freeze-up (Lunn *et al.* 2016), but the same did not hold for males. Regehr *et al.* (2007) in the same management unit found a decline in the survival of juvenile, subadult, and senescent adult bears. In Davis Strait, Polar Bear survival varied with time and geography, and was related to factors that included changes in sea-ice habitat and prey abundance, such as increases of Harp Seal numbers (Peacock *et al.* 2013). In Southern Hudson Bay, survival rates in all age and sex categories have declined (Obbard *et al.* 2007). In Southern Beaufort unit, Polar Bear survival declined with increasing ice-free days (Hunter *et al.* 2010; Rode *et al.* 2010a). In Baffin Bay, cub and adult survival declined with earlier spring sea-ice break-up (Peacock *et al.* 2012; SWG 2016).

Reduced Prey Availability - Species Distribution and Abundance

The primary prey of Polar Bear in many areas is the Ringed Seal, a species that is dependent on sea-ice for reproduction (Stirling and McEwan 1975; Iverson *et al.* 2006; Thiemann *et al.* 2008b). The distribution, abundance, and body condition of Ringed Seal and other ice-dependent sea mammals will be affected by sea-ice loss, and changes in precipitation and ocean productivity (Tynan and DeMaster 1997; Kelly 2001; Smith and Harwood 2001; Ferguson *et al.* 2005; Stirling 2005; Laidre *et al.* 2008; Iacozza and Ferguson 2014; Harwood *et al.* 2015; Stirling and Derocher 2012; Joint Secretariat 2015), which in turn will affect Polar Bear foraging success (Slavik et al 2009; Derocher *et al.* 2004; Joint Secretariat 2015; York *et al.* 2016).

ATK notes that seals are important but the impact on Polar Bear is not obvious; for example, “Inuuvialuit people have noticed that seals are affected by climate change and have observed declines in seal numbers and body condition. The impacts of development and climate change on seals will be felt by polar bears. If polar bears cannot hunt seals due to changes in sea-ice, it will be difficult for polar bears to adapt to hunting different prey. However, many harvesters and elders believe that polar bears will adapt over time” (Species at Risk Committee 2012; p viii). Declines in Ringed Seal recruitment have been attributed to warmer temperatures and decreasing snow depth (Ferguson *et al*. 2005). ATK from residents of the eastern (Québec) shore of the Southern Hudson Bay unit believe their decline is due mainly to increased turbidity from hydroelectric activity (Laforest *et al*. 2018).

Ringed Seal were listed as Threatened under the U.S.A. *Endangered Species Act* in 2012 (NMFS 2012), and includes Canadian populations. Under the IUCN Red List, Ringed Seal are listed as Least Concern (IUCN Red List 2016). In Canada, COSEWIC designated Ringed Seal as Not at Risk in 1989 but they are presently being reviewed by the COSEWIC Marine Mammal Subcommittee.

Sea-ice systems that were historically dominated by multi-year ice are being lost as the total fraction of seasonal/annual sea-ice increases. The ecological ramifications of this fundamental change are not well understood but it seems that initially there may be an increase in primary productivity and development of better ice habitat for Ringed Seal and other Polar Bear prey (Kingsley *et al.* 1985; Derocher *et al.* 2004; Arrigo *et al.* 2008; Barber *et al.* 2015). Bears appear to select for a mix of ice types and switching of multi-year ice to other types may assist bears (**Habitat** section). Thus, it is postulated (Derocher *et al.* 2004) that this change, at least until most summer ice of any type is gone, could benefit Polar Bears in management units with high proportions of multi-year ice, such as Norwegian Bay, M'Clintock Channel, and Lancaster Sound (Stirling and Derocher 2012). Caution has also been noted; the response by seals is not documented and, even if the hypothesis is correct, populations of Ringed Seal, a long-lived species (>35 years) may take many years to increase to stable populations that benefit bears if seal density is presently low in regions of multi-year ice (E. Richardson, pers. comm. 2018).

It has been hypothesized that terrestrial food sources are sufficient to maintain Polar Bear body condition (Dyck and Kebreab 2009; Gormezano and Rockwell 2015; Cardinal undated) but others (e.g., Rode *et al.* 2010b, 2015; Pilfold *et al.* 2016a) have noted that there is no evidence to support this hypothesis because most terrestrial food sources have insufficient caloric value (**Physiology and Adaptability** section).

Increasing Sea-Ice Fragmentation

Loss of sea-ice can disrupt the spatial and temporal continuity of Polar Bear habitat (Sahanatien and Derocher 2012). Loss of historically available multi-year sea-ice could disrupt the fidelity that Polar Bear have shown to the delineated management units of the archipelago (Schweinsburg and Lee 1982; Schweinsburg *et al.* 1982; Taylor *et al.* 2001). Earlier break-up can separate bears from the receding multi-year ice front and summer retreat habitat, and females from their traditional denning areas. Changes in sea-ice distribution in autumn or winter can delay bears returning to sea-ice (Derocher *et al.* 2004; Durner *et al.* 2011; Pagano *et al.* 2012; Stirling and Derocher 2012). Sea-ice fragmentation creates increased distance between the pack and landfast ice or land, contributing to more observations of energy-intensive long distance swimming (> 50 km) by Polar Bear that can cause mortality (Monnett and Gleason 2006; Molnar *et al.* 2007 Durner *et al.* 2011; Pagano *et al.* 2012; Pilfold *et al.* 2016b). Loss of spatial connectivity of sea-ice in spring may reduce mating opportunities (Molnar *et al.* 2007; Molnar *et al.* 2008) and reduce access to foraging areas. Seasonal range contraction in the Baffin Bay unit is believed to be associated with sea-ice loss (Laidre *et al*. 2018).

Low Impact Threat Categories

Hunting and Collecting Terrestrial Animals - IUCN 5.1

Hunting based on sustainable harvest rates are not considered a significant threat; a significant threat would occur if overharvest occurs, or if excessive harvest is not reported and accounted for in establishing harvest quotas (Taylor *et al.* 2002, 2005, 2006a, 2008a). The impact of overharvest is related to the bears' late age of maturity and low reproductive rate (**Biology** section). Some of the small management units found in Canada (e.g., Viscount Melville Sound, Norwegian Bay, Kane Basin) are vulnerable to over-harvest because bears have small home ranges and good habitat is limited (Taylor *et al.* 2002, 2008a). These situations can cause bears to be spatially concentrated and seemingly able to withstand high harvest rates until the population is greatly reduced. Modern hunting equipment (e.g., snowmobiles, ATV, motor boats, high powered rifles; GPS) makes finding and harvesting of bears more efficient (Atatahak and Banci 2001). Polar Bear living on land during the ice-free season can be particularly vulnerable to hunting in some regions where ice-free hunting is common. Changing sea-ice conditions are altering access to bears in some areas; in the Southern Beaufort unit, unsafe ice conditions have resulted in lower harvest (S. Carrière, pers. comm. 2018).

