Migratory Species and Climate Change Expert Workshop

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ANNEX C: CASE STUDY POLAR BEAR CCVA

(Based on a document prepared by the UK Government)

15 January 2025

Ursus maritimus

Climate Change Vulnerability Assessment - sample template for in-depth case study review (incomplete)

CMS Appendix II **CITES** Appendix II **IUCN Red list status** Vulnerable (2015) **Population** 23,000 – 26,000 **Population trend** Decreasing / Unknown **Ecosystem type** Marine & Terrestrial **Assessment Scale** Global **Migration type** **Restricted/highly fragmented distribution** No **Species vulnerability / sensitivity factors** prey availability, reduced reproductive output **Habitat vulnerability time estimates** <25,>25-75 total loss of summer Arctic sea ice projected by 2100 **Ecosystem services provided** **Barriers to migration** loss of sea ice **Priority for intervention** <25 yrs, >25 yrs **Translocation feasible** Yes **Priority for translocation** No, strandings only	

Summary

Ursus maritimus is an apex Artic predator found throughout the circumpolar Arctic in 19 subpopulations, with the most current global population estimate ranging from 23,000 – 26,000 individuals (Wiig *et al.* 2015). Projections by the Intergovernmental Panel on Climate Change (IPCC) and sea ice forecasts suggest that Arctic sea ice will decline markedly in coming decades. The expected total disappearance of the ice cover of the Arctic seas by the mid-21st century is predicted to cause a dramatic decrease in the global range and population size of the species (Seppa *et al*. 2023). Polar bears depend on sea ice to hunt their primary prey, ringed seals *Pusa hispida* and bearded seals *Erignathus barbatus*. The status of the 19 subpopulations currently varies due to differences in physical geography, biological productivity, sea ice dynamics and other factors (Regehr *et al*. 2021). Loss of Arctic sea ice due to climate change is the most serious threat to Polar Bears throughout their circumpolar range. Most populations are declining and many sub-populations are likely to go extinct over the next few decades. Almost complete extinction is predicted by 2100 (Martay *et al.* 2023). Regression analysis found prey diversity as the only significant correlate with polar bear density which is directly correlated with summer sea ice extent (Hamilton & Derocher 2018). Historically, polar bears came ashore in early August, but because of rising temperatures sea ice breakup has been occurring about 7–8 days earlier per decade in recent years. Polar bear on-shore arrival has shifted accordingly, resulting in shortened on-ice feeding and prolonged on-shore fasting. The trends towards a progressively earlier sea ice break-up and progressively earlier polar bear on-shore arrival are expected to continue with continued warming and consequent food stress is expected to lead to reduced energy stores at den entry. Declines in litter size are likely because less energy is available for gestation and lactation. Such large-scale habitat decline and fragmentation could lead to reduced genetic diversity (Kutschera *et al.* 2016). Not all polar bear subpopulations are equally at risk. Polar bears are able to survive on food sources other than seals. The species has the adaptive capacity to survive in an ice-free environment, as observed in polar bears held in captivity, however in the wild this would be correlated to there being healthy populations. Sub populations, depending on which country they occur in, may have more adaptive capacity with alternative prey availability than others and ultimately this depends on the state of biodiversity in those areas and associated impacts of climate change across trophic levels. Targeted conservation intervention for smaller declining sub populations (Hudson Bay population) with monitoring of summer onshore arrival dates to use as an indicator of sea ice and seal availability. Focus on ecoregions within the Arctic and how each is affected by climate change (Hudson Bay, Baffin Bay and the Labrador Sea are related to the North Atlantic Oscillation and Southern Oscillation). Polar bears are increasingly posing a risk to humans when scavenging for food.

The species is well studied and ongoing research and conservation measures are ongoing. Polar bears are at the top of the food chain and have an important role in the overall health of the marine environment. Over thousands of years, polar bears have also been an important part of the cultures and economies of Arctic peoples.

This is not a completed assessment; the references included in this assessment represent a fraction of the vast amount of published data available for this species. Notably, there are published risk assessments for subpopulations available. Due to limited time and resource availability there remain gaps in the assessment.

Projected range shifts could cause for this species to be removed from CMS Appendix II due to the loss of summer ice and dispersibility for migration.

Previous CCVAs

Previous CCVA for this species	**JNCC Case study, Martay *et al*. 2023** In 2008, polar bears were listed as "threatened" under the U.S. Endangered Species Act due to sea-ice loss resulting from climate change. Although most polar bears will likely experience negative effects in the long, the status of the 19 subpopulations currently varies due to differences in physical geography, biological productivity, sea ice dynamics, and other factors. Most populations are declining and many sub-populations are likely to go extinct over the next few decades. Almost complete extinction is predicted by 2100. **WWF Climate Change Vulnerability Assessment, Advani *et al*. 2016** A simplified trait-based assessment based on Exposure, Adaptive capacity, Sensitivity. Recommendations made. Polar bears rely heavily on the sea ice environment for traveling, hunting, mating, resting, and in some areas, maternal dens. Their long generation time and low reproductive rate may limit their ability to adapt to changes in the environment.

