Climate Change Impacts on Arctic Wildlife

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front cover image Polar bear on the Labrador Sea ice, off the coast of Canada
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this image Pack ice melting in the middle of June, beginning of the Arctic summer
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Introduction

The Arctic is located in the far north polar region of the planet. Floating pack ice (sea ice) over the Arctic Ocean is permanently frozen in the far north regions, and further south there is also one-year ice. The one-year sea ice provides a habitat and hunting ground for many Arctic animals. In the spring and summer this temporary sea ice retreats, and the animals move onto the land or move further north onto the permanent sea ice. Land areas within the Arctic region include northern areas of the Russian Federation, Canada, Alaska, Svalbard, Scandinavia and Greenland.

It is now very evident that the temperatures in the Arctic are warming due to climate change, with a resulting impact on sea ice. Over the past 100 years, average Arctic temperatures have increased at almost twice the global average rate (IPCC 2007). There has been a 10% to 15% decrease in the extent of sea ice in the spring and summer since the 1950s. Data from 2007 indicated that in March of that year, the Arctic sea ice covered nearly all of its long-term average extent. However, by September, sea ice covered only
4.3 million sq km, and 39% less than the 1979-2000 average (AMAP 2009). To put things into perspective, in 2008 it was reported by the Intergovernmental Panel on Climate Change (the IPCC) that sea ice loss in the Arctic is equal to the size of the States of Alaska, Texas and Washington combined Furthermore, research indicates that that sea ice thickness between 1958 and the 1990s decreased by about 40% (IPCC 2007).

An earlier break-up and melting of the Arctic sea ice in the spring and a later freeze up in winter leaves the sea unfrozen for a longer period of time. The shorter season of the temporary sea ice is now impacting on several species of Arctic animals – including polar bears and Arctic foxes, which need the sea ice to hunt, and walruses, which use sea ice as a resting and hunting platform. For polar bears, the reduction in sea ice is now considered to be a major threat to their survival in more southerly areas of the Arctic. Ice seals are also being badly affected, since they use the sea ice for raising their young and two seal species are now considered at risk of becoming endangered.

On land in Arctic areas, there are indications that this region is warming. At its margins, permafrost – defined as ground that has remained below the freezing point for at least two consecutive summers – is now thawing. There are changes in vegetation, and changes in the land temperatures are affecting lemming populations, with a possible knock-on effect on Arctic foxes in these regions.

The following set of short briefings shows that loss of sea ice habitat in the Arctic is already causing major problems for some Arctic species. This may well lead to population losses and even extinctions of marine mammal species in the future. A 2008 analysis of climate change in the Arctic noted that 'Prevention through reductions in greenhouse gas emissions appears to be the only approach that can ensure the long-term conservation of Arctic marine mammals and Arctic ecosystems as we know them' (Ragen et al. 2008).

image Polar bear in drifting and unconsolidated sea ice in Kane Basin, off Cape Clay, Greenland.
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Arctic wildlife briefings

Polar bears

The polar bear (*Ursus maritimus*) is the world's largest bear (WWF). Polar bears live on the ice-covered waters of the Arctic, relying almost entirely on the sea ice for their survival. Polar bears do not exist as one large population throughout the Arctic, but are distributed as 19 more-or-less isolated groups of bears called stocks or populations (NOAA 2011, Durner et al. 2009). They are found in Arctic areas of Canada, Greenland, mainland Norway, Russian Federation, Alaska, Svalbard and Jan-Mayen and on the ice surrounding the North Pole (Schliebe et al. 2008).

Polar bears do not occur in large numbers – a scientific paper published in 2006 estimated that the total number of polar bears in the Arctic was between 20,000 and 25,000 (Wigg 2008).