The impact threat is considered to be low because Canada has a regulated system of Polar Bear hunting that includes subsistence and guided sport hunting (Peacock *et al.* 2011). Removal rates are lower than maximum potential removal (Table 5). Hunting occurs in all provinces and territories where Polar Bear are found, except Manitoba. In most jurisdictions, except Ontario and parts of Québec (**Legal Protection and Status** section), a total allowable harvest or some form of harvest level is set for a management unit by wildlife management boards and recommended to the responsible federal, provincial, or territorial jurisdiction (Brower *et al.* 2002; Peacock *et al.* 2010; Table 5). There is a harvest quota for Nunavik Inuit of Québec in the Southern Hudson Bay unit but not in other units that Nunavik Inuit harvest bears in (Davis Strait, Foxe Basin). In both Québec and Ontario, Cree have a right to harvest that is protected under treaty rights, but not a harvest quota. Numerous factors influence harvest rates – price of gas, safety of the sea-ice, and possibly auction prices (e.g., Cooper 2015) but the total allowable harvest is managed by jurisdictions with the goal of ensuring long-term sustainability. The number of human-caused mortalities, which includes harvest, defence kills, mortalities due to research, and mortalities due to other human activity, ranged from 575 to 696 bears from 2012-2013 to 2016-2017 within Canadian units or those shared with other countries (PBTC status tables 2014-2018). This total does not include an unknown level of mortality in Ontario (part of Southern Hudson Bay unit), Manitoba (Western Hudson Bay unit), or Québec (part of Foxe Basin, Davis Strait, Southern Hudson Bay units).

In most management units, defence kills are taken out of the total allowable harvest but in some cases this mortality is additive. Across Canada there are increasing Polar Bear-human conflict incidents and kills made for defence of life and property each year, especially during the ice-free season when bears are on land (McDonald *et al.* 1997; Makivik Corporation 2001; Stirling and Parkinson 2006; Dowsley 2007; Dowsley and Wenzel 2008; Canadian Wildlife Service 2009; Nirlungayuk and Lee 2009; Towns *et al.* 2009; Henri 2010, 2012; Kotierk 2010; Lemelin *et al.* 2010b; Clark *et al.* 2012). Jurisdictions have made efforts to enhance reporting and data compilation of conflict incidents but further efforts are needed, as no summary of total Polar Bear-human conflict is currently available. Potential explanations for the apparent increase in conflict incidents vary according to location and include increasing length of time on land due to longer ice-free season, increased bear abundance, bears coming off the sea-ice in lower body condition, increasing human activity (e.g., growing communities, camps, tourism, mineral exploration and development, oil and gas industry, research activity) in Polar Bear habitat, and greater amounts of garbage and carcasses to attract bears (Stenhouse *et al.* 1988 Stirling *et al.* 1999; Derocher *et al.* 2004; Dyck 2006; Schliebe *et al.* 2008). Human-bear conflicts in Churchill (Manitoba) rose during a period of bear population decline (Towns *et al.* 2009). In the Western Hudson Bay unit, the harvest quota for the 2017-2018 and 2018-2019 hunting seasons were progressively increased to address human safety concerns. The setting of a social carrying capacity may be more common in the future if human-bear conflicts increase in other units.

Indigenous peoples and organizations have expressed concern about the impacts of immobilization drugs and handling on the health, behaviour, and survivorship of Polar Bear (Nirlungayuk and Lee 2009; Henri 2012; Joint Secretariat 2015; York *et al.* 2015; Joint Secretariat 2017; Laforest *et al.* 2018). Accidental deaths resulting from research activities are taken out of the total allowable harvest, though such incidences are rare (PBTC status tables).

Pollution - IUCN 9.0

As an apex predator that relies on a high-fat diet of marine origin, Polar Bear are exposed to high levels of pollutants including chlorinated, brominated, and fluorinated compounds, along with heavy metals that bioaccumulate in the marine food web (AMAP 2017). Most pollutants in Polar Bear are associated with long-range transport from industrialized areas. Pollution levels and the types of pollutants vary widely across space with some Polar Bear management units showing much higher levels (Norstrom *et al.* 1998; Letcher *et al*. 2010, 2018). Temporal patterns in pollutant levels also vary by management unit and pollutant type with some increasing and others decreasing over time (Dietz *et al.* 2006). A draft report has noted concentrations of mercury in some Polar Bear livers from the Canadian high Arctic and Beaufort Sea areas to be in the high exposure/health risk category (AMAP 2018). The effects of pollutants are diverse and include effects on sex steroids, thyroid levels, vitamins, growth and development, liver and renal histopathology, reproductive organs, central nervous system toxicity, bone density, immune system function, carcinogenicity, and reproductive performance (e.g., McKinney *et al.* 2010; Sonne 2010; Sonne *et al.* 2011; Dietz *et al.* 2015; Gabrielsen *et al.* 2015). The presence of pollutants has raised concerns that developing young will receive high levels of pollutants from nursing females (Polischuk *et al.* 2002; Bytingsvik *et al.* 2012; Jenssen *et al.* 2015). Concerns about synergistic effects of climate change and pollution have been raised (Jenssen *et al.* 2015).

Documented effects of pollutants have largely been at the individual level where correlative studies find relationships between a biological process (e.g., hormone level, bone density) and pollution level (Sonne 2010). Derocher *et al*. (2003) documented enough concentrations of PCB, DDT etc. in archived tissue samples from Svalbard to conclude that the toxins probably limit population growth that had been expected after hunting harvest ended. However, in general, it has been difficult to prove population declines caused by pollutants (Jenssen *et al.* 2015). The effect of oil spills is discussed in IUCN 3.0.

Negligible Impact Threat Categories:

Numerous threats identified in the threats calculator exercise were considered negligible and only those with greater importance or information are presented here. Others are noted in the threats calculator output (Appendix I).