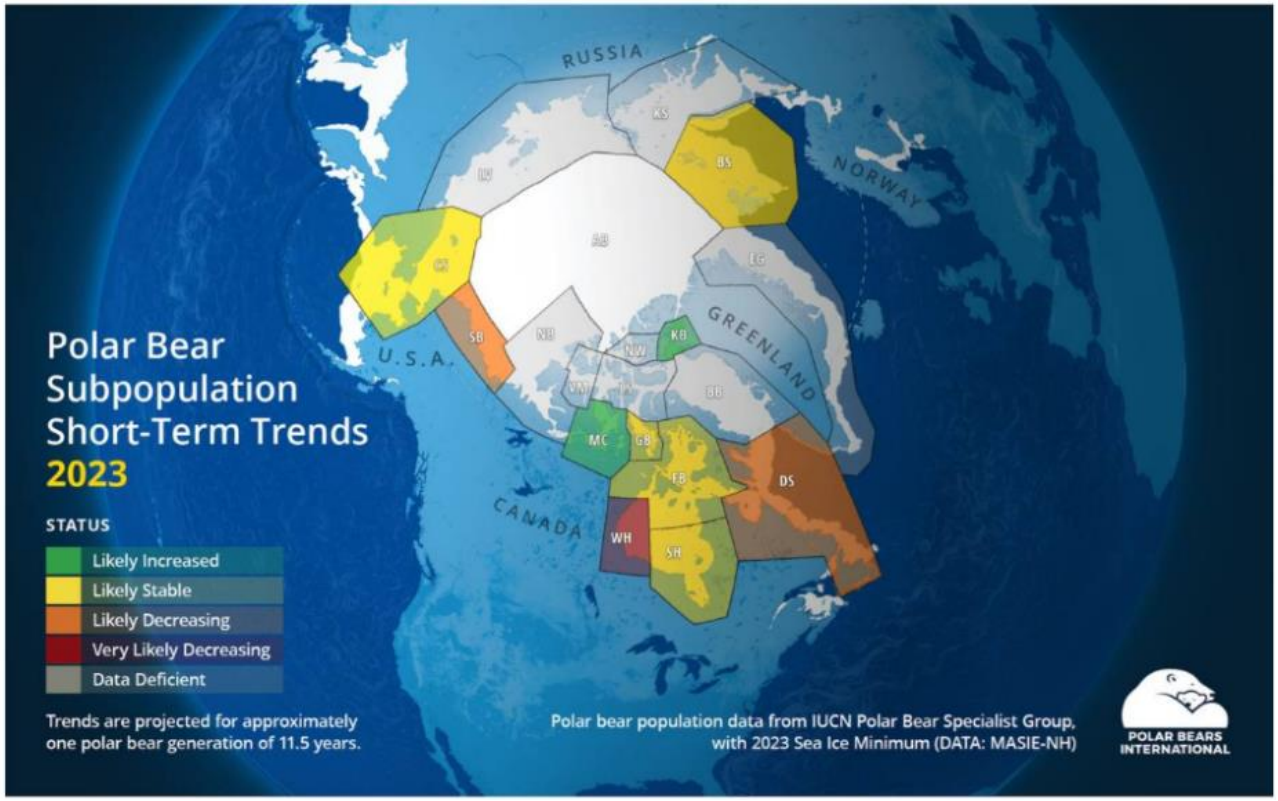
Population

Population trend predicted	Most populations are declining and many sub-populations are likely to go extinct over the next few decades (Castro de la Guardia *et al.* 2013; Bromaghin *et al.* 2021). Almost complete extinction is predicted by 2100 (Hunter *et al.* 2010; Molnár *et al.* 2020).
Population	The global population was estimated to be between 23,315 (Hamilton & Derocher 2018) and 26,000 bears (Wiig *et al*. 2015). At present, 19 subpopulation units of Polar Bears are recognized by the Polar Bear Specialist Group (PBSG). The PBSG concluded that one subpopulation (M'Clintock Channel) has increased, six were stable (Davis Strait, Foxe Basin, Gulf of Boothia, Northern Beaufort Sea, Southern Hudson Bay (-17%), and Western Hudson Bay (-30%), three were considered to have declined (Baffin Bay, Kane Basin, and Southern Beaufort Sea) and, for the remaining nine populations (Arctic Basin, Barents Sea, Chukchi Sea, East Greenland, Kara Sea, Lancaster Sound, Laptev Sea, Norwegian Bay, and Viscount Melville Sound) there were insufficient data to provide an assessment of current trend. The type, precision, and time span of data used to estimate trends varies among subpopulations.

Population health and genetic variability **Population structure (age/size structure, sex ratio)**	Polar bears have relatively high genetic diversity within the species and they have very large range. Genetic studies have shown that gene flow occurs among the various subpopulations and there is no evidence that any of the units have been evolutionarily separated for significant periods of time. Although demographic exchange may be limited between subpopulations, some demographic and genetic exchange occurs. Consequently, the Polar Bear subpopulations cannot be considered as distinct demographic units and the term "*management units*" may be more accurate. Ongoing reductions in the duration, distribution, and quality of sea ice due to climate change may result in different levels of genetic and demographic exchange among subpopulations in the future which could lead to new metapopulation dynamics or to functionally isolated subpopulations (Wiig *et al*. 2015).
Population monitoring	Satellite telemetry (ST) has played a critical role in the management and conservation of polar bears (*Ursus maritimus*) over the last 50 years. ST data provide biological information relevant to subpopulation delineation, movements, habitat use, maternal denning, health, human-bear interactions, and accurate estimates of vital rates and abundance. Given that polar bears are distributed at low densities over vast and remote habitats, much of the information provided by ST data cannot be collected by other means. Obtaining ST data for polar bears requires chemical immobilization and application of a tracking device (Laidre *et al*. 2022). Monitoring bears by drones is becoming more established.
Age to sexual maturity / Generation length	Generation length 10 – 13 years, increases with population size and varies across regions (Wiig *et al*. 2015).
Species longevity in the wild and in captivity (if known)	The Association of Zoos and Aquariums indicates that the median life-expectancy of a polar bear in an accredited facility is 23.4 years. The species lives on average 15-18 years in the wild
Life cycle & Reproductive output	Polar Bears are polygynous and genetic studies to determine paternity are rare (Wiig *et al*. 2015). For female polar bears, the cycle of life includes mating, denning, and giving birth to cubs. Between April and late June, male polar bears search for female mates on the sea ice by following scented trails left by footpads. Mating takes place on the sea ice. Fertile eggs implant during fall, and only if the female has enough fat to sustain herself and her cubs during the long denning period. This process is called delayed implantation. After mating, adult males remain with the female for a few days before taking off on their own. After feeding through the summer and fall, gaining as much weight as possible, pregnant female polar bears prepare to enter maternity dens to give birth to their cubs. To build a den, the female digs a small snow cave in a snowdrift —just large enough for her to turn around. She then waits for the snow to close the entrance tunnel and completely hide the den under the snow. Wild polar bear cubs are most often born in December. The mother gives birth to 1-3 cubs, with twins most common. The family remains in the den until spring.

	While in the den, the mother bear doesn't eat or drink. She is devoted to nursing and caring for her cubs. Totally dependent on their mothers, newborn cubs are blind, toothless, and covered with soft white fur. They weigh little more than 1/2 kg (1 lb) and are just 30-35 cm long (12 to 14 in). The cubs grow rapidly on their mother's rich milk (31% fat) and continue nursing for at least 20 months. Polar bear families generally emerge from their dens in March or April when the cubs are strong enough to survive in outside Arctic conditions and make the trek to sea ice. Mother bears can then start teaching their young how to hunt seals on the ice and survive in the Arctic (Polar bears International). Loss of Arctic sea ice due to climate change is the most serious threat to Polar Bears throughout their circumpolar range (Wiig *et al*. 2015). The mechanisms linking sea ice to litter size are well understood. For about 8 months of the year, Hudson Bay is frozen and bears hunt for seals on the sea ice. Each summer, the sea ice melts and the population is forced ashore. With little to no terrestrial food available, bears rely on their energy stores for survival and reproduction while on land. Pregnant females enter terrestrial maternity dens in early October, where they give birth and nurse 1–3 altricial cubs until den emergence in February or March. Food continues to be unavailable to females while denning, and energetic expenses of survival, gestation and lactation are met from fat and protein stores accumulated during the previous hunting season. Storage energy thus limits the number of cubs that can be raised to den emergence, and the amount of storage energy available to denning females depends on the length of the previous sea ice season. Historically, polar bears came ashore in early August, but because of rising temperatures sea ice breakup has been occurring about 7–8 days earlier per decade in recent years. Polar bear on-shore arrival has shifted accordingly, resulting in shortened on-ice feeding and prolonged on-shore fasting. The trends towards a progressively earlier sea ice break-up and progressively earlier polar bear on-shore arrival are expected to continue with continued warming and consequent food stress is expected to lead to reduced energy stores at den entry. Declines in litter size are likely because less energy is available for gestation and lactation. The species is classified by the IUCN Red List as Vulnerable under criterion A3c with climate change listed as the primary threat to the species (Wiig *et al*. 2015).
Population dynamics Natural shifts **Evidence of population declines (mortalities)/fragmentation attributed to climate change impacts**	Data-based sensitivity analysis by evaluating the potential response of the global Polar Bear population to projected sea-ice conditions using computer simulation and statistical models highlighted the potential for large reductions in the global Polar Bear population if sea-ice loss continues with a probability of a 30% decline in the mean global population (Wiig *et al*. 2015). In western Hudson Bay, predicted that climate warming induced litter size declines that jeopardize population viability: ~28% of pregnant females failed to reproduce for energetic reasons during the early 1990s, but 40–73% could fail if spring sea ice break-up occurs 1 month earlier than during the 1990s, and 55–100% if break-up occurs 2 months earlier. Simultaneously, mean litter size would decrease by 22–67% and 44–100%,