Females can breed when they reach maturity at four to five years old, males at eight to ten years old. The mother bears can give birth to one to three cubs, but the infant mortality rate is high and can exceed 70%. Only about one third of cubs reach the age of two (WWF undated). Thus the ability to replace individuals in the population is very limited and the population growth is extremely slow. A polar bear can live for 20 to 30 years, and this longevity helps to offset its low reproduction potential (NOAA 2011).

Although polar bears are found in low numbers in the far north up to the North Pole, their main habitat is the near-shore annual sea ice over the continental shelf, where their main prey – ringed seal and bearded seal – is abundant (Derocher 2008). The bears use the sea ice as a platform to travel, mate and hunt. Females from most polar bear populations use snow dens on land for giving birth to their cubs, but all polar bears are almost completely dependent on sea ice for their sustenance (Derocher et al. 2004).

However, due to major reductions of sea ice in the Arctic in the past few decades as a result of climate change, the polar bears very habitat and with it their survival is under threat. Bears are already facing poorer nutrition in some areas and are in poorer body condition. This is impacting on their survival and their cubbing.

In 2009, the IUCN Polar Bear Specialist Group (PBSG) cited climate change as the greatest challenge to the conservation of polar bears. Of the 19 bear populations, eight populations were declining, three were stable, one was increasing and for the remaining seven there was not enough information to determine their population status. Similarly, in 2008 the World Conservation Union (the IUCN) classified polar bears as 'Threatened'. 'Due to their long generation time and the current greater speed of global warming, it seems unlikely that polar bears will be able to adapt to the current warming trend in the Arctic. If climate trends continue, polar bears may become extirparated from most of their range within 100 years' (IUCN 2009).

Current impacts on polar bears

A change in temperature due to climate change in the 20th century has had profound effects on the Arctic sea ice. The quantity of sea ice normally varies annually from about 14 million sq km in March to about 7 million sq km in September. But from 1979 to 2006, the annual sea ice area decreased by about 3.2% per decade. The decrease was greater in summer than in winter and the extent of the decrease varied between different regions. Additionally, where the sea ice has not disappeared it has become significantly thinner (Wiig et al. 2008).

Hudson Bay Canada

The impact of the sea ice changes in the Arctic on polar bears has been studied in a several areas. An area where impacts are most telling is western Husdon Bay in Canada. Here, the sea ice break-up in spring is now occurring three weeks earlier than in 1979 (Wiig et al. 2008, Derocher 2008). Hudson Bay is frozen for about eight months of the year, a time when the bears can hunt for seals on the ice. When the ice melts in spring and the bears are forced to come ashore, they have to rely largely on the fat stores they have already accumulated for their survival and reproduction while on land. The bears here are being forced to come ashore earlier and have not gained the weight they would have done previously from hunting seals on the ice. They are then forced to spend a longer time on land where there is little food. Studies on bears in Hudson

Bay report declines in body condition, reproduction and survival. This has resulted in a 22% reduction in population size between 1987 and 2004 (Derocher 2008). This is primarily a result of the earlier melting sea ice, but unsustainable hunting of seals in the area by humans has aggravated the situation.

Professor Andrew Derocher is quoted in a 2010 publication on polar bears on this subject (Molnar et al. 2010) as saying 'There's been a gradual decline in the bears' body condition that dates to the 1980s, and we can now correlate that very nicely with the loss of sea ice in this ecosystem' (McCarthy 2010). Using data collected from this area and mathematical models, these scientists made predictions of the number of bears that could die from starvation due to further climate change.

One study reported that the earlier sea ice break-up in western Hudson Bay has not yet affected the survival of prime adult polar bears but has likely caused a decrease in the survival of juvenile, sub-adult and senescent polar bears in the region due to poorer nutrition (Regehr et al. 2007). Mother bears nurse their young cubs for two-and-a-half years, but less food for the mother may reduce milk production with negative consequences for cub growth and cub survival. Young bears are not as proficient in finding food as adult bears and are thus more vulnerable to the adverse conditions of reduced food availability (Molnar et al. 2010).

