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THE ADAPTABILITY OF POLAR BEARS IN THE BARENTS SEA REGION

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Svalbard's Polar Bears Adaptation to Rapid Sea ice Loss

Surprisingly, in the Barents Sea region where sea ice retreat has been particularly rapid and extensive over the last decade, polar bears have demonstrated a remarkable degree of ecological flexibility.

Few animal species have become as strongly associated with climate change as the polar bear. Images of bears stranded on small pieces of sea ice have, for decades, symbolized the rapid transformation of the Arctic. In many ways, this symbolism is justified. Polar bears (*Ursus maritimus*) are highly dependent on sea ice, and all populations across the Arctic have experienced substantial habitat loss in recent decades. Yet the scientific picture emerging from different Arctic regions is more complex than is assumed.

Figure 1 - Satellite telemetry collars are an important tool that makes it possible to follow the movements of adult females, study space use and migration, and determine whether they enter maternity dens in winter. Only females that reproduce enter dens during winter, unlike brown bears in northern areas. On the photo above, a female with a small cub, about four months old, is shown shortly after they have recovered from capture and immobilization. All handling infers stress and poses some risk to the animals, and in rare cases (two to four bears per 1,000 captures), fatal accidents may occur. The knowledge gained from monitoring through capture–recapture studies must be weighed against the negative effects on the study population. *Credit: Jon Aars/Norwegian Polar Institute*

'What we may see in future years and decades is some populations still doing well while others may be declining and possibly moving toward extinction'

Nowhere is this complexity more apparent than in the Barents Sea region around the Svalbard archipelago in the eastern Arctic. This area has experienced by far the fastest sea ice loss of any area occupied by the 20 recognised polar bear subpopulations in the Arctic (as described by the IUCN Polar Bear Specialist Group), but the polar bears there have so far, shown a surprising degree of ecological flexibility.