respectively. The expected timeline for these declines varies with climate-model-specific sea ice predictions. Similar litter size declines may occur in over one third of the global polar bear population (Molnar *et al.* 2011).



Of the 19 subpopulations, multiple lines of evidence suggest that two have experienced sea ice-related declines to date (Western Hudson Bay (WH) and d Southern Beaufort Sea (SB) (Wiig *et al*. 2015). Bears which become stranded or end up undertaking significant journeys over open water would have energy depletion thus the number of individuals in this state would impact denning and mating behaviour.

Evidence of population declines (mortalities) from other threats

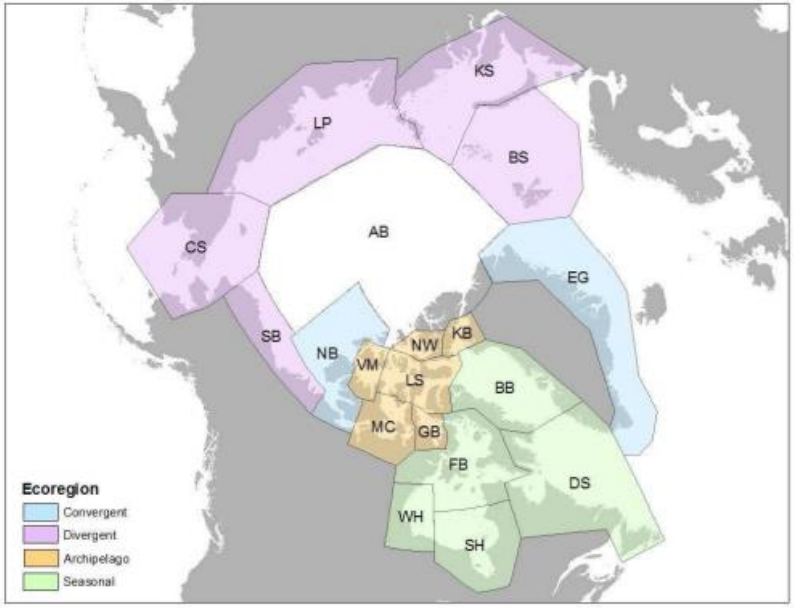
Geographic & Migratory distribution

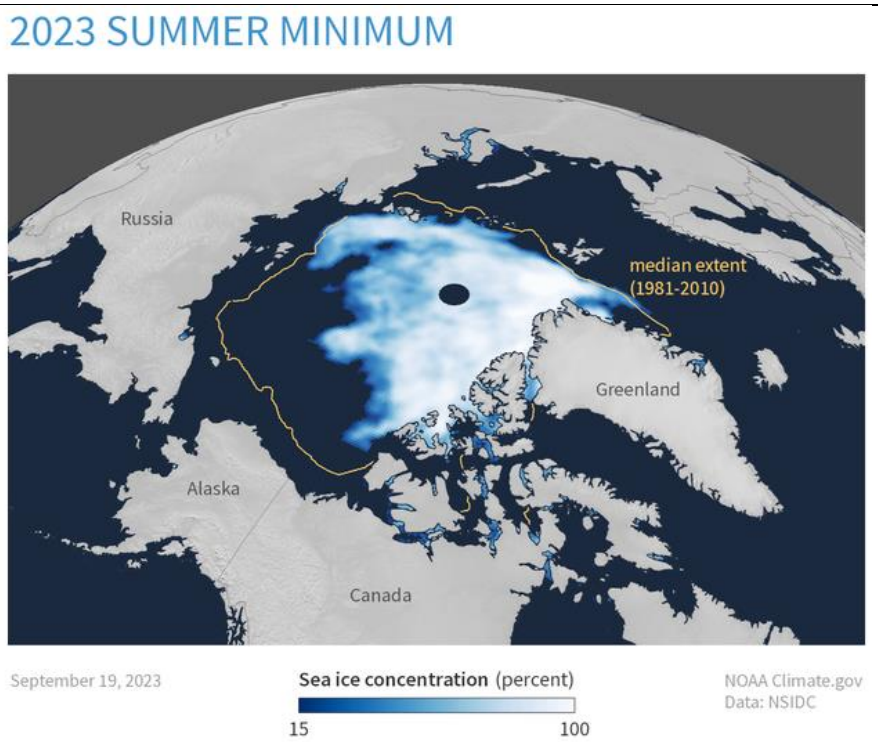
Distribution	Polar bears are unevenly distributed throughout the ice-covered waters of the circumpolar Arctic. Polar bears live across the circumpolar Arctic, primarily in the shallow productive continental shelf waters. Polar bears roam over vast territories and several subpopulations are shared between Range States.
Region	Arctic
Number of range states	Canada, Denmark(Greenland), Norway, Russian Federation , Svalbard and Jan Mayen Islands, United States of America, Iceland
Migration category	
Is migration observed	Polar Bears migrate in the autumn to sea ice edges, following their main prey, seals. In the spring, they follow retreating sea ice, moving on land for the summer months, where they hunt other prey, such as birds (Martay *et al*. 2023).
Range size	The mean home range size of female polar bears is larger for lone females than those with cubs. Home range size was related to (i) the ratio of land vs. sea within a given home range (42% of explained variance), and (ii) seasonal variation in ice cover (24%). Thus, bears using land during the ice-free season had larger home ranges and bears living in areas of great seasonal variation in ice cover also had larger home ranges (Ferguson *et al*. 1999).
Dispersal type	
Migration timing, distance	Some bears prefer to remain at the edge of the ice pack year-round, making extensive migrations as the ice advances and recedes. On the southern shores of Hudson Bay, some bears move onto land for summer and disperse over ice for the winter. Some polar bears make extensive north-south migrations in response to ice packs receding northward in the spring and advancing southward in the fall. In addition, individuals may travel vast distances to find mates or food and have been seen 100 miles from the nearest land- or icefall. Observational sea ice records suggests that polar bears have been required to travel increasing distances between summer sea ice habitats and northeast Alaska denning habitats during. Interannual variation among the annual distance estimates was high, ranging from 0 km in 1983 to 675 km in 2006 (Bergen *et al*. 2007). The length and frequency of seasonal movements undertaken by bears within subpopulations vary according to the attributes of the geographic area occupied—that is, the availability of features such as land masses, multi-year ice and polynyas—and the annual pattern of freezing and break-up of the sea ice. Data from satellite telemetry transmitters on female polar bears have shown that they do not wander aimlessly, but that their movements and distribution are determined by the way they use the sea ice habitat as a platform for feeding, mating, denning and, in some subpopulations, summer retreat areas. They tend to move on drifting ice to remain in productive habitats (e.g. over the continental shelf where seals are abundant), which often means moving against the direction of drift of the sea ice to remain in the same general geographic location (Polar Bear Agreement, 2024).