In October, the pregnant female bears build and enter dens on the land, where they give birth to and suckle their cubs. Their own energy and their milk for the initial period of lactation are provided only by their stores of fat accumulated during the previous hunting season. The problem arising from the sea ice early break-up means that females have reduced energy stores when they enter the dens to have their cubs. Declines in litter sizes are likely because less energy is available for supporting the pregnancy and lactation (Molnar et al. 2011).

In the early 1990s data indicated that 28% of energy-deprived pregnant polar bears in this area failed to have even a single cub. Using mathematical models, the scientists predicted that litter sizes will decrease further under the sea ice loss that has been predicted for the future. For example, if the spring ice break-up occurs one month earlier than in the 1990s, 40% to 73% of the pregnant female polar bears will not reproduce successfully. The scientists concluded that the western Hudson Bay population will probably not remain viable under predicted climate conditions.

Outside of western Hudson Bay, over one third of all polar bears live with similar patterns of feeding on the ice and fasting on land. It is suggested that these will also have declines in litter sizes in the future, although these would have to be calculated separately for each population (Molnar et al. 2011, Science Daily 2011).

Southern Beaufort Sea

The population of polar bears in the southern Beaufort Sea is also likely suffering as a result of poorer nutrition, because of reduced access to prey due to declining sea ice. The sea ice declines in this region in recent years have been among the greatest in the Arctic. In years with longer ice-free periods, polar bears have less time in the summer and autumn to hunt over the continental shelf. Instead, they spend more time on multi-year ice over Arctic basin waters or on land, and both of these habitats have less food availability than the annual sea ice. This means that, whether on land or on the multi-year ice, polar bears have less access to prey and likely start the winter in poorer nutritional condition (Regehr et al. 2010).

Two recently published studies on the population of polar bears in the southern Beaufort Sea looked at the body condition of the bears, their cubs and their survival (Regehr et al. 2010, Rode et al. 2010). Reductions in food supply can lead to reduced body weight and size and, in turn, this can lead to negative impacts on reproduction and on the survival of young bears. It is known that heavier females have larger litters and heavier/larger cubs are likely to have an increased chance or survival compared to smaller/lighter cubs. Research on the southern Beaufort polar bears found that the declines in sea ice between 1982 and 2006 corresponded to declines in most measures of polar bear size and body condition (Rode et al. 2010). Furthermore, smaller litter sizes and a reduction in cub weight were linked to years of lower availability to optimal sea ice. The scientists believe that reduced weight of mother bears due to less food availability is causing these negative impacts on reproduction. The results strongly suggest that declining sea ice is causing limits to nutrition of the bears, which results in their reduced body size, reduced litter size and weight, and reduced juvenile survival.

Another recent study on the Beaufort population of bears found that declines in adult polar bear survival was linked to longer annual ice-free periods over the continental shelf (Regehr et al. 2010). Survival of cubs also declined with the increasing duration of the ice-free period. The scientists proposed that the declining sea ice causes a reduction in survival of the bears, due to increasingly poorer nutrition.

image Polar bear with cub in the snow at Churchill Bay, Canada © Bernd Roemmelt / Greenpeace

Again, the study noted – as did the study on Hudson Bay bears – that the negative impacts of sea ice changes on polar bears, clearly an extinction risk, could be relevant to one third of the world's polar bears that exist in similar sea ice dynamics.

Changing sea ice conditions in the southern Beaufort Sea have affected the behaviour of seals which the bears eat. Normally, ringed seal pups are born under snow drifts and the polar bears can dig through this snow with relative ease to reach their prey. But between 2005 and 2008, seals appeared to be pupping under the ice because of altered sea ice conditions. Polar bears were seen trying to dig through ice up to 70cm thick trying to reach the young seals, their prey, a task much more difficult than digging in snow drifts and not normal hunting behaviour of polar bears. This could mean less availability to prey for the polar bears (Derocher 2008, Stirling et al. 2008).

