U.S. Fish and Wildlife Service

Polar Bear

Draft Conservation Management Plan

Disclaimer:

This Conservation Management Plan (Plan) delineates reasonable actions we, the U.S. Fish and Wildlife (USFWS), believe will contribute to the conservation and recovery of polar bears (*Ursus maritimus*). Funds necessary to achieve the objectives identified in this Plan are subject to budgetary and other constraints, as well as the need to address other agency priorities. This Plan does not necessarily represent the views, official positions, or approval of any individuals or agencies involved in its formulation, other than USFWS. The approved Plan will be subject to modification as dictated by new findings, changes in species status, and the completion of conservation management actions.

This draft plan represents the views and interpretations of the USFWS regarding the conservation and recovery of the polar bear only. USFWS's approach set forth in this draft polar bear conservation management plan does not necessarily preclude other approaches in developing ESA recovery plans or MMPA conservation plans. We seek comments from the public regarding viable alternatives for plans involving ice-dependent species and will consider all comments prior to finalizing this plan.

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The Draft Plan can be downloaded from:

http://www.fws.gov/alaska/pbrt/

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Polar Bear Conservation Management Plan

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Contents

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Executive Summary

Today, polar bears roam the frozen north, but as their sea-ice habitat continues to shrink due to Arctic warming, their future in the U.S. and ultimately their continuation as a species is at risk. Their eventual reprieve turns on our collective willingness to address the factors contributing to climate change and, in the interim, on our ability to improve the ability of polar bears to survive in sufficient numbers and places so that they are in a position to recover once the necessary global actions are taken.

Polar bears are an ice-dependent species that rely on sea ice as a platform to hunt ice seals and to raise their young. The current global polar bear population is estimated to be 20,000 to 25,000. Polar bears range across 5 Arctic nations; for management purposes, their population is divided into 19 subpopulations. These subpopulations have been further grouped into four ecoregions based on the spatial and temporal dynamics of sea ice in the subpopulations' range. The near- and mid-term impacts of sea-ice loss on polar bears will vary among subpopulations and ecoregions but over the long term, those impacts are anticipated to be significant for polar bear numbers range wide if global greenhouse gas emission levels are not significantly reduced.

PLAN PHILOSOPHY

The Polar Bear Conservation Management Plan (Plan) was developed as a practical guide to implementation of polar bear conservation in the United States. From a legal perspective, the purpose of the Plan is to articulate the conditions whereby polar bears would no longer need the protections of the Endangered Species Act (ESA) and to lay out a collective strategy that moves us towards achieving those conditions. A parallel path is laid out for improving the status of polar bears under the Marine Mammal Protection Act (MMPA).

Many governmental and non-governmental agencies, institutions, and organizations are currently involved in polar bear conservation. These entities are integral to the conservation of the species. Going forward, conservation of polar bears will require the collective will and collaboration of nations and Native communities, of government agencies and private organizations, of scientists and subsistence hunters. This Plan reflects the diverse input of several of those stakeholders. It also emphasizes local engagement, from the oil and gas industry activities on the North Slope of Alaska that keep employees safe and minimize defense-of-life kills, to the Alaska Native peoples who have lived with polar bears for thousands of years and will be integral to conservation of the species going forward.

Although the Plan satisfies the statutory requirements of the ESA and the MMPA, it is more broadly focused than a typical recovery or conservation plan. At its core, the Plan contains a set of fundamental goals reflecting shared values of diverse stakeholders. The goals focus on conservation of polar bears while recognizing values associated with subsistence take, human safety, and economic activity.

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These fundamental goals are described in quantitative terms associated with ESA and MMPA requirements, and are stepped down to measurable demographic and threats-based criteria. The Plan identifies a suite of high priority conservation and recovery actions to achieve those criteria. Strategic monitoring will focus both on implementation (the extent to which the plan is followed and recovery actions are taken) and effectiveness (the extent to which recovery actions are successful and progress is made).

This Plan is meant to be a dynamic, living document and is expected to be revised periodically as new insights arise. Recognizing the uncertainties inherent in polar bear management, monitoring and research are integral to implementation. As new information is gathered to track and evaluate progress, it should feed back into the Plan, allowing revision of the conservation and recovery criteria, as well as refinement of the conservation strategy.

THE PRIMARY THREAT TO POLAR BEARS

As identified in the final rule listing the polar bear as a threatened species under the ESA, the decline of sea ice habitat due to changing climate is the primary threat to polar bears (73 FR 28211). The single most important step for polar bear conservation is decisive action to address Arctic warming (Amstrup et al. 2010, Atwood et al. 2015), which is driven primarily by increasing atmospheric concentrations of greenhouse gases. Short of action that effectively addresses the primary cause of diminishing sea ice, it is unlikely that polar bears will be recovered. Addressing the increased atmospheric levels of greenhouse gases that are resulting in Arctic warming will require global action. While this Plan calls for action to promptly reduce greenhouse gas emissions, the focus is on wildlife management actions within the United States that will contribute to the survival of polar bears in the interim so that they are in a position to recover once Arctic warming has been abated.

CONSERVATION STRATEGY

Along with the threat posed by sea-ice loss and the inadequacy of existing regulatory mechanisms to address climate change, other current or potential sources of polar bear mortality will likely become more significant going forward. Potential management concerns in the U.S. include subsistence harvest, defense-of-life removals, disease, take from oil and gas activities, loss of denning habitat, contamination from spills, and disturbance due to increased shipping in the Arctic. This plan outlines actions the U.S. Fish and Wildlife Service (USFWS) and its partners can take to preclude these from threatening the persistence or recovery of polar bears while the global community works to address and limit atmospheric levels of greenhouse gases, especially through actions to reduce greenhouse gas emissions.

MANAGEMENT GOALS AND CRITERIA

Polar bears are important to humans for many reasons. In seeking an enduring, collaborative strategy for management, this Plan recognizes the array of values held by diverse communities engaged in polar bear conservation. The Plan proposes 6 Fundamental Goals. The first 3 involve securing the long-term persistence of polar bears on different geographic scales: (1) range-wide (the global scale of the ESA listing), (2) ecoregions (an intermediate scale that reflects a goal of maintaining intraspecific diversity), and (3) the State of Alaska (encompassing the 2 polar bear subpopulations partially within the United States). Fundamental Goal 4 recognizes the nutritional and cultural traditions of native peoples with connections to polar bear populations, including the opportunity for sustainable harvest of polar bears for subsistence purposes as that term is understood in the context of U.S. laws. Fundamental Goal 5 calls for continued management of human-bear interactions to ensure human safety and to conserve polar bears. Finally, Fundamental Goal 6 seeks to achieve polar bear conservation while minimizing restrictions to other activities within the U.S. range of the polar bear, including economic development.

Two criteria are identified as guidance for our management actions under the MMPA. The first is a take-based criterion requiring that the rate of human-caused removals maintains a subpopulation above its maximum net productivity level (MNPL) relative to carrying capacity. The second criterion calls for maintenance of the "health and stability of the marine ecosystem" and for polar bears to retain their role as a "significant functioning element of the ecosystem." This measure, which will require further development, will seek to maintain a significant portion of the historical carrying capacity.

The ESA recovery criteria for delisting are expressed at a fundamental level for two geographic scales. At the scale of the listed species, the fundamental criterion is that worldwide probability of persistence be at least 95% over 100 years. At the intermediate scale, this Plan identifies 4 recovery units, corresponding to four polar bear ecoregions. The probability of persistence in each of the 4 recovery units must be at least 90% over 100 years.

The ESA demographic criteria focus on four measures of population status: survival rate, recruitment rate, carrying capacity, and the rate of human-caused removals. Recovery is achieved when all of the following conditions are met in each recovery unit: (i) the mean adult female survival rate is at least 93-95% (currently and as projected over 100 years); (ii) the ratio of yearlings to adult females is at least 0.1-0.3 (currently and as projected over 100 years); (iii) the expected carrying capacity is at least 500 or 15% of the population size at the time of listing, whichever is greater (currently and as projected over 100 years); and (iv) the rate of human-caused removals maintains the population in each recovery unit above its maximum net productivity level relative to carrying capacity.

The Plan then identifies criteria representing the levels at which sea-ice loss, human-caused removals, and disease would not be considered a threat under the ESA. Sea-ice loss, the primary threat identified in the 2008 listing determination, will cease to be a threat to polar bear recovery when the average duration of the ice-free period in each recovery unit (i) is expected not to exceed 4 months over the next 100 years based on model projections, or (ii) is expected to stabilize at longer than 4 months and there is evidence that polar bears can meet the demographic criteria under that longer ice-free period. Human-caused removals were not identified as a threat in the 2008 listing rule. However, the rule recognized the potential that they could become a threat to polar bear recovery, in particular as populations are affected by sea ice loss. This would be the case if those removals reduce the probability of persistence below 90% over 100 years in any of the 4 recovery units. Similarly, disease and parasites, which are not currently a threat to recovery, would be considered one if there was compelling evidence of persistent infection and that infection reduced the probability of persistence below 90% over 100 years. Potential future management concerns posed by oil and gas activities, contamination from spills, and increased Arctic shipping are acknowledged but, because these factors have not been identified as threats, no recovery criteria are associated with them.

To achieve recovery under the ESA, the criteria at all three levels—fundamental, demographic, and threats-based—must be met.

CONSERVATION/RECOVERY ACTIONS

The Plan identifies a strategic suite of high priority conservation and recovery actions. The first and foremost action for the purpose of recovery is to stop Arctic warming and the loss of sea ice by limiting atmospheric levels of greenhouse gases; the principal mechanism for doing that is to substantially reduce greenhouse gas emissions. Other actions, which can be implemented by USFWS and its partners are aimed at the near- and mid-term goal of providing polar bears in the U.S. the best possible chance to rebound when climate change is addressed. These actions include managing human-bear conflicts, collaboratively managing subsistence harvest, protecting denning habitat, and minimizing the risk of contamination from spills. While the focus of this plan is primarily on actions in the U.S., priority actions also include collaborating with Canada and Russia on management of the 2 subpopulations for which we share oversight.

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Along with these actions, the Plan calls for monitoring and research specifically tied to Plan criteria and actions. Strategic monitoring will enable us to determine whether our actions, and this Plan, are effective in the near- and mid-term at conserving polar bears or whether they need to be modified.

Finally, to facilitate implementation of these actions, the Plan envisions continuation of the Recovery Team in the form of a collaborative Implementation Team. The Implementation Team will meet on a regular basis to share information, revisit priorities, and leverage resources.

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I. BACKGROUND

Polar bears occur in 19 subpopulations throughout the seasonally and permanently ice-covered marine waters of the northern hemisphere (Arctic and Subarctic), in Canada, Denmark (Greenland), Norway, Russia, and the United States (Fig. 1). The United States contains portions of two subpopulations: the Chukchi Sea and the Southern Beaufort Sea. These 2 subpopulations have also been identified as "stocks" under the MMPA.

Polar bear subpopulations have been further classified as occurring in one of four ecoregions (Fig. 2, Amstrup et al. 2008) based on the spatial and temporal dynamics of sea ice in the subpopulation's range. Subpopulations classified as occurring in the Seasonal Ice Ecoregion share the characteristic that the sea ice in their range fully melts in the summer, during which time bears are forced on shore for extended periods of time until the sea ice reforms. Subpopulations occurring in the Archipelago Ecoregion are characterized as having heavy annual and multi-year sea ice that fills the channels between the Canadian Arctic Islands. Bears in this ecoregion remain on the sea ice throughout the year. The Polar Basin Divergent Ecoregion, which includes the two United States subpopulations, is characterized by the formation of annual sea ice that is swept towards the polar basin. The Polar Basin Convergent Ecoregion is characterized by annual sea ice that converges towards shoreline, allowing bears access to nearshore ice year-round. Although information is limited, the global genetic structure of polar bears appears to reflect the four ecoregions (Paetkau et al. 1999, Peacock et al. 2014).

The most recent circumpolar population estimate by the IUCN Polar Bear Specialist Group was 20,000 to 25,000 polar bears, derived from a combination of studies and expert judgment (Obbard et al. 2010).

Polar bears are relatively long-lived, and are characterized by late sexual maturity, small litter

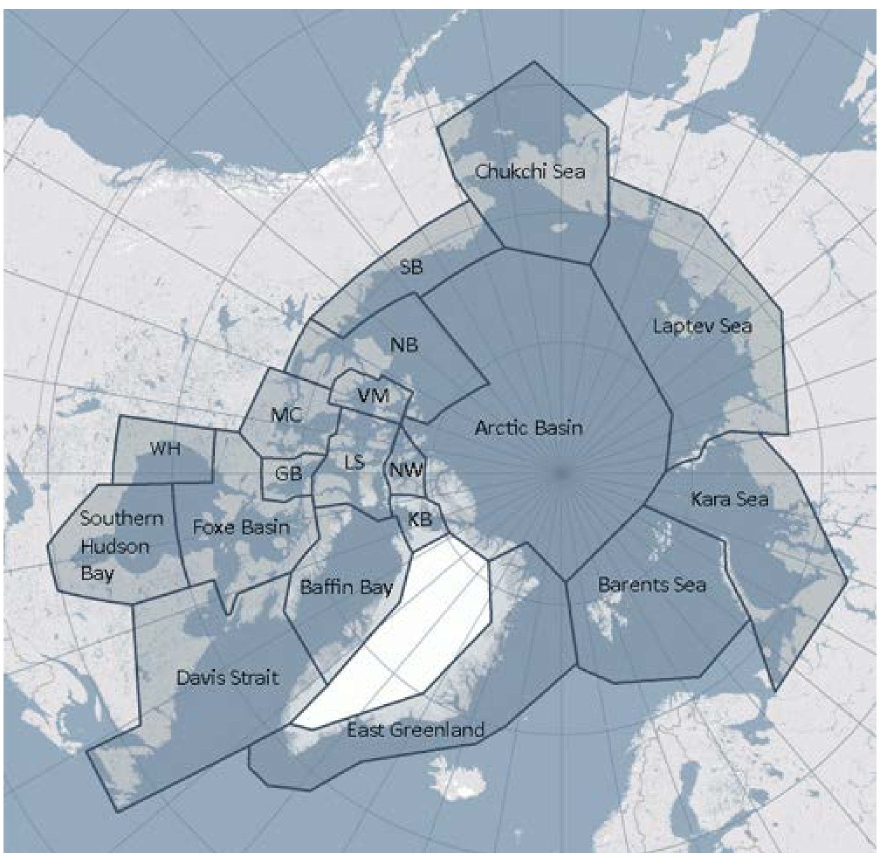

Figure 1. Map of the polar bear subpopulations (source: Polar Bear Specialist Group). subpopulations include: southern Beaufort Sea (SB), Chukchi Sea , Laptev Sea , Kara Sea, Barents Sea, East Greenland, Northern Beaufort (NB), Kane Basin (KB), Norwegian Bay (NW), Lancaster Sound (LS), Gulf of Boothia (GB), McClintock Channel (MC), Viscount Melville (VM), Baffin Bay, Davis Strait, Foxe Basin, Western Hudson Bay (WH), and Southern Hudson Bay.

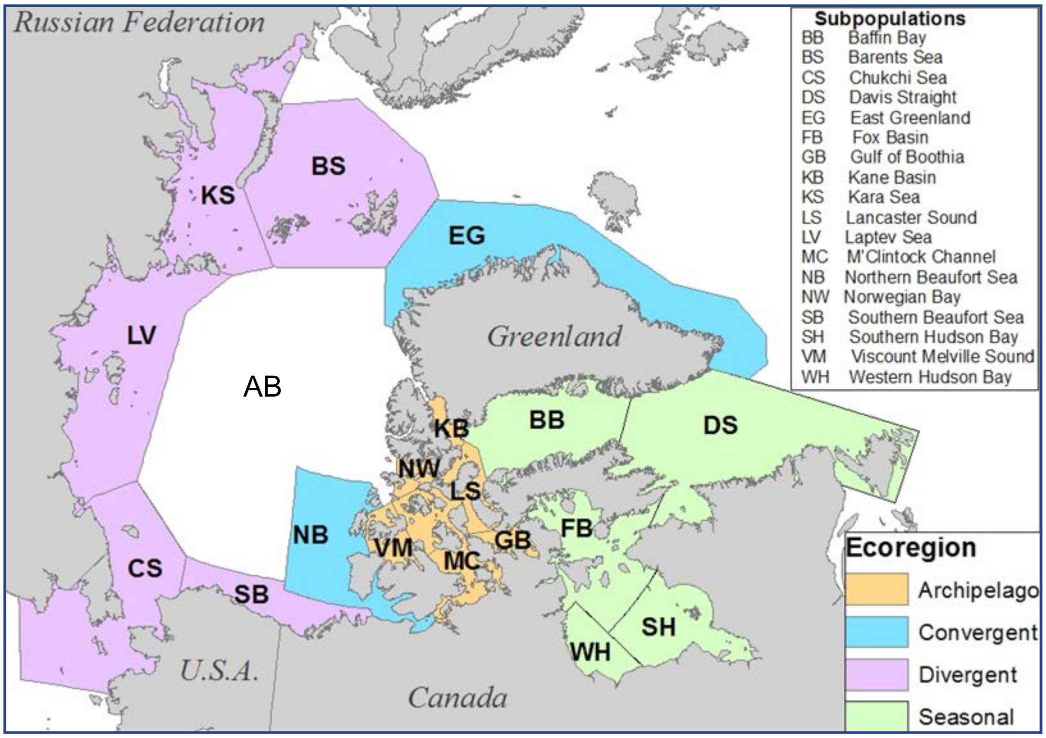

Figure 2. Ice ecoregions (Amstrup et al. 2008). These ecoregions are equated with ESA recovery units in this Plan.

sizes, and extended maternal investment in raising young. These are all factors that contribute to a low reproductive rate; as a result, high adult survival rates, particularly of females, are required to maintain population levels. Survival rates exceeding 93 percent for adult females are essential to sustain polar bear subpopulations (Regehr et al. 2015).

Sea ice is the primary habitat for polar bears. Polar bears depend on sea ice as a platform on which to: hunt and feed on seals; seek mates and breed; travel to terrestrial maternity denning areas; den; and make long-distance movements. Polar bear movements are closely tied to the seasonal dynamics of sea-ice extent as it retreats northward during summer melt and advances southward during autumn freeze.

A more detailed biological background can be found in Appendix A.

The United States Fish & Wildlife Service (USFWS) listed the polar bear (*Ursus maritimus*) as a threatened species under the Endangered Species Act of 1973 as amended (ESA) on May 15, 2008 (73 FR 28211); as a result, it automatically became a "depleted" species under the Marine Mammal Protection Act of 1972 as amended (MMPA).

The USFWS has four purposes for this Plan. The first is to meet the recovery planning requirement of the ESA. Section 4(f) directs the USFWS to develop plans for listed species which identify "objective, measurable" recovery criteria and site-specific recovery actions with estimated time and cost to completion (16 USC §1533(f)(1)(B)). The second purpose is to develop a conservation plan under the MMPA, patterned after ESA recovery plans but with a goal of conserving and restoring a species to its optimum sustainable population (16 USC § 1383 (b)). The third purpose is to create a national plan related to management of polar bears in the U.S. to be appended to the Circumpolar Action Plan for Polar Bear Conservation now in development by the signatories to the *1973 Agreement on the Conservation of Polar Bears*. Those signatories are the five countries with polar bear populations (Canada, Denmark on behalf of Greenland, Norway, Russia, and the United States), known collectively as the "Range States." Consistent with the 1973 Agreement (Articles VII and IX), the Range States are preparing a Circumpolar Action Plan, which will be supplemented by a national plan from each country to describe the specific conservation actions it will take, in accord with its domestic laws. The final purpose of this Plan is to provide a unifying framework for conservation of polar bears by partners within the United States.

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The Primary Threat to Polar Bears

Sea ice is rapidly thinning and retreating throughout the Arctic (Stroeve et al. 2012). Multiple combined and interrelated events have changed the extent and characteristics of sea ice during all seasons, but particularly during summer. Arctic warming is likely to continue for several decades given the current trends in global greenhouse gas emissions (IPCC 2014), the long persistence time of certain greenhouse gases in the atmosphere (Moore and Braswell 1994), and the lag times associated with global climate processes attaining equilibrium (Mitchell 1989, Hansen et al. 2011). Hence, climate change effects on sea ice and polar bears and their prey will very likely continue for several decades or longer unless greenhouse gases in the atmosphere can be held at suitable levels, primarily by reducing greenhouse gas emissions.

The threats to polar bears identified in the ESA listing determination were the loss of sea-ice habitat due to climate change and the inadequacy of existing mechanisms curtailing that threat (73 FR 28277). It cannot be overstated that the single most important action for the recovery of polar bears is to significantly reduce the present levels of global greenhouse gas emissions, which are the dominant source of increasing atmospheric levels that are the primary cause of warming in the Arctic. Recently, Atwood et al. (2015) corroborated the climate threat by determining through Bayesian network modeling that the most influential driver of adverse polar bear outcomes in the future will be declines in sea-ice conditions, and secondarily declines in marine prey base. Mortality from *in situ* anthropogenic factors like hunting and defense of life and property will exert considerably less influence on future polar bear population outcomes, while stressors such as trans-Arctic shipping, oil and gas exploration, and point-source pollution will have negligible effects.

The levels that global greenhouse gas emissions reach in the coming decades will have a tremendous influence on the abundance and distribution of polar bears in the future. Polar bears will likely be extirpated from much of their present-day range if emissions continue to rise at current rates throughout the 21st century (Amstrup et al. 2008); however, if anthropogenic radiative forcing is kept under 4.5 W/m^2, which could be accomplished primarily by aggressive reductions in greenhouse gas emissions, the probability of greatly reduced polar bear populations could be substantially lowered (Atwood et al. 2015). The best prognosis for polar bears entails prompt and aggressive mitigation of greenhouse gas emissions (so that forcing is kept under 3.5 W/m^2) combined with optimal polar bear management practices, which together could maintain viable polar bear populations in most regions of the Arctic (Amstrup et al. 2010). To that end, this Plan provides a framework for USFWS and its partners to accomplish the latter goal, while governments, industries, and citizens throughout the world aspire to accomplish the former.

The USFWS endorses efforts everywhere, big and small, to mitigate greenhouse gas emissions in an ecologically sound manner, and emphasizes the direct and immediate relationship between success in these efforts and the future status of the polar bear.

II. CONSERVATION STRATEGY

Although the need to reduce emissions contributing to climate change has been recognized in national plans (President's Climate Action Plan, White House 2013b) and action by the USFWS and other agencies (EPA proposed carbon pollution standards, 79 FR 34830 et seq.), more needs to be done in the United States and around the globe to slow the warming trends that are harming Arctic ecosystems and polar bears, which depend on those ecosystems and play an integral role in their functioning.

Recognizing that USFWS lacks the authority to regulate greenhouse gas emissions, we must rely on the United States and other nations to address the emissions that are the primary contributor to ongoing climate change, whether such reductions are via laws, regulations, market-based incentives, or a combination of approaches. Under this Plan, our specific contribution to global emissions control will be a science-based communication effort highlighting the urgent need for sufficient reductions in emissions to help achieve a global atmospheric level of greenhouse gases that will support conditions for recovery of polar bears from projected declines.

While global efforts are made to curb atmospheric levels of greenhouse gases, there are actions the USFWS and its partners can take in the U.S. that will improve the ability of polar bears to survive in the wild in sufficient numbers and distribution so that they are in a position to recover once climate change effects are ameliorated. Overutilization was not identified as a threat to the species throughout all or a significant portion of its range. However, the listing rule noted that continued efforts were necessary to ensure that harvest or other forms of removal did not exceed sustainable levels, particularly for subpopulations experiencing nutritional stress or declining numbers as a consequence of habitat change (73 FR 28280). Even for populations affected to a lesser degree by environmental changes and habitat impacts, the rule noted that effective implementation of existing regulatory mechanisms was necessary to address issues related to overutilization (73 FR 28280). Looking ahead, additional challenges to polar bear conservation that may rise to the level of a threat include disease, shipping, oil and gas activities, and oil spills.

Specifically, our conservation strategy includes the following actions:

- Limit global atmospheric levels of greenhouse gases to levels appropriate for supporting polar bear recovery and conservation, primarily by reducing greenhouse gas emissions
- Support international conservation efforts through the Range States relationships
- Manage human-bear conflicts
- Collaboratively manage subsistence harvest
- Protect denning habitat
- Minimize risks of contamination from spills
- Conduct strategic monitoring and research

The focus of this Plan is on those actions the USFWS and its partners can take, primarily in the U.S. These include actions with stakeholders and partners to mitigate various forms of disturbance and mortality, which although they are not currently threats to polar bear subpopulations, may become threats in the future. Conservation actions, many of which are already underway, will be proactive, informed by strategic monitoring, and carried out with ongoing support from an Implementation Team.

We will track the effectiveness of these actions in the near- and mid-term by monitoring demographic and threats-based criteria in the Divergent ecoregion—the region where polar bears may be most vulnerable to Arctic warming (Atwood et al. 2015) and the home to both of the United States' subpopulations.

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III. MANAGEMENT GOALS AND CRITERIA

A. Fundamental Goals

The fundamental goals express the intentions of this Polar Bear Conservation Management Plan and will be used to guide management, research, monitoring, and communication. They include the goals of the MMPA and the ESA, as they relate to polar bear conservation and recovery, with a particular focus on the U.S. The fundamental goals also reflect the input and aspirations of stakeholders closely connected with polar bears and their habitat including the State of Alaska, the North Slope Borough, Alaska Native peoples, conservation groups, and the oil and gas industry. In most cases, the fundamental goals represent range-wide aspirations, but the specific applications under this Plan pertain primarily to the polar bear subpopulations linked to Alaska.

The fundamental goals apply to three spatial scales: the entire polar bear range, significant regional population segments (currently equated with ecoregions), and subpopulations in the United States. They also reflect different temporal scales ranging from long-term (~100 years, to reflect generational goals), to mid-term (~50 years, to reflect steps to put polar bears in the best position to recover once the primary threat is addressed), to near-term.

Anticipating that polar bear populations are likely to decline as sea ice recedes (73 FR 28212), some of the goals reflect long-term desired outcomes, rather than predictions of the likely future. In addition, it may not be possible to achieve all of these goals simultaneously and to their fullest degree. One of the challenges in implementing this Plan will be finding the right trade-off among these fundamental goals, appropriately recognizing the statutory guidance, as well as other social values.

Fundamental Goals

The fundamental goals of the Polar Bear Conservation Management Plan arise from the statutory obligations under the Marine Mammal Protection Act and the Endangered Species Act, the goals of the Circumpolar Action Plan, as well as the values of polar bear conservation partners in Alaska.

1. Secure the long-term persistence of wild polar bears as a species and as a significant functioning element in the ecosystem of which they are a part.
2. Secure the long-term persistence of polar bears at scales that represent the genetic, behavioral, life-history, and ecological diversity of the species.
3. Secure the long-term persistence of the two polar bear subpopulations in the United States (the Southern Beaufort Sea and Chukchi Sea subpopulations).
4. Recognize the nutritional and cultural traditions of native peoples with connections to polar bear populations, including the opportunity for sustainable harvest of polar bears.
5. Continue to manage human-bear interactions to ensure human safety and to conserve polar bears.
6. Achieve polar bear conservation while minimizing restrictions to other activities within the range of the polar bear, including economic development.

Fundamental Goal 1: Secure the long-term persistence of wild polar bears as a species and as a significant functioning element in the ecosystem of which they are a part.

The central purpose of this Plan, both in itself, and as the United States' contribution to the Range States' Circumpolar Action Plan, is to ensure that polar bears remain in the wild on this planet, and remain a significant functioning element of the Arctic ecosystem, long into the future. This central purpose is readily shared by all stakeholders.

Species qualify for protection under the ESA if they are in danger of extinction throughout all or a significant portion of their range (endangered) or likely to become so in the foreseeable future (threatened). The aim of recovery efforts, therefore, is to ensure survival and reduce the risk of extinction to the point that the species no longer requires or qualifies for protection under the ESA, rather than to restore the species to historical levels.

The MMPA has specific provisions that apply to "depleted" species, a status that applies to polar bears as a species because of its ESA listing (16 USC §1362(1)). Congress found in the MMPA that species and population stocks "should not be permitted to diminish beyond the point at which they cease to be a significant functioning element in the ecosystem of which they are a part, and consistent with this major objective, they should not be permitting to diminish below their optimum sustainable population" (16 USC §1361(2)).

In 2008 the USFWS found that the polar bear is likely to become an endangered species within the foreseeable future throughout all of its range and listed the species as threatened under the ESA (73 FR 28212). Thus, the focus of Fundamental Goal 1 is on polar bears as a species. The long-term persistence aspect of this goal is especially related to requirements of the ESA, and the role of the species as a significant functioning element in the ecosystem is especially related to requirements of the MMPA.

Fundamental Goal 2: Secure the long-term persistence of polar bears at scales that represent the genetic, behavioral, life-history, and ecological diversity of the species.

Beyond the goal of keeping polar bears extant in the wild, and recognizing that Arctic warming will not affect polar bear subpopulations equally, it is also important to maintain a broad geographic distribution to conserve genetic, behavioral, ecological, and life-history diversity. Applicable recovery planning guidance developed jointly by National Marine Fisheries Service (NMFS) and USFWS under the ESA (NMFS 2010) suggests recovery units may be considered "to conserve genetic robustness, demographic robustness, important life history stages, or some other feature necessary for long-term sustainability of the entire listed entity." In addition, although they apply explicitly to listing decisions under the ESA, the "significant portion of the range" and "distinct population segment" policies provide guidance regarding the importance of intraspecific diversity. Under the MMPA, the finding by Congress that marine mammals should be maintained as significant functioning elements of their ecosystem supports the view that polar bears should be conserved in more than a small portion of their historic range. Intermediate-scale groupings of polar bears capture important intraspecies genetic and life-history diversity; as explained below, the polar bear ecoregions (Amstrup et al. 2008) provide a reasonable proxy of this diversity.