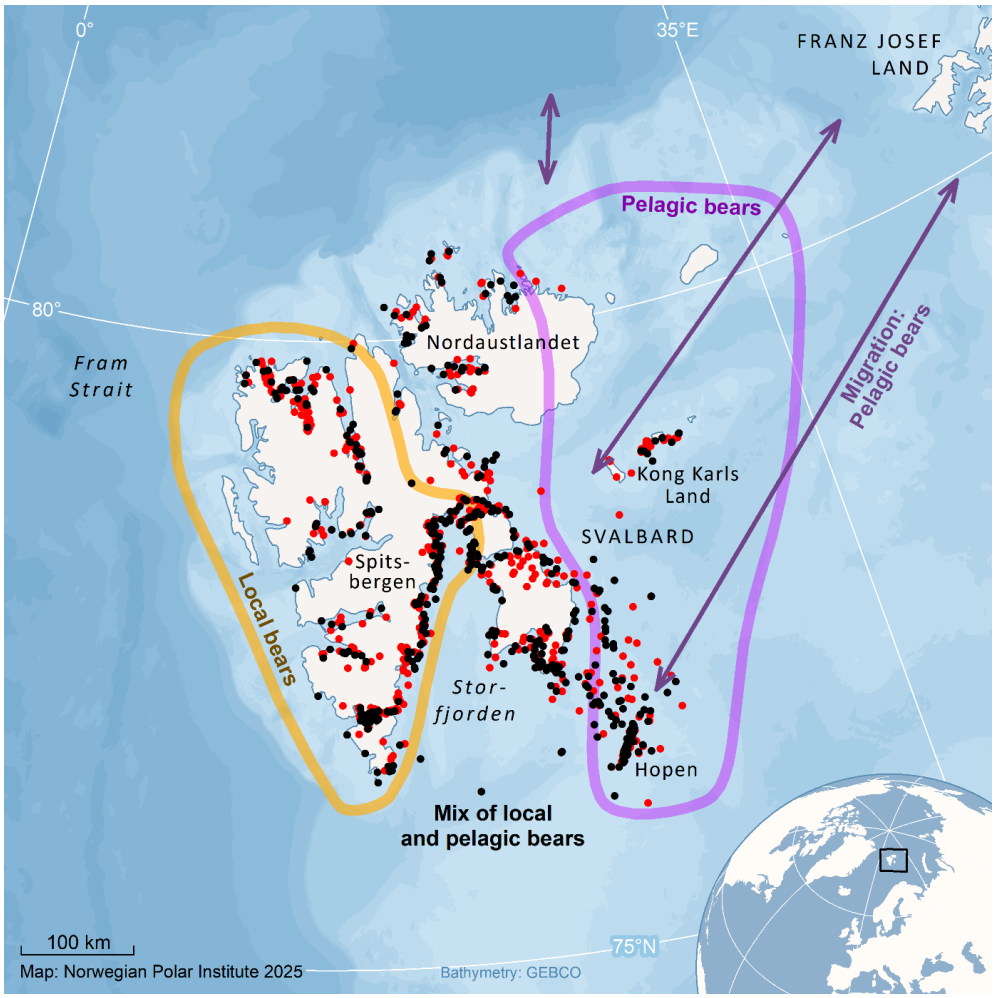

Figure 2 - Capture positions of bears from the monitoring programme over the period 1995-2019 (females=red dots, males=black dots). The yellow line encompasses an area where most bears are sedentary ("local"), and the pink line an area where they are most often migrating bears ("pelagic") that visit Svalbard seasonally. *Source: Aars J. et al., Scientific Reports 16, 2182 (2026).*

Rather than declining in size, as has been seen in some other populations where sea ice habitat has deteriorated, the population remained relatively stable, and several recent studies indicate that at least some groups of bears are currently coping better than expected with the changing environment. At the same time, there is little doubt that continued warming poses major long-term challenges. Because of habitat loss, polar bears, like many other sea ice-dependent species, are on the IUCN Red List, where they were classified as "Vulnerable" in 2006. The polar bear is a relatively young species in evolutionary terms. Genetic studies suggest that it diverged from the brown bear perhaps 400,000–600,000 years ago, although estimates vary considerably. Fossil evidence from

Svalbard shows that polar bears were already present in the region during a warmer interglacial period around 110,000–130,000 years ago. Throughout their evolutionary history, polar bears have likely experienced substantial climatic fluctuations, however, the current rate of Arctic warming and sea ice loss, is unprecedented in modern times.

Historically, the greatest threat to polar bears was hunting. Commercial hunting intensified in Svalbard and surrounding seas during the nineteenth and twentieth centuries. Norwegian hunters operated over enormous areas of drifting pack ice, and more than 300 bears per year were harvested on average for nearly a century. Polar bear cubs were also captured alive for zoos across Europe. Hunting methods included poison and self-shooting trap rifles, techniques that killed both lone bears and females with cubs. By the late twentieth century concerns over declining populations led to international agreements and protection measures. Polar bears were fully protected in Svalbard in 1973. Polar bears were subsequently listed under CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) appendix 2 in 1975, meaning trade of polar bear parts over national borders was regulated but not prohibited.

The Barents Sea population subsequently recovered remarkably well. Surveys conducted in 2004 estimated approximately 2,650 bears in the region shared by Norway and Russia, and more recent work suggests that the population has remained stable or even possibly continuing to increase. Around 250–300 bears are considered local to Svalbard year-round, while the majority follow the seasonal northward and eastward drift of the sea ice toward the Russian Arctic. Satellite telemetry has revealed strikingly different strategies among individuals. Some females remain within relatively small fjord systems throughout the year, while others undertake vast seasonal migrations across the Barents Sea.

These two broad ecological strategies (Figure 3) are often referred to as “local” and “pelagic” bears. Local bears spend increasingly long periods on land during summer and autumn as sea ice disappears from the fjords around Svalbard. Pelagic bears continue to follow the retreating ice edge northward, remaining connected to marine hunting habitat for much of the year. This distinction has become increasingly important as sea ice has declined. Sea ice is fundamental to polar bear ecology as it provides access to seals, particularly ringed seals, their primary prey throughout most of the Arctic. Polar bears are highly specialized hunters of marine mammals. In spring, they often hunt ringed seal pups inside snow lairs on the sea ice, or wait patiently beside breathing holes for seals to surface. The bears are extremely efficient at converting seal blubber into body fat reserves. Pregnant females may enter maternity dens with body fat approaching half of

their total body mass, enabling them to survive for months without feeding while nursing cubs through the Arctic winter. In Svalbard, this denning period may last four to five months, before the family leaves the den in March or April. At the same time, polar bears are also remarkably opportunistic. Although seals remain their most important food source, they consume a wide variety of prey when available. In Svalbard, bears feed on bearded seals, walrus carcasses, whale remains, birds, eggs, fish, and reindeer. As sea ice has declined, this opportunistic behaviour appears to have increased, particularly among local bears that are now on land for much of the year.