Other regions

Changes in sea ice are impacting on denning behaviour of female polar bears in some regions. Pregnant polar bears make dens in autumn or early winter, give birth in mid-winter and nurture their young in the den until early spring. Most bears den on the land. In northern Alaska, bears build their dens either in coastal areas or on offshore drifting pack ice. A 2007 study found that the proportion of dens on the pack ice decreased from 62% in 1984-1985 to 37% in 1998-2004. Thus, more polar bears were denning on land instead of drifting ice. The study found that the main reason for the change could be explained by the changing quality of the pack ice, such that it was no longer so suitable for denning. There was a reduction in stable old ice and changes in the degree of consolidation of the rest of the ice. In addition, there has been a lengthening of the melt season.

Unfortunately, there may be a problem for bears denning on the land in this region in the future, if climate change continues. The females must be able to walk on the ice or swim to the land to reach the denning area. However, because the distance in autumn between the southern edge of the pack ice and the coastal areas is increasing with climate change, this distance may become too great for the pregnant females to cross (Fischbach et al. 2007). On Svalbard this may already be occurring. For instance, between 1994 and 2001 the number of denning sites on the most southern of the denning islands, Hopen, has varied from 0 to 35, and this was strongly correlated with the date the sea ice arrived the previous autumn. It is therefore possible that certain areas with suitable denning habitat will no longer be available to pregnant female bears in the future due to declines in the extent of the sea ice (Wiig et al. 2008).

There are now cases of bears using coastal habitats more in some regions due to sea ice changes and encounters of bears with human settlements are increasing. In Alaska, the southern Beaufort Sea and Chukchi populations of bears typically move from the offshore pack ice to the near-shore environment in autumn, where seals are more plentiful for hunting. But the autumn freeze-up has been delayed by one to two months during the past 15 years. The number of interactions between 'land-locked' polar bears and humans has increased.

A similar change in distribution of polar bears is reported to be occurring in the eastern Russian Arctic and eastern Canadian Arctic (Wiig et al. 2008). In addition, nutritionally stressed bears that are spending more time on land are encroaching on areas of human dwellings seeking food (Derocher 2008).

The future?

From the above discussion it is clear that polar bears are already suffering because of changes in sea ice as a result of climate change and their future is in jeopardy. Polar bears rely on the sea ice as habitat. In 2007, using this fact, a United States Geological Survey research team concluded that two thirds of the world's polar bear could disappear by 2050 if business as usual emissions of greenhouse gases continue. There is however more hope for the polar bears if we manage to curb greenhouse gas emissions. In a paper published in 2010, it has been shown using mathematical models, that if greenhouse gases are mitigated, then substantially more Arctic sea ice would be retained and polar bears could persist throughout this century in numbers greater than those predicted in the business as usual scenario (Amstrup et al. 2010).

image Polar bears wandering over the snow, Cape Churchill, Hudson Bay, Canada
© Bernd Roemmelt / Greenpeace

Walruses

In Arctic regions, the walrus (*Odobenus rosmarus*) inhabits the Bering and Chukchi Seas of Russia and Alaska, the Laptev Sea in the west and the western Beaufort Sea in the east (Chadwick & Fischbach 2008, Lowry et al. 2008). The walrus population recovered from a depleted state in 1950 and reached historical high levels in the 1980s. The Bering-Chukchi segment of the population was estimated at approximately 201,000 in 1990, but today the size of the population both here and in the Laptev Sea region is unknown (Lowry et al. 2008).

Male walruses reach about 3.6m in length and weigh 880-1,557kg; adult females are about 3m and 580-1,039kg. Walruses feed on the sea bed on clams, worms, snails and crabs and other bottom-dwelling creatures. Although walruses can dive to depths of 250m, they generally feed in shallow waters less than 80m deep over the continental shelf (Chadwick & Fischbach 2008).