Energy Production and Mining – IUCN 3.0

Since the mid-1960s, exploration for energy and minerals has led to new types of human activity in the Arctic. Oil or fuel spills from drilling activities, tanker accidents, and spills from freighter ships are known hazards to Polar Bear. Oil is toxic and potentially lethal to bears in even small amounts (Stirling *et al.* 1990; Hurst *et al.* 1991; Durner *et al.* 2000; Arctic Council 2009) and these studies indicate that the primary threats to Polar Bear relate to effective thermoregulation if their fur is oiled, ingestion of oil from grooming or eating contaminated prey that can cause organ failure, and negative impacts on prey. There is considerable concern among northern residents about the impact of an oil spill on marine wildlife (Slavik 2009). Current infrastructure and capacity for dealing with oil or fuel spills are inadequate in the Canadian Arctic and there are no facilities for decontaminating wildlife if they are exposed to oil or fuel spills.

Significant oil and gas reserves exist in the Arctic Archipelago (Sverdrup Basin), Baffin Bay, and Beaufort Sea (Chen *et al.* 2004; Gautier *et al.* 2009). These reserves are found within the management units of Norwegian Bay, Davis Strait, Baffin Bay, Lancaster Sound, Viscount Melville Sound, and the Southern and Northern Beaufort Seas. It is not known when or if these reserves will be exploited due to the challenges of the drilling in the arctic environment and the vast distances from markets but companies remain interested as they retain their leases and have proposed new seismic testing. In the Davis Strait unit, increased exploration, seismic activity and development have occurred off the coast of Labrador (CNLOPB 2018).

Mines are operating and being developed across the range of Polar Bears in the Northwest Territories, Nunavut, Québec and Labrador. Mineral exploration has been intense across the Arctic and many deposits have been identified. Construction of mines and associated infrastructure have the potential to displace Polar Bear from terrestrial ice-free season refuge and denning habitat (Amstrup 1993; Linnell *et al.* 2000; Atatahak and Banci 2001; Keith 2005; Dyck and Baydack 2004; Slavik 2010, 2013), as well as marine habitat if year-round shipping occurs in association with mining operations.

Shipping Lanes – IUCN 4.3

New ports and year-round shipping requiring ice-breaking have been proposed which has created concerns about displacing Polar Bear from marine foraging habitat, and potential effects on prey species (Ringed and Bearded Seal) (Blix and Lentfer 1992; Slavik 2010, 2010, 2013; Canadian Wildlife Service 2009). Container ship traffic may increase as the Northwest Passage becomes seasonally ice-free. Arctic shipping routes through the Northwest Passage are predicted to open by mid-century (Smith and Stephenson 2013).

Recreational Activities – IUCN 6.1

Polar Bear are a species of great interest to tourists. There is concern that Polar Bear viewing displaces bears from terrestrial and sea-ice habitats and causes habituation that will create changes in behaviour leading to more conflict (Tetlichi *et al.* 2004; Nirlungayuk and Lee 2009). Polar Bear viewing tourism is most developed and intense at Churchill, Manitoba, with less intensive and smaller scale activities in Nunavut, Northwest Territories, Ontario, Québec, and Labrador. Little research has been done on the potential impacts of tourism on Polar Bear (Prestrud and Stirling 1994; Dyck and Baydack 2004; Lemelin 2006; Andersen and Aars 2008) but Rode *et al*. (2018) conducted surveys of managers, tour operators, community members, and scientists in order to establish the scope of the issue. The results suggest likely <10% of the population is exposed to most types of recreation. Cruise ship traffic is increasing but impacts on bears and prey species are not well understood. There is a growing interest in visiting dens, mainly in the Churchill region (e.g., Churchill Wild 2018).

Unknown Impact Threat Categories

Invasive and other Problematic Species and Genes - IUCN 8.0

There is evidence that novel pathogens are entering the Arctic system as the environment warms (Burek *et al*. 2008; Kutz *et al*. 2013). The impact on Polar Bear has not been established but there are concerns that existing pathogens will become a significant mortality factor, or reduce productivity of individual bears that are physiologically stressed (Patyk *et al*. 2015). Polar Bears have a relatively low immunity because they have evolved in a harsh environment that limits parasite richness (Weber *et al*. 2013); new pathogens may cause significant impacts. At present, the threat is considered to be unknown because the impact to populations is unknown. Also, it is not apparent which species are non-native and considered a threat (under IUCN 8.1 Invasive non-native species), or which species are native, and this would be labelled as a limiting factor and not part of the threats assessment. Native species that increase due to climate change would be considered a threat, such as Brown Bear, which are expanding from coastal areas onto sea-ice in the western region (Joint Secretariat 2015). Mortality events have been recorded (**Interspecific Interactions** section) but the extent of the threat is unknown.

Other Ecosystem Modifications – IUCN 7.3

Sea-ice change will likely alter predator prey dynamics for much of the Arctic, with possible increase in Orca abundance and a concurrent impact on seals, fish, but also scavenging opportunities on whales killed by Orca. The impact is not known.

Number of Locations

Habitat deterioration from sea-ice decline associated with human-induced climate change is the most common plausible threat to the population but there is considerable variation predicted in the severity and timing of change in ice conditions in the future over a very large (i.e., 5 million km^2) area (**Habitat Trends** section). Therefore, the number of locations is unknown, but considered to be numerous, and greater than the criterion threshold of 10 locations used in assessment.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

International

The *Agreement on the Conservation of Polar Bears* was signed by Canada, U.S.A., former Soviet Union, Norway, and Denmark/Greenland in November 1973 and came into effect in May 1976 (Larsen and Stirling 2009; Federal Register 2008).This agreement prohibits hunting of Polar Bear except by “local people” which is interpreted by Canada to mean Indigenous peoples and by transfer of exclusive rights to sport hunters guided by Indigenous peoples using dog-sled teams. The agreement also requires that each signatory conduct research relating to the conservation and management of the species, and to convey the results to each member nation on a biennial basis. The Canadian federal government signed the agreement on behalf of all provinces and territories. The ‘Range States’ continue to be committed to the agreement.

Polar Bear are listed under Appendix II of CITES. CITES is an international treaty aimed at protecting species from unregulated international trade. Under CITES, any international shipment, trade, or sale of Polar Bear or parts thereof requires a non-detrimental finding and permit. Since July 1975, a permanent record of all Polar Bear, hides, or any other products lawfully exported from or imported to Canada has been maintained by the Government of Canada.