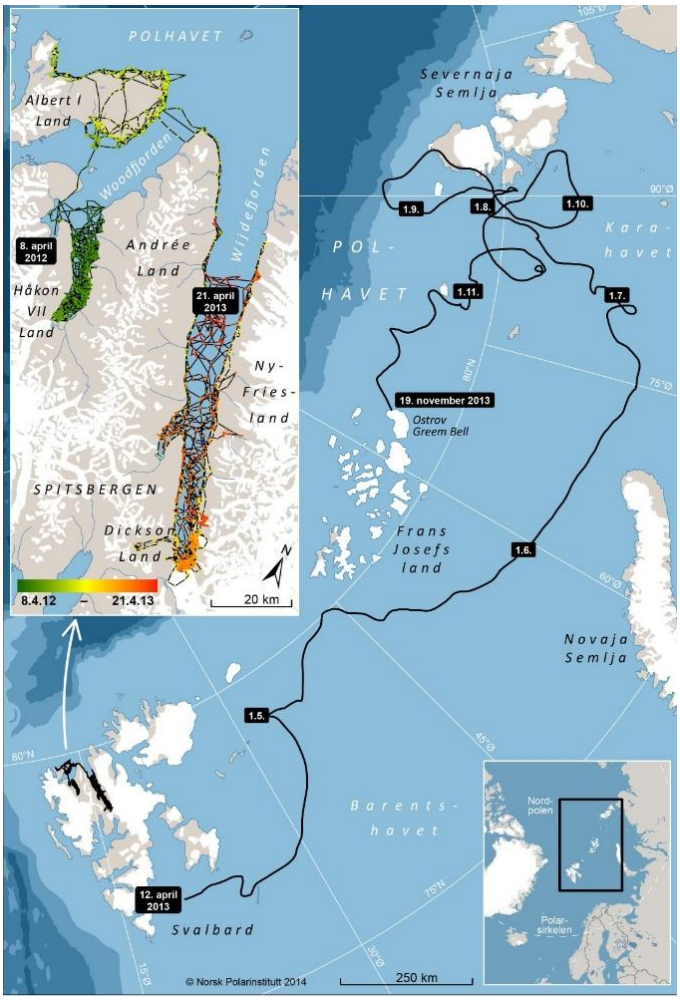

Figure 3 - Two different space-use strategies of Svalbard polar bears subpopulation. Some bears follow the ice edge as it moves seasonally (pelagic bears) and stay mostly along the ice edge, which is now on average located 200–300 km farther north than three decades ago. They may be in the Svalbard area seasonally in winter and spring, and often migrate east or northeast in summer and autumn. Local Svalbard bears stay in Svalbard year-round, often within rather small areas. On the map above, two females illustrate this difference with GPS tracks over one year (the pelagic bear entered a den in late November and stayed there until April). The track for the pelagic bear is marked with the first day of each month. *Source: Norwegian Polar Institute.*

The Barents Sea region has undergone dramatic environmental change during recent decades. The period with little or no sea ice around Svalbard is now typically two to three

months longer than around the year 2000. The ice edge has shifted hundreds of kilometres northward, and traditional denning areas have become less accessible. On islands such as Hopen, southeast in Svalbard, maternity denning by females has declined substantially because the sea ice connecting these islands to hunting areas no longer forms reliably in time for the start of the denning period in late autumn. Polar bears are also swimming longer distances than previously observed. Females equipped with satellite collars have been documented swimming hundreds of kilometres between islands and the retreating ice edge. Swimming is energetically costly, particularly for smaller bears, and long-distance swimming has become one of the most visible behavioural responses to sea ice loss in several Arctic populations. The energetic cost of swimming may help explain why pregnant females do not reach traditionally important denning areas in years when sea ice does not form there in late autumn, despite their ability to swim long distances.