Barriers to migration	Is lack of sea ice a barrier to migration?
Evidence of vagrancy	
Evidence of changing migration patterns, Migratory response	Polar Bears are now migrating further or spending more time on land (Pilfold *et al.* 2017). Both strategies reduce survival, particularly for cubs (Cherry *et al.* 2013; Miller *et al.* 2022), and increase the risk of conflict with humans (Martay *et al*. 2023).
Evidence of range shifts/ expansion/decline/fragmentation attributed to climate change	Although there have been local and regional studies on polar bear denning habitat large scale mapping of Polar Bear denning habitat across the Arctic has not occurred. It is also unknown how climate change will change denning locations and habitats, though predicted increases in forest fires may have adverse effects on maternity denning habitat in sub-Arctic regions. Declining sea ice availability can impair the ability of pregnant females to reach traditional denning areas and increases of rain events will be detrimental for denning Polar Bears (Wiig *et al*. 2015). In February 2019, the Russian archipelago of Novaya Zemlya in the Arctic Ocean experienced a mass invasion of polar bears, at least 52 bears entered the area near Belushya Guba, the main settlement on the island looking for food in the rubbish dump. Polar bears cannot subsist on a garbage-based diet because of a lack of enough protein and fat. Hunting polar bears and shooting them has been prohibited by law in Russia,[1] and vehicle patrols and dogs were not successful in deterring them . A team of experts was dispatched to the Artic region to remove polar bears coming into the inhabited area and its vicinity (Polarbearscience 2019). Satellite telemetry data and habitat selection studies in the 2000s indicate a number of ecological changes related to sea ice loss in Baffin Bay. There has been a significant reduction in the range of the BB subpopulation in all months and seasons when compared to the 1990s. The most marked reduction is a 60% decline in subpopulation range size in summer. Emigration from the BB subpopulation has declined since the 1990s, especially with a reduction of bears moving into Davis Strait and Lancaster Sound. The total number of bears marked during studies in 2011–2012 in Baffin Bay was equivalent to ~34% of the estimated BB subpopulation size. Despite this, instances of emigration were ≤1% of the recaptures and recoveries of marks for the BB subpopulation (IUCN 2019).
Projected range expansion/decline attributed to climate change	
Behavioural factors (e.g. social structure, migration, aggregating behaviour	

Ecosystem / Habitat vulnerability to climate change

Ecosystem type	Arctic sea ice
Habitat type (breeding, non breeding, resident)	Breeding: Forest (boreal) Non-breeding: Subarctic shrubland, Tundra, marine coastal rocky offshore islands, coastal sand dunes. Resident: Marine epipelagic, marine intertidal rocky shoreline, beaches, sandbars, mud flats (Wiig *et al.* 2015).
IPCC Assessment	The IPCC AR6 identifies the main subset of components of the cryosphere impacted by climate change as: Sea ice thickness and coverage in the Arctic and Antarctic, terrestrial snow cover, glacier mass, ice-sheet mass loss and extent of Greenland and Antarctic as primary drivers of sea level rise, and terrestrial permafrost (IPCC 2019). The AR5 reported that summer sea-ice minimum would very likely decrease by up to 13.6% and likely that winter sea ice thickness had decreased by 1.3-2.3m from 1980 to 2008 as well as increased speed of sea-ice drift. The Arctic Ocean will likely become practically sea ice free1during the seasonal sea ice minimum for the first time before 2050 in all considered SSP scenarios. There is no tipping point for this loss of Arctic summer sea ice (high confidence) (Fox-Kemper et al 2021). Arctic June snow cover extent on land declined by 13.4 ± 5.4% per decade from 1967 to 2018, a total loss of approximately 2.5 million km^2 , predominantly due to surface air temperature increase (high confidence). In nearly all high mountain areas, the depth, extent and duration of snow cover have declined over recent decades, especially at lower elevation (high confidence) (IPCC 2019). Between 1979 and 2018, Arctic sea ice extent has very likely decreased for all months of the year. September sea ice reductions are very likely 12.8 ± 2.3% per decade. These sea ice changes in September are likely to be unprecedented for at least 1,000 years. Arctic sea ice has thinned, concurrent with a transition to younger ice: between 1979 and 2018, the areal proportion of multi-year ice at least five years old has declined by approximately 90% (very high confidence). Feedbacks from the loss of summer sea ice and spring snow cover on land have contributed to amplified warming in the Arctic (high confidence) where surface air temperature likely increased by more than double the global average over the last two decades. Changes in Arctic sea ice have the potential to influence mid-latitude weather (medium confidence), but there is low confidence in the detection of this influence for specific weather types. Antarctic sea ice extent overall has had no statistically significant trend (1979–2018) due to contrasting regional signals and large interannual variability (high confidence) (IPCC 2019). The ocean warming trend documented in the IPCC Fifth Assessment Report (AR5) has continued and is attributed to anthropogenic forcing (very likely). Density stratification has increased in the upper 200 m of the ocean since 1970 (very likely). Observed surface