In 2008, Polar Bear were listed as Threatened by the U.S.A. under its *Endangered Species Act* (Federal Register 2008). The assessment determined that Polar Bear habitat, principally sea-ice, was declining and would continue to decline and its loss would threaten the species. Norway classes Polar Bear as a Vulnerable species and follows closely the processes applied under the IUCN system (Kålås *et al.* 2010). Similarly, in Greenland, Polar Bear are listed as a Vulnerable species (Boertmann 2007). The Polar Bear is listed in the Red Data Book of the Russian Federation with status designations based on populations with three designations of Uncertain, Rare Taxa, and Recovering Taxa (Iliashenko and Iliashenko 2000).

Canada

In Canada, provincial and territorial governments have the authority for most management activities, but share decision making with Indigenous peoples as prescribed by the Canadian Constitution, Land Claims Agreements, and other agreements and processes. The federal government has management authority on federal lands, such as national parks and wildlife areas, and in offshore areas off the Québec coast within the Nunavik Marine Region and Eeyou Marine Region. The provinces and territories share management responsibility for 6 management units, and 5 management units have internationally shared responsibilities. Four management units are managed solely by Nunavut.

The first COSEWIC review in 1986 found Polar Bear to be Not at Risk. In 1991, Polar Bear was designated as a species of Special Concern by COSEWIC. This status was reviewed and confirmed in 1999, 2002, 2008, and 2018. Polar Bear were formally listed in 2011 as Special Concern under Schedule 1 of the Canadian *Species at Risk Act* (SC 2002). The *Species at Risk Act* requires that a federal management plan be developed for Schedule 1 species of Special Concern.

In the Yukon, Polar Bear are not listed as a species of concern but are protected by the *Yukon Wildlife Act* (RSY 2002; Inuvaliut Final Agreement 1984) such that only Inuvialuit may hunt Polar Bear within the Inuvialuit Settlement Region, which includes the Yukon Beaufort Sea coast where Polar Bear occur. The Inuvialuit Game Council is responsible for allocating the total allowable harvest of Polar Bear in the Yukon to beneficiaries of the *Inuvialuit Final Agreement* (1984). The Yukon contributed to the development of the *Inuvialuit Settlement Region Polar Bear Co-management Plan* (Joint Secretariat 2017). The Yukon territorial government works with the Inuvialuit Game Council as per the *Inuvialuit Final Agreement* (1984).

In the Northwest Territories, Polar Bear were listed in 2014 as a Species of Special Concern under the *Species at Risk (NWT) Act* (SNWT 2009) due to a combination of species biological characteristics and identified threats (Species at Risk Committee 2012). In 2017, the *Inuvialuit Settlement Region Polar Bear Co-Management Plan* (Joint Secretariat 2017) was approved. The plan describes the goals and objectives for Polar Bear conservation and management for the entire Inuvialuit Settlement Region, within both the NWT and Yukon. Territorial governments work with regional and local management bodies as per the *Inuvialuit Final Agreement* (1984) regarding total allowable harvest, tags, harvest reporting, and sample submission for Polar Bear harvesting and protection. The Wildlife Management Advisory Council (Northwest Territories) and Wildlife Management Advisory Council (North Slope) recommend the total allowable harvest to the minister, and the Inuvialuit Game Council allocates quotas to communities. Inuvialuit may allocate a portion of their quota for guided hunts by transferring their exclusive right to hunt Polar Bear.

In Nunavut, Polar Bear are not listed or designated under any territorial act. Polar Bear may only be hunted by Inuit or killed in defence of life or property (*Nunavut Wildlife Act* SN 2003). Inuit have exclusive rights to hunt Polar Bear and must abide by the total allowable harvest and season restrictions set by the Nunavut Wildlife Management Board and territorial government as per the *Nunavut Land Claims Agreement* (1993). Inuit may allocate part of their quota for sport hunting but sport hunters must be guided by Inuit. Female bears with cubs and females in dens may not be hunted but cubs may be taken for ceremonial purposes. The *Draft Nunavut Polar Bear Co-Management Plan* (2017) is under review with the Nunavut Wildlife Management Board. That plan describes the goals and objectives for Polar Bear conservation and management in Nunavut, and is complemented by an action framework.

In Manitoba, Polar Bear were listed in 2008 as Threatened under the *Endangered Species and Ecosystems Act* (RSM 1990). Polar Bear are listed as a protected species under the Manitoba *Wildlife Act* (RSM 1988). Polar Bear may not be hunted, trapped, killed, or captured, including by Indigenous People. Polar Bear may only be killed in defence of life or property. Additional protection is provided by *The Resource Tourism Operators Act* (Manitoba Government 2002) and *Polar Bear Protection Act* (SM 2002).

In Ontario, Polar Bear were listed in 2009 as Threatened under the *Ontario Endangered Species Act, 2007* (SO 2007). Ontario completed its Recovery Strategy for Polar Bear in 2011(Tonge and Pulfer 2011) and has produced a government response statement (December 2016) to indicate policy direction on managing the species. Polar Bear are also protected under the *Ontario Fish and Wildlife Conservation Act, 1997* (SO 1997), and there is no hunting or trapping season. First Nations hunters, who are Treaty 9 members, residing on the Hudson Bay and James Bay coasts may hunt Polar Bear and there is no set total allowed harvest. The number of bears harvested by Indigenous hunters is uncertain because harvest reporting is voluntary for Treaty 9 groups, and because Polar Bear skins may not be sold.