Beyond its fundamental importance, this goal also serves as an effective means to secure the long-term persistence of polar bears range-wide (Fundamental Goal 1) and of polar bears in the United States (Fundamental Goal 3). Conserving the broad spatial distribution and ecological diversity of polar bears over the near- and mid-term—while longer-term solutions to climate change emerge—will provide the greatest opportunity and flexibility for future actions to achieve the ESA and MMPA standards and goals for polar bears.

Fundamental Goal 3: Secure the long-term persistence of the two polar bear subpopulations in the United States (the Southern Beaufort Sea and Chukchi Sea subpopulations).

Conservation of polar bears in Alaska is important for ecological, cultural, spiritual, economic, and aesthetic values. To achieve desirable outcomes associated with these values, securing persistent populations of polar bears in the United States over the long term is an important goal. Admittedly, current predictions pointing to range reductions and population declines highlight the aspirational nature of this goal. In the short- and mid-term, forestalling potential extirpation of polar bears from the United States will serve as a means to achieve Fundamental Goals 1 and 2.

This Plan seeks conservation and recovery of the species range-wide, even if the primary focus of the Plan's conservation and recovery actions is on the two United States subpopulations. The individual management plans produced by the other Range States to underpin the Range States' Circumpolar Action Plan will address additional actions for the remaining subpopulations in a manner consistent with each nation's own statutory, cultural, and economic objectives as well as the *1973 Agreement on the Conservation of Polar Bears*. We acknowledge and support the conservation actions of the other Range States to the extent they contribute to recovery of the species.

Fundamental Goal 4: Recognize the nutritional and cultural traditions of native peoples with connections to polar bear populations, including the opportunity for sustainable subsistence harvest of polar bears.

Local native communities throughout the Arctic have a long tradition of living with polar bears. Those communities have engaged in polar bear harvest consistent with long-standing cultural traditions and have been integral to the success of polar bear conservation activities. Article III of the *1973 Agreement on the Conservation of Polar Bears* allows harvest of polar bears in the exercise of traditional rights of local people. Congress recognized the cultural importance of subsistence harvest to Alaska Native peoples in both the MMPA and the ESA. The MMPA specifically allows non-wasteful harvest of marine mammals, including those that are depleted, by coastal-dwelling Alaska Native peoples (take of polar bears from the Chukchi Sea subpopulation is governed under Title V, 16 USC §1423). The ESA similarly exempts Alaska Native subsistence harvest from the prohibition on take of threatened or endangered species. Commercial trade is not authorized, however. This does not preclude creation and sale of authentic Alaska Native handicrafts and clothing as authorized by these two statutes. Both the MMPA and ESA acknowledge the conservation context of the subsistence exception by authorizing the Secretary to regulate such harvest if necessary (16 USC §1371(b), 16 USC §1539(e)).

This fundamental goal is intended to provide the cultural opportunity to harvest polar bears to many future generations of Alaska Natives. Achievement of this goal will require the continued responsible management of harvest by Alaska Native peoples, other indigenous peoples, the United States, and other Range States.

Fundamental Goal 5: Continue to manage human-polar bear interactions to ensure human safety and to conserve polar bears.

The likelihood of interactions between humans and polar bears increases as polar bears spend more time on shore due to receding sea ice, as their primary prey declines and they seek alternative food, as the human population near the Arctic coast increases, and as industrial activity in the Arctic increases. Ensuring the safety of people living and working in the coastal areas frequented by polar bears is a paramount concern. A secondary but important consideration for polar bear conservation is the outcome of human-bear interactions on polar bears. Frequent interactions with people pose a threat to polar bears, both directly, if bears have to be killed, and indirectly, through habituation to humans, food conditioning, and other possible risks.

Fundamental Goal 6: Achieve polar bear conservation while minimizing restrictions to other activities within the range of the polar bear, including economic development.

Local, regional, state, national, and global communities benefit from human activities in the Arctic, including tourism, recreation, oil and gas development, mining, shipping, and scientific research. In some cases, these activities may be compatible with polar bear conservation; in others, there may be conflicts. Finding strategies here in the United States that allow both would benefit multiple stakeholders. This goal reflects objectives in the administration's "National Strategy for the Arctic Region" (White House 2013a), which calls on United States federal agencies to use integrated Arctic management to balance economic development, environmental protection, and cultural values.

In the following three sections (organized by the MMPA, ESA, and other motivations, respectively), the Fundamental Goals are expressed as quantitative measures; for the goals related to the MMPA and ESA, criteria associated with conservation and recovery are provided. Where appropriate, these fundamental criteria are further described with stepped-down demographic and threats-based criteria (Table 1).

Table 1. Three-tier framework for MMPA conservation criteria, ESA recovery criteria, and performance metrics for the other fundamental goals. The criteria and metrics are arranged in three tiers: fundamental (directly related to the fundamental goals); demographic (stepped-down to the level of population demographic rates); and threats-based (stepped-down further to the level of threats). Performance thresholds are provided for the criteria associated with the MMPA and ESA. For the other fundamental goals (FG), performance metrics are described, without thresholds.

MMPA Conservation	ESA Recovery	Other Fundamental Goals
Fundamental Criteria & Performance Metrics		**FG4:** Cumulative sustainable take (all human-caused removals) level over the next 50 years for each subpopulation that includes parts of Alaska. **FG5**: Number of human-bear conflicts in Alaska that result in injury or death to humans or bears. **FG6**: Economic impacts of polar bear management actions, including direct and indirect expenses, and lost or foregone opportunities.
Conservation Criterion 1: Each subpopulation is managed so that its population size is above the maximum net productivity level relative to carrying capacity. AND **Conservation Criterion 2**: The health and stability of the marine ecosystem, as evidenced by its capacity to support polar bears, are maintained, and each subpopulation of polar bears is maintained as a significant functioning element of that ecosystem.	**Recovery Criterion 1**: The worldwide probability of persistence is at least 95% over 100 years. AND **Recovery Criterion 2**: The probability of persistence in each recovery unit (ecoregion) is at least 90% over 100 years.	
Demographic Criteria		
MMPA Demographic Criterion 1: Total human-caused removals in each subpopulation do not exceed a rate *h* (relative to the subpopulation size) that maintains the subpopulation above its maximum net productivity level relative to carrying capacity. AND **MMPA Demographic Criterion 2:** The intrinsic growth rate of each subpopulation is above, and is expected to remain above, a minimum level that indicates the health of the marine ecosystem is not substantially impaired; and the carrying capacity in each subpopulation is above, and is expected to remain above, a minimum level that indicates that the stability of the marine ecosystem is not substantially impaired. (To be further developed.)	**ESA Demographic Criterion 1:** The mean adult female survival rate (at a density corresponding to maximum net productivity level) in each recovery unit is at least 93–96%, both currently and as projected over the next 100 years. AND **ESA Demographic Criterion 2:** The ratio of yearlings to adult females (at a density corresponding to maximum net productivity level) in each recovery unit is at least 0.1–0.3, both currently and as projected over the next 100 years. AND **ESA Demographic Criterion 3:** The expected carrying capacity in each recovery unit is at least 500, both currently and as projected over the next 100 years. AND **ESA Demographic Criterion 4:** Total human-caused removals in each recovery unit do not exceed a rate *h* (relative to the population size in the recovery unit) that maintains the population above its maximum net productivity level relative to carrying capacity.	

Continued

Table 1. Continued.

MMPA Conservation	ESA Recovery	Other Fundamental Goals
Threats-based Criteria		
	Sea ice: In each recovery unit, either (a) the average ice-free period is expected not to exceed 4 months over the next 100 years based on model projections using the best available climate science, or (b) the average ice-free period is expected to stabilize at longer than 4 months over the next 100 years based on model predictions using the best available climate science, and there is evidence that polar bears in that recovery unit can meet ESA Demographic Criteria 1, 2, and 3 under that longer ice-free period. AND **Human-caused removals:** For each recovery unit, the total level of direct, lethal removals of polar bears by humans, in conjunction with other factors, does not reduce the probability of persistence below 90% over 100 years. AND **Disease and parasites:** For each recovery unit, the best available science indicates that (1) infection is not persisting endemically, as measured by an assessment of trend in indicators of exposure (e.g., prevalence, incidence) to disease agents (i.e., bacteria, viruses, and parasites); or (2) infection is persisting endemically, but forecast population-level effects that consider future infection rates as a function of biotic and abiotic interactions suggest that the risk of extirpation due to infections, in conjunction with other factors, is less than 10% over 100 years.	

B. Conservation Criteria Under the Marine Mammal Protection Act

Conservation plans are developed for depleted species or stocks under the MMPA. "Each plan shall have the purpose of conserving and restoring the species or stock to its optimum sustainable population. The Secretary shall model such plans on recovery plans required under section 4(f) of the Endangered Species Act of 1973" (16 USC §1383b(b)(2)). Species or stocks of marine mammals are designated as "depleted" in one of three ways: because they fall below the optimum sustainable population (OSP) level, as determined by the federal government or by a state to whom authority has been transferred; or because they are listed as endangered or threatened under the ESA. In this case, to no longer be considered depleted, polar bears would have to be delisted under the ESA. (The ESA recovery criteria are covered later; this section considers only the MMPA criteria.) This Plan describes MMPA conservation criteria at two levels: fundamental and demographic (Table 1). These criteria are nested: the demographic criteria are derived from the fundamental criteria using the best scientific information available at the time of assessment.

MMPA fundamental criteria

Fundamental Goals 1, 2, and 3 are tied to the conservation standards of the MMPA. Here, those Goals are translated into specific criteria. At the fundamental level, the goals for conservation of polar bears under the MMPA are achieved when both of the following criteria are met:

> **MMPA Conservation Criterion 1: Each subpopulation is managed so that its population size is above the maximum net productivity level relative to carrying capacity.**
>
> **MMPA Conservation Criterion 2: The health and stability of the marine ecosystem, as evidenced by its capacity to support polar bears, are maintained, and each subpopulation of polar bears is maintained as a significant functioning element of that ecosystem.**

The MMPA criteria apply both to the worldwide population and to the individual subpopulations. The depleted entity is the worldwide population of polar bears, because the depleted status under the MMPA was due to the listing of the species under the ESA. Thus the criteria apply to the species as a whole. To meet the criteria worldwide, it is sufficient to meet them in each stock. The two Alaskan polar bear subpopulations (Southern Beaufort Sea, Chukchi Sea) have been identified as "stocks" under the MMPA (74 FR 69139). This Plan further assumes that all 19 of the polar bear subpopulations qualify as stocks under the MMPA. The management focus of this Plan is the United States' contribution to polar bear conservation, so the conservation actions described below focus primarily on the two subpopulations found in United States territory.

Basis for the MMPA fundamental criteria

In the MMPA, Congress found that stocks should not be permitted to diminish below their OSP level. The MMPA defines OSP as "the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element" (16 USC §1362(9)). One of the challenges in interpreting OSP for polar bears is the expectation that both the carrying capacity and the intrinsic growth rate of subpopulations may change over time due to anthropogenic forces, namely climate change. We have addressed that expectation by adopting two MMPA criteria in this Plan: one focused on managing lethal removals to maintain each subpopulation above MNPL, and one focused on maintaining healthy and stable marine habitat.

Maximum Net Productivity Level. The first criterion addresses the extent to which it is acceptable for lethal removals to reduce the size of a polar bear subpopulation relative to its potential size in the absence of such removals. This criterion integrates the biological concepts of carrying capacity, MNPL, intrinsic growth rate, sex- and age-composition of the population, sex- and age-composition of lethal removals (including subsistence harvest), and sustainable take. At any point in time, the population size at which a population is most productive is conditional on the extent to which limiting resources are utilized. The availability of limiting resources, which determine the carrying capacity, can vary naturally or through anthropogenic forces, and the MNPL will vary in proportion. Likewise, the intrinsic growth rate can vary over time, as a function of the health of the ecosystem, and the intrinsic growth rate also affects the maximum net productivity. Both of these considerations, the possibly changing carrying capacity and the possibly changing intrinsic rate of growth, need to be kept in mind when evaluating the sustainable number of removals. In long-lived mammal populations in which removals are unbiased with regard to age or sex, maximum net productivity occurs at some population size greater than 50% of carrying capacity; for polar bears, demographic analysis suggests that this level occurs at approximately 70% of carrying capacity (Regehr et al. 2015).

Health and stability of the marine ecosystem. The second criterion addresses the degree to which it is acceptable for carrying capacity or the health of the ecosystem to decline due to anthropogenic causes. It is clear that significant declines are not acceptable under the MMPA. In the "findings and declaration of policy" section of the MMPA, Congress indicates that "the primary objective of [marine mammal] management should be to maintain the health and stability of the marine ecosystem" (16 USC §1361(6)). Another purpose of the law is to ensure that stocks do not "diminish beyond the point at which they cease to be a significant functioning element in the ecosystem of which they are a part" (16 USC §1361(2)). Further, Congress directed that the "health of the ecosystem" be kept in mind when determining OSP (16 USC §1362(9)). In the extreme, if polar bears are extirpated from large parts of their range because of loss of sea ice, then they surely will have ceased to be a significant functioning element of the ecosystem; indeed, the "health and stability of the marine ecosystem" will have been compromised. The health and stability of the marine ecosystem likely can, however, be maintained, and polar bears likely can remain a significant functioning element of the ecosystem without remaining at historical numbers, provided efforts are made "to protect essential habitats… from the adverse effects of man's actions" (16 USC §1361(2)). We propose to evaluate the health of the marine ecosystem using the intrinsic growth rate for polar bears, and the stability of the marine ecosystem using the carrying capacity for polar bears. If the health of the ecosystem declines, the survival and reproductive rates of polar bears, and hence their intrinsic rate of population growth, will decline. If the ability of the ecosystem to support polar bears declines, the carrying capacity will decline.

This second MMPA criterion, perhaps the highest and most ambitious standard in this Plan, would likely require substantial reduction in worldwide greenhouse gas emissions as well as substantial reduction in the loss of sea ice Arctic-wide.

Significant functioning element in the ecosystem. Congress did not provide any further explanation of the term "significant functioning element in the ecosystem," there is not any legislative history associated with this term, and the case law is limited. Further, we are not aware of any regulatory action or conservation plans by either the USFWS or NMFS that have defined or incorporated this term. Nor is there guidance on interpreting "health and stability of the marine ecosystem." Nevertheless, we believe these purposes of the MMPA are particularly relevant for polar bear conservation because of the nature of the long-term threats, and thus, we are applying these terms in this plan.

Polar bears play a unique function in the Arctic ecosystem as a top predator. Other marine mammals also demonstrate a powerful function in their ecosystems: when sea otters (*Enhydra lutris*), for example, recolonize an area, sea urchin biomass decreases by 50–100% and kelp abundance increases greatly (Estes and Duggins 1995). Although the MMPA conservation plan for sea otters in Alaska does not discuss their function in the ecosystem in more than a passing manner (USFWS 1994), the ESA recovery plan for the southwest Alaska DPS of the northern sea otter includes a recovery objective to "maintain enough sea otters to ensure that they are playing a functional role in their nearshore ecosystem," which was estimated to occur when >50% of islands sampled were in a kelp-dominated state (USFWS 2013). In considering the ecological function of other top predators (grizzly bears and wolves) in their ecosystems, Pyare and Berger (2003) argue that the ecological function of these large carnivores is as important a measure of status as their demographic prospects, because "Research continues to demonstrate that these terrestrial carnivores, perhaps more so than most other threatened or endangered species, have far-reaching consequences for their ecosystems."

It is difficult to develop metrics that directly correlate with the function of polar bears in their ecosystem, but potential indicators include: energy flow among trophic levels linked to polar bears (Fig. 3); behavior of prey species (e.g., distribution or hauling behavior); abundance and demographics of prey species; persistence and distribution of scavengers that rely on polar bear kills (e.g., Arctic foxes); and the availability of polar bears for sustainable subsistence harvest. In an opposite manner, the role of polar bears in the terrestrial ecosystem could be indicated by effects on colonially nesting birds. Greater detail about potential measures for these indicators is provided under "MMPA Demographic Criteria" below.

MMPA demographic criteria

Maximum Net Productivity Level. At the fundamental level, MMPA Conservation Criterion 1 requires that each polar bear subpopulation size is above its MNPL; at this time, we estimate this occurs at approximately 70% of the maximum number of polar bears the environment can support on average (Regehr et al. 2015). Estimating the subpopulation size at carrying capacity, and by extension the MNPL, is challenging because environmental factors limiting population growth vary with time and are difficult to measure. Indeed, many wildlife professionals are no longer attempting to estimate theoretical concepts such as carrying capacity directly. Nonetheless, it is possible to manage wildlife populations in a way that satisfies the fundamental criterion if removal levels are based on an estimate of current population size and a harvest rate h that is designed to maintain a population above its MNPL with some acceptable level of probability. Thus, the MMPA demographic criteria

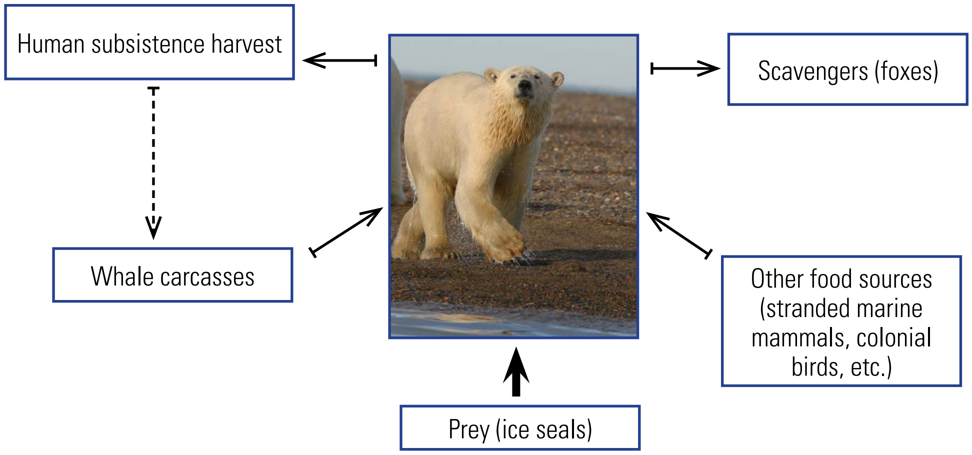

Figure 3. Functional role of polar bears in the Arctic ecosystem, from the standpoint of energy flow. The arrows and their boldness indicate the direction and magnitude of energy flow. For example, ice seals provide energy to polar bears; some small portion of that energy is left for foxes. The dashed line indicates that human activities provide whale carcasses, which can then provide energy to polar bears. The ratios of these energy flows may differ among ecoregions.

for this goal can be stated using this more proximate metric:

> **MMPA Demographic Criterion 1: Total human-caused removals in each subpopulation do not exceed a rate *h* (relative to the subpopulation size) that sustainably maintains the subpopulation above its maximum net productivity level relative to carrying capacity.**

The sustainable removal rate, h, depends on the underlying demographic rates for the subpopulation, the sex and age composition of the subpopulation, as well as the sex and age composition of removals. A valuable reference point is the removal rate, h_{MNPL}, that achieves MNPL at equilibrium when removals are in direct proportion to the sex and age composition of the subpopulation (i.e., when removals do not select for certain sex or age classes of animals). The value of h_{MNPL} is derived based on population dynamics theory, general life history parameters for the species, and subpopulation-specific demographic information (Runge et al. 2009). For polar bears, h_{MNPL} is likely 79–84% of the intrinsic population growth rate (Regehr et al. 2015). The theoretical maximum population growth rate for the species is approximately 6–14% (Taylor et al. 2009, Regehr et al. 2010) but may be less if habitat loss or other factors affect subpopulations negatively through density-independent effects.

In practice, the sustainable removal rate h can be different from the reference rate h_{MNPL} for a variety of reasons. For example, it is possible to adjust h based on the sex and age class of bears removed to allow for a 2:1 male-to-female ratio in the removals (Taylor et al. 2008), based on biological (e.g., the different reproductive value of females vs. males) or management considerations. The intent of Demographic Criterion 1 is to establish MNPL on the assumption of asymptotic population dynamics and unbiased removals, and then to ensure that the actual removals, whether biased or unbiased with regard to sex and age of the individuals removed, maintain the subpopulation size above MNPL. The specific demographic thresholds referenced here are initial proposals; further work is being undertaken to refine them, and they should be revised over time as additional data become available. Further, the risk tolerance associated with uncertainty in the estimates of these thresholds has not yet been established; there should be a high probability that the actual rate of take is less than or equal to the rate needed to achieve MNPL, but further deliberation is needed to establish what size buffer is needed to account for uncertainty in estimates of abundance and removal rate, and still produce reasonable performance relative to well-established management objectives (see Regehr et al. 2015).

It is important to note that this demographic criterion focuses on a human-caused removal rate that can be sustained, not a fixed quota. Fixed-rate harvest has a sound basis in theory and practice (Hilborn and Walters 1992), including for management of polar bears (Taylor et al. 1987). Further, it can be responsive to changing conditions, notably, a changing carrying capacity. If a subpopulation declines due to declining carrying capacity, in the absence of other legal constraints[1] take can continue

[1] The U.S.-Russia bilateral agreement concerning management of the Chukchi Sea subpopulation defines a sustainable harvest level as a “harvest level which does not exceed net annual recruitment to the population and maintains the population at or near its current level, taking into account all forms of removal, and considers the status and trend of the population, based on reliable scientific information.” In most cases, this definition of

but absolute take levels would decline. For example, at a fixed removal rate of 4.5% (Taylor et al. 1987), subpopulation sizes of 800 and 400 would lead to removal levels of 36 and 18 bears per year, respectively. The key to managing with a fixed removal rate is ongoing monitoring of the population size, the annual take, and the demographic parameters that affect the intrinsic population growth rate. Further, to ensure that the criterion is met with high probability, the data quality and precision must be taken into account (Regehr et al. 2015). Such a management program calls for the collaborative partnership of Alaska Native entities and federal agencies.

For the purposes of this Plan, several details about the interpretation of MNPL are specified. First, MNPL is understood to be proportional to the carrying capacity. If the carrying capacity changes, whether owing to anthropogenic or non-anthropogenic causes, MNPL changes in proportion. Second, MNPL is calculated by assuming that removals are unbiased with regard to age and sex of polar bears, that is, polar bears of different ages and sexes are removed in proportion to their relative abundance. Third, the proportions of actual removals need not be unbiased with regard to age and sex, provided that the total population size relative to the carrying capacity, as specified by MNPL, is sustainably achieved. These interpretations of MNPL represent the views of USFWS for the purpose of conserving polar bears. This approach does not necessarily preclude other approaches to determining MNPL in other conservation plans.

Health and stability of the marine ecosystem. As suggested above, the health and stability of the Arctic marine ecosystem, respectively, are reflected in the intrinsic rate of growth and the carrying capacity of polar bear populations. The intent of the second MMPA criterion is to ensure that polar bears remain a functioning element of the ecosystems associated with each subpopulation and that the intrinsic growth rate and carrying capacity do not decline to the point that this function is lost. Although this does not require maintaining the historical levels of intrinsic growth rate and carrying capacity, it will require substantial and successful efforts to limit the anticipated losses from climate change, so that polar bears and their ecosystem remain healthy and stable. The following criterion is intended to serve as a placeholder until a more specific criterion can be developed.

sustainable take is more conservative (it restricts take more) than the definition in this Plan. Thus, management of human-caused removals in the Chukchi Sea under the pre-existing bilateral agreement is also likely to meet the criteria for human-caused removals under this Plan.

MMPA Demographic Criterion 2: The intrinsic growth rate of each subpopulation is above, and is expected to remain above, a minimum level that indicates the health of the marine ecosystem is not substantially impaired; and the carrying capacity in each subpopulation is above, and is expected to remain above, a minimum level that indicates that the stability of the marine ecosystem is not substantially impaired. (To be further developed.)

Significant functioning element in the ecosystem. Regarding polar bears as a functioning element of the ecosystem, complex methods to assess the functional diversity of ecosystems have been proposed (e.g., Petchey and Gaston 2002), but the application of such methods to a changing Arctic involving polar bears would likely be difficult and insensitive to meaningful near-term ecological changes. Thus, at this time, we do not have enough information to propose more detailed measures, and associated thresholds, to directly assess the functional role of polar bears in their ecosystem. Development of such measures is an important task under this Plan. Instead, we offer some potential approaches that could serve as proxies by focusing on particular roles that polar bears play. Thoughtful development of approaches like these could help with assessment as this Plan is updated in the future.

- Energy flow among trophic levels linked to polar bears (Fig. 3). Complex assessments of trophic level energy flow have been produced for some Arctic systems (Whitehouse et al. 2014), but the suitability of these complex models to assess polar bear-specific changes in energy flow as sea ice declines and as polar bear distribution and numbers respond is unknown at this time.
- Behavior of prey species. As a top predator in the Arctic ecosystem, polar bears have influenced the behavioral responses of their primary prey, ice seals. An indicator of the loss of polar bears as functioning elements of the ecosystem might be changes in prey behavior, such as pupping site selection and flight response. Of course, changes in prey behavior could also result directly from habitat and climate changes; care would be needed to identify the cause of changes.
- Distribution and demographics of prey species. Likewise, loss of the ecosystem function of polar bears might become apparent in changes in the distribution and demographics of ice seals. Seal productivity might increase and the age-distribution of seal populations might change.
- Persistence and distribution of scavengers that rely on polar bear kills (e.g., foxes).

One aspect of trophic energy flow in the Arctic is from polar bear prey remains to other species like foxes and avian species (Stirling and Archibald 1977). While difficult to document with caloric measures, such energy flow could be measured indirectly by the persistence and distribution of carrion-dependent species such as arctic fox (Alopex lagopus).

- Availability of polar bears for sustainable subsistence harvest. One of the functional roles that polar bears have played in the Arctic ecosystem for millennia is as traditional resource for humans. The availability of sustainable subsistence harvest of polar bears is an indicator of the retention of their functional role in the ecosystem.
- Polar bear behavioral diversity necessary to maintain resilience to environmental stressors. Resilience is "the capacity of a system to absorb disturbance, undergo change and still retain essentially the same function, structure and feedbacks" (Walker and Salt 2006). Behavioral diversity could be measured by diversity of food habits, adaptation to different ice conditions, diversity of movement patterns and distribution resulting in successful survival and reproduction, and adaptation to longer periods on land.
- Measures of habitat that could serve as proxies for the health of the ecosystem.

ESA Threats-based Criterion 1 (see below) describes sea-ice conditions that would contribute to recovery. These same conditions might also be useful indicators of the health and stability of the marine ecosystem, although they would need to reflect the differences between the conservation goals of the MMPA and the recovery goals of the ESA.

For all of these potential approaches, although it would be a challenge to separate direct climate effects on the ecosystem from indirect effects of climate through the role of polar bears in the ecosystem, there may nevertheless be ways to quantify the function of polar bears in a sufficiently healthy ecosystem.

USFWS

C. Recovery Criteria Under the Endangered Species Act

The ESA requires a recovery plan to incorporate, to the maximum extent practicable, "objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list [of endangered and threatened wildlife]…" (16 USC §1533(f)(1)(B)(ii)). Following a three-tier framework, this Plan describes recovery criteria at three levels (Table 1): fundamental, demographic, and threats-based. These criteria are meant to be compatible: the demographic and threats-based criteria are derived from the fundamental criteria, using the best available scientific information available at the time of assessment. To achieve recovery, the criteria at all three levels need to be met.

ESA fundamental criteria

The aspects of Fundamental Goals 1 and 2 that refer to securing long-term persistence are tied to recovery under the ESA. Here, those Goals are translated into quantitative measures with threshold criteria associated with recovery. At the fundamental level, both of the following criteria need to be met to achieve recovery of polar bears:

> **Recovery Criterion 1: the worldwide probability of persistence is at least 95% over 100 years.**

> **Recovery Criterion 2: the probability of persistence in each recovery unit (ecoregion) is at least 90% over 100 years.**

Basis for the ESA recovery criteria

The conservation of species is a key purpose of the ESA, and the Act defines conservation in terms of bringing species to the point that the Act's provisions are no longer necessary. The ESA does not specify a numerical standard for determining when a species is threatened or endangered, nor is there a universal approach for making such determinations. Although the ESA does not use terms such as "probability" or "persistence," the definitions of endangered ("in danger of extinction throughout all or a significant portion of its range," 16 USC §1532(6)) and threatened suggest that the risk of extinction is a primary concern. Thus, many scholars of the ESA have identified the fundamental goal of recovery as reducing the probability of extinction to an acceptable level, stated equivalently as keeping the probability of persistence above some threshold (e.g., Doremus 1997, Gregory et al. 2013, Ralls et al. 2002, Regan et al. 2013, Seney et al. 2013). In listing decisions and recovery plans where probability of persistence has been used, the threshold between "threatened" and "listing is not warranted" has been characterized by a number of values, roughly ranging between 90% and 99% probability of persistence over a century (e.g., USFWS 1995, 2002; see also DeMaster et al. 2004, Regan et al. 2013).