Walruses spend most of their lives associated with sea ice and migrate with the ice as it expands and moves south in the winter and breaks up and retreats in the spring and summer. In winter, the ice is a platform for resting, feeding and breeding. During the spring and summer the male walruses remain mainly on land, whereas large numbers of the females with their calves stay on the ice, using it as a rafting platform for resting, feeding and nursing their young.

However, some females in the western Bering and Chukchi seas do stay on the land, although those in the eastern Bering and Chukchi seas remain mainly with the ice. For walruses on land, their prey may eventually become depleted, leading to their redistribution as they seek new feeding areas. For those walruses floating on sea ice, they use the ice as a platform to dive for food and the prevailing ocean currents continually carry them over new areas where new food sources are abundant (Robards et al. 2009).

Current threats to walruses in the Arctic

Over the past several decades the extent of Arctic summer sea ice has decreased. In the past few years, the areas over the Chuckchi Sea shelf was ice free from one week to as much as two-and-a-half months, whereas previously there was always some ice cover over this region. When the sea ice retreats to just the deep ocean basin, walruses must either continue to use the ice in deeper waters where there is little access to food, or move to the land. In 2007, there was no ice for about 80 days and several thousand walruses moved to shores in northwest Alaska that had never been used by walruses before. This retreat of the sea ice has caused problems for the walruses. During the autumn of 2007, herds of walruses had to move to land along the northern coast of Chukota because of retreating sea ice. Here, a few thousand deaths among the population were reported because of overcrowding and panic stampedes into the water (Chadwick & Fischbach 2008). Such mass congregations that can lead to violent stampedes are particularly dangerous for the young walruses.

Again in 2009, 130 walrus deaths were reported to occur southwest of Barrow, Alaska, due to walruses coming on land in large numbers because of the ice retreat (WWF 2009).

In 2009, 20,000 walruses congregated on the shore of Russia's Cape Schmidt. One scientist commented that if so many walruses congregate in one area it won't be long until their food source runs out (WWF 2009).

In recent years, sea ice retreated past the shelf break in the deep Arctic basin. Both researchers and hunters observed the poor body condition of females at their haul outs early in the autumn, and evidence of abandoned calves (Robards et al. 2009). One study reported at least nine walrus calves separated from adult females in waters up to 3,000m from July to August in 2004 in the Canada Basin of the Arctic (Cooper et al. 2006). Walruses are not normally observed in such deep waters because of the lack of food as they cannot dive to more than 250m. Normally, mother walruses invest considerable maternal care into raising their young and only very rarely separate from them. It is likely that there were many other abandoned calves during this time. It is possible that the abandoning of the calves had occurred due to the rapid retreat of sea ice at that time. The scientists commented that 'if, as a result of environmental changes in the Arctic, sea ice continues to decline in thickness and extent or if, as we observed here, seasonal sea ice retreat occurs rapidly, it is possible that female walruses will have difficultly nourishing themselves and caring for their young'.

It is clear that shrinking ice in the Arctic is already affecting the walrus. Continued reductions in sea ice are predicted to occur in the future that are likely to further impact on walrus populations. In February 2011, the walrus was added to the list of candidates for Endangered Species Act protection because of threats of shrinking sea ice. But, despite the fact that the Obama administration recognised extinction threats to the walrus due to the sea ice, the species was not put onto the list itself, which could have helped protect its status. Instead, the status will be reviewed annually (Environment News Service 2011).

image Walruses on icefloe, Chukchi Sea, USA

image Ringed seal in a melt pool on the front of the tongue of the Petermann glacier in Greenland
© Nick Cobbing / Greenpeace

Ice seals

The Arctic is home to several species of seals known as ice seals. These include ribbon seals, bearded seals, ringed seals, spotted seals, harp seals and hooded seals. Ice seals are reliant on the ice for rearing their young, moulting and resting, and the sea ice must be sufficiently stable for them to rear pups. There is currently great concern over the impact that reduced sea ice is having on these seals.