In Québec, the Polar Bear has been listed as ‘Vulnerable’ under Loi sur les espèces menacées ou vulnérables" since 2009 (RLRQ, c E-12.01) (LEMV) (CQLR, c E-12.01) and is afforded protection under the "Loi sur la conservation et la mise en valeur de la faune" (RLRQ, c. C- 61.1) (LCMVF) (CQLR, c. C-61.1) (Gouvernement du Québec, undated). In northern Québec, listed species are subject to the *Act Respecting Hunting and Fishing Rights in the James Bay and New Québec Territories* (SQ 1978). The *James Bay and Northern Québec Agreement* (1975) restricts taking of Polar Bears to Indigenous peoples and they are allocated a “guaranteed harvest level” of 62 bears/year (58 Inuit, 4 Cree); this is not a quota but rather the level of harvest by Indigenous peoples that can occur before any commercial activities are permitted. In 1984, an agreement between the Nunavik Hunting, Fishing and Trapping Association and Québec set out harvesting seasons, prohibition on harvest of cubs, females with cubs, and females in dens. Sport hunting is not permitted, only subsistence hunting is. Hides may be sold if tagged by the province but there is no mandatory reporting of Polar Bear harvest by Inuit or Cree. In November 2014, an agreement was reached between Nunavut, Québec, and Ontario, establishing a voluntary harvest limit for each jurisdiction within the Southern Hudson Bay management unit, as well as non-quota limitations for a period of 2 years. In October 2016, a total allowable harvest and non-quota limitations were established for the Southern Hudson Bay management unit within the Nunavik Marine Region, but legislation is not in place for implementation. For the shared Davis Strait management unit, a total annual allowable harvest of 116 Polar Bear allocated between Nunavut (61), Nunavik (35), and Nunatsiavut (20) was recommended but no decision occurred and there are no regulations to enforce the harvesting restrictions in Québec. For the shared Foxe Basin management unit the Nunavik total allowable harvest has not been set. The Nunavik Marine Region Wildlife Board and Eeyou Marine Region Wildlife Board are responsible for wildlife management in the offshore and decisions regarding Polar Bear management as per the *Nunavik Inuit Land Claims Agreement* (2008) and *Eeyou Marine Region Land Claims Agreement* (2010). Wildlife management in the onshore portions of Nunavik and Eeyou Istchee, including Polar Bear, is under the responsibility of The Hunting, Fishing, and Trapping Coordinating Committee established under the *James Bay and Northern Québec Agreement (1975).* The *Québec-Nunavik Marine Region-Eeyou Marine Region Polar Bear Management Plan* is expected to be finalized in 2019.

In Newfoundland and Labrador, Polar Bear were listed as Vulnerable in 2002 under the *Newfoundland and Labrador Endangered Species Act* (RSNL 2001). Polar Bear are protected under the Newfoundland and Labrador *Wild Life Act* (RSNL 1990) and Regulations and the *Labrador Inuit Land Claims Agreement* (2005). Labrador Inuit have exclusive rights to hunt Polar Bear in this province; the 2018 allocation is 12 animals. Bears may be killed in defence of life and property. Any defence kills that are reported can be used to fill a licence. The Torngat Wildlife and Plants Co-management Board in consultation with the Nunatsiavut Government establishes allowable harvest limits and makes recommendations on non-quota limitations for wildlife. In 2006, the *5-year Management Plan* (2006–2011) for the Polar Bear in Newfoundland and Labrador (Brazil and Goudie 2006) was completed with the objective of ensuring sustainable management of Polar Bear in Labrador belonging to the Davis Strait management unit. The Newfoundland and Labrador Government is now working with the Nunatsiavut Government, Parks Canada, Torngat Wildilfe and Plants Co-management Board, and Canadian Wildlife Service on an updated Polar Bear management plan, under the *Endangered Species Act*.

Non-Legal Status and Ranks

International Union for Conservation of Nature Red List

Polar Bears were listed as Vulnerable in 2015 under criterion A3c (Wiig *et al.* 2015) by the International Union for Conservation of Nature (IUCN) Red List process; http://www.iucnredlist.org/details/22823/0. This status ranking did not change from the 2006 assessment. Earlier assessments by the IUCN had Polar Bear listed as Lower Risk/Conservation dependent in 1996 but Vulnerable for the five previous assessments back to 1982. The pre-2006 assessments focused on the risks of population depletion associated with excess harvest, but from 2006 onward the justification for the Vulnerable listing was linked to the loss of Arctic sea-ice associated with climate change and the potential for large reductions in the global abundance of Polar Bear if sea-ice loss continues. The 2015 assessment also reported that the global Polar Bear population trend is unknown due to poor or outdated information for some management units.

Interjurisdictional Agreements

For all internationally shared management units, agreements have been developed to provide mechanisms and processes for collaborating on research, information collection and sharing, protection of females with cubs and denning females, management objectives, total allowable harvest, and allocation between users and jurisdictions. In 1988, the Inuvialuit of the ISR, Canada and Inupiat of Alaska signed a collaborative agreement, the *Inuvialuit-Inupiat Polar Bear Management Agreement in the Southern Beaufort Sea* (Brower *et al.* 2002) and this agreement was updated in 2001. In 2006, the Inuvialuit and Inuit of the Kitikmeot West Region, Nunavut signed the *Polar Bear Management Agreement for the North Beaufort Sea and Viscount Melville Sound Polar Bear Populations between the Inuit of the Kitikmeot West Region in Nunavut and the Inuvialuit*. In 2008, the *Memorandum of Understanding between Environment Canada and the United States Department of the Interior for the Conservation and Management of Shared Polar Bear Populations* was signed. In 2009, Greenland, Nunavut, and Canada signed a *Memorandum of Understanding for the Conservation and Management of Polar Bears of Kane Basin and Baffin Bay*.

National Polar Bear Conservation Strategy

The *National Polar Bear Conservation Strategy for Canada* was completed in 2011 (http://www.ec.gc.ca/nature/default.asp?Lang=En&n=60D0FDBD-1). The goals of the plan are to contribute to the long-term conservation of Polar Bear by taking into account the threats this species faces and increasing coordination between provincial and territorial jurisdictions on Polar Bear management.

Wildlife management boards establish harvest levels and non-quota limitations, although provincial, territorial, and federal governments have the ultimate responsibility for wildlife management.

The Polar Bear Administrative Committee (PBAC) is the national forum for provincial, territorial and federal jurisdictions, land claim organizations, and wildlife co-management boards, to work together on Polar Bear management and to ensure that Canada fulfills its obligations to the *Agreement on the Conservation of Polar Bears*. The PBAC role is to ensure national coordination and cooperation within and between jurisdictions. The second Canadian interjurisdictional forum is the Polar Bear Technical Committee (PBTC) at which harvest, population status, research, and management information is shared. The PBTC provides advice and reports to the PBAC. The PBTC members are comprised of scientific and technical representatives from all jurisdictions, land claim organizations, and wildlife co-management boards. The PBTC conducts an annual review and assessment of the abundance estimates, status, trends, threats, total allowable harvest limits, and total annual kill of each management unit. Scientific and traditional knowledge information is used in the PBTC assessments (Table 4).