This Plan uses probability of persistence to express the fundamental recovery criteria for polar bears. Given the nature of the primary threat to polar bears–loss of sea ice due to changes in climate–as well as the speed at which the climate would respond to changes in atmospheric levels of greenhouse gases, 100 years is a time period over which we could see movement towards recovery or towards extinction depending on worldwide efforts to curtail emissions. The first criterion focuses on the listed entity (the worldwide population of polar bears) and indicates this particular measure of recovery will be achieved when the probability of persistence over 100 years is at least 95%.

Beyond this Plan's first criterion for survival of the listed entity, the second criterion further specifies that a significant portion of the diversity of the species, as represented by the ecoregions, must also be conserved, in order to promote recovery through representation, redundancy, and resilience. The risk tolerance for extinction for each of the individual ecoregions (10%) is higher than for the species as a whole (5%) because the ecoregions are only components of the listed entity.

The purposes of an intermediate-scale (i.e., recovery unit) in Recovery Criterion 2 include (1) to preserve diversity among polar bears—diversity that is at the heart of ESA protection and important to species viability; (2) to acknowledge that polar bears in different regions may experience different threats and conditions and exhibit different responses to those, which may warrant different conservation approaches now or in the future; and (3) to augment resilience, and hence the survival of the species, by conserving polar bears in more than one region. In order to remove the danger of extinction "within the foreseeable future throughout all or a significant portion of the range" (16 USC §1532(20)), a high probability of persistence in each of the recovery units is needed.

Ecoregions. The best available science suggests that the "ecoregions" proposed by Amstrup et al. (2008) capture broad patterns in genetic and life history variation for the species. Furthermore, ecoregions were based on observed and forecasted changes in sea-ice habitat and thus capture anticipated variation in the primary long-term threat. We recognize that further research, building on an existing body of work (Spalding et al. 2007, Thiemann et al. 2008), is needed on details of the genetic, behavioral, ecological, and threats-based factors that distinguish spatial groupings of polar bears.

Recovery Units. In ESA recovery planning, a "recovery unit" is "a special unit of the listed entity that is geographically or otherwise identifiable and is essential to the recovery of the entire listed entity, i.e., recovery units are individually necessary to conserve genetic robustness, demographic robustness, important life history stages, or some other feature necessary for long-term sustainability of the entire listed entity." Furthermore, "establishment of recovery units can be a useful recovery tool, especially for species occurring across wide ranges with multiple populations or varying ecological pressures in different parts of their range." (NMFS 2010, section 5.1.7.1). Because recovery units are "essential to the recovery of the entire listed entity," the criteria must be met in all recovery units in order for recovery to be achieved and for delisting to be recommended.

Ecoregions as recovery units. Polar bears occur in 19 subpopulations throughout the circumpolar Arctic; one of the largest ranges for an extant large carnivore. Within this range the species exhibits variation in genetics, behavior, and life history strategies. Within the timeframe considered by this Plan, polar bears are expected to experience different pressures resulting in potentially high probabilities of extirpation (e.g., in some parts of the Polar Basin Divergent Ecoregion) to moderate probabilities of persistence (e.g., in the Archipelago Ecoregion) (Amstrup et al. 2008, 2010). National and local management regimes, including collaborative management across jurisdictions, also vary across the species' range.

This Plan uses the four ecoregions as recovery units because this approach provides a reasonable representation of important variation for both polar bears and the threats they face. This approach helps augment the resilience of polar bears as a whole by conserving them in multiple regions and allowing conservation actions to be tailored to the most pressing issues in each region. Although there is reasonable certainty about many climate effects likely to emerge over the next century in the Arctic, as well as how polar bears are likely to respond to those effects, there also are uncertainties (Atwood et al. 2015). In addition, there is considerable uncertainty about how the primary threat of sea-ice loss can or will be addressed through global action. Consequently, persistence of polar bears in all four ecoregions is necessary to the recovery of the listed entity.

As understanding of polar bears, climate change effects, and other relevant information increases, the delineation of the recovery units should be reviewed and, if appropriate, modified, to reflect the best available science. Any intermediate-scale grouping of polar bears will reflect a number of assumptions and imperfections, due to scientific uncertainty and the dynamic nature of climate change and its effects on ecosystems. Using the four ecoregions as recovery units represents a precautionary approach in that current knowledge of the ecological diversity of polar bears and their future response to climate change is imperfect. As a result, it is important to conserve as broad a representation of current polar bear diversity as possible, while seeking to improve our scientific understanding of the distribution of important polar bear ecological diversity.

Definition of "persistence." In the two ESA recovery criteria (above), we define "persistence" as maintaining the population size in a recovery unit (or worldwide) at greater than 15% of the population size of the unit at the time of listing or greater than 100 individuals, whichever is larger. If, at any point during a 100-yr forecast, the projected population drops below this threshold, it is considered not to have persisted. This threshold is not a desired population target. Rather, by focusing on the probability of persisting above the threshold, the criteria represent the risk tolerance at which we could reasonably conclude that polar bears are no longer threatened. To achieve recovery, the population size needs to be sufficiently larger than the threshold and the threats sufficiently reduced to ensure that the risk of dropping below the threshold is small (i.e., less than 10% over 100 years). For large mammals, the effects of demographic stochasticity become prominent at population sizes less than 100 (Morris and Doak 2002, Wieglus 2001). For polar bears, mating success may decline when subpopulation density falls below a fraction of present-day values (i.e., there might be an Allee effect), but this point depends on the sex- and age-structure of the population, as well as the population-specific demographic parameters (Molnár et al. 2008, 2014). As the geographic scope expands from subpopulation to recovery unit to species, the Allee effect threshold may occur at lower fractions of the original population size, and will depend on the geographic distribution of bears within the unit. The 15% threshold is a placeholder based on available information at a subpopulation level (Molnár et al. 2008), and should be re-evaluated on a case-by-case basis and as new information arises.

ESA demographic criteria

The demographic recovery criteria are derived from the fundamental recovery criteria, but are stated in more proximate measures of population status. The spatial scale of the demographic criteria is the recovery unit. Although the listed entity is polar bears throughout their range, Recovery Criterion 2 identifies the ecoregions as recovery units. To meet the ESA recovery criteria, the fundamental and demographic recovery criteria need to be met for each recovery unit. Thus, the recovery criteria can be focused at the recovery unit level. Recognizing that the United States only has management jurisdiction in parts of one recovery unit (the Polar Basin Divergent Ecoregion), that unit is the main focus of our recovery efforts, but assessment of the recovery of the listed entity needs to consider all of the recovery units.

The demographic criteria focus on three measures of population status: survival rate, reproductive rate, and carrying capacity. Recovery at the recovery-unit (ecoregion) scale would be achieved when all four of the following criteria are met:

> **ESA Demographic Criterion 1: The mean adult female survival rate (at a density corresponding to maximum net productivity level) in each recovery unit is at least 93–96%, both currently and as projected over the next 100 years.**
>
> **ESA Demographic Criterion 2: The ratio of yearlings to adult females (at a density corresponding to maximum net productivity level) in each recovery unit is at least 0.1–0.3, both currently and as projected over the next 100 years.**
>
> **ESA Demographic Criterion 3: The expected carrying capacity in each recovery unit is at least 500 or 15% of the population size at the time of listing, whichever is greater, both currently and as projected over the next 100 years.**
>
> **ESA Demographic Criterion 4: Total human-caused removals in each recovery unit do not exceed a rate *h* (relative to the population size in the recovery unit) that sustainably maintains the population above its maximum net productivity level relative to carrying capacity.**

Although Fundamental Recovery Criterion 2 (90% probability of persistence at the recovery unit level) is the standard for assessment, these demographic criteria use population metrics to represent an equivalent condition, given the current state of knowledge. These are, of course, a simplification of all the population dynamics that give rise to a high probability of persistence, but these are based on the most influential drivers of persistence. Based on life-history theory, adult female survival exerts the largest influence on population growth rate, which is, in turn, a strong driver of resilience and persistence. The ratio of yearlings to adult females incorporates a number of aspects of the recruitment process: breeding probability, litter size, and cub-of-the-year survival. Populations need recruitment to persist, and for some long-lived species, recruitment rates vary more than adult survival rates and drive most of the observed variation in population growth rate. Finally, the probability of persistence is related to population size and hence carrying capacity, because the risk associated with annual variation and chance events is magnified at smaller population sizes.

The first three demographic recovery criteria are not independent. The specific threshold required for any one depends on the thresholds required for the other two (Fig. 4). For example, if the carrying capacity were only expected to remain above 500 and the recruitment rate (ratio of yearlings to adult females) were expected to remain above 0.2, the adult female survival rate would need to remain above 0.95 (assuming the rate of human-caused removals is less than h). Because many possible combinations of these three parameters can produce the same probability of persistence, the criteria are described as ranges, but to achieve recovery, the combination of demographic criteria needs to meet the standards for ESA Fundamental Criterion 2 (90% probability of persistence for the recovery unit).

The third demographic criterion (carrying capacity greater than 500 bears or 15% of the population size at the time of listing, whichever is greater) provides the buffer that is needed to protect the population in a recovery unit from dropping below the level at which small-population dynamics take over. The threshold of 500 is derived by considering what is needed to achieve ESA Recovery Criterion 2 at the subpopulation level (Fig. 4, Regehr et al. 2015). As noted earlier, there is uncertainty about how to scale potential Allee effects up to the ecoregion level; 15% of the population size at the time of listing is retained as a protective threshold until better scientific information is available.

The fourth demographic criterion specifies an upper bound on the rate of human-caused removals, and the other demographic criteria have been calculated assuming that rate. If the rate of human-caused removals is less than this upper bound, the demands for the other demographic criteria can be reduced, provided the persistence criterion is met. It is also possible to meet ESA Fundamental Criterion 2 (90% probability of persistence over 100 years) without meeting ESA Demographic Criterion 4 (human-caused removal rate less than h), but this would require even higher survival and reproductive rates than specified by the second and third demographic criteria (see discussion, below, of ESA Threats-based Criterion 2). Thus, while the fourth demographic criterion is not strictly necessary for recovery, we have included it as a recovery criterion because it is by far the more likely path to recovery, the combination of non-anthropogenic mortality and anthropogenic mortality is critical, and the other demographic criteria can only be set in the context of the anthropogenic mortality.

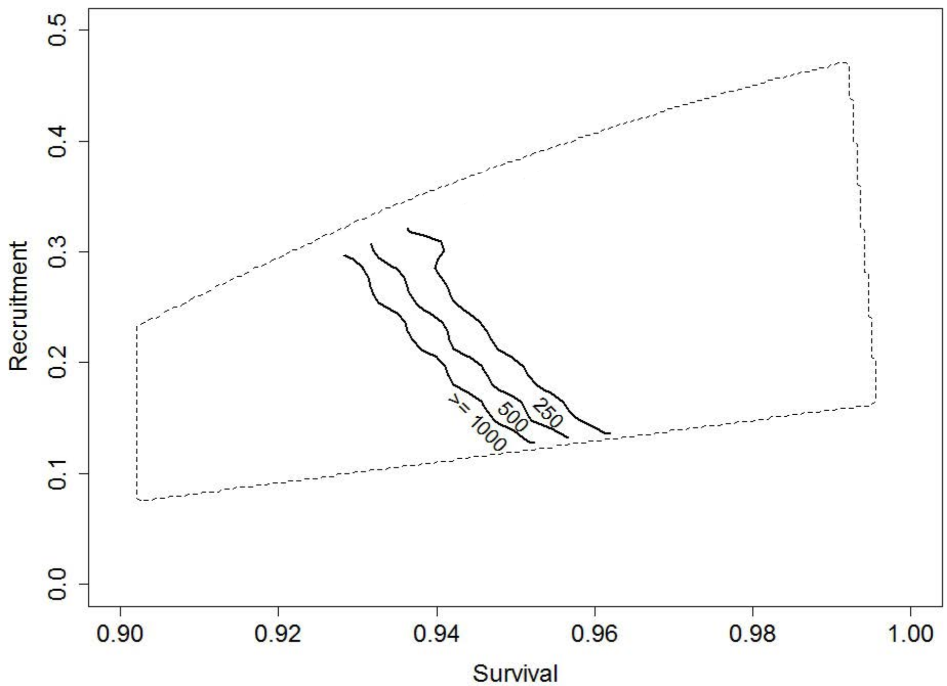

Figure 4. Values of three ESA demographic criteria that provide a 90% probability of persistence (Regehr et al. 2015). There are trade-offs among these criteria, such that if any of these measures are quite high, the standard for the others can be lower. For example, if the recruitment rate (yearling to adult female ratio) was expected to remain above 0.3 and the carrying capacity was expected to remain above 1000, the adult female survival rate would only need to be 0.93 to achieve recovery. In this graph, the rate of total human-caused removals is assumed to be at the maximum rate allowable under MMPA Demographic Criterion 1.

There are three particular challenges in developing and evaluating these demographic criteria: climate change effects, density-dependence, and harvest. First, sea-ice loss related to climate change is a long-term threat that will present changing conditions for ice-dependent Arctic species like the polar bear. All of these demographic criteria are likely met currently for the Divergent Ecoregion, as well as for others; the concern is that they will not continue to be met as climate-driven sea-ice loss increases, which is why polar bears were listed. Thus, the evaluation of the demographic criteria needs to assess whether they will continue to be met over the next 100 years. Second, survival and recruitment (the first two demographic criteria) may be density-dependent, that is, they naturally decrease as the population size approaches carrying capacity. Thus, a threshold value for those rates is meaningless unless it is associated with a particular population density. Here, we have chosen to establish these criteria in reference to the MNPL, which is the population size, relative to the carrying capacity at a point in time, that produces the highest net annual production, assuming removals are unbiased with regard to age and sex. This is a particularly practical reference point because for polar bear populations that are managed to be near MNPL, the observed survival and recruitment rates can be compared directly to the criteria. Third, for any populations that are subject to direct human-caused removals, the survival rate will be the product of both the survival rate in the absence of anthropogenic take and the survival rate associated with those removals, taking into account the sex and age composition of the population and of the removals. The survival rate in Demographic Criterion 1 refers to the survival rate in the absence of removals, and hence encompasses non-anthropogenic mortality; the total take rate in Demographic Criterion 4 refers to anthropogenic mortality.

The demographic criteria listed above are stated in terms of average values of the true underlying rates, not annual rates. Annual variation around these mean values is expected; the criteria require that the mean values of those stochastic processes be above the indicated thresholds. Using average values assumes that potential future change in how much the rates vary from year-to-year will not, in itself, have a meaningful effect on persistence. Also the demographic criteria were derived assuming a perfect ability to estimate them; the empirical precision needed has not yet been developed. If the demographic rates are measured or forecast with considerable error, then it is possible to think that the criteria have been achieved when the true values do not, in fact, meet the criteria or, vice versa, to think that the criteria have not been achieved when, in fact, they have. The risk due to sampling error has not been directly incorporated into the interpretation of these criteria, but that consideration should be evaluated carefully whenever a population status assessment is made, and could be incorporated into a future revision of this Plan.

The estimation of annual and mean rates for three of the four demographic parameters (survival, recruitment, and take rates) can be conducted with monitoring programs that are already in place in several polar bear subpopulations, including the Southern Beaufort Sea. These programs involve the marking and recapturing of individual bears over time. Note, however, that the existing monitoring programs are focused at the subpopulation level but the ESA demographic criteria are focused at the recovery unit level; research will be needed to understand how to make inference at the recovery unit level from data at the subpopulation level (Regehr et al. 2015). The estimation of the fourth demographic parameter, carrying capacity, is notoriously challenging, because the link between habitat variables and population responses is often poorly understood. Modern statistical methods (known as "hierarchical models") provide a way to estimate "latent" parameters like carrying capacity, by integrating survival, recruitment, harvest, habitat, and population size data into a single statistical framework (Royle and Dorazio 2008). If such a statistical model is developed for polar bears, it can then be linked to forecasts of the habitat variables (Durner et al. 2009) to provide the current and projected estimates of carrying capacity needed for Demographic Criterion 3.

As noted above, these demographic criteria should be subject to periodic revision as new information becomes available to inform their derivation. Because of this, use of the demographic criteria is not a substitute for development of a full population viability analysis for evaluation of the fundamental recovery criteria. Such development will allow both refinement of the demographic criteria as well as direct evaluation of the fundamental criteria.

ESA threats-based criteria

The ESA threats-based recovery criteria are derived from the fundamental and demographic recovery criteria described above, but are stated with regards to the threats to the species, so that they correspond to the listing factors described in the ESA (16 USC§1533(a)). The listing rule for polar bears identified one threat, loss of sea ice, under Factor (A) "threatened destruction…of its habitat." The rule also acknowledged, under Factor (D) "inadequacy of existing regulatory mechanisms," that "there are no known regulatory mechanisms in place at the national or international level that directly and effectively address the primary threat to polar bears—the range-wide loss of sea-ice habitat" (73 FR 28288). In what follows, we discuss threats-based recovery criteria in three categories: those threats that were identified in the listing rule and are currently an impediment to recovery (sea-ice loss); those potential threats that are not currently an impediment to recovery, but could become impediments before the threats in the first category are addressed; and those potential threats that could become an issue in the future, but are of more distant concern at this time. We develop threats-based recovery criteria for the first two categories, but not the third, noting that future revisions of this Plan will need to revisit the proximity and severity of threats and potential threats in all categories.

As with the demographic recovery criteria, the scale of the threats-based criteria is the recovery unit. To meet the ESA recovery criteria, the demographic and threats-based recovery criteria need to be met for each recovery unit.

Sea ice and terrestrial habitat. The primary threat to polar bears is loss of its sea-ice habitat, driven by global climate change. In several subpopulations, the physiological and demographic effects of longer ice-free periods are already evident (Regehr et al. 2007, 2010; Rode et al. 2014; Bromaghin et al. 2014) and polar bears already have exhibited behavioral responses to longer ice-free periods, spending more time on land during the summer (Fischbach et al. 2007, Schliebe et al. 2008). Given the predicted increase in ice-free periods, these behavioral changes are anticipated to increase and are expected to lead to an increase in population-level demographic effects in the future. In the long-term, recovery of polar bears will require measures to address the loss of sea ice (climate change mitigation); in the mid-term, recovery may also require attention to conservation of the terrestrial habitats polar bears use during the ice-free months. While there could be some trade-off among these efforts, such that greater terrestrial conservation might allow for achieving recovery of polar bears with lesser climate mitigation than otherwise would be needed, the most critical aspect is that polar bears are able to maintain adequate access to prey resources. Both aspects of this threat (sea ice and terrestrial habitat) are discussed below: a specific criterion is offered for sea ice; development of a criterion for terrestrial habitat will require more research.

In three of the four recovery units (Polar Basin Divergent, Polar Basin Convergent, Archipelago, Fig. 2), the annual ice-free period has historically been short and polar bears have had potential access to seals nearly uninterrupted year-round. But for one of the recovery units (Seasonal Ice, Fig. 2), polar bears have historically coped with an ice-free summer during which they had reduced access to prey. There is empirical evidence that the potential for fasting mortality may increase after 120 days (Lunn and Stirling 1985; Molnár et al. 2010, 2014; Robbins et al. 2012; Cherry et al. 2013), thus, we assume that polar bears, given sufficient access to prey during other times of year, are capable of persisting with an average ice-free period of less than 4 months. It is possible that polar bears can persist with a longer ice-free period than 4 months, or could do so if they made adaptations (e.g., altered seasonal migration, alternative food sources). To achieve recovery in a recovery unit, we would either need to have evidence that the ice-free period was going to remain shorter than 4 months, or evidence that the ice-free period was going to stabilize at something longer than 4 months and that polar bears were able to persist at that longer ice-free period.

> **ESA Threats-based Criterion 1 (Sea ice): In each recovery unit, either (a) the average annual ice-free period is expected not to exceed 4 months over the next 100 years based on model projections using the best available climate science, or (b) the average annual ice-free period is expected to stabilize at longer than 4 months over the next 100 years based on model predictions using the best available climate science, and there is evidence that polar bears in that recovery unit can meet ESA Demographic Criteria 1, 2, and 3 under that longer ice-free period.**

In making this assessment, the focus is on the area of seasonal or permanent sea ice supporting prey resources that underlie the carrying capacity of a recovery unit. An ice-free month is defined as a month during which less than 50% of the relevant area of sea is covered by sea ice with more than 50% ice concentration (based on monthly average sea-ice concentration, or for more than 15 days if based on daily sea-ice data). In addition to aligning with the timeframe of the fundamental recovery criteria, a 100-year period is used to allow positive feedbacks in the climate system to equilibrate (e.g., the potential release of sequestered sources of greenhouse gases), and to average over short-term trends caused by natural decadal-scale climate oscillations (Kay et al. 2011, Lovejoy 2014). The assessment of the stability of the ice-free period in part (b) above should accommodate the expectation that uncertainties in 100-year forcing scenarios and differences among model ensembles may produce some forecasts with subtle increases in the length of the ice-free period (i.e., of no more than 1 month over 100 years), which we accept as indistinguishable from "stable."

These criteria may change in future revisions of the Plan as more is learned about polar bears, their habitat requirements, the availability of alternate prey (such as stranded marine mammals), and how they and their prey populations respond to diminishing sea ice. The sea-ice criteria use ice cover projections as a proxy for the amount of time polar bears will be forced ashore or away from sea ice over shelf waters during summer in the future. How an ice-free month is defined underpins the proxy's efficacy, and the definition should be revised as more is learned about what sea-ice conditions best predict when polar bears arrive and depart from land, and how those relationships differ in different recovery units.

Assessments of future sea-ice conditions should be made using projections from an ensemble of state-of-the-art, fully-coupled, general circulation models (GCMs) (Harris et al. 2014). Each model in the ensemble should possess reasonable ability to simulate past satellite observations of seasonal sea-ice dynamics (Wang and Overland 2009, Massonnet et al. 2012). For projecting future sea-ice conditions, the GCMs should be forced with one or more scenarios that depict plausible levels of forcing for a baseline future in which no presumptions are made about greenhouse gas mitigation practices that have not yet been adopted into law or that do not already show empirical evidence of adoption. What constitutes the baseline will change over time as nations enact both statutory and voluntary changes to address greenhouse gas emissions, and future assessments should reflect these changes. If more than one baseline forcing scenario is deemed plausible, the sea-ice criteria should be evaluated using projections from an unbiased representation of the competing scenarios. Each model should be represented by an equivalent number of realizations (model runs), preferably more than one.

Using projections of future sea ice from climate models assumes that the primary limiting feature of the environment for polar bears is the sea-ice platform itself, and that if the platform is stabilized then polar bears will have adequate access to prey (primarily ice seals). It is conceivable that changes to the environment could alter the seal populations and distributions so that even if the ice platform were stabilized, polar bears would not have access to suitable prey. Such a situation was not identified as a threat in the listing rule, but future status assessments should be aware of and reevaluate this assumption, especially as four subspecies of ringed seals and one distinct population segment of bearded seals currently are listed under the ESA (77 FR 77706, 77 FR 76740).

Although polar bears in several of the recovery units have historically spent the majority of their life on the sea ice, land has been and is increasingly becoming important for denning and as a summer refuge (Kochnev 2002, Ovsyanikov 2012, Fischbach et al. 2007). Given that the extent of summer sea ice is projected to decline through the 21st century (Overland and Wang 2013), terrestrial habitat is likely to become an increasingly important refuge for polar bears.

The ability of bears to maintain access to terrestrial denning areas without compromising foraging opportunities pre- and post-denning may be an important factor determining whether reproduction and cub survival is affected by sea-ice loss (Derocher et al. 2004). Land as a summer refuge, to rest and minimize energetic losses, may become increasingly important to polar bears as summer sea ice declines. This seasonal change in polar bear distribution may have effects on shore-based industrial development, human communities, and the ecosystem. This distributional change may also have ramifications for the status of the polar bear recovery units if use of terrestrial habitat has fitness or genetic implications.

While ice habitat is critical to the ability of polar bears to access their prey, protection of denning and summering habitats is and may become increasingly important in supporting the long-term persistence of polar bears, including in the Polar Basin Divergent Ecoregion. Increased use of land is likely to heighten the risk of human-bear interactions and conflicts, particularly if anthropogenic activity in the Arctic increases as projected (e.g., Vongraven et al. 2012), the human population in the Arctic grows, and management of attractants to polar bears is not improved. Moreover, an expanding anthropogenic footprint has the potential to influence the spatial distribution, connectivity, and quality of lands that might serve as terrestrial refugia for polar bears. Currently, we believe that access to usable terrestrial habitats is not compromised for polar bears, but there is insufficient data at this time to formalize the criteria required to protect terrestrial habitat. Further monitoring is needed of any potential threats to polar bear terrestrial habitat use and availability, and the effects those threats may have on population vital rates.

Human-caused removals. There are multiple types of direct, lethal removals of polar bears, including sustainable legal harvest, unsustainable legal harvest, illegal harvest (poaching), authorized incidental take, human-bear conflicts that result in the death of polar bears, and polar bears killed as a direct result of human activity (e.g., oil spills). In many of the polar bear subpopulations where data are available, mortality due to harvest exceeds mortality to manage human-bear conflict, which exceeds human-caused mortality from other sources (Shadbolt et al. 2012).

The subsistence harvest of polar bears, as represented by Fundamental Goal 4, was not identified as a threat to polar bears in the listing rule, and should not become a threat to recovery so long as harvest occurs at a sustainable rate that has only a small or negligible effect on the persistence of populations (Atwood et al. 2015, Regehr et al. 2015). Guidelines for a sustainable rate for total human-caused removals, including subsistence harvest, are established under the MMPA-based demographic criteria associated with Fundamental Goal 3 and related to Fundamental Goal 4. In brief, these criteria seek to: (1) identify a sustainable human-caused removal rate that maintains populations above the MNPL; (2) protect the opportunities for subsistence harvest by minimizing other lethal take; and (3) establish co-management of polar bears by Alaska Native and Federal partners.

The ESA-based criterion for the total level of direct, lethal removals for polar bears by humans, as described here, does not replace the MMPA-based criteria for human-caused removals. Rather, the ESA-based criterion represents a less protective take threshold at which removals would compromise polar bear persistence in relation to Fundamental Goals 1 and 2 (the MMPA-based criterion additionally requires that take be low enough to allow the population to stabilize above MNPL). A quantitative Population Viability Analysis, similar to that used for estimating demographic criteria, represents an appropriate tool for evaluating the effects of total human-caused removals following the tiered framework proposed below.

The 2008 listing rule found that currently, human-caused removals "[do] not threaten the polar bear throughout all or a significant portion of its range" but that "Continued efforts are necessary to ensure that harvest or other forms of removal do not exceed sustainable levels" (73 FR 28280). Provided the following criterion is met, human-caused removals will not be considered a "threat" to recovery.

> **ESA Threats-based Criterion 2 (human-caused removals): For each recovery unit, the total level of direct, lethal removals of polar bears by humans, in conjunction with other factors, does not reduce the probability of persistence below 90% over 100 years.**

As written, this criterion is largely a recapitulation of ESA Fundamental Criterion 2 (90% probability of persistence in each recovery unit), with a focus on the effect of human-caused removals on the probability of persistence. In the event that an appropriate quantitative model is not available to assess this criterion, it could be evaluated using a tiered approach:

1. **Criterion met:** Total human-caused removals are below the sustainable removal rate that maintains the population above MNPL (*h*), as defined under ESA Demographic Criterion 4. Removals at this rate are likely to have no effect, or a negligible effect, on persistence. In this case, a population viability analysis would not be needed to know this criterion was met. As noted earlier, this is also the most likely path to recovery, given the other motivations in this plan to maintain removals at or below this sustainable level.
2. **Criterion possibly met:** Total human-caused removals exceed *h* but are below the upper limit described under "Criterion not met." Removals within this range could result in different outcomes, including: sustainable with a negligible effect on persistence; sustainable but leading to a small equilibrium population size, and therefore either having some negative effect on persistence over the period of interest or shortening the median time to extirpation; or unsustainable and having a significant negative effect on persistence. The annual removal rate and its effects must be balanced against other Fundamental Goals and threats to achieve the desired overall level of persistence as stated in ESA Fundamental Recovery Criterion 2. This is the range in which ESA Demographic Criterion 4 is not met but recovery is still possible, provided the other demographic rates exceed their minimal standards enough to meet the persistence criterion. If the human-caused removals in a recovery unit were in this range, a population viability analysis would be needed to assess this potential threat.
3. **Criterion not met:** Total human-caused removals result in a 10% or greater decrease in the probability of persistence over 100 years, compared to a scenario with no removals. At this upper limit, removals would violate ESA Fundamental Criterion 2 even in the absence of all other threats.