In December 2010, ringed seals and bearded seals were awarded protection by the Obama administration under the Endangered Species Act, after consideration by the National Oceanic and Atmospheric Administration (NOAA) (Centre for Biological Diversity 2010). NOAA's Fisheries Service found that ringed seals and bearded seals were at risk of becoming endangered species in the foreseeable future warranting a listing of threatened.

- For bearded seals, the loss of pack ice where they give birth to and nurse their pups threatens their ability to breed and is lowering their food supply on their shallow foraging grounds in the Bering Sea (NOAA 2010).
- Ringed seals live mainly in the high Arctic and are dependent on the sea ice for birthing and pup rearing, and resting. Ringed seals build lairs or snow dens on the sea ice for shelter and rearing of their young. Since the ice is melting earlier in the year than previously, pups are becoming separated prematurely from their mothers and dying because there is not enough ice and snow to complete their six week nursing period. Also, warmer spring temperatures cause the roofs of lairs to prematurely collapse leaving ringed seals without shelter and exposed to predators. Already in 2006-2007 many fjords on the west coast of Svalbard did not freeze at all for the first time in known history, and the seals could not breed here (IUCN 2009).

Results of a recent study showed that breeding habitats for harp seals had declined since records began in 1979 up to 2010 (Johnston et al. 2012). In the Gulf of St Lawrence Canadian Arctic in 2007, harp seals could not breed because the area was virtually devoid of sea ice. Already in 2002 about 75% of harp seals pups had died in this area because of lack of ice (Carillo-Rubio 2011). In 2010, scientists observed the lowest amount of sea ice on record off Canada's east coast with virtually no ice in the Gulf of St. Lawrence and off Newfoundland's east coast. This was devastating to the harp seals, because with no ice the mothers abort their pups in the water.

Ribbon seals number about 200,000 in Arctic waters. They depend on sea ice from March to June for having their pups, and moulting. There is concern that the loss of sea ice will have a negative impact on the seals and in 2007 the Centre for Biological Diversity petitioned the National Marine Fisheries Service to list the species as threatened under the endangered species act. However, after a review the ribbon seals were not listed as threatened but were given the status of a Species of Concern (NOAA 2009).

Bowhead whales

Bowhead whales (*Balaena mysticetus*) live in the Arctic and adjacent seas. Their range extends nearly all around the Arctic Circle. Physical barriers such as land and impassable ice are believed to have divided the bowheads into five separate populations (Fisheries and Oceans Canada 2011). Small populations occur in the Sea of Okhotsk, Davis Strait, Hudson Bay, and the offshore waters of Spitsbergen. These populations only have small numbers of whales numbering a few tens to a few hundreds of individuals. There is a fifth larger population, the Western Arctic stock, with approximately 10,000 bowhead whales (Alaska Marine Mammal Stock Assessments 2006). They live for 50 to 75 years, with some perhaps reaching 100 years of age (Fisheries and Oceans Canada 2011). All five stocks are listed as endangered by the World Conservation Union (Reilly et al. 2011).

Historically all bowhead whale populations were severely depleted by commercial hunting (Reilly et al. 2011). By the time commercial hunting ceased to occur, the whales were in very low numbers. However, their population has grown in more recent years. Today, the main threat facing these whales is loss of sea ice due to climate change. There has also been concern since the 1970s that disturbance from oil and gas exploration and extraction activities in the Arctic region might affect bowhead whales (Reilly et al. 2011).