Habitat Protection or Ownership

Polar Bear habitat in Canada has formal, legislated protection within approximately 180,000 km^2 of national, territorial, and provincial parks, wildlife management areas, national wildlife areas, and marine protected areas (see Appendix II for a list of protected areas; Figure 6). Hunting is permitted but these protected areas limit development and primarily conserve summer terrestrial retreat and winter denning habitat with some nearshore (fiords and bays) marine sea-ice habitat included in national park boundaries. There are two established and one proposed Arctic marine protected areas in Canada: Anguniaqvia Niqiqyuam (created in part to protect Polar Bear and seal habitat) and Tarium Niryutait, both in the Northwest Territories and the proposed Tallurutiup Imanga (Lancaster Sound) National Marine Conservation Area in Nunavut. Three protected areas were created specifically for Polar Bear conservation: Polar Bear Provincial Park in Ontario, Wapusk National Park in Manitoba, and Polar Bear Pass National Wildlife Area in Nunavut. Polar Bear habitat protection was a factor in the creation of other protected areas, e.g., Torngat Mountains National Park in Newfoundland and Labrador. The level of habitat protection varies with the protected areas establishment legislation, from complete (no industrial activities permitted) to partial protection (industrial activities permitted with conditions).

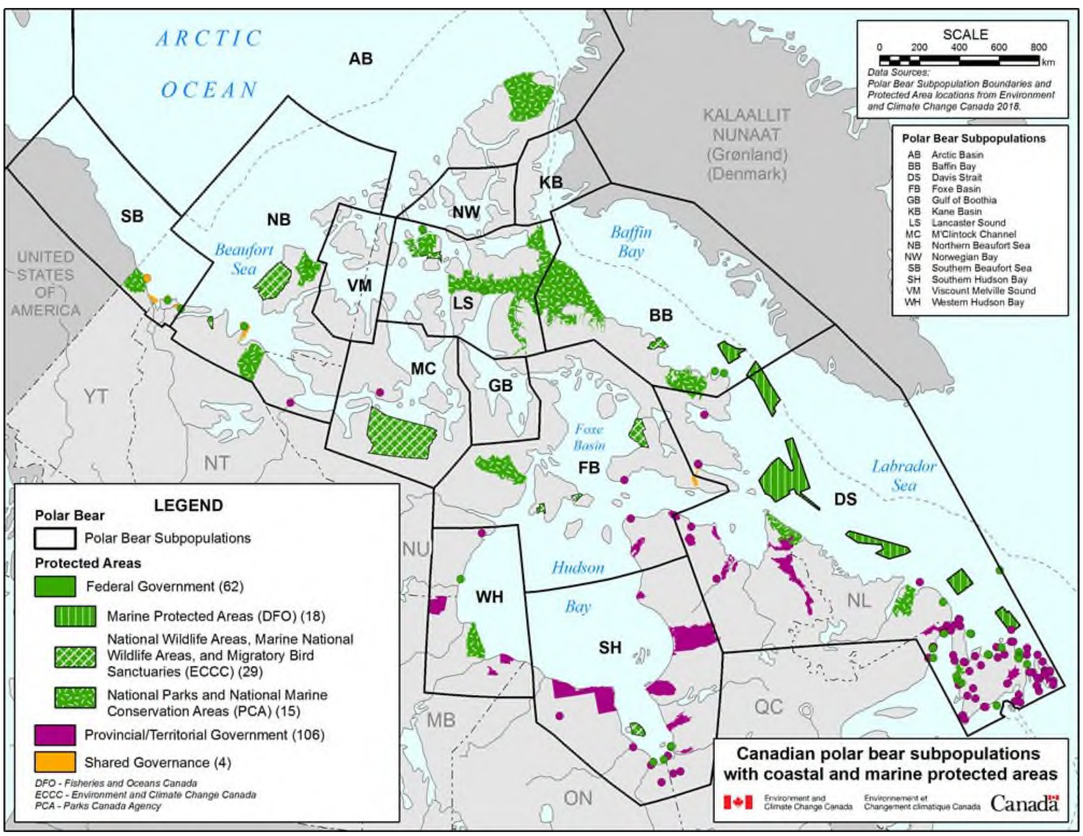

Figure 6. Location of lands protected from development within the Canadian subpopulations. The subpopulations are considered management units in the COSEWIC report.

The Federal Marine Protected Areas Strategy describes the federal approaches, legislation (*Oceans Act, Canada Wildlife Act, Canada National Marine Conservation Areas Act)*, and responsibilities for establishing marine protected areas that could benefit Polar Bear sea-ice habitat and prey.

In the Northwest Territories, the *Inuvialuit Settlement Region Polar Bear Joint Management Plan* recommended that key habitats (e.g., denning) be identified for future protection (Joint Secretariat 2017). The Yukon North Slope land withdrawal order (*Inuvialuit Final Agreement, 1984*) created a conservation area land use zone where wildlife habitat protection is of highest priority. Inuvialuit *Community Conservation Plans* identified and zoned important terrestrial and marine areas for Polar Bear habitat protection (e.g., terrestrial denning) and recommend protective measures to be considered during environmental assessment screening of proposed projects and activities (e.g., Community of Paulatuk *et al.* 2008; Community of Tuktoyaktuk *et al.* 2008).

The Draft Nunavut Land Use Plan (2016) recognized that Polar Bear denning areas are important coastal wildlife habitats. The draft plan has designated the known Polar Bear denning areas as Mixed Use and containing Valued Ecosystem Components that require “particular consideration” in regards to future activity proposals (Nunavut Planning Commission 2016). This is the only land use plan within the Canadian Polar Bear range that specifically addresses Polar Bear habitat.

Ontario recognizes that protection of Polar Bear terrestrial habitat outside Polar Bear Provincial Park is important and has committed to working with Ontario Coastal Cree Nations through community land use planning efforts and developing best management practices for future industrial development (e.g., mining) activities (Tonge and Pulfer 2011).

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No collections were examined.

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APPENDIX I. Threats calculator exercise for Polar Bear.