Ecoregion(s)	ocean warming and high latitude addition of freshwater are making the surface ocean less dense relative to deeper parts of the ocean (high confidence) and inhibiting mixing between surface and deeper waters (high confidence) (IPCC 2019). <u>Determine ecoregion type and sea ice dynamics within each ecoregion and inland arrival times</u>  **Figure 1**. The 19 Polar Bear subpopulations (PBSG 2010) and the four Polar Bear ecoregions as proposed by Amstrup ***et al.*** (2007, 2008). The Polar Bear subpopulations are Arctic Basin (AB), Baffin Bay (BB), Barents Sea (BS), Chukchi Sea (CS), Davis Strait (DS), East Greenland (EG), Foxe Basin (FB), Gulf of Boothia (GB), Kane Basin (KB), Kara Sea (KS), Lancaster Sounds (LS), Laptev Sea (LP), M'Clintock Channel, (MC), Northern Beaufort Sea (NB), Norwegian Bay (NW), Southern Beaufort Sea (SB), Southern Hudson Bay (SH), Viscount Melville Sound (VM), and Western Hudson Bay (WH). (Wiig *et al*. 2015)
Impacts on habitats attributed to climate change	Arctic sea ice reaches its minimum extent each September. September Arctic sea ice is now shrinking at a rate of 12.2% per decade, compared to its average extent during the period from 1981 to 2010. This graph shows the size of the Arctic sea ice each September since satellite observations started in 1979. The monthly value shown is the average of daily observations across the month of September during each year and is measured from satellites (Nasa). The median April (maximum) and September (minimum) sea-ice varies in extent and in thickness. Multiyear sea ice remains frozen year round whilst annual sea ice melts each summer and re-freezes. The Arctic has seen an average loss of 13% of sea ice per decade since 1978.



Arctic sea ice extent for September 19 2023 was 4.23 million square kilometres (1.63 million square miles). It was the sixth smallest summer minimum on record. The orange line shows the 1981 to 2010 average extent for that day. NOAA Climate.gov image, based on data from the National Snow and Ice Data Center (Climate.gov).

The North American Arctic is an exceptionally productive and biologically diverse area, but warming at roughly twice the global average rate. The Pikialasorsuaq polynya remains free of sea ice all year and teems with migratory and marine life including narwhal, walrus, seals and polar bears, as well as seabirds and fish. At about 80,000 square kilometres, it's the world's largest Arctic polynya and is kept open by wind, tides and an ice bridge, which once supported regular trips of Inuit between Canada and Greenland. Climate change is driving the North Water Polynya toward collapse. The critically important area of open water between Greenland and Canada — known to Inuit as Pikialasorsuaq — is changing with "unprecedented speed an area of year-round open water wedged between Greenland and Canada's Ellesmere and Devon islands, and it's a hotspot of biological productivity. the North Water polynya, a unique sea ice ecosystem that sustains the world's northernmost Inuit communities and several keystone Arctic species (Ribeiro *et al*. 2021).

During recent decades, there has been dramatic Arctic sea ice retreat. This has reduced the top-of-atmosphere albedo, adding more solar energy to the climate system. There is substantial uncertainty regarding how much ice retreat and associated solar heating will

	occur in the future. This is relevant to future climate projections, including the timescale for reaching global warming stabilization targets. The amount of solar energy that would be added in the worst-case scenario of a complete disappearance of Arctic sea ice throughout the sunlit part of the year, assuming constant cloudiness is equivalent to the effect of one trillion tons of CO_2 emissions. These results suggest that the additional heating due to complete Arctic sea ice loss would hasten global warming by an estimated 25 years (Pistone et al. 2019).
Interactions with other species	
Predator/prey/ competitor interactions	Polar bears are at the top of the food chain and have an important role in the overall health of the marine environment. Over thousands of years, polar bears have also been an important part of the cultures and economies of Arctic peoples. Rates of poleward shifts in distributions across different sub-species should be monitored. Impacts on prey availability , ringed seals *Pusa hispida*. and bearded seals *Erignathus barbatus*. As seals rely on sea ice for breeding, Polar Bear populations will also be impacted by likely declines in seal population (Martay *et al*. 2023). In their Arctic range there is little other prey available and polar bears have adapted to hunting seals on sea ice. The response of the seal populations needs to be understood as they may also be forced inland which with intense predation rates could decline seal populations .
Are impacts observed Mutualisms / symbiosis Evidence of change/ disruption/ breakdown of dependent mutualisms Disturbance to food web	In recent decades, Arctic net primary production has increased in ice-free waters (high confidence) and spring phytoplankton blooms are occurring earlier in the year in response to sea ice change and nutrient availability with spatially variable positive and negative consequences for marine ecosystems (medium confidence (IPCC 2019).
Does the species provide ecosystem service	Polar bears are at the top of the food chain and have an important role in the overall health of the marine environment. Over thousands of years, polar bears have also been an important part of the cultures and economies of Arctic peoples.

Ecosystem engineer (e.g. elephant, rhino	
Other species this can be applied to	The information in this assessment can be used to undertake Climate Change Vulnerability Assessments for species which occur in the same environment which have habitat dependency on sea ice such as narwhal, walrus, ringed seals and bearded seals. The NOW or Pikialasorsuaq ('the great upwelling' in Greenlandic) is the largest and most productive polynya in the northern hemisphere, an annually recurring ice-free area in northern Baffin Bay. The ice-free waters of the NOW allow for an enhanced and unusually early phytoplankton bloom lasting for two-four months. The polynya ecosystem sustains keystone Arctic species, including Arctic cod, seabirds, and marine mammals such as narwhal, beluga, walrus, and polar bear, which all serve to underpin the hunting and fishing economies of Inuit communities in the region. The World Conservation Union (IUCN) has identified the NOW as one of the most ecologically significant marine areas in the Arctic and proposed it as a UNESCO Natural Marine World Heritage Site due to its Outstanding Universal Value (Ribeiro *et al*. 2021). The NOW supports >80% of the global breeding population of little auk, which is the most abundant seabird in the North Atlantic. The little auk is tightly linked to the copepod *Calanus hyperboreus*, on which the chicks are raised, and >60 million birds depend on the unique availability of this prey item in the NOW. By transporting vast quantities of marine-derived nutrients (MDN) from sea to land in the form of guano, little auks have transformed extensive parts of the NOW coastal landscapes into green oases. At little auk colonies, temporal changes in the MDN flux in sediments can be used as a proxy for changes in bird numbers and, by inference, NOW productivity over time (Ribeiro *et al*. 2021).

Species Ecological Flexibility and Adaptive capacity

Ecological Flexibility Degree of specialisation	All Polar Bears depend on sea ice for fundamental aspects of their life history, and loss of sea ice is the primary long-term threat to the species (Wiig *et al*. 2015). Regression analysis found prey diversity as the only significant correlate with polar bear density (Hamilton & Derocher 2018).
Genetic plasticity	Such large-scale habitat decline and fragmentation could lead to reduced genetic diversity (Kutschera i. 2016).
Adaptive capacity Responses to climate change	The response of Polar Bears to ecological change is likely to be variable in time and space (Wiig *et al.* 2015).