Disease and parasites. At present, as described in the 2008 listing rule, exposure to disease and parasites is not a threat to the persistence of polar bears. However, data on the exposure of polar bears to disease agents and parasites are quite limited (i.e., restricted almost entirely to the Southern Beaufort Sea subpopulation), and there is no information on putative links between disease status and population vital rates. The lack of information is a concern given that climate change is expected to have both direct and indirect effects on disease dynamics in the Arctic due to changes in host-pathogen associations, altered transmission dynamics, and host and pathogen resistance (Burek et al. 2008). Concern is exacerbated by the fact that polar bears have a naïve immune system (Weber et al. 2013), which may make them particularly vulnerable to new pathogens, and greater time on land during ice-free summers may increase exposure to new pathogens. Nonetheless, the best available science currently indicates that disease and parasites are not a threat to polar bears (Atwood et al. 2015). Disease and parasites will remain not a threat provided the following criterion continues to be met:

> **Disease and parasites: For each recovery unit, the best available science indicates that (1) infection is not persisting endemically, as measured by an assessment of trend in indicators of exposure (e.g., prevalence, incidence) to disease agents (i.e., bacteria, viruses, and parasites); or (2) infection is persisting endemically, but forecast population-level effects that consider future infection rates as a function of biotic and abiotic interactions suggest that the risk of extirpation due to infections, in conjunction with other factors, is less than 10% over 100 years.**

Additional factors of potential future concern. A number of other factors, including shipping, oil and gas development, and oil spills, were evaluated in the 2008 listing rule for polar bears but not found to be threats; thus, they do not require threats-based recovery criteria. Further, because the potential for these factors to become threats in the future is distant or low enough (Atwood et al. 2015), they do not warrant development of specific criteria to indicate when they might become a threat. The continued decline of summer sea ice will allow greater human access to the Arctic Ocean, easing the prospect of oil and gas exploration and development (Gautier et al. 2009) and the opening of new shipping routes (Smith and Stephenson 2013). There are a number of hypothesized ways this increased activity could affect polar bears, but perhaps the greatest risk is through exposure to oil spills, because even minimal ingestion of oil by polar bears can be lethal (St. Aubin 1990). Other activities, like coastal patrol, research, and commercial fishing, could also increase with the decline of summer sea ice. But, changing ice conditions have only recently allowed increased human activities in the Arctic Ocean and limited information exists to predict how polar bear populations would respond to increased human activity (Peacock et al. 2011, Vongraven et al. 2012). The current partnerships in the United States between industry and natural resource management agencies have led to successful mitigation efforts that have limited disturbance to denning bears and reduced the number of bears killed in defense of life, and are likely to continue to do so in the near future. While monitoring of these potential avenues of stress to polar bears is warranted, these factors do not require threats-based criteria at this time. In future updates to this Plan, however, these factors should be reevaluated.

D. Other Measures of Achievement

Fundamental Goals 4, 5, and 6 are not derived directly from statute, but instead are included because they are expressions of other societal values that could be affected by polar bear management. Performance requirements do not need to be prescribed for these goals (as they do for ESA recovery criteria and MMPA conservation criteria). It is important, however, to measure achievement of these goals, particularly to provide an adaptive feedback loop for improving future conservation actions. The following three measurement scales provide quantitative expressions of these Fundamental Goals.

Fundamental Goal 4, measurement scale: cumulative sustainable take (all human-caused removals) level over the next 50 years for each subpopulation that includes parts of Alaska. The cumulative sustainable take level over the next 50 years represents the opportunity for subsistence harvest by multiple generations of Alaska Natives combined with other forms of human-removal. We strive to ensure sustainable subsistence harvest opportunities, although providing the opportunity does not require that the take rise to the full sustainable level. Note that in this context "sustainable" may include ongoing harvest—even for populations that are declining due to environmental effects—as long as the harvest is responsibly managed and does not in itself become a driver of declining ability to secure long-term persistence.

Fundamental Goal 5, measurement scale: number of human/bear conflicts in Alaska that result in injury or death to humans or bears. With decreasing sea ice, we anticipate an increase in the number of bears onshore and an increase in human activities in the Arctic. This combination will likely result in an increase in human-bear encounters. To ensure that the measurement scale actually reflects the effectiveness of conservation efforts in improving human safety, monitoring of additional variables associated with human-bear encounters will be needed to provide context.

Fundamental Goal 6, measurement scale: economic impacts of polar bear management actions, where "economic impacts" means additional cost (direct expense, indirect expense, lost or foregone opportunity, additional time) associated with a specific action. This goal acknowledges that while our primary goal is polar bear conservation, we recognize the need for compatible economic activity in the United States Arctic. The measurement scale provides a means to consider whether and how potential conservation strategies and actions may affect economic development, both locally and globally. This allows a more explicit consideration of the trade-offs between economic development and conservation actions, to seek solutions in which economic development does not undermine the ability to achieve recovery and conservation of polar bears, and in which conservation does not unnecessarily limit economic development.

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E. The Population Dynamics of Conservation, Recovery, and Harvest

If we are successful in achieving the criteria described in this Plan, what will conservation and recovery of polar bears look like? The conservation criteria under the MMPA and the recovery criteria under the ESA are not stated in terms of desired population sizes, because conservation and recovery could be achieved at different population levels. Instead, the criteria are stated in terms of demographic processes (e.g., persistence, survival, reproduction, carrying capacity, anthropogenic mortality) that link back to the fundamental goals for polar bears, several of which were framed in terms of probability of persistence. The concepts behind the demographic processes may be unfamiliar to some readers, so it is fair to ask, what would conservation and recovery look like? Why do all of these criteria add up to fulfillment of the obligations under MMPA and ESA? And how is it that harvest can be compatible with conservation and recovery?

A picture of conservation

As described above, the proposed MMPA criteria seek two things: to maintain each polar bear subpopulation above its maximum net productivity level; and to maintain the health and stability of the marine ecosystem, as reflected in the intrinsic growth rate and carrying capacity for polar bears, above a certain level. The MNPL is the population size at which the net productivity (birth and survival of juveniles to adulthood, less deaths of adults) is greatest; for polar bears, this is estimated to be around 70% of the carrying capacity (Regehr et al. 2014). We have interpreted the MNPL as proportional to the carrying capacity at any point in time (Fig. 5)—as the carrying capacity declines, so does the population size at which productivity is highest. If human-caused removals exceed the sustainable rate, the population will decrease below MNPL (Fig. 5, scenario 1). If all human-caused removals, including subsistence take, are well-managed, then the population size should remain between MNPL and carrying capacity (Fig. 5, scenarios 2 and 3). To do this requires adjusting the total take as the population size declines, as the intrinsic growth rate declines, or both.

The second proposed MMPA criterion indicates that there is a limit to the loss of carrying capacity that can occur before the stability of the marine ecosystem is lost and polar bears would cease to be a significant functioning element of the ecosystem (Fig. 5, scenario 2). We have not yet determined where that threshold is located, but presume that a substantial portion of the historical carrying capacity must be maintained (where "historical" carrying capacity refers to the carrying capacity in the absence of an anthropogenic effect on the environment). If a declining carrying capacity stabilizes and is expected to remain stabilized above the threshold associated with a stable ecosystem, then the second criterion is met (Fig. 5, scenario 3). This criterion does not require that the historical carrying capacity (Fig. 5, scenario 3, black line) be maintained, but

Key Terms

Carrying capacity. The size at which a population would stabilize if there were no anthropogenic removals. The carrying capacity can change over time, if the underlying habitat changes.

Intrinsic growth rate. The population growth rate in the absence of anthropogenic removals and at low density. This is the maximum potential growth rate, not the observed growth rate, and is an important measure of the resilience of a population.

Maximum Net Productivity Level. The population size at which the net growth in the population (births minus non-anthropogenic deaths) is greatest. From the scientific perspective of population dynamics, MNPL changes in proportion to carrying capacity.

Quasi-extinction floor. The threshold for evaluating "extinction" under the ESA. in this Plan. Rather than use outright extinction as the condition to be avoided, we are using a more conservative definition that avoids the conditions that might give rise to an unavoidable downward spiral.

Stable ecosystem threshold. The threshold for carrying capacity identified in MMPA Conservation Criterion 2 below which the stability of the marine ecosystem is unacceptably altered.

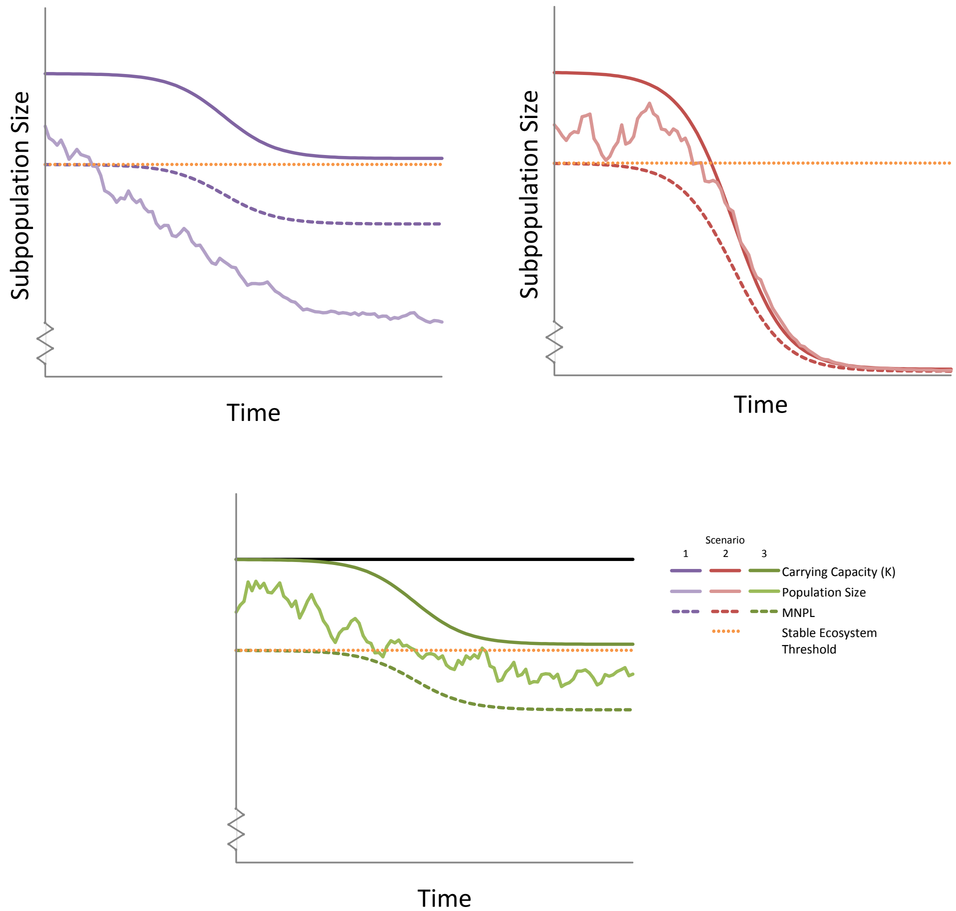

Figure 5. Achieving the MMPA conservation criteria requires keeping the population between MNPL and carrying capacity, and keeping carrying capacity above the stable ecosystem threshold. Scenario 1 (purple) shows the trend over time of a subpopulation with unsustainable levels of take, which cause the population size to decline below MNPL. Scenario 2 (red) shows the trend over time of a subpopulation with sustainable take, but in an ecosystem that loses nearly all capacity to support polar bears. Scenario 3 (green) shows the trend over time of a subpopulation with well-managed take and an ecosystem that stabilizes before it reaches the point at which the health and stability are lost, even though a portion of the original carrying capacity is lost. The black line in scenario 3 provides a reference to the carrying capacity in the absence of an anthropogenic effect on polar bear habitat. This figure is a simplification for the purpose of illustration; assessment of the criteria will also need to take into account annual variation, precision of estimates, and other considerations.

rather that the decrease in carrying capacity is limited and ultimately stabilized; the historical carrying capacity is nevertheless a valuable reference point for understanding the extent of decrease in carrying capacity and associated ecosystem stability. Note that the second criterion concerns the carrying capacity, not the population size (which may be below the carrying capacity because of human-caused removals); if the population size drops below the threshold, but the carrying capacity does not, the criterion is still met, although some thoughtful consideration of the level of take might be prompted.

Thus, scenario 3 (green) in Figure 5 shows a picture of successful achievement of both MMPA conservation criteria developed in this Plan. This picture, however, is not the current expectation for most of the subpopulations worldwide. The first MMPA criterion (maintenance of MNPL) is not a primary concern, because the United States will continue to work with its partners to maintain the Southern Beaufort and Chukchi Sea populations above MNPL, and because processes exist, or are being initiated by the individual Range States, to manage human-caused removals in many of the other subpopulations. On the other hand, in all four of the ecoregions significant loss of carrying capacity is expected as the extent, thickness, and duration of sea ice decline (Atwood et al. 2015). Although the specific analyses have not been completed against the second MMPA criterion (ecosystem health and stability), the best scientific information available suggests that in at least three of four ecoregions, this criterion is expected to be violated within 50–100 years (e.g., scenario 2 in Fig. 5). Thus, to achieve the conservation purposes of the MMPA for polar bears, global actions need to be taken to reduce the long-term loss of sea ice to tolerable levels, while responsibly managing all forms of human-caused removal, including subsistence harvest, at sustainable levels.

A picture of recovery

The ESA criteria described above fundamentally seek a high degree of assurance that viable populations of polar bears (as defined for the purposes of this Plan) will persist in all four ecoregions for a long period of time. To achieve such assurance, three important qualities of the populations are needed: resilience, buffering, and limited removals. Resilience arises when the intrinsic population growth is high, so that the population can quickly rebound from any short-term decline; such resilience comes from having high survival and reproductive rates (ESA Demographic Criteria 1 and 2). A high carrying capacity buffers the population from the risk that natural variation will cause it to decline to unacceptable low levels (ESA Demographic Criterion 3). Finally, human-caused removals (for any purpose, including defense-of-life and subsistence) remove some of the resilience (by reducing the survival rate), so they must be limited (ESA Demographic Criterion 4). To assure long-term persistence, these criteria not only need to be met at the time of assessment, but also at all points in time going forward 100 years from that point.

Polar bears do not meet these criteria in at least three ecoregions (Seasonal Ice, Polar Basin Divergent, and Polar Basin Convergent). Based on forecasts of atmospheric gases, Arctic air and sea temperatures, and sea-ice extent, polar bear populations are expected to decline to small fractions of their historical population sizes (Atwood et al. 2015). The red line in Figure 6 shows a hypothetical scenario that roughly matches the expectation for one or two of the ecoregions (including the Polar Basin Divergent ecoregion)—as sea ice is lost, the population will decline precipitously, crossing below the threshold at which the dynamics of small populations take over. These dynamics include demographic stochasticity, Allee effects, and inbreeding, which may create an "extinction vortex" that leads to nearly inescapable extinction. The population level at which these small population dynamics take over is called the quasi-extinction floor. To achieve recovery, the forecast trend needs to be changed, so that the population is expected to remain safely buffered above the quasi-extinction floor. In most species that have recovered under the ESA (e.g., wolves, bald eagles, peregrine falcons), the trajectory looked like the blue line in Figure 6: the species showed a substantial decline; the species

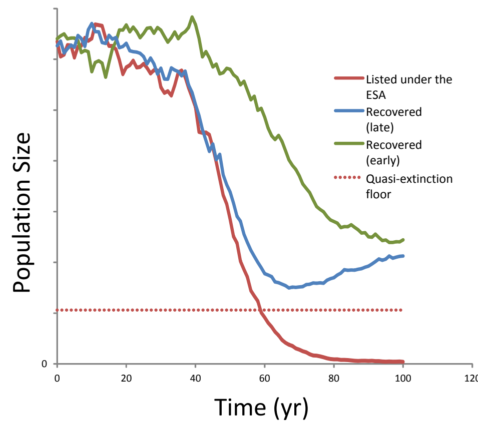

Figure 6. Achieving ESA recovery criteria requires keeping the population level high enough that there is a low chance of ever crossing below the quasi-extinction floor. Three hypothetical scenarios show population response to a substantial loss of habitat. Recovery occurs when the threats are adequately ameliorated and available information indicates with a high degree of confidence that the population will not drop below the quasi-extinction floor. This requires resilience in the population (high potential growth rate) as well as a buffer (carrying capacity far enough above the floor), but does not require the population to return to historical levels. The green and blue lines depict hypothetical species trajectories where adequate management of threats occurs, stopping the decline and resulting in stability, either without (green) or with (blue) the need for some restoration, whereas the red line depicts a situation where threats are not ameliorated and the species' status deteriorates until extinction occurs.

was listed under the ESA, often as the population approached the lowest point on the blue line (near year 60 or 70); recovery actions were implemented and the population trend turned around; then delisting occurred when the long-term prognosis was secure. But note that recovery under the ESA did not necessarily return these species to historical levels, only to levels that assured the species no longer needed the protection of the ESA. Polar bears were listed at a much earlier stage because the primary threat, loss of sea ice, could be foreseen in advance. With this advanced notice, we have the potential opportunity to achieve recovery without ever approaching perilously low numbers (green line, Fig. 6).

The ESA criteria in this Plan add up to recovery. Achievement of the demographic criteria would indicate that the populations in each ecoregion were resilient, and would remain so for a long period of time. The carrying capacity criterion would provide a buffer against the effects of small populations. The achievement of these criteria in all four recovery units would confer representation and redundancy, ensuring that the genetic, behavioral, life-history, and ecological diversity of polar bears is conserved. Achievement of the threats-based criteria would indicate that the threats that led to listing had been addressed. Finally, achievement of the fundamental criteria indicates that the likelihood of becoming endangered had been reduced to the point that polar bears no longer needed the protections of the ESA. While it may seem counterintuitive that all of this might be achieved while still losing a substantial portion of the present population, this is a consequence of having been able to list polar bears early enough to address a long-term threat. Reflection on past successful recovery efforts shows that rather than a return to historical levels, the ESA strives to reduce threats to the point that the species is not in danger of extinction, nor likely to become so in the foreseeable future, throughout all or a significant portion of its range. For many species, recovery can be achieved at less than historical population levels.

The compatibility of harvest with conservation and recovery

It is not unusual to authorize incidental take of a species protected under either the MMPA or the ESA, and the standards for such authorization are well described and well implemented. It is, however, much less common to purposefully seek to harvest species that need the protections of the ESA or the MMPA, but it does occur in a small number of special cases. Subsistence harvest of polar bears for a variety of cultural purposes is a central tradition for Alaska Native people, as well as other native Arctic peoples. The ESA and MMPA both recognize the importance of subsistence harvest for Alaska Native people. In fact, both laws allow certain subsistence harvest by Alaska Native people even when a species is "threatened" or "depleted." In this Plan, we recognize sustainable subsistence harvest as a fundamental goal associated with polar bear conservation and recovery. We also provide conditions for harvest to ensure: under the ESA, that harvest does not appreciably reduce the likelihood of survival or recovery; and under the MMPA, that harvest does not affect our ability to achieve the conservation goals of the Act.

But the question remains, how can harvest be compatible with the conservation and recovery of a species that is expected to decline in the near- and mid-term? In this Plan, we describe how such harvest opportunity can be sustained.

There are two ways climate change effects may cause a decline in polar bears numbers. In the first scenario ("density-dependent"), reduction in the sea-ice platform may reduce access to prey and create a greater competition for resources, reducing the carrying capacity. But if some bears are able to access prey, and thus retain high survival and reproductive rates, the intrinsic population growth rate might remain the same, even if the overall population number declines. In this situation, harvest is sustainable if the total rate of human-caused removals remains at or below *h* (the removal rate that maintains a population above its MNPL). Annual quotas for human-caused removal would need to be reduced in proportion to the decrease in the population size, but the rate of removal could remain the same. For example, if the sustainable removal rate was 3.0% and the subpopulation size was 2,000, up to 60 bears could be taken; if the subpopulation size was only 1000, no more than 30 bears could be sustainably removed. This would maintain the population size at roughly the same ratio relative to changing carrying capacity, even as the carrying capacity decreased.

In the second scenario ("density-independent"), an increase in the ice-free period could increase the fasting period for all bears, reducing survival and reproductive rates across the board. In this case, the intrinsic population growth rate and population resilience would decrease, perhaps to the point of becoming negative and inducing population decline. If this happened, the rate of harvest would need to decrease to remain sustainable. For example, if the intrinsic population growth rate is 7%, then a sustainable removal rate might be 4.5%; but if density-independent effects of climate change caused the population growth rate to fall to only 2%, then the sustainable removal rate might be closer to 1.3% or less. If the intrinsic growth rate is negative, then there is no sustainable removal rate (the metric in MMPA Demographic Criterion 1 and ESA Demographic Criterion 4, *h*, is 0); indeed, the population would be expected to become extirpated even in the absence of harvest.

In reality, some combination of these two effects is also possible. In addition, the precise mechanisms by which climate change effects will affect polar bears are not well understood at this time. Research and monitoring will clarify these issues. But the Plan's MMPA and ESA criteria relative to human-caused removals take into account both potential mechanisms for the effects of climate change on polar bear populations. The framework for management of human-caused removals will need to be responsive to changes in the growth rate and carrying capacity. But, provided that the growth rate remains positive, a sustained opportunity for removal remains possible, even with a decline in carrying capacity. Provided that climate change—the threat that is driving the changes in growth rate and carrying capacity—is addressed, the framework established in this Plan would allow for recovery under the ESA and conservation under the MMPA.

The concepts underlying this framework for management of human-caused removals are founded in harvest theory (Wade 1998, Runge et al. 2009) and can be illustrated with yield curves. Yield curves show the annual total removals and the corresponding equilibrium population size for a range of sustainable harvest rates (Fig. 7). The peak of the yield curve is the maximum net productivity, and removals that keep the population above MNPL will fall somewhere on the right shoulder of the yield curve. A density-dependent impact to the population will shrink the yield curve by reducing the carrying capacity (Fig. 7, left panel), while otherwise allowing the same rate of removal (although the allowable quota decreases). A density-independent impact to the population will flatten the yield curve by reducing the intrinsic growth rate (Fig. 7, right panel), thereby reducing the sustainable rate of removal.

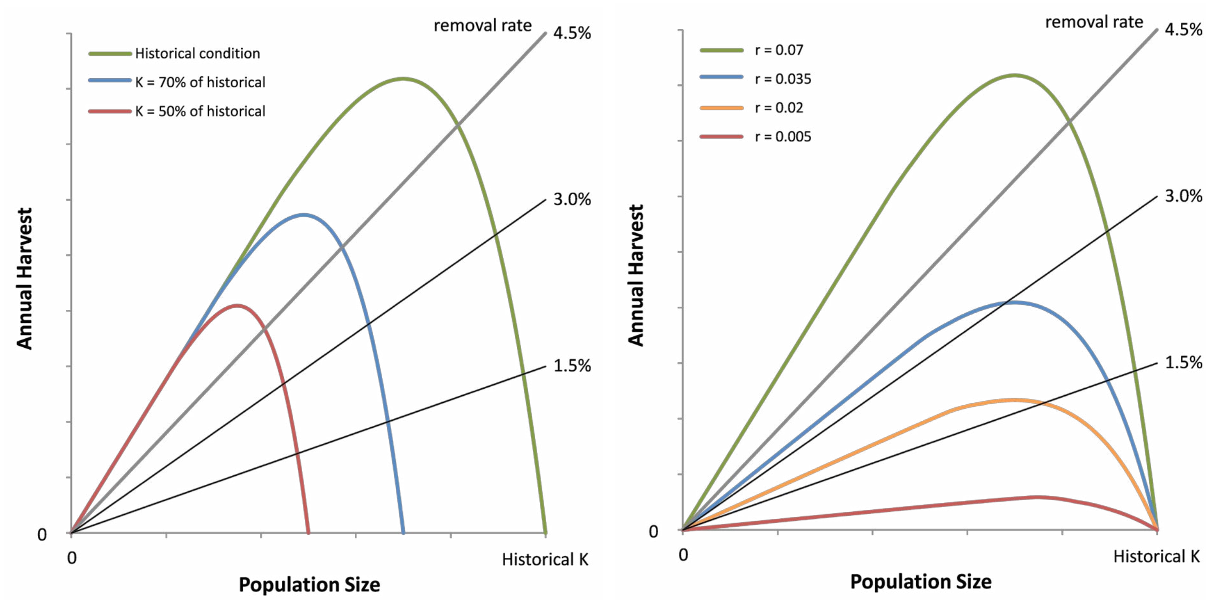

Figure 7. The effects of reduced carrying capacity and reduced growth rate on harvest yield curves. Each graph shows the sustainable annual harvest against the corresponding equilibrium population size; three reference lines show removal rates of 4.5%, 3.0%, and 1.5%. The left panel shows three scenarios where the carrying capacity changes, but the intrinsic rate of growth remains the same (r = 0.07). The right panel shows four scenarios where the intrinsic rate of growth changes, but the carrying capacity remains the same. The graphs were derived using a theta-logistic population model with θ = 5.045, which roughly corresponds to dynamics for polar bears (Regehr et al. 2015).

F. Uncertainty, Assumptions, and the Need for Adaptive Feedback and Management

The links between the tiers of this framework are based on our current understanding of polar bear demography and threats, which is incomplete. Thus, in deriving demographic criteria, assumptions and uncertainty about the demographic processes (such as regarding Allee effects), the means and variances of the survival and reproductive rates, the mechanism and magnitude of density-dependence, and the role of density-independent drivers of change give rise to uncertainty about the demographic criteria. Likewise, the derivation of threats-based criteria is affected by various types of uncertainty, such as: uncertainty regarding the nature, mechanism, and magnitude of the various threats; uncertainty about the behavioral responses of polar bears to changing conditions in the marine ecosystem, such as prey base, denning conditions, and other effects of climate change; uncertainty in the trajectory of sea ice as driven by climate change; and uncertainty in climate forecasts themselves. We recognize there are other gaps in knowledge that add to scientific uncertainty. Even if there is strong policy certainty about the fundamental criteria, the demographic and threats-based criteria might be less certain, because of the scientific uncertainty inherent in their derivation. We also acknowledge policy uncertainty in the establishment of the fundamental criteria themselves.

For these reasons, this Plan should be viewed as dynamic, not static, and the criteria should be revised over time as new data are acquired and critical scientific and policy uncertainties are reduced or resolved. The fundamental criteria could be revised if policy insights arise. Depending on the nature of any changes that may be made in the fundamental criteria, the demographic criteria may change. Further, even if the fundamental criteria do not change, the demographic criteria may be fine-tuned as new scientific information increases our understanding of polar bear population dynamics. The threats-based criteria will likely be subject to revision as new data help us understand the nature of the current and emerging threats and the responses of polar bear populations to them. Any changes to the demographic and threats-based criteria will remain founded in the fundamental criteria.

It is the intent of this Plan to use an adaptive management approach to revise and update the fundamental goals, conservation criteria, and recovery criteria, as well as various assumptions underlying our analyses, as new scientific and policy information becomes available that demonstrates such revisions are appropriate. By using such an adaptive feedback approach, we will be able to identify triggers for such revisions to conservation and recovery criteria and, therefore, maintain transparency and support for any modifications.

IV. CONSERVATION MANAGEMENT STRATEGY

A. Collaborative Implementation

Implementation of the Conservation Management Plan will rely on the participation of Alaska Native, State, Federal, other Range States, and private partners with a vested interest in polar bears in the Alaskan Arctic. This strategy primarily focuses on the actions within the purview of the partners who developed this Plan; however, in the long term the recovery and conservation of polar bears will depend on actions taken by a much larger group of nations, agencies, companies, entities, and individuals to address the primary threat, as well as potential future threats. With the exception of management of atmospheric greenhouse gases, which requires global engagement, this Plan addresses the actions that can be taken under the jurisdiction of partners in the Alaskan Arctic with an interest in polar bears. Thus, in the text to follow, "we" refers to those agencies and entities that helped develop this Plan and who will be primarily involved in its implementation. This Plan focuses mostly on actions needed to conserve and recover the polar bear subpopulations linked to the United States. It was generally not practicable to develop conservation and recovery actions for the subpopulations outside of the United States. Given the autonomy and unique statutory and cultural considerations of individual Range States, developing actions beyond what is included in this Plan would not promote the conservation and survival of the species. However, this Plan will be part of the Circumpolar Action Plan for polar bears that is being developed by the five Range States with the goal of achieving polar bear conservation rangewide. In addition, there are actions outside the context of this Plan that the United States government may undertake bilaterally or multilaterally to advance polar bear conservation internationally.

Each of the agencies and entities involved in drafting the Plan has a role in its implementation and will, within their area of responsibility, carry out implementation actions. A Recovery Implementation Team will be created to coordinate implementation, monitoring, and research activities to maximize efficiency and effectiveness with available resources. The Implementation Team will evaluate progress toward the criteria identified in Section III of this Plan and will make recommendations regarding appropriate adaptive management. It will serve as a venue for the exchange of data, ideas and information among agencies, Native communities, entities, and interested parties. In turn, it will make summaries available to the public.

Given the broad interests represented on the Recovery Team who drafted this Plan, it is our goal to maintain similar representation on the Implementation Team. Therefore, the Implementation Team will be composed of representatives from Alaska Native, State, Federal, International, and private agencies and entities with a vested interest in and authority to manage for polar bear conservation. The majority of the focus of the Implementation Team will be on the Polar Basin Divergent Ecoregion, specifically the two United States subpopulations. Recognizing that recovery of polar bears requires effort in each ecoregion, however, the USFWS will remain active in implementing the 1973 *Agreement on the Conservation of Polar Bears* and the 2000 *Agreement with the Government of the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population*. Similarly, the USFWS will remain an advisor to the *Inuvialuit-Inupiat Polar Bear Management*

Agreement for management of polar bears in the Southern Beaufort Sea subpopulation and will welcome opportunities to engage with Canada under the 2008 *Memorandum of Understanding for the Conservation and Management of Shared Polar Bear Populations.*

The Implementation Team will consist of a Coordinating Committee that will be broadly responsible for sharing and promoting the exchange of data and information on: Alaska polar bear populations and their habitat; threats; and ongoing management, monitoring and research activities. The Coordinating Committee will produce reports at least every two years highlighting ongoing activities and tracking progress toward the fundamental, demographic, and threats-based criteria. The Coordinating Committee is not a decision-making body, although it may provide recommendations to member agencies and entities. The Coordinating Committee does not supersede the authority of the management agencies.