Species Scientific Name	*Ursus maritimus*		
Element ID		**Elcode**	
Date (Ctrl + ";" for today's date):	04/04/2018		
Assessor(s):	Graham Forbes, Dave Fraser, Vicki Sahanatien, Andrew Derocher, Gregory Thiemann, Chris Johnson, Tom Jung, Caryn Smith, Shelley Moores, Jessica Humber, Christina Davy, Ruben Boles, Mieke Hagestien, Shelley Pruss, Kyle Ritchie, Marcus Dyck, Mark Basterfield, Jody Maring, Marsha Branigan, Stephen Petersen, Scott Gilbert, Hugh Broders, Nicolas Lecomte, Jason Fisher, Jim Goudie, Steve Ferguson, Kim Parsons, Evan Richardson, Karyn Rode, Richard Elliott, René Malenfant, Gina Schalk, Lisa Twolan, Shelley Garland, Gregor Gilbert, Sybil Feinman, Lauren Schmuck, Veronique Brondex, Kristin Helias, Diana Ghikas, Ken Tuininga, Julie Nadeau, Peter Kydd, Melissa Gibbons, Darroch Whittaker, Rick Taylor, Marie-Claude Richer, John Pisapio, Sara McCarthy, Philip McLoughlin, John Cheechoo, Kendra Tagoona, Jennifer Lam, Chanda Turner, J Lucas, Rob Letcher, Karen Timm		
References:			
Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
	Threat Impact	**high range**	**low range**
	A Very High	0	0
	B High	1	1
	C Medium	0	0
	D Low	2	2
	Calculated Overall Threat Impact:	High	High
	Assigned Overall Threat Impact:		
	Impact Adjustment Reasons:		
	Overall Threat Comments	Generation Time 11.5 years (3 gens=34.5) EOO=8,700,000 km² (1% = 87000 km²)	

Threat			Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	
1.1	Housing & urban areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Polar Bear-human conflict increasing in coastal communities due to longer ice free season and attractants, and possibly increased abundance (see 9.4).
1.2	Commercial & industrial areas		Negligible	Negligible (<1%)	Extreme (71-100%)	Insignificant/Negligible (Past or no direct effect)	