	Polar bears have relatively high genetic diversity within the species and they have very large range (WWF) across land and sea ice, therefore have adaptive capability. The Polar Bear's diet is shifting to include other species, such as ground-nesting birds, whales (Rode *et al.* 2022), fish and blueberries. However, these food sources are not likely to sufficiently replace their seal prey (Martay *et al*. 2023). Climate change is affecting the ecology and habitat use of CS bears. Between 1986 and 2013, the percent of females summering on land increased from 20% to 39% and the average time spent on land increased by 30 days Energetics models linking the duration of fasting on land to recruitment and survival suggest that reduced on-ice hunting opportunities could lead to demographic declines for CS bears by ~2040. Similar declines ´ have already been observed for some other polar bear subpopulations (Lunn *et al*. 2016), (Regehr *et al*. 2021). Polar bears have adaptations that help them spend part of their time in the water. They are streamlined for swimming and have a layer of fatty blubber that keeps them warm. Polar bears even have tiny webs between their toes that help them swim through the water. They are classified as marine mammals even though they do not live in the water full-time like whales, dolphins, manatees, and other marine mammals. However, even with adaptations that make them exceptional swimmers, polar bears have recently been found drowned for the first time. Because pieces of sea ice are getting smaller and further apart, the bears must swim farther, 60 miles or more, to get from one piece of ice to another. Some become exhausted during the long journey and drown (SCIED 2024). At the northern edge of North America, polar bear populations are particularly vulnerable. Polar bears are moving to land on the north coast of Alaska because the sea ice is melting and no longer connects to shore. This separates the bears from their preferred hunting grounds, the sea ice. With less sea ice, polar bears cannot hunt for food as often, and so they wind up with less to eat. Polar bears, it has been reported, occasionally eat land animals like reindeer and musk oxen. Even so, scientists have found that polar bears weigh less than they used to and that polar bear cubs off the North coast of Alaska are less likely to survive (SCIED 2024). Polar bears have relatively high genetic diversity within the species and they have very large range. Genetic studies have shown that gene flow occurs among the various subpopulations and there is no evidence that any of the units have been evolutionarily separated for significant periods of time. Although demographic exchange may be limited between subpopulations, some demographic and genetic exchange occurs. Consequently, the polar bear subpopulations cannot be considered as distinct demographic units and the term "management units" may be more accurate. Ongoing reductions in the duration, distribution, and quality of sea ice due to climate change may result in different levels of genetic and demographic exchange among subpopulations in the future which could lead to new metapopulation dynamics or to functionally isolated subpopulations (Wiig *et al*. 2015).

Evidence of past adaptation to climate change	Polar bears in captivity are shown to live happily in an ice free environment and are not sustained on seal meat but rather rats, rabbits, fish. Polar bears are the most carnivorous of the Ursidae family, and prey primarily on ringed seals in the wild. Other seals, whales, walrus, reindeer, sea birds, carrion, and vegetation may be consumed as well. At this point data do not exist for polar bears indicating they are obligate carnivore or strictly omnivore. Polar bears in the wild are primarily carnivorous, but will occasionally consume plant matter. Polar bears in zoos and aquariums also will readily consume plant matter. Consequently, a range of nutrient levels encompassing both feeding strategies (carnivorous and omnivorous) is appropriate for the formulation of polar bear diets in zoos and aquariums (AZA 2009).

Other threats / interactions with other processes

Threats to the species	Polar bears are important to the livelihoods of Indigenous Peoples and, as apex predators, are essential to maintaining ecosystem balance in the Arctic region. Along with sea ice loss, other potential threats to the species include pollution, resource exploration and habitat change due to development. Oil development in the Arctic, for example, poses a wide range of threats, from oil spills to increased human-bear interaction. Whilst sea ice loss is the major threat to polar bears, the full range of current and potential threats must be considered in polar bear management plans (CMS Press Release Nov 2015). The Circumpolar Action Plan identifies the following threats to polar bears: 1. Climate change 2. Disease 3. Human-caused mortality 4. Mineral and energy resource exploration and development 5. Contaminants and pollution 6. Shipping 7. Tourism and related activities In May 2014, CITES conducted a Significant Trade Review and reached the conclusion that current international trade was considered to be sustainable (Durner *et al*. 2016).

	Polar Bear subpopulations may be influenced by other ecological and anthropogenic factors, such as industrial development and human-caused removals. Traditional threats to polar bears such as pollution and unsustainable development now pale in comparison with the threat of climate change and related increase in human activities in the Arctic (Wiig *et al*. 2015). Prolonged fasting due to declines in food availability will increase the tissue concentrations of dangerous pollutants, which is likely to have population-level impacts on reproduction (Martay *et al*. 2023). Polar bear congregations have been known to occur around grey whale strandings. In Russia there seems to be an increase of brown bears along the northern coast, and more interactions between brown/grizzly bears and polar bears could be expected.

Conservation actions

Conservation actions in place	Action to mitigate the threat of climate change is beyond the ability of either the IUCN SSC Polar Bear Specialist Group or the five governments that comprise the Polar Bear Range States. Polar bear range states have recently agreed on a Circumpolar Action Plan – the first global conservation strategy to strive for the long-term persistence of polar bears in the wild. IUCN is actively working with those countries, providing scientific data and advice to help implement the agreed plan in the most efficient and cohesive way possible (CMS Press Release Nov 2015). The 2015 Circumpolar Action Plan: Conservation Strategy for Polar Bears is critical to help secure the long-term persistence of Polar Bears in the wild that represent the genetic, behavioural and ecological diversity of the species. The PBSG considers periodic updated assessments of the status and trends of the world's 19 recognised subpopulations, identification of areas of essential habitat for Polar Bears, and further understanding and refining of definitions of sustainable harvest of polar bears. In order to achieve the goal of the CAP, the Range States have developed six key objectives that address the aforementioned threats: 1. Minimize threats to polar bears and their habitat through developing, implementing and sharing adaptive management practices based on coordinated research and monitoring efforts, use of predictive models and interaction with interested or affected parties; 2. Communicate to the public, policy makers, and legislators around the world the importance of mitigating greenhouse gas emissions to polar bear conservation; 3. Ensure the preservation and protection of essential habitat for polar bears; 4. Ensure responsible harvest management systems that will sustain polar bear subpopulations for future generations; 5. Manage human-bear interactions to ensure human safety and to minimize polar bear injury or mortality; and 6. Ensure that