Bowheads are well adapted to ice-covered waters although they also use open water habitats. As the ice melts in spring, the plankton blooms and provides and abundant food source for the whales together with small crustaceans such as krill (Higdon & Ferguson 2010). In winter, ice covered waters provide safe habitat for calving and rearing the young because it protects from killer whales, a predator of bowheads (Moore & Laidre 2006). Although earlier break-up of the ice in spring may be beneficial to the whales because of increased food abundance, the increased threat of killer whales as a result of a loss of protection by the sea ice could be a major threat facing bowhead whales as a result of climate change. However, there are no direct studies on this impact as yet. Another possible impact of climate change on the whales which is suggested by research is that the bowhead may not be able to adapt to ice free waters because the whales are heat intolerant. They have an extensive blubber layer and an increase in temperature and increased solar radiation may have negative effects (Higdon & Ferguson 2010).

Arctic foxes

The Arctic fox (*Alopex lagopus*) inhabits tundra regions throughout the Arctic. It is present in Alaska, Canada, Greenland, Iceland, Svalbard, Russia and Scandinavia. The foxes live in both inland tundra and coastal tundra (Fuglei & Ims 2008, IUCN 2009).

Foxes living in the inland tundra areas prey mainly on lemmings and voles. In years when lemmings are not abundant, the Arctic foxes are forced to live on other prey such as ptarmigan and geese, and scavenge on carrion of reindeer and musk ox. These inland foxes do not usually breed in years when lemming populations are low. Most only live for three to four years, although they have been found up to the age of 13 (Fuglei & Ims 2008, IUCN 2009).

Arctic foxes living in coastal regions where lemmings are not found, such as Iceland, West Greenland and Svalbard, rely more on seabirds and their eggs and chicks as a source of prey. Foxes in these areas are also known to hunt ringed seal pups on the sea ice, and to take fish. Some foxes follow polar bears on the sea ice in the winter and feed on the carrion they leave behind (Fuglei & Ims 2008, IUCN 2009).

In some areas, the Arctic foxes do not fall directly into the categories of inland or coastally dependent species but inhabit both types of region. For instance, in coastal tundra areas that have lemmings, Arctic foxes switch between lemmings and marine food sources (Fuglei & Ims 2008). Also, inland foxes that rely on lemmings may migrate periodically to coastal areas to hunt of the sea ice (Norén et al. 2011).

Scientists have proposed that there are now two major threats facing Arctic foxes due to a shrinking habitat as a consequence of climate change:

1. Foxes inhabiting the lower tundra regions are under threat because of a loss of habitat that is due to a predicted northwards movement of boreal forest with the warming temperatures. Arctic foxes cannot survive in this forest environment. As the vegetation changes with increasing temperatures this also means that lemming populations will likely decline and therefore impact on the fox's survival. Furthermore, red foxes are predicted to move northwards further threatening the Arctic fox survival because red foxes can kill Arctic foxes.
2. Foxes inhabiting more northerly areas which rely on sea ice could be threatened because of retreating sea ice which they use to travel long distances both to feed and to breed.

image Arctic fox

Impacts of the loss of tundra habitat

As temperatures warm, plants from more southerly regions are able to move and colonise regions further north. In this way it is predicted that boreal forests will move northwards into tundra regions. This will displace Arctic foxes because forest habitat is unsuitable for them.

Furthermore, warmer temperatures are likely to negatively impact on lemmings, the main prey of Arctic foxes. The lemming population cycle is dependent on long, cold and stable winters. But already there has been a tendency for warmer and more unstable winters with repeated freeze/thaw events. This causes ice-crusting, which makes it difficult for lemmings to forage for plants in the snow pack and on the ground (Fuglei & Ims 2008).

There may, however, be some benefits for the foxes from the warmer winters temporarily because the ice crusting prevents larger animals such as reindeer and musk ox from grazing. For example, the increased supply of carrion caused by this problem for reindeer populations in Svalbard has increased the breeding success of Arctic foxes there. In the longer term though, further increases in temperature will be expected to melt ice and make pastures more available for plant-eating mammals. This will also likely bring the movement northwards of the Arctic fox's rival, the red fox (Fuglei & Ims 2008).