The Coordinating Committee will establish Working Groups as needed to address key issues and focus areas (Fig. 8). Initially, Working Groups will be created to address the following: (1) Monitoring; (2) Research; (3) Human-Polar Bear Interactions; and (4) Outreach. While there is obvious overlap between the monitoring Working Group and any other Working Group, particularly the Research Working Group, the goal is to have the Monitoring Working Group focused on the specific monitoring actions to track the fundamental, demographic, and threats-based criteria contained in this Plan. In contrast, the Research Working Group is much broader and will serve as a forum for exchange of information on ongoing and planned research activities and also to identify priority areas for research initiatives into the future. While broad, the Research Working Group will focus on applied research, with a strong emphasis on knowledge that will help to achieve the fundamental goals in this Plan. Both the monitoring and research groups should appropriately integrate empirical knowledge and Traditional Ecological Knowledge (Voorhees et al. 2014).

The Working Groups and the Coordinating Committee are not entities charged with action. They are focused on coordinating and making recommendations. It is ultimately up to the individual agencies, entities, and organizations themselves to take actions consistent with their mandates, priorities, and available resources. For example, the Outreach Working Group may identify a need for information to be provided to local communities on deterrence methods for polar bears. Once this need was identified, the responsible agencies or entities would inform the Coordinating Committee whether this was an action they could implement. The Outreach Working Group will be asked to work with the Coordinating Committee to establish a website to facilitate information exchange within the Coordinating Committee as well as with the general public.

In the first five years of its existence, the Polar Bear Conservation Management Plan Implementation Team will meet at least twice a year. The intention is that one meeting will be the annual assessment focused on documenting activities conducted and new information made available over the prior calendar year and looking forward to planned activities for the upcoming calendar year. The information on actions and progress in the United States can then be provided as input to monitor the Circumpolar Action Plan. A check-in meeting will be held at approximately the six month point to assess whether activities have proceeded as planned and to make adjustments, as necessary and appropriate. The meetings may occur in person or by teleconference, as needed. After the first five years, the Implementation Team should reconsider the schedule on which it meets.

Terms of reference, appointment letters, and roles and responsibilities for the Coordinating Committee and associated Working Groups will be developed so that they can be issued along with the final Conservation Management Plan.

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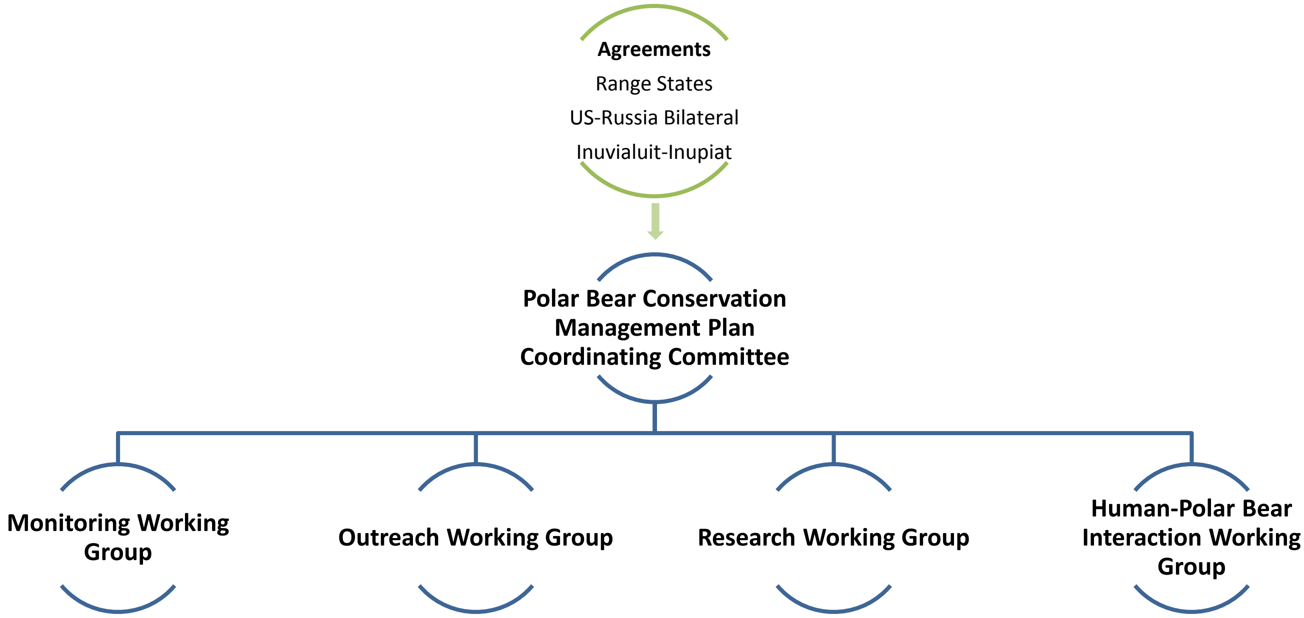

Figure 8. Structure of the Polar Bear Recovery Implementation Team.

B. Conservation and Recovery Actions

The following high-priority actions (each explained in detail below) are necessary to achieve the fundamental goals of this Plan:

- Limit global atmospheric levels of greenhouse gases to levels appropriate for supporting polar bear recovery and conservation, primarily by reducing greenhouse gas emissions
- Support international conservation efforts through the Range States relationships
- Manage human-bear conflicts
- Collaboratively manage subsistence harvest
- Protect denning habitat
- Minimize risks of contamination from spills
- Conduct strategic monitoring and research

Aside from actions to promote swift and substantial reductions in greenhouse gas emissions at the global and other large scales, the actions above are primarily, but not exclusively, focused on the United States portion of the Polar Basin Divergent Ecoregion with a management focus on the two subpopulations shared by the United States. Many of the actions emphasize the importance of local engagement and implementation and are already underway. The role of this Plan and the Implementation Team is to continue and expand those actions, using adaptive management to make them more effective where possible.

Time and cost. The cost estimates in this document are the projected annual costs, including salaries, for 2016–2020 as required to meet the proposed conservation needs for the United States portion of the Polar Basin Divergent Ecoregion during this initial five-year period. We anticipate that continuation of all of the high priority recovery actions will be necessary until sea-ice loss is no longer driving the population towards extinction or until our adaptive management efforts lead us to identify new priorities. Therefore, our estimated costs should be projected forward in five-year increments, with appropriate adjustments for inflation, until either of those conditions occurs. These cost estimates are significantly higher than current funding for polar bear management and research in the United States because some needs currently are being inadequately addressed. All cost estimates are approximate and subject to revision. The actions described here will be undertaken if and when funding is available.

Contingent on funding, these actions, if not already underway, will be initiated in the next five years and should continue until the effects of climate change no longer pose a threat to polar bear conservation, and recovery criteria have been met.

Limit global atmospheric levels of greenhouse gases to levels appropriate for supporting polar bear recovery and conservation, primarily by reducing greenhouse gas emissions

As previously stressed, *the single most important action for conservation and recovery of polar bears* is a global reduction in the emission of greenhouse gases contributing to Arctic warming (Amstrup et al. 2010), even if that is not something this Plan and the partners implementing it can dictate or regulate. Some progress has been made but more action is needed in the United States and elsewhere to move from the current baseline trajectory to an aggressive effort to curtail emissions globally. Numerous efforts are underway to inspire that change by informing key audiences about the likely impacts of changes in global climate (see for example, U.S. Global Climate Change Research Project http://www.globalchange.gov and Environmental Protection Agency http://www.epa.gov/climatechange).

Our specific contribution to this effort will be to develop and deliver a communication strategy that articulates the consequences to polar bears and their habitat of the likely effects of the current baseline greenhouse gas emissions scenario compared to one that reflects an aggressive approach to curtailing emissions worldwide. The ultimate goal of this effort is to prompt the needed actions to maintain and as needed, restore sea ice habitat by implementing sufficient regulatory, market-driven, or voluntary actions at global and national scales to address the anthropogenic causes of Arctic warming and abate the threat to polar bears posed by sea-ice loss. The strategy would also communicate the impact of changes in climate on coastal Arctic peoples who derive cultural and nutritional benefit from polar bears.

Conservation and Recovery Actions
1. Develop and deliver an effective communications strategy to inform United States and global audiences of the urgent need to reduce greenhouse gas emissions and the consequences to polar bears of failing to do so.
2. Develop and implement an effective strategy to communicate to United States and global audiences the impact of climate change on coastal Arctic peoples with connections to polar bears.
3. Ensure that the appropriate entities, both in the U.S. and internationally, take regulatory, market-driven, or voluntary actions necessary to address the anthropogenic causes of Arctic warming and abate the threat to polar bears posed by sea-ice loss. (Cost undeterminable)
4. Continue implementation of USFWS actions pursuant to its commitment to be carbon neutral by 2020 and identify any further steps the agency can take to engage in climate change mitigation.
Total cost: minimum of approximately $671,000 per year

Support international conservation efforts through the Range States relationships

Work closely with other Range States to implement conservation actions outlined in Circumpolar Action Plan for the global population. Polar bear range reaches five Arctic nations. These Range States have long recognized the need to coordinate polar bear conservation efforts (*1973 Agreement on the Conservation of Polar Bears*). In their capacity as parties to that Agreement, the Range States resolved in 2009 to develop a Circumpolar Action Plan. The purpose of the Circumpolar Plan is to broadly address range-wide conservation challenges such as the threat to polar bears posed by global greenhouse gas emissions, and potential threats like human-bear conflicts and illegal trade, which must be effectively managed for the species to survive until climate change is addressed. As a Range State and an active contributor to the Circumpolar Action Plan, we anticipate contributing to the implementation of international priorities that coincide with our own priorities and are in alignment with our statutory responsibilities. We also plan to share strategies and best management practices with our Range State partners. In turn, advances in knowledge and management practice made by Range State partners will actively inform implementation of this Plan in the United States. The Recovery Team recognizes that there may be benefit in supplementing this Plan and the Circumpolar Action Plan with additional national or international actions for the benefit of Arctic ecosystems and polar bears.

Pursue targeted conservation efforts with Canada and Russia by sharing resources and expertise. Along with implementation of measures in the Circumpolar Action Plan focused on polar bear conservation range-wide, we anticipate undertaking specific conservation efforts with Russia and Canada, international neighbors with whom we share management of the Chukchi Sea and Southern Beaufort Sea polar bear subpopulations, respectively. Specifically, we will work with Russia to better monitor and manage human-caused removals in that country. Based on recent information, polar bear take in Russia may be declining (Kochnev 2014) but in past accounts, mortality was thought to be large (Aars et al. 2006). We will also work with Russia to protect denning habitat in Chukotka and on Wrangel Island, where almost all denning for the Chukchi Sea population occurs (Garner et al. 1990). Likewise, we will provide support to Canada's efforts to manage polar bears in the Canadian Archipelago, which we anticipate will provide key terrestrial polar bear refugia as sea ice declines (Derocher et al. 2004; Amstrup et al. 2008, 2010; Peacock et al. 2014).

Conservation and Recovery Actions
1. Work closely with the other Range States to implement the conservation actions outlined in the Circumpolar Action Plan for polar bears range-wide that are consistent with national priorities and in alignment with statutory responsibilities.
2. Work with Russia a. to protect denning habitat in Chukotka and Wrangel Island through development of den detection models and avoidance strategies. b. to better monitor human-caused removal of polar bears in Russia and jointly improve efforts to minimize human-bear conflicts.
3. Provide support for polar bear management efforts in the Canadian Archipelago.
Total cost: approximately $783,600 per year

USFWS

Manage human-polar bear conflicts

With reduced ice extent, increasing numbers of polar bears with poorer body condition than observed historically are making their way to shore earlier in the spring and staying later in the fall (Obbard et al. 2006). Once on land, polar bears are unable to reach their preferred food, ice seals, so they primarily fast (Ramsay and Hobson 1991) or scavenge (Miller et al. 2004). Simultaneously, reductions in summer sea ice will allow expanded development opportunities and growing human activity in polar bear habitat (Vongraven et al. 2012). These factors increase the likelihood of human-bear conflicts with negative consequences for both humans and bears.

Minimizing lethal take of polar bears from human-bear conflicts, including take from industrial, research, or other activities, contributes to polar bear conservation over the long term (Fundamental Goal 3) and in the near term, protects opportunities for sustainable subsistence harvest (Fundamental Goal 4). From a demographic perspective, wildlife populations are affected by the total level of direct human-caused removals. For polar bears, there are multiple types of removals that have different causes and different value to humans. Consistent with provisions in the ESA and MMPA, this Plan recognizes the importance of providing opportunities for sustainable subsistence harvest as an inherently important component. Lethal take of polar bears incidental to human-bear conflicts, industrial, or research activities should be minimized because they have negative implications for the conservation of subpopulations in the United States including potentially reducing opportunities for sustainable subsistence harvest.

Provisions to minimize these other sources of take will continue to be implemented within the existing regulatory frameworks (e.g., the USFWS Incidental Take Program under the MMPA, for industrial activities) or review processes (e.g., the USGS, USFWS, and ADF&G Institutional Animal Care and Use Committees, for research activities). Examples of these ongoing efforts include partnerships with the oil and gas industry over the past 30 years of operations on the North Slope, and polar bear patrols led by the North Slope Borough. To build on these efforts, we will develop an overarching strategy and best management practices to prevent, monitor, and manage human-polar bear conflicts in the United States. Those practices will include rapid response plans for situations where a large number of hungry bears are stranded on shore.

We will work with local communities and with industry to develop human-polar bear interaction and safety plans that include attractant management (to minimize bears being attracted to human communities for food), bear awareness training, safety procedures for bear encounters, proper hazing techniques, and reporting requirements. And we will work with communities to implement the components of those plans such as best practices for garbage management at households and community landfills, bear-proof food-storage options, and location of whale bone piles to reduce food attractants that draw polar bears into human communities.

We will continue to support local capacity for polar bear patrols and other management efforts. Specifically, we will expand the scope and improve the effectiveness of community polar bear patrols through funding, standardized methods, and better reporting of data on interactions.

Conservation and Recovery Actions

1. Develop and communicate a strategy to prevent, monitor, and manage human-polar bear conflicts for the subpopulations in the United States with input from local residents, conservation partners, and invited experts.
2. Develop and communicate response plans for the subpopulations in the United States to address the prospect of increasing numbers of hungry bears on shore with input from local residents, conservation partners, and invited experts.
3. Develop and implement human-polar bear interaction and safety plans for United States communities with polar bears, to include attractant management, bear awareness training, safety procedures for bear encounters, proper hazing techniques, and reporting requirements.
4. Reduce attractants in United States communities with polar bears, through development and distribution of best practices for garbage management and food storage.
5. Improve the scope and effectiveness of United States community polar bear patrols, through increased funding, standardized methods, and better reporting of data on interactions.

Total cost: approximately $1,193,000 per year.

Collaboratively manage subsistence harvest

The co-management of polar bears by Alaska Native and Federal partners is supported under domestic laws and the *1973 Agreement on the Conservation of Polar Bears*, recognizing the importance of co-management for maintaining traditions, mitigating human-polar bear conflicts, monitoring subsistence harvest, and ensuring subsistence harvest rates at a level that is sustainable, as described in Section III of this Plan.

In this Plan, we adopt a framework for identifying sustainable limits on total human-caused removals. The goals of this framework include: to ensure that removals do not have a negative effect on population persistence, thus increasing the likelihood that recovery is possible once climate change has been addressed; and to provide long-term opportunities for subsistence use of polar bears by Alaska Natives. A co-management system between Alaska Native, Federal, and other partners provides the foundation for this framework and its success. This includes the ability to monitor take and collect biological samples from harvested polar bears (e.g., through the USFWS Marking, Tagging, and Reporting Program and the North Slope Borough) and the ability to adjust harvest rates towards adherence with the principles in Section III of this Plan (e.g., through the U.S.-Russia Bilateral Agreement and the Inupiat-Inuvialuit Agreement). Because both United States polar bear subpopulations are shared with other countries, continued cooperation with international partners is necessary for responsible management and conservation.

The framework for management of human-caused removals, including subsistence harvest, is founded on three principles. First, human-caused removals are managed at the subpopulation level by the appropriate co-management partners, taking into account factors specific to that subpopulation (e.g., traditional practices, management objectives, and local conditions). Second, annual removal levels are state-dependent with respect to population size (and by extension, carrying capacity) and intrinsic growth rate. Thus, the framework is intended to account for multiple ecological mechanisms through which ecological change (e.g., loss or gain of sea-ice habitat, decrease or increase in prey availability) and other factors could affect polar bears. Third, a three-level system identifies thresholds at which increasing efforts are taken to minimize the effects of human-caused removals.

Under the three-level system, graduated management and conservation actions are tied to pre-established thresholds. Above the upper threshold, the subpopulation shows a resilient intrinsic rate of growth and the carrying capacity provides a large buffer against the risk of extirpation. In this first zone, ESA and MMPA criteria regarding take are met, and total human-caused removals are managed using a state-dependent strategy. It may be possible to meet conservation goals for subpopulations in this zone with a relatively low investment in monitoring, for example, with longer intervals between monitoring efforts.

A subpopulation would fall into the second zone (i.e., between the upper and lower thresholds) if the carrying capacity, population size, or intrinsic growth rate fell below thresholds indicating that one or more conservation criteria were not being met. In this zone, additional actions are warranted, and the best combination of actions will depend on local considerations and the causes of decline. Potential actions include: greater investment in monitoring of human-caused removals, population size, carrying capacity, or intrinsic growth rate; decreased interval between monitoring efforts; increased efforts to reduce conflicts that require defense-of-life and other removals besides subsistence harvest; and reduction in the rate of total removals, including subsistence harvest. Thus, should a U.S. polar bear subpopulation drop below either of the MMPA demographic criteria (MNPL or minimum carrying capacity), additional restrictions on all human-caused removals, including harvest, may be warranted. It should also be considered that natural feedback mechanisms may decrease removal rates for a subpopulation in this zone, such as decreased interactions between humans and polar bears, decreased access to traditional subsistence hunting areas, and voluntary changes in the behavior of individual hunters or villages.

A subpopulation would fall into the third zone (i.e., below the lower threshold) if the carrying capacity, population size, intrinsic growth rate, or other measures indicated that the risk of extirpation was heightened. In this zone, emergency measures should be considered to reduce or minimize all human-caused removals, with a goal of affording the subpopulation an increased probability of persistence. Preliminary analyses suggest that a subpopulation size below 350 animals may warrant concern in this regard (Science and TEK Work Group, unpublished data), although multiple interacting factors can affect when a declining subpopulation enters this third zone. Furthermore, historically smaller subpopulations (e.g., those with smaller geographic ranges) may meet the MMPA demographic criteria, and thus remain in the first zone for management purposes, at population sizes below this threshold. Thus, this threshold should only serve as preliminary guidance and should be further evaluated on a subpopulation-specific basis. If a subpopulation is managed according to this framework for human-caused removals, we believe that removals will not be a threat to persistence. Thus, a subpopulation should fall into the third zone if the primary threat has not been adequately addressed; reduction of human-caused removals at this point can only serve to provide a small amount of additional time to address the primary threat.

The details of the three-level system will, and should be, specific to each subpopulation. The particular criteria and thresholds that indicate transitions between zones, and the actions to be undertaken in each zone, will need to be developed. This Plan offers guidance, in the form of the framework described above, and the Implementation Team can offer technical support. It is the vision of this Plan that the specifics of management of subsistence harvest and other human-caused removals be developed at the subpopulation level by the participating co-management partners.

Conservation and Recovery Actions

1. Collaborate with the North Slope Borough, Alaska Nanuuq Commission, and others on implementation of robust and sustainable subsistence management strategies for the Chukchi Sea and Southern Beaufort Sea subpopulations in the context of existing agreements.

2. Develop detailed guidance, with proposed analytical methods, for designing a take-management framework at the subpopulation level.

Total cost: approximately $2,072,000 per year.

Protect denning habitat

The availability of and access to terrestrial denning habitat is an important component of polar bear reproduction. Collaborative processes are currently in place to minimize effects on denning bears (e.g., the Incidental Take Program under the MMPA, for industrial activities). Going forward, we will continue those efforts with industry and others, and will work to improve our ability to detect dens and identify desirable denning habitat.

As sea ice declines and the availability of stable sea ice suitable for denning decreases, terrestrial denning habitat will become even more important (Fischbach et al. 2007). We will work with partners to minimize development and disturbance on barrier islands, which provide or could provide crucial habitat for denning, migrating, and resting and, we will work collectively to minimize and mitigate impacts when development occurs there.

Conservation and Recovery Actions

1. Continue den detection, mapping, and habitat work in polar bear habitat in the United States.
2. Minimize development and disturbance on barrier islands (where denning habitat is most limited). Where development occurs in polar bear habitat within the United States, work collaboratively to mitigate loss of denning habitat.

Total cost: approximately $886,600 per year.

Minimize risk of contamination from spills

Anticipated increases in ship traffic and offshore oil and gas activities due to summer sea ice declines (Gautier et al. 2009, Smith and Stephenson 2013) increase the risk of exposure to oil spills. Spills have the potential to harm polar bears in numerous ways, including through impaired thermoregulation (Hurst and Øritsland 1982, Hurst et al. 1991), ingestion (Derocher and Stirling 1991, Øritsland et al. 1981, St. Aubin 1990), and consumption of contaminated prey (Stirling 1990). Depending on the size, location and timing, a spill could affect a large number of animals (Amstrup et al. 2006).

Current regulatory processes (e.g., NEPA analyses, ESA section 7 consultations, MMPA incidental take regulations) and industry-led plans and practices have contributed to the absence of any major mishaps affecting polar bears in 30 years of oil and gas operations on the North Slope. Continued vigilance is imperative, particularly with the opening of new shipping lanes, the prospect of offshore oil exploration and development, and the increased risk of contaminant release from community tank farms and landfills along the coast. We will pursue several avenues to minimize the risk of marine spills and, should a spill occur, to improve the ability of responders to minimize harm to polar bears and their prey. Examples of specific actions include continuing to provide feedback on oil exploration plans and compliance documents; ensuring that responders and companies have current information on seasonal bear movements, aggregations and important habitat areas; and developing standard operating procedures for deterrence, rescue, and handling of oiled bears.

Conservation and Recovery Actions

1. Update existing oil spill modeling and scenarios; anticipate potential overlap with seasonal polar bear movements, aggregations, and important habitats within the United States.
2. Review and comment on proposed projects and activities in polar bear habitat within the United States (e.g., oil and gas exploration, new shipping routes and regulations, and community tank farms) that could affect polar bears.
3. Develop and distribute standard operating procedures for deterrence, rescue, and handling of oiled polar bears.

Total cost: approximately $403,800 per year.

Conduct strategic monitoring and research

This section focuses on strategic monitoring to evaluate the effectiveness of this Plan. Areas of research are identified and more details are provided in an appendix. The monitoring actions identified at this time are those possible with available knowledge and tools. Investment in additional research is essential to improve our knowledge and identify additional more effective and efficient methods for monitoring population status and the effectiveness of our actions.

In addition, we recognize that to address the uncertainties in the scientific evidence and policy interpretations used in developing the fundamental goals, demographic criteria, and threats-based criteria described above, an adaptive management plan for updating and revising the conservation and recovery criteria should be designed early in the recovery implementation process. Some of the components of such a plan are described in detail below; others are identified elsewhere in the document. One of the first tasks of the Implementation Team will be to prioritize these information needs.

Conservation and Recovery Action

1. Develop adaptive management plan for updating and revising the conservation and recovery criteria.

Total cost: (included in operational costs of Implementation Team).

1. Strategic monitoring to determine if Plan goals are being met

As stated previously, the ultimate measure of success of this Plan will be evaluated with the fundamental criteria and performance metrics (Table 1). As a practical matter, the specified demographic and threats-based criteria are intended to guide conservation planning and status assessments. These criteria are more easily-measured proxies for our fundamental goals, and can be used to track progress toward those goals. In addition to monitoring these criteria, which describe the condition of polar bears and their environment, it is also important to track implementation of the management activities identified in the previous conservation and recovery action section of this Plan. Furthermore, it is important to evaluate whether the management activities had the intended effect. Monitoring must focus both on implementation (the extent to which the plan is followed and recovery actions are taken) and effectiveness (to what extent recovery actions are successful and progress is made). Collectively, monitoring the demographic and threats-based criteria, tracking implementation of management activities, evaluating the effect of management activities, and continuing to refine the demographic and threats-based criteria as new information is obtained, provide the adaptive management framework necessary to meet the goals of this Plan.

This section outlines methods to monitor demographic and threats-based criteria. The ultimate goals of monitoring are to understand the state of the system, continue to learn about its dynamics, detect changes including those due to management activities, and use this information to trigger new or additional management actions as necessary to meet the goals of the Plan. Recovery is an iterative process. Through careful monitoring, the data generated and lessons learned through implementing individual recovery actions feed back into refining the recovery plan and strategy.

One of the key questions regarding monitoring is the appropriate scale. The ESA demographic and threats-based criteria apply to each recovery unit and the MMPA demographic criteria apply to each subpopulation. Because of the logistical challenges associated with monitoring outside the United States, the focus of the monitoring actions in this Plan is on the two subpopulations of polar bears resident in the United States within the Polar Basin Divergent Ecoregion. The fundamental goals will ultimately be evaluated at the species level, which will require international coordination.

This section provides the metrics that will be used to monitor the Conservation Management Plan. It is likely that the Implementation Team may identify the need for a more detailed monitoring plan that will specify the power of different monitoring approaches, including use of Traditional Ecological Knowledge, to detect change, what kinds of changes are important (increases or decreases), and over what time period. Once these objectives are specified, scientists can then design monitoring that will meet the stated needs. The Implementation Team may also identify different or additional metrics to track progress toward the fundamental goals.

a. MMPA Demographic Criteria

Maximum Net Productivity Level Total human-caused removals in each subpopulation do not exceed a rate *h* (relative to the subpopulation size) that maintains the subpopulation above its maximum net productivity level relative to carrying capacity.

Health and stability of the marine ecosystem. The intrinsic growth rate of each subpopulation is above, and is expected to remain above, a minimum level that indicates the health of the marine ecosystem is not substantially impaired; and the carrying capacity in each subpopulation is above, and is expected to remain above, a minimum level that indicates that the stability of the marine ecosystem is not substantially impaired.

Significant functioning element in the ecosystem. As stated previously, at this time we do not have enough information to propose measures to directly assess the functional role of polar bears in their ecosystem. Instead, we offer some potential approaches that could serve as proxies by focusing on particular roles that polar bears play. Further thought should be given to these approaches during implementation of this Plan and adjustments to monitoring should be made as appropriate.

- Energy flow among trophic levels linked to polar bears
- Behavior of prey species
- Distribution and demographics of prey species
- Persistence and distribution of scavengers that rely on polar bear kills (e.g., foxes).
- Availability of polar bears for subsistence harvest
- Polar bear behavioral diversity necessary to maintain resilience to environmental stressors
- Polar bear densities (e.g., bears per km^2) on sea ice or land habitats at certain times of year
- Carrying capacity and intrinsic growth rate at the subpopulation and ecoregion level, as estimated through hierarchical modeling of demographic and habitat data
- Habitat measures (like ice-free months) that could serve as a proxy for health and stability of the ecosystem

Monitoring Activity	Data Obtained / Output
Monitor the number of subsistence hunting removals in the SB subpopulation	Number of direct, lethal removals in the SB subpopulation
Monitor the number of defense-of-life removals in the SB subpopulation from villages, industry, and any other causes	
Monitor the number of subsistence hunting removals in the CS subpopulation	Number of direct, lethal removals in the CS subpopulation
Monitor the number of defense-of-life removals in the CS subpopulation from villages, industry, and any other causes	
Total cost: $540,400 per year	

b. ESA Demographic Criteria

- The mean adult female survival rate (at a density corresponding to MNPL) in each recovery unit is at least 93%–96%, both currently and as projected over the next 100 years.
- The ratio of yearlings to adult females (at a density corresponding to MNPL) in each recovery unit is at least 0.1–0.3, both currently and as projected over the next 100 years.
- The expected carrying capacity in each recovery unit is at least 500 or 15% of the population size at the time of listing, whichever is greater, both currently and as projected over the next 100 years.
- Total human-caused removals in each recovery unit do not exceed a rate *h* (relative to the subpopulation size) that maintains the population above its MNPL relative to carrying capacity.

Monitoring Activity	Data Obtained / Output
Conduct spring capture-based and genetic sampling work on the sea ice in the southern Beaufort subpopulation	Adult female survival rate Ratio of yearlings: adult females
Conduct spring capture-based and genetic sampling work on the sea ice in the Chukchi Sea subpopulation	Adult female survival rate Ratio of yearlings: adult females
Demographic parameter estimation	Index or estimate of subpopulation size, index or estimate of subpopulation capacity for positive growth (e.g., r_{MNLP}, the per capita growth rate at MNLP), relationships between vital rates and environmental conditions
Demographic modeling and population viability assessment	Projected values of demographic criteria into the future, probability of population persistence in the future
Total cost: approximately $5,680,800 per year	

c. ESA Threats-based criteria

The 2008 final listing of polar bears as threatened under the ESA summarized the best available scientific and commercial information regarding threats to the polar bear. The conclusion of that analysis was that the polar bear is threatened throughout its range by habitat loss (i.e., sea-ice declines). No known regulatory mechanisms in place at the national or international level were identified that directly and effectively address the primary threat to polar bears—the range wide loss of sea-ice habitat. While not identified as factors currently threatening polar bears, overutilization, disease and predation, and contaminants were identified as potential future threats as habitat loss occurs, declining population levels are realized, and nutritional stress becomes more prevalent. Given that context, the sea ice threats-based criterion below addresses the factor determined to be currently threatening polar bears whereas the criteria for human-caused removals and disease and parasites are intended to monitor and manage these factors to ensure they do not threaten polar bears in the future.