Yet despite these dramatic environmental changes, recent studies from Svalbard have produced results that surprised many researchers. A long-term study of body condition among adult polar bears from 1995 to 2019 found no evidence for the predicted long-term decline in average body condition. In fact, body condition improved after approximately 2000 for both adult males and adult females. These findings contrast with observations from populations such as Western Hudson Bay and the Southern Beaufort Sea, where reduced sea ice has been associated with lower survival, poorer reproduction, smaller body size, and population decline. In Svalbard, data also show that adult bears have high survival and that females reproduce in years with little sea ice.

The explanation for this apparent contradiction likely lies in regional ecological differences. Arctic ecosystems vary enormously, and polar bear populations do not respond identically to climate change. In Western Hudson Bay, bears are forced ashore for long periods every summer due to the complete disappearance of sea ice. During this fasting period, feeding opportunities on land are limited. In contrast, many Barents Sea bears still retain access to productive marine hunting areas near the ice edge for much of the year. At the same time, ecological changes in Svalbard may temporarily have benefited some bears. Populations of walrus and Svalbard reindeer have increased substantially after historical overharvesting. The distribution of harbour seals, a more temperate species, has expanded in western Svalbard. Polar bears now spend more time feeding in bird colonies. Whale carcasses are also a significant resource for polar bears, and in some instances larger groups of bears may scavenge on them for up to a couple of years. Stable isotope and fatty acid analyses indicate that Svalbard bears now obtain a

larger proportion of their diet from terrestrial and coastal food sources than earlier. This does not mean that polar bears are becoming terrestrial animals. A polar bear population cannot persist without access to sea ice for at least part of the year. Even bears that spend long periods on land still depend on successful seal hunting to build sufficient fat reserves. Terrestrial food likely supplements, rather than replaces, the energy obtained from marine mammals. A polar bear feeding on eggs, berries, or occasional reindeer cannot energetically compensate for the loss of abundant seals over the long term.

Another important point is that responses to climate change often occur with time lags. Polar bears are long-lived mammals with high adult survival. Population declines may therefore emerge gradually, even when habitat changes are severe. Some demographic effects are already visible in the Barents Sea region. Denning patterns have changed, movement distances have increased, and more bears now spend extended periods on land. The northward shift of the ice edge may also eventually give access to areas with reduced ecosystem productivity because the new hunting areas emerge farther offshore, over deeper Arctic waters that generally support lower seal densities.

The recent findings from Svalbard therefore should not be interpreted as evidence that climate change is harmless for polar bears. Rather, they illustrate that biological responses can be more variable and regionally complex than simplified narratives sometimes suggest. Polar bears possess considerable behavioural flexibility, and some populations cope better than expected with changing conditions. Others are already experiencing substantial negative effects. This regional variation is increasingly recognized across the Arctic. In the Chukchi Sea north of Alaska and Russia, several studies have also reported relatively good body condition and reproduction despite sea ice decline, likely because prey availability remains high. In contrast, Western Hudson Bay and parts of the Southern Beaufort Sea have shown clearer negative demographic trends linked to longer ice-free seasons. Extrapolating results from one region to another can therefore be misleading.

Polar bears have nevertheless become powerful symbols in global climate change communication. This is understandable. They are charismatic apex predators living in one of the fastest-warming regions on Earth, and their dependence on sea ice makes them particularly vulnerable to environmental change. But the symbolism has occasionally simplified a far more nuanced ecological reality. The Arctic is not changing uniformly, and neither are polar bear populations. For scientists working in Svalbard, one of the most striking lessons from recent decades has been the importance of long-term monitoring. Many of the ecological changes now observed would have been impossible to document

without decades of capture-recapture work, satellite telemetry, and repeated field studies. Such long-term datasets are rare in Arctic ecosystems, but they are essential for understanding how wildlife responds to rapid environmental change. Other possible threats to polar bears may act independently of climate change and habitat loss, or interact with them.