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.3	Tourism & recreation areas					
2	Agriculture & aquaculture					
2.1	Annual & perennial non-timber crops					
2.2	Wood & pulp plantations					
2.3	Livestock farming & ranching					
2.4	Marine & freshwater aquaculture					
3	Energy production & mining	Negligible	Negligible (<1%)	Extreme (71-100%)	Low (Possibly in the long term, >10 yrs/3 gen)	
3.1	Oil & gas drilling	Negligible	Negligible (<1%)	Extreme (71-100%)	Low (Possibly in the long term, >10 yrs/3 gen)	Presently some oil and gas development underway in Alaska (Southern Beaufort unit), and a small number of Canadian bears are exposed to this outside of Canada's boundaries. In Greenland, oil and gas development is planned for Davis Strait and Baffin Bay, which have shared populations with Canada. In the Davis Strait unit, there is recent seismic exploration and licence activity off the northern Labrador shore (www.cnlopb.ca/sea/)
3.2	Mining & quarrying	Negligible	Negligible (<1%)	Extreme (71-100%)	Low (Possibly in the long term, >10 yrs/3 gen)	
3.3	Renewable energy					Wind, solar, tidal projects are not causing impacts at present.
4	Transportation & service corridors	Negligible	Small (1-10%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
4.1	Roads & railroads	Negligible	Negligible (<1%)	Negligible (<1%)	Low (Possibly in the long term, >10 yrs/3 gen)	
4.2	Utility & service lines	Negligible	Negligible (<1%)	Negligible (<1%)	Insignificant/Negligible (Past or no direct effect)	Possibly some small impacts from future developments in Western Hudson Bay unit, but probability and timing are uncertain.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.3	Shipping lanes		Negligible	Small (1-10%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Minimal impacts and severity expected as shipping would likely be in open water season. At current time, ice breakers are not in use to extend season, but may be in the future. Proposed year-round shipping from Baffinland mines is highly likely to go forward, and could affect bears in eastern Canadian Arctic.
4.4	Flight paths		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	Scheduled commercial flights may help keep bears away from communities.
5	Biological resource use	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Polar Bear harvest is managed in most management units by adhering to sustainable total allowable harvest allocations, specific to management units. Management objectives may be in place to increase, maintain, or reduce local populations, reflecting current population status and community tolerance. Includes poaching and removal of problem bears.
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources						Commercial fishing may impact Ringed Seal population; harvesting of Ringed Seal may impact Polar Bear primary prey abundance.
6	Human intrusions & disturbance		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Polar Bear viewing is an increasing tourism industry throughout range on land and at sea (using ice breaking cruise ships). Helicopter tourism, primarily in Manitoba, but also in Nunavut, could impact Polar Bear on a local scale. Establishment of additional marine and terrestrial protected areas will cause increased human activity with potential for disturbance. Increases in tourism near dens and using cruise ships in and near Parks were considered. Impacts of recreational activities may be higher at a local level, but population-level impacts may not result.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.2	War, civil unrest & military exercises		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	DND has 2-4 annual exercises on land and on sea-ice.
6.3	Work & other activities		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	Ongoing mineral exploration and potential future oil and gas exploration and development activities were discussed. Frequency of exploration anticipated to increase and likely impact more bears during the 10-year period. Impacts from Polar Bear research were also considered.
7	Natural system modifications		Unknown	Small (1-10%)	Unknown	High (Continuing)	
7.1	Fire & fire suppression		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	Local fires in Western Hudson Bay and Southern Hudson Bay units can potentially impact denning habitat, but no population level impacts anticipated, as denning habitat is not limited. In general, no fire suppression occurs in that area.
7.2	Dams & water management/use		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	Low (Possibly in the long term, >10 yrs/3 gen)	Hydro development projects considered in long-range plans in Labrador may affect winter ice dynamics.
7.3	Other ecosystem modifications		Unknown	Small (1-10%)	Unknown	High (Continuing)	Change in prey dynamics and prey capture rates expected with sea-ice change. Changes in seal abundance may result from impacts of commercial fisheries. Ecosystem changes may result from changing fresh water inputs from Hudson Bay dams, with good evidence of changing water flows (impacts of water diversion) affecting freeze-up in Churchill system. Changes in ecosystem due to fresh water inputs from Hudson Bay dams. If Killer Whale (top predator) range extension creates feeding on same prey (seals), this could present an ecosystem modification of a population level effect. However, Bowhead Whale carcasses from Killer Whale predation could provide a food source to bears (benefit). Potential impacts of Killer Whales on seal prey were discussed, but impacts unknown (although likely negative).
8	Invasive & other problematic species & genes		Unknown	Pervasive - Large (31-100%)	Unknown	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.1	Invasive non-native/alien species/diseases		Unknown	Unknown	Unknown	High (Continuing)	Concern of novel pathogens entering system (likely due to warming climate bringing parasites northward in vertebrate vectors) that may impact bears. At present data on population response by bears is inadequate.
8.2	Problematic native species/diseases		Unknown	Pervasive - Large (31-100%)	Unknown	High (Continuing)	Issues that may result from expanding range of Killer Whale discussed in 7.3. Disease expansion, includes toxoplasmosis, brucellosis and other unicellular parasites. Few relevant data exists, but many diseases increasing in the Arctic, especially with new vectors. Distemper and other viruses expanding as well. Some mortality events have been recorded between Polar Bear and Brown Bear that are expanding their range northward.
8.3	Introduced genetic material		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Hybridization in western Canadian Arctic with Brown Bear discussed, and is unlikely to cause impacts at population level. To this point, hybrids have backcrossed with Brown Bear, so offspring are not included in the Polar Bear population. There is evidence that 2-3 Brown Bear per year are now denning in Wapusk National Park (Western Hudson Bay unit).
8.4	Problematic species/diseases of unknown origin		Unknown	Unknown	Unknown	Unknown	
8.5	Viral/prion-induced diseases		Unknown	Unknown	Unknown	Unknown	
8.6	Diseases of unknown cause		Unknown	Unknown	Unknown	Unknown	Alopecia (hair loss) seems to be on the rise in Southern Beaufort unit; however, causes are unknown.
9	Pollution	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
9.1	Domestic & urban waste water		Negligible	Negligible (<1%)	Unknown	High (Continuing)	Impacts and spread of toxoplasmosis in urban waste water considered in 8.2. Little information available on potential local sources of contamination (including persistent pollutants) in wastewater.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.2	Industrial & military effluents		Unknown	Small (1-10%)	Unknown	High (Continuing)	Long-range transport of pollutants through air when chemicals volatilize, movement through water was considered as well. PCBs and radioactive material can have a wide regional impact, especially in marine systems. Radioactive materials at Thule were discussed.
9.3	Agricultural & forestry effluents		Negligible	Negligible (<1%)	Unknown	High (Continuing)	
9.4	Garbage & solid waste		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Garbage and solid waste near communities and outpost camps contributes to an ongoing attractant issue that causes human-bear conflict, but burning garbage at community landfills now illegal in NWT. Cases of known Polar Bear mortality associated with scavenging at dumps recorded at Churchill. Issues of leachate discussed but impacts on a large scale unknown, though likely to be small.
9.5	Air-borne pollutants	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Atmospheric transport of pollutants and pesticides was considered. Mercury contamination an issue as well. Routine burning at community dump sites is another source of air-borne pollutants.
9.6	Excess energy						
10	Geological events		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Increasing incidence of slumping of permafrost and coastal erosion events are increasing and could can affect bears using coastlines, especially for denning.
11	Climate change & severe weather	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.1	Habitat shifting & alteration	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	NOTE: This section primarily considers changes in extent and duration of sea-ice foraging and wintering habitat in relation to changing climates, and denning on sea-ice. The scores reflect information in status report, teleconference discussions, modelling predictions, as well as literature on body condition, productivity, survival, etc. related to sea-ice. Assumptions used in various models results in ranges of uncertainty in their predictions of actual population level response. There was agreement that significant negative effects of climate change on sea-ice are expected, although there is unlikely to be a linear relationship between population levels and sea-ice, with a range of consequences and impacts. The recent model by IUCN (Wiig *et al.* 2015) was discussed, which presents three approaches to analyze relationships between Polar Bear demography and the extent/duration of sea-ice cover. As the best long-term data sets for the global model come from Canadian management units, the global IUCN conclusions are broadly representative of the Canadian situation, although Canada has a wide range of sea conditions. However, the units in Canada with the most data are also the most southerly ones, which are units likely to be impacted to the greatest extent by sea-ice change. Note that over a 30-year window, some areas may have a period of improved habitat (with better access to prey), though this is debated because Ringed Seal are long-lived species and it may take years for populations in low density areas on multi-year ice environments to increase to stable levels on thinner ice. Scenarios used in the IUCN model differed in how they addressed differing rates of population change in different ecoregions, related to factors such as ice thickness and prey availability, so caution should be used in considering conclusions of that analysis. Therefore, we applied a range of severity to this threat.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.2	Droughts		Negligible	Negligible (<1%)	Unknown	Low (Possibly in the long term, >10 yrs/3 gen)	Droughts do not pose a threat.
11.3	Temperature extremes		Unknown	Small (1-10%)	Unknown	High (Continuing)	Temperature extremes can effect both earthen denning (permafrost thawing and loss of snow events), as well as snow dens on land. Den collapse could potentially kill offspring. However, these events are local in scale and likely would not cause a population level impact. (these types of dens are not considered in 11.1). Note that early rain events in the past have had impacts on den collapse. Rain on ice and snow events are predicted to increase and can have impacts on females at a vulnerable time.
11.4	Storms & flooding		Unknown	Unknown	Unknown	High - Low	Increasing storm events, and changes in wind (directions and strength) and possible effects on thinning ice were discussed. However, since impacts are not well understood, scoring was unknown.
11.5	Other impacts		Unknown	Unknown	Unknown	Unknown	
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							

APPENDIX II. List of Established Protected Areas That Protect Polar Bear Habitat.

DESIGNATION	NAME	MARINE	TERRESTRIAL
National Park	Aulavik	x	x
	Auyuittuq		x
	Ivvavik[1]		x
	Qaussuittuq	x	x
	Quttinirpaaq	x	x
	Sirmilik	x	x
	Torngat Mountains		x
	Ukkasiksalik	x	x
	Wapusk		x
National Wildlife Area	Polar Bear Pass		x
Marine Protected Area	Anguniaqvia Niqiqyuam	x	
	Tarium Niryutait	x	
Provincial Park	Polar Bear (Wabusk)		x
	Parc national Kuururjuaq		x
	Parc national Tursujuq		x
Territorial Park	Herschel Island		x
	Katannilik		x
Wildlife Management Area	Churchill WMA		x
	Kaskatamagan WMA		x

1. Additional lands in the Yukon North Slope adjacent to Ivvavik NP are under a Land Withdrawal (IFA Section 12.4), which protects terrestrial habitat.