Sea ice: In each recovery unit, either (a) the average annual ice-free period is expected not to exceed 4 months over the next 100 years based on model projections using the best available climate science, or (b) the average annual ice-free period is expected to stabilize at longer than 4 months over the next 100 years based on model predictions using the best available climate science, and there is evidence that polar bears in that recovery unit can meet ESA Demographic Criteria 1, 2, and 3 under that longer ice-free period.

Human-caused removals: For each recovery unit, the total level of direct, lethal removals of polar bears by humans, in conjunction with other factors, does not reduce the probability of persistence below 90% over 100 years[2].

[2] The level of human-caused removal is needed to calculate the effect of those removals on persistence, but collecting data on human-caused removals is captured in the previous table of monitoring activity so is not repeated here.

Disease and parasites: For each recovery unit, the best available science indicates that (1) infection is not persisting endemically, as measured by an assessment of trend in indicators of exposure (e.g., prevalence, incidence) to disease agents (i.e., bacteria, viruses, and parasites); or (2) infection is persisting endemically, but forecast population-level effects that consider future infection rates as a function of biotic and abiotic interactions suggest that the risk of extirpation due to infections, in conjunction with other factors, is less than 10% over 100 years.

Monitoring Activity	Data Obtained / Output
Update sea ice projections as substantial new research, data, or tools become available	Projected duration of the ice-free period in each recovery unit over the next 100 years
Conduct analysis to determine the effect of human-caused removals on persistence	Probability of persistence with and without human-caused removals
Monitor exposure rates	Exposure rates
Model population-level effects from infection	Risk of extirpation due to infection
Total cost: $690,000 per year per subpopulation	

d. Other Measures of Achievement

As stated previously, fundamental Goals 4, 5, and 6 are not derived directly from statute, but instead are expressions of other societal values that could be affected by polar bear management. Performance requirements do not need to be prescribed for these goals (as they do for ESA recovery criteria and MMPA conservation criteria). It will be important, however, to address achievement of these goals, particularly to provide an adaptive feedback loop for improving future conservation actions. If we are successful in managing other threats to polar bears such that populations persist, then we will be better positioned to successfully recognize the nutritional and cultural traditions of Native peoples with connections to polar bears (Fundamental Goal 4). Monitoring the MMPA Demographic Criteria specified above requires collection of data on the number of lethal removals of polar bears, but to put this into context data should be collected on the broader effort to manage human-polar bear interactions and the relative success of various deterrence strategies (Fundamental Goal 5). Finally, at a minimum there should be a qualitative assessment of our success at achieving polar bear conservation while minimizing restrictions to other activities, including economic development (Fundamental Goal 6).

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2. Research needs for United States polar bear subpopulations

The previous section focused on monitoring demographic and threats-based criteria to inform management actions and adjustments. This section focuses on research designed to develop or refine the criteria that serve as proxies for our fundamental goals, improve monitoring of these criteria, and improve our understanding of the relationships (e.g., between sea ice availability and vital rates) and ecosystem dynamics that cumulatively determine polar bear persistence. We divide research into the following five areas: (1) population dynamics and distribution; (2) habitat ecology; (3) health and nutritional ecology; (4) nutritional and cultural use of polar bears; and (5) human-polar bear interactions. We briefly review these areas of research and a list of representative research projects is attached (Appendix B). We envision a dynamic and adaptive process through which this Plan is updated to reflect new information, and research planning is updated to reflect the living Conservation Management Plan document.

Population dynamics and distribution. Research in this area is intended to improve our understanding of the relationship between polar bears and the environment. This research will provide insights into how factors such as sea ice and prey abundance and availability affect polar bear distribution and vital rates. We have learned from research and monitoring on the two polar bear subpopulations shared by the United States that physical and biological differences among populations may affect how polar bears respond to habitat loss associated with climate change, especially in the near term. Long-term studies of subpopulation status (e.g., including vital rates used as demographic criteria) and trends are needed to measure progress towards persistence-based goals.

Habitat ecology. Under this research area, we will study the response of polar bear subpopulations to biotic and abiotic changes in the environment, including intermediate effects on primary (seals) and alternate (e.g., stranded marine mammals) prey. This will provide an improved understanding of the mechanistic links between habitat and demographics.

Health and nutritional ecology. This research will attempt to identify causal links between factors that determine health and population-level processes, which are difficult to establish for marine mammals that inhabit Arctic or subarctic ecosystems.

Nutritional and cultural use of polar bears. Historically, native communities throughout the coastal Arctic have relied upon polar bears as both a nutritional and cultural resource. Research, including through Traditional Ecological Knowledge, may help to better understand the cultural and nutritional significance of polar bears to communities that have historically relied upon them, and how the use of polar bears as a renewable resource may change in the future.

Human-polar bear conflict. There is a need to continuously improve our understanding of human-polar bear interactions including the causes and consequences. Understanding the factors that cause an interaction to result in a conflict, with consequences to humans, polar bears, or both, will provide essential feedback to evaluate the effectiveness of existing mitigation measures.

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VI. GLOSSARY

Allee effect. A negative population growth rate that occurs at low population density. There are a number of mechanisms that could give rise to this effect; in polar bears, the most likely mechanism is difficulty in finding mates (Molnár et al. 2014).

Conservation. As defined under the MMPA, conservation is "the collection and application of biological information for the purposes of increasing and maintaining the number of animals within species and populations of marine mammals at their optimum sustainable population" (16 USC §1362(2)). In this Plan, we use the term "conservation" to refer to the activities designed to achieve the purposes of the MMPA. Note that the ESA also contains a definition of the term, "the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measured provided pursuant to this Act are no longer necessary (16 USC §1532(3)). To avoid confusion, in this Plan, "conservation" is used in reference to the MMPA and "recovery" is used in reference to the ESA.

Demographic stochasticity. Variation in demographic rates due to the random events that happen to individual animals. This type of variation becomes important at small population sizes.

Distinct population segment (DPS). Under the ESA, a "species" includes "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature" (16 USC 1532(16)). Under policy guidance issued by USFWS and NMFS (61 FR 4722–4725), three elements should be considered in deciding whether a population qualifies as a DPS: the discreteness of the population in relation to the rest of the species; the significance of the population segment to the species; and the population segment's status in relation to the standards for listing under the ESA.

Ecoregion. Amstrup et al. (2008) defined polar bear ecoregions on the basis of temporal and spatial patterns of sea-ice dynamics, observations of the patterns of polar bear responses to these dynamics, and forecasts of future sea-ice patterns. There are four ecoregions: the Seasonal Ice Ecoregion (SIE), the Archipelago Ecoregion (AE), the Polar Basin Convergent Ecoregion (PBCE), and the Polar Basin Divergent Ecoregion (PBDE). The two subpopulations found in United States territory both fall within the PBDE.

Endangered. Under the ESA, an endangered species is "any species which is in danger of extinction throughout all or a significant portion of its range" (16 USC 1532(6)). This classification represents the highest level of concern for a species under the ESA.

Health of the marine ecosystem. In the MMPA, Congress found that the "primary objective of [marine mammal] management should be to maintain the health and stability of the marine ecosystem" (16 USC 1361(6)). The term "health of the marine ecosystem" is not otherwise defined, although the definition of OSP makes reference to it. In this Plan, we assume that the health of the marine ecosystem is reflected in its ability to support marine mammals, and use the intrinsic growth rate of a polar bear subpopulation as its measure.

Inbreeding depression. A negative consequence of small population size. Inbreeding depression can arise through breeding of related individuals, the consequent reduction in genetic diversity, and the expression of deleterious recessive genes.

Intrinsic population growth rate. The rate of growth of a population in the absence of human-caused removals and at a low density relative to the carrying capacity. This growth rate is a measure of resilience—the higher the intrinsic rate of growth, the quicker a population can rebound from a short-term impact.

Maximum net productivity level (MNPL). The population size that results in the greatest net annual increment in population numbers or biomass resulting from addition to the population due to reproduction and growth less losses due to non-anthropogenic mortality. This is a theoretical construct when applied to populations that have a long and significant harvest history. In this Plan, we use this term to refer specifically to the scientific concept of MNPL, which is proportional to the carrying capacity at each point in time. Further, in calculating MNPL we assume removals are unbiased with regard to age and sex of the animals taken. The statutory definition of maximum net productivity level (as related to OSP) may or may not differ from the scientific concept.

Optimum sustainable population (OSP). As defined in the MMPA, OSP is "the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element" (16 USC 1362(9)). Congressional reports and agency policies have further clarified that OSP represents a range of population sizes between the maximum net productivity level and the carrying capacity of the ecosystem. One of the primary purposes of the MMPA is to restore and maintain marine mammal populations at OSP.

Population. A group of animals in the same taxon below the subspecific level, in common spatial arrangement that interbreed when mature (50 CFR 17.3). Specific populations have not been identified for polar bears. The smallest groupings recognized by the Polar Bear Specialist Group are referred to as "subpopulations." In this Plan, we avoid using the term "population," except as a generic term to refer to a group of polar bears.

Recovery. Under the ESA, the Secretary (of the Interior or of Commerce) is required to develop recovery plans "for the conservation and survival of endangered species and threatened species listed pursuant to this section" (16 USC 1533(f)(1)). The term "recovery" is not defined in the ESA, but is interpreted to be similar to "conservation" under the ESA (see above), namely, improvement in the status of a listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the ESA (50 CFR 402.02). We use the term "recovery" to refer to the purposes of this Plan under the ESA (and "conservation" to refer to the purposes of this Plan under the MMPA).

Recovery unit. Under the ESA, "a special unit of the listed entity that is geographically or otherwise identifiable and is essential to the recovery of the entire listed entity, i.e., recovery units are individually necessary to conserve genetic robustness, demographic robustness, important life history stages, or some other feature necessary for long-term sustainability of the entire listed entity" (NMFS 2010). In this Plan, the four polar bear ecoregions are identified as recovery units.

Significant functioning element of the ecosystem. In the MMPA, Congress found that "species and population stocks should not be permitted to diminish beyond the point at which they cease to be a significant functioning element in the ecosystem of which they are a part, and, consistent with this major objective, they should not be permitted to diminish below their optimum sustainable population" (16 USC 1361(2)). The term is not otherwise defined. In this Plan, the maintenance of polar bears as a significant functioning element of the Arctic marine ecosystem is an important conservation goal. As a top predator, polar bears have a significant role in the energy flow in the ecosystem, and in the distribution and behavior of prey species. Potential measures for their function in the ecosystem are proposed in the Plan.

Stability of the marine ecosystem. In the MMPA, Congress found that the "primary objective of [marine mammal] management should be to maintain the health and stability of the marine ecosystem" (16 USC 1361(6)). The term "stability of the marine ecosystem" is not otherwise defined. In this Plan, we assume that the stability of the marine ecosystem is reflected in its ability to support marine mammals, and use the carrying capacity of a polar bear subpopulation as its measure.

Stock. Under the MMPA, a stock is "a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature" (16 USC 1362(11)). The Southern Beaufort Sea and Chukchi Sea polar bear subpopulations have been identified as stocks under the MMPA. In this Plan, we assume that all subpopulations could be identified as stocks.

Subpopulation. The Polar Bear Specialist Group has identified 19 relatively discrete "subpopulations" of polar bears (Fig. 1). In this Plan, we reserve this term to refer specifically to those groupings of polar bears.

Sustainable take (or, sustainable yield). In this Plan, we define sustainable take (or yield) as a fixed-rate removal of polar bears that maintains a subpopulation above its MNPL. Under this definition, sustainable take is possible even when the carrying capacity and the population size are declining, provided the take is adjusted annually to account for the change in the population size, and the population size at all times is maintained above its MNPL relative to carrying capacity. This definition is offered for the broader purposes of this Plan, but does not preclude more protective definitions being used for specific subpopulations (e.g., sustainable take is defined differently under the United States-Russia bilateral agreement for the Chukchi Sea subpopulation).

Take. Under the MMPA, "take" means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal" (16 USC 1362(13)). Under the ESA, "take" means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 USC 1532(19)). This Plan primarily addresses lethal take of polar bears, and is less specific about non-lethal take. Thus, for the purpose of brevity, unless otherwise noted, "take" refers to all anthropogenic lethal removals of polar bears, but the broader definitions remain the legal standard.

Threatened. Under the ESA, a threatened species is "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (16 USC 1532(20)). Polar bears were classified as threatened under the ESA in 2008.

Traditional ecological knowledge (TEK). The cumulative body of knowledge about local natural resources accumulated by indigenous, aboriginal, or local people and often passed down through generations through practice and oral traditions. This Plan recognizes that there is an appropriate role for TEK in science and management of polar bears, just as there is an appropriate role for the empirical methods of Western science; indeed, these sets of knowledge can often enhance each other.

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Appendix A—Background

BRIEF OVERVIEW/SPECIES STATUS

Polar bears (*Ursus maritimus*) occur in 19 relatively discrete subpopulations (Fig. 1) throughout the seasonally and permanently ice-covered marine waters of the northern hemisphere (Arctic and Subarctic), in Canada, Denmark (Greenland), Norway, Russia and the United States (U.S.). The status of each of these subpopulations varies (Polar Bear Specialists Group Status Table; http://pbsg.npolar.no/en/status/status-table.html). The U.S. contains portions of two subpopulations: the Chukchi Sea (also called the Alaska-Chukotka subpopulation in the U.S.–Russia Bilateral Agreement) and the Southern Beaufort Sea subpopulation. The polar bear was listed as a threatened species under the U.S. Endangered Species Act of 1973, as amended (16 USC 1531 *et seq.*)(ESA) on May 15, 2008 (73 FR 28212). The total circumpolar population is estimated to be 20,000 to 25,000 polar bears (Obbard et al. 2010).

SPECIES DESCRIPTION

Polar bears are the largest living bear species (DeMaster and Stirling 1981, p. 1), and are characterized by large body size, a stocky form, and fur color that varies from white to yellow. They are sexually dimorphic; females weigh 181 to 317 kilograms (kg) (400 to 700 pounds (lbs)) and males up to 654 kg (1,440 lbs).

Polar bears evolved in Arctic sea ice habitats and are evolutionarily well adapted to this habitat. Their unique adaptations include: (1) white pelage with water-repellent guard hairs and dense underfur; (2) a short, furred snout; (3) small ears with reduced surface area; (4) teeth specialized for a carnivorous rather than an omnivorous diet; and (5) feet with tiny papillae on the underside, which increase traction on ice (Stirling 1988, p. 24). In addition, they have large, paddle-like feet (Stirling 1988, p. 24), and claws that are shorter and more strongly curved than grizzly bear claws, and larger and heavier than those of black bears (*Ursus americanus*) (Amstrup 2003, p. 589).

In the U.S., polar bears are considered marine mammals under the Marine Mammal Protection Act (MMPA), because their primary habitat is sea ice (Amstrup 2003, p. 587).

DISTRIBUTION

The boundaries of the 19 relatively discrete polar bear subpopulations (Fig. 1) usually, but not always, reflect ecological boundaries. However, in some cases, boundaries are practical delineations for management purposes. Polar bear subpopulations have been further classified as occurring in one of four ecoregions (Fig. 2; Amstrup et al. 2008) based on the spatial and temporal dynamics of sea ice in the subpopulation's range. Subpopulations classified as occurring in the seasonal ice ecoregion share the characteristic that the sea ice in their range fully melts in the summer, during which time bears are forced on shore for extended periods of time until the sea ice reforms. Subpopulations occurring in the archipelago ecoregion are characterized as having heavy annual and multi-year sea ice that fills the channels between the Canadian Arctic Islands. Bears in this ecoregion remain on the sea ice throughout the year. The divergent ice ecoregion is characterized by the formation of annual sea ice that is advected towards the polar basin. Conversely, the convergent ice ecoregion is characterized annual sea ice that converges towards shoreline allowing bears to access nearshore ice year-round.

The Chukchi Sea subpopulation is shared by the U.S. and Russia. The boundaries of this subpopulation are described differently in the *Agreement between the United States of America and the Russian Federation on the Conservation and Management of the Alaska—Chukotka Polar Bear Population*" (Bilateral Agreement) and in Polar Bear Specialist Group (PBSG) publications. The Bilateral Agreement describes the CS subpopulation within a line extending north from the mouth of the Kolyma River and on the east by a line extending north from Point Barrow (Obbard et al. 2010). However, the PBSG describes the northeastern boundary near Icy Cape, Alaska to a western boundary near Chauniskaya Bay, Russia, in the Eastern Siberian Sea (Obbard et al. 2010).

The Southern Beaufort Sea subpopulation is shared by the U.S. and Canada. The western boundary is near Icy Cape, Alaska (Obbard et al. 2010). The eastern boundary was originally determined to be south of Banks Island and east of the Baillie Islands, Canada. Recently, the government of the Northwest Territories and the Inuvialuit Game Council agreed to move the eastern boundary westward, near the community of Tuktoyaktuk, Canada (Obbard et al. 2010). The change was proposed to better align management boundaries with the current distribution of polar bears in this region (including the adjacent Northern Beaufort subpopulation), based on radiotracking data. These changes are being implemented for the 2013/2014 season.

POPULATION TRENDS

Accurate estimates of polar bear subpopulation sizes and trends are difficult to obtain due to the species' low densities, the vast and inaccessible nature of their sea ice habitat, the movement of bears across international boundaries, and limited budgets (USFWS 2010a and 2010b).

Chukchi Sea Subpopulation

Reliable estimates of subpopulation size or status are not available for the Chukchi Sea subpopulation. The most recent quantitative estimate of the size of this subpopulation was 2,000–5,000 polar bears (Belikov 1992), based on incomplete denning surveys in Russian portions of the Chukchi Sea where most of the subpopulation is believed to den (Belikov 1980). In 2005, expert opinion among the PBSG members was that the subpopulation had around 2,000 bears (Aars et al. 2006). This estimate was derived by extrapolating the earlier estimate of Belikov (1992) forward in time using a qualitative negative trend (Regehr et al. in prep). At the time of the ESA listing in 2008, the PBSG reported this subpopulation at approximately 2,000 animals. Subsequently, the PBSG listed the size of this subpopulation as "unknown," and currently lists the CS subpopulation trend as "data deficient."

Southern Beaufort Sea Subpopulation

The Southern Beaufort Sea subpopulation is estimated at approximately 1,526 animals (Regehr et al. 2006). This is reduced from the estimated population in the late 1980s. Analyses of 2001–2006 data indicated that the survival and breeding of polar bears during this period were affected by sea ice conditions, and that subpopulation growth rate was strongly negative in years with long ice-free seasons (Hunter et al. 2007, Regehr et al. 2010). In addition, analyses of over 20 years of data on the size and body condition of bears in this subpopulation demonstrated declines for most sex and age classes and significant negative relationships between annual sea ice availability and body condition (Rode et al. 2010a). These lines of evidence suggest that the Southern Beaufort Sea subpopulation is currently declining due to sea ice loss.

LIFE HISTORY/ECOLOGY

Polar bears are a K-selected species, characterized by late sexual maturity, small litter sizes, and extended parental investment in raising young. All of these factors contribute to the species' low reproductive rate (Amstrup 2003, pp. 599–600). Females generally mature and breed for the first time at 4 or 5 years and give birth at 5 or 6 years of age. Litters of two cubs are most common, but 3-cub litters are seen on occasion across the Arctic (Amstrup 2003, p. 599). The minimum reproductive interval for adult females is three years.

Females enter a prolonged estrus between March and June, when breeding occurs. Though bears ovulate in the spring, implantation is delayed until autumn. The timing of implantation, and therefore the timing of birth, likely depends on body condition of the female, which is determined by many environmental factors. When foraging conditions are difficult, polar bears may "defer" reproduction in favor of survival (Derocher and Stirling 1992, Eberhardt 2002). Pregnant females that spend the late summer on land prior to denning may not feed for eight months (Watts and Hansen 1987, p. 627); this period coincides with the time when the female gives birth and nourishes new cubs.

Newborn polar bears have fur, but are blind, helpless and weigh only 0.6 kg (1.3 lb) (Blix and Lentfer 1979, p. 68). Cubs grow rapidly, and may weigh 10 to 12 kg (22 to 26 lbs) by the time they emerge from the den in the spring. Young bears will stay with their mothers until weaning, which occurs most commonly in early spring when the cubs are 2.3 years old. Female bears are available to breed again after their cubs are weaned.

Polar bears are long-lived and are not generally susceptible to disease, parasites, or injury. Due to extended maternal care of young and low reproductive rates, polar bears require high adult survival rates, particularly of females, to maintain population levels (Eberhardt 1985, p. 1,010; Amstrup and Durner 1995, pp. 1,313, 1,319). Survival rates are generally age dependent, with cubs-of-the-year having the lowest rates and prime age adults (prime reproductive years are between approximately 5 and 20 years of age) having survival rates that can exceed 90 percent (Regehr et al. 2007b). Survival rates exceeding 90 percent for adult females are essential to sustain polar bear populations (Amstrup and Durner 1995, p. 1,319).

Polar bears are top predators in the Arctic marine ecosystem. Adult polar bears need to consume approximately 2 kg (4.4 lbs) of fat per day to survive. They prey heavily on ice-seals, principally ringed seals (*Phoca hispida*), and to a lesser extent, bearded seals (*Erignathus barbatus*). Bears occasionally take larger animals such as walruses (*Odobenus rosmarus*) and belugas (*Delphinapterus leucas*) (Kiliaan and Stirling 1978). Research in the Canadian Arctic suggests that, in some areas and under some conditions, prey other than seals or carrion may sustain polar bears when seals are unavailable (Stirling and Øritsland 1995, p. 2,609). Bears that have the most specialized diets may be most vulnerable to climate-related changes in sea ice conditions (Thiemann et al. 2008).

Polar bears will eat human garbage (Lunn and Stirling 1985, p. 2,295). When confined to land for long periods, they will also consume plants and other terrestrial foods (Russell 1975, p. 122; Derocher et al. 1993, p. 252); however the relevance of such foods to the long-term welfare of polar bears is limited by their patchy availability and relatively low nutritional content (e.g., Derocher et al. 2004, p. 169; Rode et al. 2010b).

Changes in body condition have been shown to affect bear reproduction and survival, which in turn can have population-level effects (Regehr et al. 2010, Rode et al. 2010a). The survival of polar bear cubs-of-the-year has been directly linked to their weight and the weight of their mothers, with lower weights resulting in reduced survival (Derocher and Stirling 1996; Stirling et al. 1999). Changes in body condition indices were documented in the Western Hudson Bay subpopulation before a statistically significant decline in that subpopulation was documented (Regehr et al. 2007a). Thus, changes in these indices may serve as an "early warning" that signal imminent subpopulation declines.

In a Southern Beaufort Sea study, Rode et al. (2010a) found that between 1986 and 2006 the body size of all polar bears over three years of age declined over time and the size of young, growing bears was smaller after years when sea ice availability was reduced. Litter mass and cub recruitment also declined over that period. These observations suggest a downward trend in the nutritional status of SBS bears. The significant relationship between several of these measures and sea ice cover over the continental shelf suggests that nutritional limitations are associated with changing sea-ice conditions.

HABITAT CHARACTERISTICS AND NEEDS

Pack ice is the primary summer habitat for polar bears in the U.S. (Durner et al. 2004, pp. 16−20). Polar bears depend on sea ice as a platform from which to hunt and feed on seals; to seek mates and breed; to travel to terrestrial maternity denning areas; sometimes for maternity denning; and to make long-distance movements (Stirling and Derocher 1993, p. 241). Polar bears prefer certain sea-ice stages, concentrations, forms, and deformation types (e.g., Arthur et al. 1996; Mauritzen et al. 2001, p. 1,711; Durner et al. 2009, pp. 51–53). They have been shown to prefer the floe ice edge, stable shore-fast ice with drifts, and moving ice (Stirling et al. 1993, p. 18).

Polar bear movements are closely tied to the seasonal dynamics of sea-ice extent as it retreats northward during summer melt and advances southward during autumn freeze. The formation and movement patterns of sea ice strongly influence the distribution and accessibility of ringed and bearded seals. When the annual sea ice begins to form in the shallower water over the continental shelf, polar bears that had retreated north of the continental shelf during the summer return to the shallower shelf waters where seal densities are higher (Durner *et al.* 2009a, p. 55). During the winter and spring, when energetic demands are the greatest, nearshore lead systems (i.e., cracks in the ice where bears can hunt hauled-out seals) and polynyas (areas of open sea surrounded by sea ice) are important for seals, and are thus important foraging habitat for polar bears.

During the spring, nearshore lead systems continue to be important hunting and foraging habitat for polar bears. The shore-fast ice zone, where ringed seals construct subnivean (in or under the snow) birth lairs for pupping, is also an important foraging habitat during the spring (Stirling *et al.* 1993, p. 20). Polar bears in the SBS are thought to reach their peak weights during the fall and early winter period (Durner and Amstrup 1996, p. 483). Thus, availability and accessibility of prey during this time may be critical for survival through the winter.

Shore-fast ice is used by polar bears for feeding on seal pups, for movement, and occasionally for maternity denning (Stirling *et al.* 1993, p. 20). In protected bays and lagoons, the shore-fast ice typically forms in the fall and remains stationary throughout the winter. The shore-fast ice usually occurs in a narrow belt along the coast. Most shore-fast ice melts in the summer.

Polar bears also depend upon sea ice as a habitat on which to seek mates and breed (Stirling and Derocher 1993, p. 241). Breeding occurs in the spring, between March and June (Schliebe et al. 2006 pp. 17–18). In the Southern Beaufort Sea, the probability that adult females will survive and produce cubs-of-the-year appears to decline in association with longer duration ice-free periods over the continental shelf (Regehr et al. 2007b).

The variable nature of sea ice results in an ever-changing distribution of suitable habitat for polar bears, and eliminates any benefit to defending individual territories (Schliebe et al. 2006 p. 34.). Males must be free of the need to defend territories if they are to maximize their potential for finding mates each year (Ramsay and Stirling 1986, Schliebe et al. 2006 p. 34.)

Throughout the species' range, most pregnant female polar bears excavate dens in snow located on land in the fall–early winter period (e.g., Ramsay and Stirling 1990, p. 233; Amstrup and Gardner 1994, p. 5), or, in the case of portions of the SBS subpopulation, in snow caves on pack and shore-fast ice. The key characteristic of all denning habitat is topographic features that catch snow in the autumn and early winter (Durner *et al.* 2003, p. 61), because successful denning requires accumulation of sufficient snow for den construction and maintenance. Adequate and timely snowfall combined with winds that cause snow accumulation leeward of topographic features create denning habitat (Harington 1968, p. 12).

In some areas, the majority of polar bear denning occurs in core areas (Harington 1968, pp. 7–8; Stishov 1991a, p. 107; Ovsyanikov 2005, p. 169), which show high use over time. In some portions of the species' range, polar bears den in a more diffuse pattern, with dens scattered over larger areas at lower density (e.g., Stirling and Andriashek 1992, p. 363; Amstrup and Gardner 1994, p. 5; Ferguson et al. 2000a, p. 1125;).

In Alaska, most polar bear dens occur relatively near the coast along the coastal bluffs and riverbanks of the mainland, on barrier islands, or on the drifting pack ice (Amstrup and Gardner 1994, p. 5; Amstrup 2003, p. 596). Certain areas such as barrier islands, river banks, much of the North Slope coastal plain, and coastal bluffs that occur at the interface of mainland and marine habitat receive proportionally greater use for denning (Durner et al. 2004; Durner et al. 2006). Denning areas on the north slope of Alaska are in relatively flat topography (e.g., Durner et al. 2003, p. 61). Currently approximately 37% (Fischbach et al. 2007) and 5–10% (USFWS & USGS unpubl. data) of pregnant females den on ice in the SBS and CS subpopulations, respectively.

Some habitat suitable for use for denning has been mapped on the North Slope (Durner et al. 2006). The primary denning areas for the CS subpopulation occur on Wrangel Island, Russia, where up to 200 bears per year have denned annually, and the northeastern coast of the Chukotka Peninsula, Russia (Stishov 1991a, p. 107; Ovsyanikov 2005, p. 169).

THREATS ASSESSMENT/REASONS FOR LISTING UNDER THE ESA

The primary threat to polar bears is the loss of sea ice habitat due to climate change (USFWS 2008). Polar bears evolved over thousands of years to life in a sea ice environment. They depend on the sea ice-dominated ecosystem to support essential life functions. The sea ice ecosystem supports ringed seals, primary prey for polar bears, and other marine mammals that are a part of their prey base.

Sea ice is rapidly thinning and retreating throughout the Arctic. Ice conditions that affect polar bear habitat include: (1) fragmentation of sea ice; (2) a dramatic increase in the extent of open water areas seasonally; (3) reduction in the extent and area of sea ice in all seasons; (4) retraction of sea ice away from productive continental shelf areas throughout the polar basin; (5) reduction of the amount of heavier and more stable multi-year ice; and (6) declining thickness and quality of shore-fast ice, if it restricts access to seals. These combined and interrelated events change the extent and quality of sea ice during all seasons, but particularly during the spring-summer period.