In a narrow zone in the low Arctic tundra, red foxes and Arctic foxes live together in the same landscape, but recently there has been a northward expansion of red foxes into tundra regions. This is problematic for the Arctic foxes because the red fox is a superior hunter and so is a rival competitor. Further, the red fox will hunt both juvenile and adult Arctic foxes (Fuglei & Ims 2008). The encroachment of the red fox into more northerly habitats looks set to continue as the tundra warms (IUCN 2009). The problem has been investigated by some studies. For example:

- In Russia, red foxes have moved northwards. Scientists observed a red fox taking over a breeding den of an Arctic fox, which resulted in den abandonment by the Arctic fox. These observations support the view that direct interference with breeding dens by the red fox may cause movement of Arctic foxes away from the southern limits of the Arctic tundra in Russia (Rodnikova et al. 2011).
- In northern Alaska, at Pruhoe Bay, red foxes appear to becoming more numerous, and they have been filmed killing Arctic foxes (Pamperin 2006).
- The Arctic fox is classified by the World Conservation Union as critically endangered in Finland, Norway and Sweden. It currently appears to be extinct in Finland (WWF 2008). Conservationists say that Scandinavia's Arctic fox population, with fewer than 200 individuals remaining , now faces serious threat of extinction (Owen 2007). A major threat to these foxes is from the red fox which take over dens and kill Arctic foxes. The increase in red fox abundance is most likely a result of more tree cover due to climate change (WWF 2008). Culling of red foxes has been introduced in Arctic fox territories. (Owen 2007).
- A study in Finnmark, northern Norway was conducted to find out if there are links between the retreat of the Arctic fox in this southern edge of the Arctic and climate change (Killengreen et al. 2007). In areas where the Arctic fox has stopped breeding, the study found evidence of plants being abundant that would be expected with climate change. Furthermore, there were fox scats most likely from red foxes in the areas where Arctic foxes had ceased to breed. The authors of this report say that further studies on a larger scale are now needed to better elucidate the link between climate change, food webs and foxes.

In the course of time, with ongoing climate change, changes in the Arctic tundra environment may exclude the Arctic fox from large parts of the circumpolar tundra within a few decades. Its best hope for survival will be in the high Arctic islands (Fuglei & Ims 2008).

Impacts of changes in sea ice

Arctic foxes use the sea ice as habitat to hunt and travel. Migrating inland Arctic foxes and coastal Arctic foxes all travel on the sea ice to find food. They feed on the remains of kills left behind by polar bears and they hunt for ringed seal pups (Pamperin et al. 2008, Fuglei & Ims 2008). However, due to climate change the Arctic sea ice has declined in recent years and the timings of ice break-up and freeze-up have changed. This has already impacted on polar bear survival and so there is an inevitable knock-on effect for foxes scavenging on carrion left by the bears (Geffen et al. 2007). Ringed seals are also expected to decline due to climate change (IUCN 2009).
A reduction in prey for the Arctic fox as a result of declining sea ice will likely impact on their very survival in winter if prey on land is not sufficient.

image An Arctic fox pauses in the doorway of a cabin in Svalbard © Nick Cobbing / Greenpeace

Sea ice is very important for maintaining connections between Arctic fox populations (Norén et al. 2010). This connection means that fox populations are not isolated because they can travel and interbreed, which in turn maintains high genetic diversity and good fitness within the population (Fuglei & Ims 2008). The Arctic fox currently populates numerous islands in the Arctic Sea and the pack ice connects many such Arctic Sea islands to the mainland in winter months (Geffen et al. 2007). If the seasonal ice connection is lost as is predicted under continued climate change, the small isolated populations that remain on the islands will have a higher rate of inbreeding and lose genetic diversity (Geffen et al. 2007, Norén et al. 2010). This is obviously not favourable for maintaining a healthy population.

Sea ice is therefore important for the Arctic fox survival both as habitat and for maintaining good connections between populations and further loss will likely have negative impacts on the foxes.

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image Bearded seal in Kane Basin, on a patch of sea ice
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