Inclusion in Protected Areas **Conservation actions required for mitigating climate change impacts** **Effectiveness of past, existing actions** **Species present in captivity / can be bred in captivity** Measures to manage migratory routes and range changes including Nature-based solutions and/or ecosystem-based approaches, embracing conserving migratory species' habitats, including maintaining or enhancing connectivity and ecosystem integrity. **Species Action Plan(s)**	international legal trade of polar bears is carried out according to conservation principles and that poaching and illegal trade are curtailed (PolarBearAgreement.org). In 2016, American and Russian scientists began collaborative research on Wrangel under a bilateral treaty. By 2019, they had collected data on habitat use, body condition and reproduction for 1,600 polar bears. They used non-invasive methods to collect genetic samples from another 100. In addition to collecting data needed for management and conservation using systematic survey methods, the project has sought to build capacity among Russian scientists. This paid dividends in 2020 when experienced staff from the Wrangel Island State Nature Reserve conducted research without American participation (due to COVID-19 restrictions). The researchers collected observational data on a record 747 bears and genetic samples from 113 bears. Even subpopulations like the Chukchi Sea, which appear to be doing well for now, are expected to experience stress and declining numbers as sea-ice loss continues. As the summers lengthen, Wrangel Island is providing bears with a critical terrestrial refuge and researchers with an opportunity to collect data needed for managing and conserving the Chukchi Sea subpopulation. American-Russian research on the island represents the type of international cooperation and capacity development that will be increasingly important as climate change affects both polar bears and our ability to study them. https://www.arcticwwf.org/the-circle/stories/america-and-russia-work-together-during-challenging-times/

Recommendations	
	To be made

Assessor name /affiliation	Sonia Khela Joint Nature Conservation Committee UK
Date	December 2024
CMS Reviewed	
Specialists consulted	
Specialist review	
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Definitions and Criteria

Use of scoring system (McNamara et al 2020)

Vulnerability of habitat/s : to identify whether species will be affected by climate change impacts on key dependent habitats.

Impacting factor	Severity of impacting factor					Other considerations
	LOW (1)	LOW / MEDIUM (2)	MEDIUM (3)	MEDIUM / HIGH (4)	HIGH (5)	
Vulnerability of habitat/s:						
Resilience to change >Climatic changes projected for habitat area. >Impact that projected changes will have upon the habitat.	Minimal impact on habitat(s) utilised. Habitat likely endure climatic changes largely unchanged	Some impacts on habitat(s) utilised. Habitat likely to endure climatic changes with few changes	Moderate projected changes within habitat(s) due to climate change. System function and essential niche occupied by species operational to some extent but degraded and fragile.	One or more vital habitat(s) projected to be highly degraded by climatic changes	One or more vital habitat(s) projected to be severely degraded by climatic changes	Ability of the habitat to maintain pace with the projected eco-zone (bioclimatic envelope) shift and any barriers to that shift should be considered. Will habitats shift across large distances? Will changes occur rapidly?

Ecological flexibility : to identify the adaptation potential and resilience of species to climate change by reviewing key life history traits and characteristics. These include species degree of specialisation and ability to disperse to new suitable ranges as well as the degree to which climate change will impact on reproductive success and important environmental triggers or phenological cues.

Impacting factor	Severity of impacting factor					Other considerations
	LOW (1)	LOW / MEDIUM (2)	MEDIUM (3)	MEDIUM / HIGH (4)	HIGH (5)	
Ecological flexibility and adaptation potential:						
Degree of specialisation	Dynamic species with a wide diet and a broad niche. Species may utilise many habitats. Equipped to manage a changing environment.	Species has a wide niche and a varied diet. Species may utilise a number of habitats.	Some degree of specialisation, some biological requirements, including dietary and habitat, are limited / rare or found in few areas.	Specialised species with a well defined niche. Specific and limited dietary and habitat requirements.	Highly specialised species. Sensitive species with a narrow niche breadth. May be endemic to one region/area.	Ability to adapt to changing conditions and switch food or other resource requirements. Is the species current habitat and/or resource use facultative or obligate? What factors limit species adaptation potential?
Environmental triggers and phenological cues	No fixed dependency on phenological cues or triggers that will be affected by climate change.	Little dependency on phenological cues or triggers that will be affected by climate change and high ability to adapt.	Potential dependency on phenological cues or triggers that will be affected by climate change but some ability to adapt.	Dependency on phenological cues or triggers that will be affected by climate change but some ability to adapt.	Fixed dependency on phenological cues or triggers that will be affected by climate change. Little ability to adapt.	Will changes in environmental triggers lead to phenological mismatch?

Evidence of adaptation in the past	Evidence of rapid migration and adaptation response to climatic changes in the recent past. Culturally driven migration rather than genetically driven migration.	Migration and adaptation response to climatic changes in the past have been good and is likely to be sufficient to keep pace with projected rates of ecosystem shift.	Some migration and adaptation response to climatic changes in the past.	Migration and adaptation response to climatic changes in the past have been slow and is likely to be slower than projected rates of ecosystem shift.	No evidence of migration or adaptation response to climatic changes. Genetically driven migration rather than culturally driven migration.	Is there any evidence of migration/ecological changes since the end of the last ice age? What does this evidence infer upon the prospects of future adaptation? If no evidence is found at all in regard to this section please identify as NA.
Dispersability	High ability to disperse to new areas and shift migration patterns. No natural barriers to migration to new or more suitable range/ habitats.	Some ability to disperse to new areas and shift migration patterns. Minimal natural barriers to migration to new or more suitable range/ habitats.	Moderate ability to disperse to new areas and shift migration patterns. Some natural barriers to migration to new or more suitable range/ habitats.	Little ability to disperse to new areas and shift migration patterns. Several natural barriers to migration to new or more suitable range/habitats which will make dispersal hard but not impossible.	Migration patterns are fixed to specific areas. No ability to disperse to new or more suitable range/ habitats. Natural barriers prevent dispersal to more suitable range/ habitats.	Are species dependent on a vector such as wind and water currents for migration and dispersal? Are these vulnerable to change and will this limit the species ability to disperse to new suitable habitats? Are critical life stages threatened by these changes? Are there sufficient metapopulation numbers in areas adjacent to new suitable habitats that will facilitate effective dispersal?
Reproduction rate and resilience: Climate related changes to fecundity or reproductive success	Rapid reproduction rate, no known climate related changes to fecundity or reproductive success. Species environmental tolerances will not be exceeded due climate change and reproductive resilience is shown.	Good reproduction and little climate-related reduction of fecundity or reproductive success expected. Displays reproductive resilience to potential climate change impacts.	Average reproduction rate. Some climate-related reduction of fecundity or reproductive success expected. Non optimal environmental tolerances experienced with some impacts on reproductive success.	Below average rate of reproduction. Reproduction likely to be hampered by climate change related decrease in fecundity. Low reproductive resilience to potential climate change impacts.	Slow rate of reproduction. Reproduction likely to be hampered by climate change related decrease in fecundity. Species environmental tolerances will be exceeded resulting in low reproductive resilience to climate change impacts.	The biological aspects of dispersability should be considered. Are specific metapolulations at greater risk?