Climate change will continue to affect Arctic sea ice for the foreseeable future. Due to the long persistence time of certain greenhouse gases (GHGs) in the atmosphere, the current and projected patterns of GHG emissions over the next few decades, and interactions among climate processes, climate changes for the next 40–50 years are already largely set (IPCC 2007, p. 749; Overland and Wang 2007). Climate change effects on sea ice and polar bears will continue through this timeframe and very likely further into the future. However, Amstrup et al. (2010) demonstrated that significantly reducing GHG emissions even by 2020 could make a difference for polar bears at mid-century and beyond.

The ultimate effect will be that polar bear subpopulations will decline or continue to decline. With a diminished sea ice platform, bear distribution and seasonal onshore abundance will change. Not all subpopulations will be affected evenly in the level, rate, and timing of effects.

Below, we discuss the various threats that have been identified, organized by the ESA listing factors (section 4(a)(1)) addressed in the Final Rule. In addition to the factors identified in the listing, additional threats were investigated during development of this Plan.

THE PRESENT OR THREATENED DESTRUCTION, MODIFICATION, OR CURTAILMENT OF THE SPECIES' HABITAT OR RANGE

Loss of Access to Prey

Without sea ice, polar bears lack a platform that allows them access to their ice-seal prey. Longer melt seasons and reduced summer ice extent will likely force bears to increase use of habitats where hunting success will be lower (Derocher et al. 2004, p. 167; Stirling and Parkinson 2006, pp. 271–272). In the summer, ice seals typically occur in open water and therefore are virtually inaccessible to polar bears (Harwood and Stirling 1992, p. 897). Bears have only rarely been reported to capture ringed seals in open water (Furnell and Oolooyuk 1980, p. 88). Thus, hunting in ice-free water will not compensate for the loss of sea ice and the hunting opportunities it affords polar bears (Stirling and Derocher 1993, p. 241; Derocher et al. 2004, p. 167).

Once sea ice concentration drops below 50 percent, polar bears have been documented to quickly abandon sea ice for land, where access to their primary prey is almost entirely absent. Bears may also retreat northward with the more consolidated pack ice over the polar basin, which may be less productive foraging habitat. The northward retreat is most likely related to reduced hunting success in broken ice with significant open water and need to reduce energetic costs once prey availability and food intake drops below some threshold (Derocher et al. 2004, p. 167; Stirling et al. 1999, pp. 302–303). Rode et al. (2010a) demonstrated that available terrestrial food resources are likely inadequate to offset the nutritional consequences of an extended ice-free period.

Increased Movements, Energy Expenditure

The best scientific data available suggest that polar bears are inefficient moving on land and expend approximately twice the average energy when walking compared to other mammals (Best 1982, p. 63; Hurst 1982, p. 273). Increased rate and extent of sea ice movements will require polar bears to expend additional energy to maintain their position near preferred habitats (Derocher et al. 2004, p. 167). This may be an especially important consideration for females with small cubs (Durner et al. 2010). As movement of sea ice increases and areas of unconsolidated ice also increase, some bears are likely to lose contact with the main body of ice and drift into unsuitable habitat from which it may be difficult to return (Derocher et al. 2004, p. 167). The increased energetic costs to polar bears from increased movements are likely to result in reduced body weight and condition, and a corresponding reduction in survival and recruitment rates (e.g., Regehr et al. 2010, Rode et al. 2010a).

Diminished sea ice cover will also increase the risk of drowning that may occur during long distance swimming or swimming under unfavorable weather conditions. Ice reduction not only increases areas of open water across which polar bears must swim, but may influence the size of wave action. These may result in increases in bear mortality associated with swimming (Monnett and Gleason 2006, p. 5). In addition, diminished sea ice cover may result in hypothermia for young cubs that are forced to swim for longer periods than at present.

Redistribution of Polar Bears to Where They Are More Vulnerable to Impacts

The continued retraction and fragmentation of sea ice habitats that is projected to occur will alter previous habitat use patterns seasonally and regionally. Recent studies indicate that polar bear movements and seasonal fidelity to certain habitat areas are changing and that these changes are strongly correlated with simultaneous changes in sea ice. These changes have been documented for a number of polar bear subpopulations, with the potential for large-scale shifts in distribution by the end of the 21st century (Durner et al. 2007, pp. 18–19).

Changes in movements and seasonal distributions can affect polar bear nutrition and body condition. In Western Hudson Bay, sea ice break-up now occurs approximately 2.5 weeks earlier than it did 30 years ago because of increasing spring temperatures (Stirling et al. 1999, p. 299; Stirling and Parkinson 2006, p. 265), and this earlier break-up is highly correlated with dates that female bears come ashore (Stirling et al. 1999, p. 299). Declining reproductive rates, subadult survival, and body mass (weights) have occurred because of longer fasting periods on land resulting from this progressively earlier break-up (Stirling et al. 1999, p. 304; Derocher et al. 2004, p. 165), leading to reduced population size (Regehr et al. 2007b).

Analyses of the relationship of polar bear distribution to potential food resources in Alaska suggest that, while seal densities near shore and availability of bowhead whale carcasses may play a role in polar bear distribution changes, sea ice conditions are influencing the distribution of polar bears in the Southern Beaufort Sea. Results also suggest that increased bear use of coastal areas may continue if the summer retreat of sea ice continues into the future as projected (e.g., Schliebe et al. 2008, Gleason and Rode 2009). If bears spend more time on land during the open water period, there is potential for increased disease transmission, particularly where bears form aggregations such as at whale bones piles (i.e., sites where the remains of subsistence harvested whales are deposited outside of villages). Such aggregations are also more susceptible to the impacts from potential oil spills (BOEMRE 2011).

Gleason and Rode (2009) noted a greater number of bears in open water of the Southern Beaufort Sea and on land during surveys in 1997–2005, when sea ice was often absent from their study area, compared to 1979–1996 surveys, when sea ice was a predominant habitat in the area. Bears in open water likely were swimming in an attempt to reach offshore pack ice or land. Schliebe et al. (2008) determined that the number of bears on land in the U.S. portion of the Southern Beaufort Sea between 2000 and 2005 was higher during years when the sea ice retreated further offshore. Their results suggest that a trend of increasing distance between land and sea ice over time would be associated with an increasing number of bears on shore and/or an increase in the duration of time they spend there.

Seasonal polar bear distribution changes, the negative effect of reduced access to primary prey, and prolonged use of terrestrial habitat are all concerns for polar bears. Although polar bears have been observed using terrestrial foods such as blueberries (*Vaccinium sp.*), snow geese (*Anser caerulescens*), and reindeer (*Rangifer tarandus*), these alternate foods cannot replace the energy-dense diet polar bears obtain from marine mammals (e.g., Derocher et al. 2004, p. 169, Rode et al. 2010b, Smith et al. 2010). Polar bears are not known to regularly hunt musk oxen (*Ovibos moschatus*) or snow geese (Lunn and Stirling 1985, p. 2,295). Thus, greater use of terrestrial habitats will not offset energy losses resulting from decreased seal consumption. Nutritional stress is a likely result. This conclusion is well-supported by evidence from Western Hudson Bay, as previously cited.

Impacts to Prey Species

Polar bear subpopulations are known to fluctuate with prey abundance (Stirling and Lunn 1997, p. 177). Declines in ringed and bearded seal numbers and productivity have resulted in marked declines in polar bear subpopulations (e.g., Stirling and Øritsland 1995, p. 2,609; Stirling 2002, p. 68). Accurate, current population estimates and trends for these seal species are unavailable. However, ringed and bearded seals (two southern Distinct Population Segments) were recently listed by NOAA as threatened under the ESA, primarily as a result of projected declines in snow and ice cover resulting from climate change and their impacts on seal productivity and survival (77 FR 76706).

Diminishing ice and snow cover are the greatest challenges to the persistence of ringed seals. Within the century, snow cover is projected to be inadequate for the formation and occupation of subnivean birth lairs over most of the species' range (Kelly et al. 2010). Pups in lairs with thin snow roofs are more vulnerable to predation than pups in lairs with thick roofs (Hammill and Smith 1991, p.131; Ferguson et al. 2005, p. 131). The thickness of the snow layer surrounding birth lairs is also crucial for thermoregulation and hence, the survival of nursing pups when air temperatures fall below zero degrees C (Stirling and Smith 2004, p. 65). When lack of snow cover has forced birthing to occur in the open, it has been observed that nearly 100 percent of pups died from predation (e.g., multiple sources cited in Kelly 2001, p. 49).

Rain-on-snow events during the late winter are increasing and can damage or eliminate snow-covered pupping lairs (ACIA 2005. p 26). The pups are then exposed to the elements and risk hypothermia. Damaged lairs or exposed pups are relatively easy prey for polar bears and arctic foxes (*Alopex lagopus*) (Stirling and Smith 2004, p. 65). Stirling and Smith (2004, p. 66) postulated that should early season rain become regular and widespread in the future, mortality of ringed seal pups will increase, especially in more southerly parts of their range.

Pupping habitat on landfast ice (McLaren 1958, p. 26; Burns 1970, p. 445) and drifting pack ice (e.g., Wiig et al. 1999, p. 595; Lydersen et al. 2004) can be affected by earlier warming and break-up in the spring, which shortens the length of time pups have to grow and mature (Kelly 2001, p. 48; Smith and Harwood 2001). In addition, high ringed seal fidelity to birthing sites makes them more susceptible to localized impacts from birth lair snow degradation, harvest, or human activities (Kelly et al. 2006, p. 15).

Changes in snow and ice conditions can also affect polar bear prey other than ringed seals (Born 2005, p. 152), and will likely result in a net reduction in the abundance of species such as ribbon seals (*Phoca fasciata*), bearded seals, and Pacific walrus (ACIA 2005, p. 510). As a result, polar bears in Alaska likely won't be able to compensate for the reduced availability of ringed seals by increasing their taking of other species (Derocher et al. 2004, p. 168). One exception to this trend is that increased use of terrestrial haulouts by walrus may make them more available to polar bears, in the short term, if sea ice extent and duration continue to decline as projected.

Inadequate Conditions For Successful Denning

Climate change could negatively influence denning (Derocher et al. 2004). Insufficient snow would prevent den construction or result in use of poor sites where the roof could collapse (Derocher et al. 2004). Changes in the amount and timing of snowfall could also impact the thermal properties of dens (Derocher et al. 2004). Since polar bear cubs are born helpless and need to nurse for three months before emerging from the den, major changes in the thermal properties of dens could negatively impact cub survival (Derocher et al. 2004). Unusual rain events are projected to increase throughout the Arctic in winter (Liston and Hiemstra 2011), and increased rain in late winter and early spring could cause den collapse (Stirling and Smith 2004).

Loss of Access to Denning Areas

Many female polar bears repeatedly return to specific denning areas on land (e.g., Harrington 1968, p. 11; Ramsay and Stirling 1990, p. 233; Amstrup and Gardner 1994, p. 8). For bears to access preferred denning areas, pack ice must drift close enough or must freeze sufficiently early to allow pregnant females to walk or swim to the area by late October or early November (Derocher et al. 2004, p. 166). As distance increases between the pack ice edge and coastal denning areas, it will become increasingly difficult for females to access preferred denning locations. Distance to the ice edge is one factor thought to limit denning in western Alaska by the CS subpopulation. Increased travel distances could negatively affect individual fitness, denning success, and ultimately subpopulations of polar bears (Aars et al. 2006).

Under most climate change scenarios, the distance between the edge of the pack ice and land will increase. Derocher et al. (2004, p. 166) predicted that under future climate change scenarios, pregnant female polar bears will not be able to reach many of the most important denning areas in the Arctic National Wildlife Refuge and north coast of the Beaufort Sea. Bergen et al. (2007, p. 2) found that between 1979 and 2006, the minimum distance polar bears traveled to denning habitats in northeast Alaska increased at an average linear rate of 6–8 km (3.7–5.0 mi) per year and almost doubled after 1992. They projected that travel distances would increase threefold by 2060 (Bergen et al. 2007, p. 2–3).

Loss of Mating Platform

Moore and Huntington (2008) classify the polar bear as an "ice-obligate" species because the bears rely on sea ice as a platform for breeding as well as resting and hunting. Loss of sea ice may impact polar bear mating success. Molnár et al. (2011) predicted future declines in female mating probability in Western Hudson Bay due to sea ice area declines and habitat fragmentation.

OVERUTILIZATION

Overutilization does not currently threaten the species throughout all or a significant portion of its range (USFWS 2008). However, continued high levels of poaching and increased mortality from human-bear encounters or other forms of mortality may become a more significant threat in the future, particularly for subpopulations experiencing nutritional stress or declining numbers as a consequence of habitat change.

Trophy hunting by non-Natives using aircraft began in the late 1940s, and population declines due to sport hunting became an increasing international concern during the 1950s and 1960s. In the 1960s, State of Alaska hunting regulations became more restrictive. Nonetheless, between 1954 and 1972, an average of 222 polar bears was harvested annually in Alaska, resulting in a population decline (Figure 1; Amstrup et al. 1986, p. 246).

As a result of declines, actions were taken. Biologists from the five polar bear nations met and formed the Polar Bear Specialist Group under the IUCN. The PBSG was largely responsible for the development and ratification of the *1973 Agreement on the Conservation of Polar Bears ("Range States Agreement"),* which calls for cooperative international management of polar bear populations based on sound conservation practices, prohibits polar bear hunting except by local people using traditional methods, calls for protection of females and denning bears, and bans use of aircraft and large motorized vessels to hunt polar bears (Prestrud and Stirling 1994). In 1972, the MMPA was passed, ending all polar bear hunting in the U.S. except by coastal dwelling Alaska Natives for subsistence and handicraft purposes. The effect of eliminating sport hunting in Alaska is evident in Figure 3. As of the effective date of the ESA listing, authorization for the import of sport-hunted polar bear trophies from Canada to the U.S. is no longer available under section 104(c)(5) of the MMPA.

Poaching

Polar bear hunting has been prohibited in Russia since 1956, however poaching increased in northeast Russia (Chukotka) after the collapse of the Soviet Union, and the level of illegal killing was estimated to be high enough to be unsustainable and to pose a serious threat to the subpopulation in the 1990s (Obbard et al. 2010). However, recent research suggests that the annual number of polar bears illegally killed in Russia has declined substantially (A. Kochnev, unpublished data). There is no evidence that poaching is an issue in the U.S. While the CS subpopulation is currently listed as data deficient to assess population trends (http://pbsg.npolar.no/en/status/status-table.html), recent research suggests that the polar bears in CS subpopulation has a high capacity for growth (Rode et al. 2014).

Subsistence Harvest

Polar bears are of considerable social and cultural importance and value to the Inupiat and Yupik people. Polar bear subsistence hunting by coastal Alaska Natives has occurred for centuries (Lentfer 1976, p. 209) and polar bears continue to be an important resource for coastal communities throughout northern and western Alaska. Polar bears provide a source of meat and raw materials for clothing and handicrafts, and polar bear hunting is a source of pride, prestige, and accomplishment for Native hunters.

Active harvest management programs are in place in Alaska, where polar bears are harvested by coastal Alaska Natives. Polar bear harvest is also actively managed in Canada. These actions, along with the ban on sport hunting in Alaska, are largely viewed as having succeeded in reversing overharvests that resulted in population depletion during the years prior to the multilateral 1973 Agreement (Prestrud and Stirling 1994).

Polar bear harvest in Alaska is monitored by the Service's marking and tagging program (USFWS 2010c). A thorough review and evaluation of past and current harvest, including other forms of removal, for Alaska's subpopulations has been described (Schliebe et al. 2006, pp. 108–127; USFWS 2011).

The mutual concern of Russia and the U.S. for the CS subpopulation resulted in the signing of the Bilateral Agreement in 2000[1]. The Bilateral Agreement identified goals to improve polar bear conservation and safeguard the cultural and traditional use of polar bears by Native peoples. For Chukotka Natives, the Bilateral Agreement re-establishes their ability to hunt polar bears for subsistence purposes. Alaskan Natives have supported the subsistence rights of their Russian neighbors and have long recognized the need to cooperatively manage this subpopulation.

In June 2010, and reaffirmed in 2014, the U.S.-Russia Polar Bear Commission decided to place an upper limit on harvest from the Alaska-Chukotka population of 19 female and 39 male (for a total

1 Implementing legislation for the Bilateral Agreement was signed in the U.S. in January 2007.

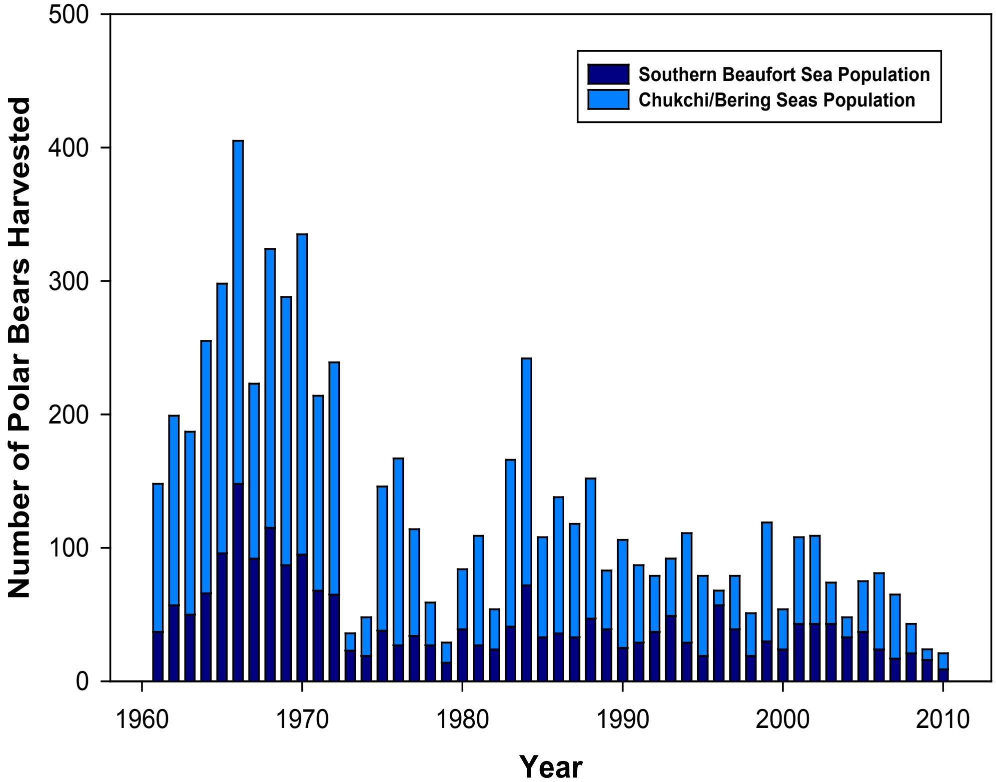

Figure 3. Alaska polar bear harvest, 1961–2010.

of 58) polar bears per year. This limit was set based on subsistence needs and the best available science and local information. Harvest will be split evenly between Native peoples of Alaska and Chukotka. Details of implementing this harvest limit are currently being developed in both Russia and the U.S. The Service and the Alaska Nanuuq Commission (ANC) will work in partnership with local communities to implement the new harvest limits in the U.S. (USFWS 2011, p. 4).

For the Southern Beaufort Sea subpopulation, hunting is regulated through an agreement between the Inuvialuit of Canada and the Inupiat of Alaska (Brower et al. 2002, p. 371). In 1988, the Commissioners for the Agreement established a total annual harvest quota of 76 bears, split evenly between the U.S. and Canada; all human-caused mortalities were included in the quota. For the 1997–98 season, Commissioners requested a quota of 80 bears, with several caveats. In 2000, the Agreement was revised to include kills of problem bears or research handling deaths in the annual harvest calculation, and it was agreed that the female portion of the harvest should not exceed one-third of the total. In 2010, Commissioners recommended that the quota be reduced to 70, shared equally between the U.S. and Canada (USFWS 2011, p. 6).

Defense-of-life removals

Human-bear interactions and defense-of-life kills may increase under projected climate change scenarios where more bears are on land and in contact with humans (Derocher et al. 2004, p. 169). Polar bears are inquisitive animals and often investigate novel odors or sights. This trait can lead to polar bears being killed when they investigate human activities (Herrero and Herrero 1997, p. 11). Since the late 1990s, the timing of freeze-up in the fall has occurred later and later, resulting in an increased amount of time polar bears spend on land. This increases the probability of human-bear interactions on land. With projections indicating that the Arctic Ocean may be largely ice free in the summer in the next few decades, there will be an increase in human-polar bear conflicts as nutritionally stressed bears are forced on shore and closer to people.

Humans often create dangerous situations through attractants near settlements, camps, and cabins, including garbage, harvested animal remains, meat caches, and dog yards. Attractants suppress polar bears' natural wariness; when onshore they are attracted to human activities and are sometimes killed. To date, polar bear attacks on humans have been rare, but when they occur they evoke strong negative public reaction, often to the detriment of polar bear conservation.

A primary management goal of the Service is to ensure the safe coexistence of polar bears and humans in the face of accelerating climate change. To date, human-polar bear interactions have been poorly documented throughout the Arctic, causing the Range States' to undertake an initiative to develop a system to track and analyze human-polar bear conflicts, and to use the data to craft strategies to reduce conflicts. The Service-led Polar Bear-Human Information Management System (PBHIMS) database will document, quantify, and evaluate human-bear interactions and other information relevant to bear management. Range States will then analyze factors and use the findings to develop improved management strategies to reduce human-bear conflicts and the number of bears killed.

One way to reduce conflicts is to reduce attractants such as garbage and human food. In the absence of attractants, polar bears are generally cautious and more susceptible to being scared away in encounters with people. Establishing Polar Bear Patrols in coastal communities is another effective technique to reduce human-bear conflicts. These programs enable local residents to deter polar bears from coming into town using a variety of techniques. Bears that learn to associate people with unpleasant experiences will be less likely to interact with them in the future. While deterrence may not be effective on every bear, it does provide a non-lethal option for keeping bears away from villages in the majority of cases.

The World Wildlife Fund and other NGOs have been working with government agencies and local communities throughout the Arctic to remove attractants from villages, provide bear-proof storage containers for food, provide electric fencing, and fund polar bear patrols. These initiatives have gone a long way towards making northern communities safer by preventing dangerous human-bear conflicts, but much work remains.

Other Removals

Other forms of removal include take associated with accidental mortality during scientific research, placement of orphaned cubs into public display facilities, and industrial accidents. These levels of take have been determined to be insignificant and have no effect on the population. These sources of mortality are incorporated into consideration of harvest management regimes, by considering them as a component of the total human removals from each subpopulation (Schliebe et al. 2006).

Research impacts

Research activities may cause short-term effects to individual polar bears targeted in survey and capture efforts (Thiemann et al. 2013) and may incidentally disturb those nearby. In rare cases, research efforts may lead to injury or death of polar bears. Between 1967 and 2012, there were around 4401 capture events of polar bears in Alaska with at least 19, and perhaps as many as 27, deaths (a capture mortality rate ranging from 0.4–0.6% since 1967). In 2001 the USGS began an intensive capture/mark/recapture project in the Southern Beaufort Sea that is ongoing and mortality has been low (3 research related mortalities resulting from 1260 captures, or .24%).

DISEASE AND PREDATION

Polar bears are long-lived mammals not generally susceptible to disease, parasites, or injury. In the Final Rule for listing polar bears under the U.S. Endangered Species Act, the Service examined the best available scientific information on disease and determined that diseases do not threaten the species throughout all or any significant portion of its range.

Although disease pathogen titers are present in polar bears, no epizootic outbreaks have been detected, and it is likely that any resultant demographic effects are minor. However, the potential for disease outbreaks, an increased possibility of pathogen exposure from changed diet, increased susceptibility of polar bears to existing pathogens, or the occurrence of new pathogens that have moved northward with a warming environment all warrant continued monitoring and may become more significant threat factors in the future for polar bear populations experiencing nutritional stress or declining numbers (USFWS 2008).

The occurrence of diseases and parasites in polar bears is rare compared to other bears, with the exception of the presence of *Trichinella* larvae and *T. gondii*. *Trichinella* has been documented in polar bears throughout their range; although infestations can be quite high, they are normally not fatal. Antibodies to the protozoan parasite, *Toxoplasma gondii,* have been found from modest to very high levels in polar bear populations from different areas (e.g., Oksanen et al. 2009, Jensen et al. 2010).

A relationship between high levels of pollutants and impaired resistance against diseases has been demonstrated in polar bears (Lie et al. 2004). Polar bears in areas with high pollutant loads may thus be more vulnerable to diseases. Further, it is likely that climatic effects and those of pollutants may not simply be additive, but interact (Jenssen 2006), as nutritionally stressed bears will release lipophilic contaminants and their metabolites to the blood stream (Lie et al. 2004).

Emergence of New pathogens in Polar Bears

Whether polar bears are more susceptible to new pathogens due to their lack of previous exposure to diseases and parasites is unknown. As the effects of climate change become more prevalent, there are concerns with the expansion of existing pathogens within polar bears' range, the potential for pathogens crossing human-animal boundaries (e.g. giardia), and new threats from existing pathogens that may be able to establish in immuno-compromised/stressed individuals. Many different pathogens and viruses have been found in seal species that are polar bear prey, so the potential exists for transmission of these diseases to polar bears. In addition, new pathogens may expand their range northward from more southerly areas under projected climate change scenarios (Harvell et al. 2002, p. 60).

Continued monitoring of pathogens and parasites in polar bears is appropriate. Due to the predicted effects of climatic warming and the synergistic effects of pollutants on polar bears' resistance to disease and parasites, future research and monitoring should focus on establishing good baseline data for the most common diseases in different populations of polar bears, and by tracking temporal trends in prevalence for each disease.

Intraspecific Competition

Cannibalism has been documented among polar bears (Derocher and Wiig 1999, p. 307; Amstrup et al. 2006, p. 1). Although infanticide by male polar bears has been documented (e.g., Taylor et al. 1985, p. 304; Derocher and Wiig 1999, p. 307), this activity likely accounts for a small percentage of cub mortality. Given our current knowledge of predation, there is no indication that these stressors have resulted in population level effects.

Interspecific Competition

One form of interspecific competition is cross-breeding, or hybridization. The ranges of polar bears and grizzly bears overlap only in portions of northern Canada, Chukotka (Russia), and northern Alaska. The first documented case of cross-breeding in the wild was reported in 2006: the cross-breeding of a female polar bear and male grizzly bear (Paetkau, pers. comm. May 2006). Since then, two additional cases have been confirmed in Canada, one of which is considered a "second generation" hybrid, the result of a female grizzly-polar hybrid mating with a male grizzly bear (CBC News, 2010). Cross-breeding in the wild is thought to be rare, but cross-breeding may pose concerns for subpopulations and species viability in the future should the rate of occurrence increase.

Along Alaska's northern coast, polar bears compete with brown bears for a food source. Preliminary results from a study conducted in 2005–2007 (Miller et al. in prep.) indicate that brown bears are socially dominant and frequently displace polar bears from a "bone pile" food source. The physiological effects of these interactions on individual polar bears are not fully determined.

INADEQUACY OF EXISTING REGULATORY MECHANISMS

In the Final Rule, the Service reviewed existing regulatory mechanisms and determined that potential threats to polar bears from direct take, disturbance by humans, and incidental or harassment take are, for the most part, adequately addressed existing regulatory mechanisms. However, there are no known regulatory mechanisms in place at the national or international level that directly and effectively address the primary threat to polar bears—the rangewide loss of sea ice habitat within the foreseeable future.

Loss of Sea Ice

As noted above, there are no known regulatory mechanisms at the national or international level that directly and effectively address the rangewide loss of sea ice habitat within the foreseeable future. There are some existing regulatory mechanisms to address anthropogenic causes of climate change, though these mechanisms are not expected to be effective in counteracting the worldwide growth of GHG emissions within the near future. National and international regulatory mechanisms to comprehensively address the causes of climate change are currently being debated within United Nations Framework Convention on Climate Change.

OTHER NATURAL OR MANMADE FACTORS AFFECTING THE POLAR BEAR'S CONTINUED EXISTENCE

Large Oil Spills

Increases in circumpolar Arctic oil and gas development, coupled with increases in shipping due to the lengthening open water season, increase the potential for an oil spill to negatively affect polar bears and their habitat. Polar bears are particularly vulnerable to oil spills due to their inability to effectively thermoregulate when their fur is oiled, and to poisoning that may occur from ingestion of oil from grooming or eating contaminated prey (St. Aubin 1990, p. 237). In addition, polar bears are known to be attracted to petroleum products and can be expected to actively investigate oil spills; they also are known to consume foods fouled with petroleum products (St. Aubin 1990, p. 237; Derocher and Stirling 1991, p. 56).

Polar bears overlap with many active and planned oil and gas operations throughout their range. Numerous safeguards are in place to prevent oil spills, but spills do occur. In Alaska, where hydrocarbon exploration and development has been ongoing for approximately 50 years, an average of 70 oil and 234 waste product spills per year occurred between 1977 and 1999 in the North Slope oil fields (71 FR 14456). Many spills are small (less than 50 barrels), but larger spills (greater than or equal to 500 barrels) account for much of the annual volume. For example, seven large spills have occurred between 1985 and 2009 on the Alaskan North Slope.

To date, no major offshore spills have occurred on the North Slope. However, small, chronic leaks in underwater pipelines could result in large volumes of oil being released offshore without detection (MMS 2007). Bureau of Ocean Energy Management (formerly the Minerals Management Service (MMS)) estimated an 11 percent chance of a marine spill greater than 1,000 barrels in the Beaufort Sea from the Beaufort Sea Multiple Lease Sale in Alaska (MMS 2004, pp. 10, 127). BOEMRE's EIS on the *Chukchi Sea Planning Area; Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea* determined that polar bears could be affected by both routine activities and a large oil spill (MMS 2007). According to the EIS, if the 193 Chukchi Lease Sale results in an oil and gas development, the chance of one or more large oil spills (greater than or equal to 1,000 barrels) occurring over the production life of the development is 35–40% (MMS 2007). In 2011, BOEMRE updated the 193 Chukchi Sea EIS with an analysis of a low probability, high impact very large oil spill (VLOS) resulting from a drilling blowout. It concluded that a VLOS resulting in the loss of large numbers of polar bears, particularly adult breeding age females, would have a significant impact on the SBS and/or CS stocks of polar bears (BOEMRE, 2011).