Polar bears in Svalbard are exposed to a range of long-range transported pollutants, including persistent organic pollutants (POPs) such as PCBs, DDT-related compounds, brominated flame retardants, and per- and polyfluoroalkyl substances (PFAS, often called "forever chemicals"). These contaminants largely originate from industrial and agricultural regions far south of the Arctic and are transported northwards through atmospheric circulation and ocean currents before accumulating in Arctic ecosystems. Some pollutants also originate from local settlements or activities. Because polar bears are apex predators feeding mainly on seal blubber, pollutants *biomagnify* ("the tendency of pollutants to concentrate as they move from one trophic level to the next within a food web") and accumulate in their fat tissues. These substances may disrupt hormone systems, suppress immune function, impair reproduction, and affect neurological development, particularly in cubs exposed through the placenta and milk. However, substantial uncertainties remain regarding the long-term and combined effects of multiple pollutants, especially in interaction with climate-driven stressors such as sea ice loss and nutritional stress. Although the population-level consequences of contaminant exposure in Svalbard polar bears remain uncertain, continued loss of sea ice could increase nutritional stress in future years. In such situations, pollutants released from fat reserves into the bloodstream of already weakened bears may have greater negative consequences.

Another possible threat in a warmer climate is the northward spread of diseases, including pathogens introduced by species expanding their ranges. So far, polar bears generally appear to have few diseases. Ectoparasites are not seen in the wild, and the endoparasites that have been found are unlikely to have significant effects on survival in most cases. In recent years, avian influenza has had a major impact on wildlife in the Arctic. Although few fatal cases have been observed among mammals there, a polar bear died in Svalbard this year after feeding on the carcass of a walrus infected with the virus. In a warmer climate, polar bears may become increasingly vulnerable to emerging diseases, particularly if they are exposed to novel pathogens or disease variants to which they have not previously been exposed and against which they have not developed effective immune defences.

The future outlook for polar bears in Svalbard remains uncertain. At present, the region still supports productive marine ecosystems and substantial seal populations. Some bears appear able to exploit alternative food resources and adjust their movements and behaviour. However, climate models predict continued reduction in sea ice throughout the Barents Sea during coming decades. Longer ice-free seasons may eventually exceed the adaptive capacity even of the relatively flexible Barents Sea bears. The key question is whether behavioural flexibility and ecological opportunism can continue to compensate for the large-scale loss of the sea ice platform upon which their entire hunting strategy ultimately depends. No one yet knows the answer with certainty.

Interactions between humans and polar bears are also considered a possible threat in several Arctic areas, and may increase in the future with a warmer climate as bears use more time on land. Further, the peak season for tourism snowmobile excursions coincides with the most vulnerable period for species that depend on sea ice. To prevent the disturbance of these species, the Governor of Svalbard has since 2018 laid down temporary traffic regulations pertaining to the sea ice in several fjords on west Spitsbergen. From 1 January 2025, the traffic regulations became permanent following an amendment to the Regulations relating to motorized traffic in Svalbard. Under the strict prevailing regulations, where it is not legal to provoke bears in any way, and it is not allowed to approach bears closer than 500 or 300 meters depending on season, tourism is considered a minor threat.

What is already clear is that the story of polar bears in a warming Arctic is more complex than either optimism or pessimism alone can capture. In Svalbard, polar bears currently demonstrate both resilience and vulnerability[1] at the same time — a reminder that ecological responses to climate change are rarely simple, even for one of the Arctic's most iconic species. And what we may see in future years and decades is some populations still doing well, while others may be declining, and possibly moving toward extinction.

Jon AARS[2] for POLAR WATCH[3]

[1] At the Antarctic Treaty Consultative Meeting XLIV (Berlin, 2022), several Parties proposed designating the emperor penguin (*Aptenodytes forsteri*) as a Specially Protected Species (SPS) under the Environmental Protocol to the Antarctic Treaty. In response, China submitted a document (IP123) entitled *The Case of Polar Bears Conservation Informed by Climate Models and the Potential Similar Case of Emperor Penguin*, arguing that as polar bears appear to show resilience to climate change in the Arctic, emperor penguins were likely to do the same inn the Antarctic, and did not require SPS designation. The scientific sources cited in the paper were found to be unreliable. China has since consistently opposed proposals to designate the emperor penguin as an SPS. (Editor's note).

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[3] The opinions expressed in this article are the responsibility of the author.

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