<u>Species interactions</u> : to identify whether species will be affected by climate change due to impacts on predator, prey, competitor species as well as impacts on key mutualistic and symbiotic relationships

Impacting factor	**Severity of impacting factor**					**Other considerations**
	LOW (1)	**LOW / MEDIUM (2)**	**MEDIUM (3)**	**MEDIUM / HIGH (4)**	**HIGH (5)**	

Species interactions:						
Changing dynamics of predator/ prey/ competitor interactions	No known dependency on any interspecific predator / prey / competitor interactions that are likely to be disrupted by climate change.	Major disturbance of the foodweb unlikely due to climate change impacts. Impacts on interspecific predator / prey / competitor interactions and community likely to be small	Moderate disturbance of foodwed possible due to climate change impacts. Moderate reduction of food resources or moderate increase in predation likely. Some impacts on interspecific predator / prey / competitor interactions and community likely.	Moderate to high disturbance of foodwed probable due to climate change impacts. Some major impacts on interspecific predator / prey / competitor interactions and community likely.	Disappearance of prey species or inability to catch dependent prey due to climate change impacts. Increase in threat to species due to burgeoning predator or competitor populations	The degree of reliance on other species that may be affected by climate change. How will climate change affect the foodweb and timing of resource availability? What is the cumulative impact for populations of the species in question? Will predator / prey / competitor species be affected by changes in environmental triggers or phenological cues and how will this impact on subject species?
Impacts upon mutualisms/ symbiosis.	No disorientation of important mutualism. Moderate disorientation of some non-dependent mutualisms due to climate change.	Partial disorientation of some important mutualism. Moderate disorientation of some non-dependent mutualisms due to climate change.	Serious disruption of some non-dependent mutualisms. Moderate disorientation of dependent mutualisms due to climate change.	Serious disruption of dependent mutualism/s due to climate change.	Evidence of breakdown of the necessary dependant mutualisms due to climate change.	Number of mutulisms important, as is the relative reliance upon those mutulisms

Synergistic threat processes : to identify whether further threats, including those directly anthropogenic driven as well as diseases and invasive species, will reduce species ability to adapt and reduce their resilience to climate change impacts alongside any potential interactions between these threat processes and climate change.

Impacting factor	Severity of impacting factor					Other considerations
	LOW (1)	LOW / MEDIUM (2)	MEDIUM (3)	MEDIUM / HIGH (4)	HIGH (5)	
How do other threats act synergistically with climate change?						
Habitat loss/ fragmentation	Intact habitat, little evidence of disturbance affecting habitat and species resilience to climate change impacts	Some habitat disturbance, loss or fragmentation, but habitat largely intact and resilience to climate change impacts not seen to be greatly affected.	Fragmented/depleted habitat but large areas still intact. Habitat and species resilience to climate change impacts has been greatly depleted but still opportunities for bounce back if good management and restoration practices are put in place and adhered to.	A high level of habitat loss/fragmentation. Significant implications for habitat and species resilience to climate change	Habitat loss/fragmentation severe. Greatly impacting habitat and species resilience to climate change	Other threats should also be noted. Will anthropogenic activities act synergistically with climate change to increase habitat loss/ fragmentation? Will anthropogenic transformation of migration route or newly climatically suitable areas create barriers to migration or dispersal? Will this be due to agriculture, deforestation, urbanization or other activities?

Exploitation	No significant exploitation. No affect on species resilience and adaptation potential to climate change.	Low levels of exploitation with minor impact on resilience and adaptation potential of species to climate change.	Moderate levels of exploitation with some impacts on species resilience and adaptation potential to climate change.	High levels of exploitation impacting on species resilience and adaptation potential to climate change.	Unsustainable exploitation posing a serious threat to the viability of the species. Exploitation levels give little chance that species will be able to adapt and have resilience to climate change impacts.	Will exploitation increase with climate change predictions or will species be exposed to new exploitation threats as they migrate to new areas?
Disease	No known disease threat and no predicted disease threat increase due to climate change	Low disease threat and some increase due to climate change	Medium level of disease threat with impacts on population levels increasing as a result of climate change.	Significant level of disease threat with strongly increased impacts on population levels as a result of climate change.	Disease a serious threat to the viability of the species and threat levels will be greatly increased by climate change.	Will disease spread to new areas that will affect species due to climate change?
Invasive species	No known threat from invasive species due to climate change	Some invasive species will compete indirectly for resources due to climate change	Likely that some invasive species will compete directly for resources due to climate change	Available resources substantially diminished by invasive species due to effects of climate change increasing their competitive advantage	Habitat very likely to be invaded by species which will directly outcompete the subject species, or destroy the dependent food-web, due to climate change	Will invasive species range be increased by climate change? How will this impact species both directly and indirectly?

<u>Species traits to assess against Exposure, Sensitivity, Adaptability</u>

- Life history (e.g. low fecundity, slow growth rate of the individual, high age at first maturity, long generation time)
- Low absolute numbers or biomass or restricted area of distribution
- Population structure (age/size structure, sex ratio)
- Behavioural factors (e.g. social structure, migration, aggregating behaviour)
- Density (for sessile or semi-sessile species)
- **Specialized niche requirements (e.g. diet, habitat)**
- Species associations such as symbiosis and other forms of co-dependency
- Reduced genetic diversity
- Depensation (prone to continuing decline even in the absence of exploitation)
- Endemism
- Adaptive ability
- Reproductive
- Generation length
- Age wild/captivity (if known)
- Reproductive output
- Related to migration

<u>Climate change impacts</u>

- Climate Change Process - Temperature Impacts / Vulnerability
- Climate Change Process - Precipitation Impacts / Vulnerability

- Climate Change Process - Sea Level Rise Impacts / Vulnerability
- Climate Change Process - Ocean Circulation Impacts / Vulnerability
- Climate Change Process - Ocean Acidification Impacts / Vulnerability
- Climate Change Process - Extreme Weather Events Impacts / Vulnerability
- Climate Change Process - Season Changes Impacts / Vulnerability
- Climate Change and Biological Response Process - Phenological Shifts Impacts / Vulnerability
- Climate Change and Biological Response Process - Biome Shifts Impacts / Vulnerability
- Climate Change and Biological Response Process - Food Availability Impacts / Vulnerability
- Climate Change and Biological Response Process - Species Interactions (prey/competitor/symbionts) Impacts / Vulnerability
- Climate Change and Biological Response Process - Reproduction (rates and fecundity) Impacts / Vulnerability
- Climate Change and Biological Response Process – Range Shifts Impacts / Vulnerability
- Climate Change and Biological Response Process - Adaptation Potential
- Climate Change Interactions with other Threats - Limits to Dispersal / Migration to Suitable Future Habitats
- Climate Change Interactions with other Threats - Disease Impacts / Vulnerability
- Climate Change Interactions with other Threats - Invasive Species Threats Impacts / Vulnerability
- Climate Change Interactions with other Threats - Habitat Fragmentation / Degradation Impacts / Vulnerability
- Climate Change Interactions with other Threats - Other Synergistic Anthropogenic Threats Impacts / Vulnerability