Loss of Arctic sea ice has resulted in a large increase in shipping within Arctic areas, and is expected to increase rapidly given projections of an ice-free Arctic in the near future (Smith and Stephenson 2013). Increased traffic will increase the chances of an oil spill from a tanker accident, ballast discharge, or discharges during the loading and unloading of oil at ports.

Oil spills in the fall or spring during the formation or break-up of sea ice present a greater risk because of difficulties associated with clean up during these periods, and the presence of bears in the prime feeding areas over the continental shelf. During the autumn freeze-up and spring break-up periods, any oil spilled in the marine environment would likely concentrate and accumulate in open leads and polynyas, areas of high activity for both polar bears and seals (Neff 1990, p. 23).

The Service analyzed the effects of oil and gas activities and applied the general provisions of the MMPA, described below, to polar bear conservation programs in the Beaufort and Chukchi Seas (71 FR 43926, 73 FR 33212, 76 FR 47010). Regulations developed under the MMPA include an evaluation of the cumulative effects of oil and gas industry activities on polar bears from noise, physical obstructions, human encounters, and oil spills. The likelihood of an oil spill occurring and the risk to polar bears is modeled quantitatively and factored into the evaluation.

Oil spills remain a concern for polar bears throughout their range. Although the probability of an oil spill affecting a significant portion of Alaska's polar bears in the foreseeable future is low, we recognize that the potential impacts from such a spill could be significant, particularly if subsequent clean-up efforts were ineffective. The potential impacts would be greatest where polar bears are relatively aggregated, such as Barter and Cross Islands during the fall open water period. At present, the Service is working with industry, oil spill response agencies, zoos, and others to increase response capabilities for dealing with oiled or compromised bears in the event of a spill.

Disturbance (habitat/behavioral)—Industrial Development

Disturbance from activities associated with oil and gas activities can result in direct or indirect effects on polar bear use of habitat. Direct disturbances include displacement of bears due to the movement of equipment, personnel, and ships through polar bear habitat. An example of indirect effects to polar bears would be displacement or preclusion of their primary prey (ringed and bearded seals) from preferred habitats.

Documented direct impacts on polar bears by the oil and gas industry during the past 30 years are minimal. Currently, oil and gas exploration, development, and production activities do not threaten the species in Alaska based on: (1) mitigation measures in place now and likely to be used in the future; (2) historical information on the level of oil and gas development activities occurring within polar bear habitat; (3) the lack of direct quantifiable impacts to polar bear habitat from these activities noted to date in Alaska; (4) the current availability of suitable alternative habitat; and (5) the limited and localized nature of the development activities, or possible events, such as oil spills (Schliebe et al. 2006).

Disturbance (habitat/behavioral)—Tourism, Shipping and Other

It is unlikely that properly regulated ecotourism will have a negative effect on polar bear subpopulations, although increasing levels of ecotourism and photography in polar bear habitat may lead to increased polar bear-human conflicts. Ecotourists and photographers may inadvertently displace bears temporarily from preferred habitats or alter natural behaviors (Lentfer 1990, p.19; Dyck and Baydack 2004, p. 344). If increased human conflict leads to polar bears being killed in defense of life, this could also lead to reduced opportunities for subsistence harvest. Conversely, ecotourism has the positive effect of increasing the worldwide constituency of people with an interest in polar bears and their conservation.

Polar bear viewing has been ongoing near Barrow for at least a decade; effects of tourism on polar bears have not been monitored there to date. At Barter Island, Alaska, tourism is increasing because of the opportunity to observe polar bears near the village of Kaktovik during the fall. In the last few years, the Service has worked with the community of Kaktovik to reduce human-bear conflicts that might result from large aggregations of bears occurring in such close proximity of the village. The Service will continue to provide technical expertise to local guides, leaders, and visitors to reduce human-bear conflicts at Kaktovik associated with tourism.

Previously ice-covered sea routes are now opening up in summer, allowing access for commercial shipping. Increased shipping may cause disturbance to polar bears and their prey, and increase the potential for additional oil spills, which was discussed above (Skjoldal et al. 2009, p. 99). Russian scientists cite increasing use of a Northern Sea Route for transit and regional development as a major source of disturbance to polar bears in the Russian Arctic (e.g., Belikov and Boltunov 1998, p. 113; Ovsyanikov 2005, p. 171). When ice-breaking activities occur, they may alter habitats used by polar bears, possibly creating ephemeral lead systems and concentrating ringed seals within the leads. This, in turn, may allow for easier access to ringed seals and may have some beneficial values. Conversely, this may cause polar bears to use areas that may have a higher likelihood of human encounters as well as increased likelihood of exposure to oil or waste products that may be released into the marine environment.

Contaminants

Although loss of sea ice is the greatest threat to polar bears, contaminants can exacerbate the effects of this and other threats. A large body of literature exists and has been summarized (e.g., Arctic Monitoring and Assessment Program, AMAP) on contaminant concentrations and effects in polar bears. Particular stocks have different contaminants at concentrations of concern. Recovery actions addressing contaminants threats may therefore vary by region. Despite regulatory steps taken to decrease the production or emissions of toxic chemicals, increases in some relatively new compounds are cause for concern. Some of these compounds have increased in the last decade (Ikonomou et al. 2002, p. 1,886; Muir et al. 2006, p. 453). For example, although PCB concentrations are declining in polar bears, emerging persistent brominated and fluorinated organics may be increasing, and are therefore of more concern.

To reasonably estimate contaminant effects on polar bears requires data on the magnitude, geographic distribution, and (often) time trends of contaminant concentrations. When there are not enough data to accurately prioritize contaminants threats, additional data collection, followed by risk analysis, may be appropriate.

Understanding the potential effects of contaminants on polar bears in the Arctic is confounded by the wide range of contaminants present, each with different chemical properties and biological effects, and their differing geographic, temporal, and ecological exposure regimes. Further, contaminant concentrations in polar bear tissues differ with polar bears' age, sex, reproductive status, and other factors. Contaminant sources and transport; geographical, temporal patterns and trends; and biological effects are detailed in several recent AMAP publications (e.g., AMAP 2004; AMAP 2005). Three main groups of contaminants in the Arctic are thought to present the greatest potential threat to polar bears and other marine mammals: petroleum hydrocarbons, persistent organic pollutants (POPS), and heavy metals. Climate change may increase long-range marine and atmospheric transport of contaminants (Macdonald et al. 2003, p. 5; Macdonald et al 2005, p.15).

It is uncertain whether contaminant concentrations presently have population level effects on polar bear subpopulations; this is a topic of on-going analysis for this Plan as the Service considers new information provided to date. The Alaskan subpopulations continue to have some of the lowest concentration of PCBs, chlorinated pesticides, and flame retardants of all the polar bear subpopulations (McKinney et al. 2011, Verreault et al. 2005). The SBS subpopulation continues to have some of the highest concentrations of mercury in the Arctic (Routti et al. 2011) which is a concern, but there have been no direct links between the level of contamination and population levels effects. Contaminants may become a more significant threat in the future for polar bear subpopulations experiencing declines related to nutritional stress brought on by sea ice loss and environmental changes.

CURRENT CONSERVATION MEASURES AND MANAGEMENT EFFORTS

Many governmental and non-governmental agencies, institutions, and organizations are involved in polar bear conservation. These entities provide an active conservation constituency and are integral to the conservation/recovery of the species. The following conservation agreements and plans have effectively addressed many threats to polar bears from direct and incidental take by humans. However, as noted in the "Threats" section, there are no known regulatory mechanisms in place at the national or international level that directly and effectively address the primary threat to polar bears—the range-wide loss of sea ice habitat within the foreseeable future.

International Conservation Agreements and Plans

- **Agreement on the Conservation of Polar Bears (1973 Agreement).** All five range countries are parties to the 1973 Agreement. The 1973 Agreement requires the Range States to take appropriate action to protect the ecosystem of which polar bears are a part, with special attention to habitat components such as denning and feeding sites and migration patterns, and to manage polar bear subpopulations in accordance with sound conservation practices based on the best available scientific data. The 1973 Agreement relies on the efforts of each party to implement conservation programs and does not preclude a party from establishing additional controls (Lentfer 1974, p. 1). In 2009, the Range States agreed to initiate a process that would lead to a coordinated approach to conservation and management strategies between the parties. Each party will develop conservation action plans for polar bears within their jurisdiction. From these plans, the parties will identify issues of shared concern, and the management and research needs necessary to address them. The Range States expect to make significant progress on a collaborative action plan before the next biennial meeting in 2015.
- **Inupiat—Inuvialuit Agreement for the Management of Polar Bears of the Southern Beaufort Sea**. In January 1988, the Inuvialuit of Canada and the Inupiat of Alaska, groups that both harvest polar bears for cultural and subsistence purposes, signed a management agreement for polar bears of the Southern Beaufort Sea (I-I Agreement) (Brower et al. 2002). This agreement is based on the understanding that the two groups harvest animals from a single population shared across the international boundary. The I-I Agreement provides joint responsibility for conservation and harvest practices (Treseder and Carpenter 1989, p. 4; Nageak et al. 1991, p. 341). In Canada, recommendations and decisions from the I-I Commissioners are implemented through Community Polar Bear Management Agreements, Inuvialuit Settlement Region Community Bylaws, and NWT Big Game Regulations. In the United States, the I-I Agreement is implemented at the local level. Adherence to the agreement's terms in Alaska is voluntary, and levels of compliance may vary. There are no Federal, State, or local regulations that limit the number or type (male, female, cub) of polar bear that may be taken. Since inception of the I-I Agreement, harvest levels have remained below sustainable limits established based on science.
- **Agreement between the United States of America and the Russian Federation on the Conservation and Management of the Alaska—Chukotka Polar Bear Population (Bilateral Agreement). I**n October 16, 2000, the United States and the Russian Federation signed a bilateral agreement for the conservation and management of polar bear subpopulations shared between the two countries. The Bilateral Agreement expands upon the progress made through the multilateral 1973 Agreement by implementing a unified conservation program for this shared population. Beginning in 2007, parties to the treaty established a joint U.S.-Russia Commission responsible for making management decisions concerning polar bears in the Alaska-Chukotka region. The Commission is composed of a Native and federal representative from each country. The Commissioners have appointed a scientific working group (SWG) and tasked this SWG with a number of objectives, with the top priority being identifying a sustainable harvest level for the Alaska-Chukotka population.

  In response to this initiative, the SWG provided the Commission with a peer-reviewed report of their recommendations regarding harvest and future research needs. At a meeting in June 2010, the Commission decided to place an upper limit on harvest from the CS population of 19 female and 39 male (for a total of 58) polar bears per year based on the recommendation of the SWG and subsistence needs. Harvest will be split evenly between Native peoples of Alaska and Chukotka. The Service and the Alaska Nanuuq Commission (ANC) will work in partnership with local communities to implement the harvest quota.
- The **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES**) is a treaty designed to protect animal and plant species at risk from international trade. CITES regulates international wildlife trade by listing species in one of its three appendices; the level of monitoring and regulation to which an animal or plant species is subject depends on the appendix in which it is listed. Polar bears were listed in Appendix II of CITES on July 7, 1975. As such, CITES parties must determine, among other things, that any polar bear, polar bear part, or product made from polar bear is legally obtained and that the export will not be detrimental to the survival of the species, prior to issuing a permit authorizing the export of the animal, part, or product. All five range states are CITES signatories and have the required Scientific and Management Authorities. CITES is effective in regulating the international trade in polar bear parts and products, and provides

conservation measures to minimize that potential threat to the species.

Domestic Regulatory Mechanisms

- The **Marine Mammal Protection Act (MMPA)** was enacted on October 21, 1972. All marine mammals, including polar bears, are protected under the MMPA. The MMPA prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S. (http://www.nmfs.noaa.gov/pr/laws/mmpa/).

  Passage of the MMPA in 1972 established a moratorium on sport and commercial hunting of polar bears in Alaska. However, the MMPA exempts harvest, conducted in a non-wasteful manner, of polar bears by coastal dwelling Alaska Natives for subsistence and handicraft purposes. The MMPA and its implementing regulations also prohibit the commercial sale of any marine mammal parts or products except those that qualify as authentic articles of handicrafts or clothing created by Alaska Natives.

  Section 119 of the MMPA was added to allow the Secretary to "enter into cooperative agreement with Alaska Native organizations to conserve marine mammals and provide co-management of subsistence use by Alaska Natives." This also authorizes grants to be made to Native organizations in order to carry out agreements made under the section. The **Alaska Nanuuq Commission (ANC)** is the Service's primary co-management partner and was formed in 1994 to represent villages in Northern and Northwestern Alaska on matters concerning the conservation and sustainable subsistence use of polar bears. The ANC is made up of 15 coastal villages that had a historically significant subsistence harvest of polar bears and represents coastal villages from Kaktovik to St. Lawrence Island in the management of polar bears.

  The MMPA Incidental and Intentional Take Program (IITP) allows for the incidental non-intentional take of small numbers of marine mammals during specific activities. The MMPA also allows for intentional take by harassment of marine mammals for deterrence purposes. The Service administers an IITP that allows polar bear managers to work cooperatively with stakeholders (i.e., oil and gas industry, the mining industry, the military, local communities, and researchers) working in polar bear habitat to minimize impacts of their activities on bears. The IITP has been an integral part of the Service's management and conservation program for polar bears in Alaska since its inception in 1991. The program's success depends on its acceptance by our conservation partners

- The **Endangered Species Act** was passed to provide a mechanism to conserve threatened and endangered plants and animals and their habitat. Listing implements prohibitions on the take of the species. Under section 7 of the ESA, all Federal agencies must ensure that any actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species, or destroy or adversely modify its designated critical habitat. Consultations occur with Federal action agencies under section 7 of the ESA to avoid and minimize impacts of proposed activities on listed species.

- The **Alaska National Interest Lands Conservation Act of 1980** (16 U.S.C. 3101 et seq.) (ANILCA) created or expanded National Parks and National Wildlife Refuges (NWRs) in Alaska, including the expansion of the Arctic NWR. One of the establishing purposes of the Arctic NWR is to conserve polar bears. Section 1003 of ANILCA prohibits production of oil and gas in the Arctic NWR, and no leasing or other development leading to production of oil and gas may take place unless authorized by an Act of Congress.

  The Bureau of Land Management (BLM) is responsible for vast land areas on the North Slope, including the National Petroleum Reserve, NPRA. Habitat suitable for polar bear denning and den sites have been identified within NPRA. The BLM considers fish and wildlife values under its multiple use mission in evaluating land use authorizations and prospective oil and gas leasing actions. Provisions of the MMPA regarding the incidental take of polar bears on land areas and waters within the jurisdiction of the United States apply to activities conducted by the oil and gas industry on BLM lands.

- **The North Slope Borough Polar Bear Deterrence Program.** The North Slope Borough (NSB) Department of Wildlife Management has maintained a polar bear hazing program in Barrow and surrounding villages to protect residents since 1992. Patrols have been a collaborative effort by the NSB and the Native Village of Barrow and Kaktovik. This program has been very successful in Kaktovik and Barrow in limiting the number of bears killed in recent years due to public safety concerns. Efforts to formalize training and hazing programs have been an important step in making the program successful. Continued efforts are needed to implement training programs annually, and to provide funds needed to support the program.

In summary, existing international and domestic agreements have been in place for 40 years to guide the conservation and management of polar bears. Their main strength to date has been to help regulate the harvest and trade of polar bears, as well as non-lethal take of bears. While these agreements have addressed direct take of polar bears, they are currently insufficient to reduce the main threat to polar bears—the range wide loss of their sea ice habitat. However, they remain an important foundation on which to develop this Plan.

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Appendix B— Specific Conservation and Recovery Actions Considered

Management Objectives and Actions

Support Global Conservation Efforts Through the Range States Relationships
(Action) Participate in circumpolar efforts to reduce human-bear conflicts.
(Action) Participate in circumpolar efforts to track and reduce international illegal trade in polar bears and polar bear parts.
Manage Human-Bear Conflicts
(Action) Convene a community-based working group – including whaling captains — to explore options for managing bone piles. Develop best management practices that can be shared with communities.
(Action) Remove or disperse bone piles to reduce bear concentrations (i.e., reduce risk of harmful impacts from disease transmission, oil spills).
(Action) Develop and share best practices for managing bear viewing to minimize impacts on polar bears and potential human-bear conflicts. Build on existing efforts, e.g. NSB program.
(Research) Assess the highest temporal/spatial risk areas for negative human-bear encounters. Monitor changes in the human-bear interactions hotspots/focal points.
(Action) Develop emergency response plans for extreme events such as mass bear strandings, low immune response to pathogens, and an absence of whale carcasses at Kaktovik.
(Research) Monitor effectiveness of deterrence programs, collect data to differentiate cause of bear deaths, and analyze polar bear mortalities.
(Action) Scholarship programs/work with ANSEP/Ilasagvik College to develop professional bear expertise in local communities.
(Education) Work with local residents and other experts to effectively communicate the importance of minimizing human-bear conflicts.
(Research/Education) Standardize a community-based monitoring & data management program for polar bears and for human-bear conflicts. Engage residents, industry, researchers, NGOs and others living & working in Arctic. Communicate what is being monitored and why. Share the results.
(Education) Work with local residents to communicate the value of reporting human-bear interactions.
Collaboratively Manage Subsistence Harvest
(Education) Develop clear, understandable materials for conveying harvest management principles; include clarification of the various interpretations of the term "sustainable." Update existing information for user-group audiences.
(Action) Pass on knowledge to future generations regarding responsible and effective hunting and harvest management.
(Action) Implement Chukchi harvest quota in U.S. (US/Russia bilateral agreement).
(Action) Work with Russian colleagues to implement Chukchi harvest quota in Russia.
(Research) Monitor input parameters needed to estimate maximum net productivity (i.e. within optimum sustainable population).
(Education) Work with partners and subsistence users to communicate relationship between maximum net productivity and harvest; if a subpopulation declines due to declining carrying capacity, subsistence harvest will continue but harvest levels will go down.

Continued

Management Objectives and Actions (Continued)

(Research) Develop separate harvest rate estimates for male and female bears.
(Action) Consistent with existing agreements, prohibit all harvest of females with cubs.
(Research) Ensure on-going, long-term, adequate basic monitoring of Chukchi Sea & SBS populations.
(Research) Support the on-going, long-term, and consistent monitoring of polar bears across the entire range. (PBSG)
(Research/Monitoring) Improve subsistence harvest monitoring, e.g., tagging, genetic sampling, bio-sampling etc.
Protect Denning Habitat
(Action) Protect polar bear travel corridors and seasonal habitat areas (e.g., barrier islands).
(Action) Create denning opportunities in prime habitat (i.e., barrier islands) through use of snow fences to create snow drifts.
Minimize Risk of Contamination From Spills
(Action) Improve spill response capability—deterrence, rescue & handling of oiled bears. Train local community members as first responders. Stage equipment and supplies in villages.
(Action) Minimize risk of oil spills (e.g., collaborate with Industry and other regulatory agencies on better inspections and maintenance of pipelines, production facilities, etc.).
(Action) Work with Arctic Council, Russia, USCG, and others on improving spill response plans for Chukchi and Southern Beaufort Seas.
(Research) Map current and future overlap of bear distribution with resource extraction activities.

Additional Management Actions Considered

Effects of Shipping
(Research) Study the effects of shipping on bears.
(Action) Encourage greater Coast Guard presence in Arctic (Arctic Marine Mammal Commission is working on this issue).
(Action) Support the commercial fishing moratorium north of the Bering Straits until marine mammal management protection plans and mitigation measures are in place.
(Action) Ratify law-of-the-sea treaty
(Action) Expand observer program on ships to document marine mammal interactions. Engage and train local communities to staff such a program.
(Action) Work with international partners to improve off-shore development & shipping regulations to minimize potential impacts on bears, especially with Russia and Canada.
Effects of Contaminants
(Research) Monitor contaminants and their effects on bears through harvest monitoring programs and minimally invasive sample collection from live animals; potential partners include Range States.
(Action/Education) Reduce potential for exposure from acute, lethal contaminant exposure (e.g., ethylene glycol).
(Action) Develop, assess, update best practices for handling contaminants, and responding to inadvertent exposures.

Continued

Additional Management Actions Considered (Continued)

(Action) Manage landfills via fencing and other actions to reduce exposure to contaminants.
(Research) Assess current contaminant threat to bears and where the greatest risks are.
(Action) Clean up legacy oil wells.
(Research/Action) Determine whether contaminant levels in polar bears have implications for human consumption (food safety, food security).
Effect of Research Impacts
(Action) Evaluate and manage the cumulative effects of research on polar bears.
(Action) Evaluate specific research protocols by examining value to polar bear conservation and direct impact on bears. i.e. cost-benefit analysis.
(Action) Develop safe-handling protocols for polar bears.

RESEARCH ACTIONS

Population dynamics and distribution. Information on population dynamics and distribution informs most aspects of wildlife management, including subsistence harvest and human-bear interactions, and is key to understanding current and future conservation status. The ecological dependence of polar bears on sea-ice as a platform from which to access energy-rich marine prey has shown for some populations that changes in the physical sea-ice environment can induce declines in population vital rates, and thus must be considered when evaluating future persistence. Because of this, long-term studies of subpopulation status, including the vital rates used as demographic recovery criteria, are needed to measure progress towards persistence-based goals. Research and monitoring on the two polar bear subpopulations shared by the U.S suggests that physical and biological differences between populations may affect how polar bears respond to habitat loss, especially in the near term, underscoring potential spatial and temporal variation in the response of polar bears to climate change.

Research activity
1. Estimation of population status and trend: a. via estimation of demographic parameters including population size, population growth rate, survival, and recruitment, or indices of these parameters. b. via biological and ecological indices. c. via the sex, age, and reproductive composition of human-caused removals.
2. Determine current distribution of populations and implications for population size estimation, harvest allocation, and meta-analysis of data from overlapping populations.
3. Evaluate the mechanistic relationships between sea-ice, prey abundance, and polar bear vital rates over timeframes relevant to the Conservation Management Plan.
4. Estimate the numbers of bears coming on shore in late summer and assess differential survival and fitness for bears that spend time on shore versus remaining on sea-ice. a. Expand onshore non-invasive genetic sampling,
5. Monitor the level and type (e.g., sex and age) of human-caused lethal removals
6. Develop models to evaluate future population status and management actions, perform sensitivity analysis with respect to management actions, perform risk assessments with respect to human-caused removals, and identify key information needs. a. Develop a standardized and adaptive approach for estimating sustainable harvest rates, communicating the risks and tradeoffs of different harvest strategies to managers, and evaluating the effects of harvest on population status.
7. Analyze optimal study design, sample size, and spatial and temporal distribution of sampling effort to answer key demographic questions; perform cost-benefit analyses.
8. Evaluate emerging technologies (e.g., high-resolution satellite imagery and other technological advancements) for integration into existing monitoring plans.
9. Develop effective and less-invasive research and monitoring techniques.
10. Evaluate circumpolar patterns in genetic, behavioral, life-history, and ecological diversity for polar bears in relation to the groupings of polar bears considered in FG2.
11. Improve our understanding of why polar bear populations differ in their response to sea-ice loss and based on that understanding identify representative populations in different ecoregions for monitoring responses to sea-ice loss.
12. Improve our understanding of the physiological response of polar bears to environmental and anthropogenic stressors and develop methods for monitoring those responses.

Habitat ecology. Understanding how bears respond to functional changes in their environment is necessary to predict the consequences of loss of sea-ice habitat to population status, distribution, and ultimately the likelihood of persistence. Improving our understanding of the links between environmental change and polar bear persistence will allow decision-makers to determine future policies regarding the chances of enhancing persistence.

Research activity— *Habitat Ecology.*
1. Improve our understanding of the environmental and biological characteristics (e.g., bathymetry, ice concentration, benthic productivity) of important polar bear habitats, identify key habitat areas (including denning areas), and projected future availability of habitats. a. Incorporate resource selection information from prey species into analyses
2. Determine the behavioral and demographic responses of polar bear prey, primarily ringed and bearded seals, to sea-ice loss and changes in late-winter and spring snow depths on the sea-ice. Evaluate whether such responses affect the accessibility of prey to polar bears.
3. Identify the ecological mechanisms by which polar bears are responding to sea-ice loss to improve short-term and long-term projections of population-level responses.
4. Determine the relationship between sea-ice conditions, the proportion of bears using land, and the duration of time spent there. Develop predictions for the rate at which increased numbers of bears may occur onshore and the necessary management responses.
5. Characterize the spatial overlap of activities and the potential response of polar bears to on- and off-shore resource exploration and extraction activities. a. Study potential disturbance of polar bears by shipping and other development activities, with attention to high-use areas such as the Bering Strait b. Evaluate data submitted on observations of polar bears in the oil fields to detect spatial and/or temporal changes
6. Model the distribution of large- and small-scale oil spills relative to on- and off-shore habitats and polar bear distribution. Evaluate potential effects of spills on the availability of suitable habitat.
7. Use local observations and traditional ecological knowledge to evaluate seasonal distribution patterns and polar bear behavior, including denning and movements. a. Standardize objectives and methods for community-based monitoring
8. Continue and expand den detection, mapping, and monitoring activities throughout the range of polar bear population in Alaska.
9. Model and forecast cumulative impacts on polar bears using a Bayesian Network approach.

Health and nutritional ecology. An individual's health reflects the interaction between its behavioral choices and the environment. Because of this, measuring changes in health over time has great potential for revealing important associations between environmental stressors and population dynamics.

Research activity— *Health and Nutritional Ecology.*
1. Determine if polar bears are being increasingly exposed to diseases and parasites and the potential impact of disease on body condition, reproduction, and survival.
2. Characterize baseline exposure to hydrocarbons, atmospherically-transported contaminants, and industrial pollutants associated with resource extraction practices. 3. Evaluate methods to decontaminate oiled polar bears
4. Characterize the physiological stress response of polar bears relative to life history, physiological states, and environmental conditions, and determine if a relationship exists between stress responses and measures of body condition and reproduction.
5. Improve our understanding of the relationships between polar bear feeding ecology and behavior, body condition and food intake, demography, and sea-ice availability.
6. Evaluate the potential cumulative impacts of research, hunting, industry, tourism activities on polar bear health, behavior, and vital rates

Nutritional and cultural use of polar bears. Historically, native communities throughout the coastal arctic have relied upon polar bears as both a nutritional and cultural resource. Research is needed to describe the cultural and nutritional significance of polar bears to communities that have historically relied upon them as a renewable resource.

Research Activity— *Nutritional and Cultural Use of Polar Bears*
1. Periodically assess key community perspectives, values and needs regarding: human-polar bear interactions, sustainable use of polar bears, and incentives associated with polar bear harvest. Also, evaluate the cultural and traditional uses of polar bears. a. Evaluate the cultural effects of harvest management decisions b. Return to key communities to verify and present findings
2. Evaluate the use of polar bears from human nutritional health and food security perspectives. (e.g., dietary quality of polar bear in comparison to store bought meat, implications of the presence and potential effect(s) of contaminants in the meat). a. Evaluate the effects of restrictions/quotas on the food security and nutritional status of coastal native communities b. Evaluate the influence of harvest management on the availability, types, and quality of food resources
3. Ongoing polar bear health assessments through samples and observations by local communities and hunters. Combine polar bear sampling program as part of larger marine arctic ecosystem and other marine mammal sampling (e.g., ice seal biomonitoring). a. Analyze hunter samples b. Analyze agency capture samples c. Compare results to global polar bear health studies

Human-polar bear interactions. There is poor understanding of how conflict affects polar bear populations and concomitantly how conflict affects humans living and working in polar bear range. The goal of this work is to better understand the dynamics of human-polar bear conflict by gaining insight about potential drivers of interaction and conflict. This information is needed so that mitigation actions can be developed, implemented, and evaluated.

Research Activity— *Human-Polar Bear Interactions*
1. Collect, process, and synthesize all existing records of human-polar bear interactions to gain insight on the quality of conflict records, spatial and temporal trends in conflicts, severity of conflict, potential biases in conflict reporting, and types of management strategies used to mitigate conflict. a. standardize operating procedures for polar bear patrols and the reporting methods used to document human-bear conflicts b. maintain central database (i.e., Polar Bear Human Information Management System) c. monitor the effectiveness of all deterrence programs including non-lethal methods used in Chukotka
2. Characterize environmental, spatial, and anthropogenic factors that contribute to human-polar bear conflict around industrial activity centers and villages. a. develop best practices for polar bear viewing and ecotourism b. develop best practices for attractant management (e.g., ice cellars, dumps, drying racks, dog lots)
3. Develop models for predicting the risk of human-polar bear conflict given scenarios of environmental change, increased use of terrestrial habitat, and increased anthropogenic activities.
4. Evaluate the effects of concentrated attractants (e.g., dumps) and supplemental feeding (e.g., remains of subsistence-harvested whales) on polar bear distribution, habitat use, nutritional status, and human-bear interactions.

5. Expand non-invasive genetic sampling around seasonally abundant, concentrated food sources (e.g., bone piles).