



# FACTSHEET

## Effects of climate change on arctic ecosystems

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### Background

Scientists have devoted considerable attention to arctic ecosystems when investigating the effects of global warming. One of the main reasons for this is that the Arctic is expected to experience the most dramatic changes and at the same time undergo more rapid warming than any other biome on earth. Compared to other biomes, the Arctic is perceived as being relatively constant over time and is considered to have little resistance to climate change. For this reason the Arctic is particularly vulnerable to the relatively rapid, major climate changes that are being observed on earth today.

Arctic ecosystems are highly restricted by low temperatures and permafrost. Huge quantities of carbon have accumulated in the soil in the form of frozen or buried organic deposits. Scientists believe that these layers of organic materials are a potential source of major emissions of the greenhouse gases carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>). If the permafrost melts, these organic materials will break down more rapidly and there will be dramatic increases in emissions of carbon dioxide and methane. This is one example of a so-called “positive feedback effect” where a warmer climate leads to increased emissions of greenhouse gases, further reinforcing the greenhouse effect. Arctic warming has already resulted in an increase in net emissions of carbon dioxide and methane and is contributing to increasing atmospheric concentrations of carbon.



The Arctic, showing the minimum extent of sea ice in 1979 (top) and in 2005 (bottom). This reduction has accelerated in recent years. In September 2007, the sea ice cover was 1.2 million km<sup>2</sup> smaller than in 2005. (Photos courtesy of NASA.)



Inland ice and glacier arms protruding into the sea  
© Christian PEDERSEN

## Arctic vegetation

The dominant plant species that constitute arctic vegetation are very different from most other types of vegetation (apart from alpine vegetation) because these species are able to carry out their metabolic and reproductive processes just above or below 0°C. Permafrost levels in the Arctic have existed for thousands of years, covered by just a thin, active layer of soil that thaws every summer. Access to nutrients is limited due to the low temperatures and the thin layer of soil. Arctic plant species have adapted their access to nutrients and their growth to this thin but relatively constant soil. Climate change can alter several of the environmental factors to which arctic plant species have become adapted. An extended growth season, earlier snow-melting, altered precipitation patterns, deeper layers of soil and increased mineralisation and decomposition rates will all affect the productivity responses and phenological development of these plants.



Arctic landscape and glacier rivers  
© Christian PEDERSEN

As the arctic climate warms, it is likely that the tree line will move north. This will suppress the vegetation already growing there. However, it is not just the tree line that could change. The species composition of plant communities will also change. This could affect the animal species that are dependent on the plants that are disappearing, in favour of more southern species. This applies to arthropods such as insects and spiders, mammals and to some extent also birds. (For further information, see the factsheet on arctic vegetation.)

## Arctic animal life

Insect pollination is one of the results of evolution and long-term coexistence between insects and plants. Some of these symbiotic relationships are very strong and thus particularly vulnerable to climate change. For example, a warmer climate could result in earlier flowering, without the life cycle of the insects on which the plants are dependent undergoing a similar shift.



Svalbard poppy (*Papaver dahlianum*)  
© WWF-Canon / Miriam GEITZ

Early-flowering tundra plants constitute a group that would be particularly vulnerable, but little is known about the extent to which climate change would affect this vulnerable coexistence. At the same time, foreign species of insects coming from the south could suppress those insect species that have adapted to the current arctic climate.

Arctic mammals consist of predators and plant-eaters. For herbivores like reindeer, musk oxen, arctic hares and lemmings, the consequences of climate change are dependent on access to plant food. Increased plant production resulting from an extended growth season could be advantageous, but harder winters could make life tougher. Snow conditions are decisive for musk oxen and reindeer. The formation of ice-crusts on their grazing grounds could result in a lack of food and starvation.

The situation for predators such as arctic foxes, wolverines and wolves is dependent on access to herbivores. Arctic foxes are particularly dependent on lemming populations, and there are signs that

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years when lemmings are particularly abundant are less frequent due to climate change. With regard to other predators, humans are currently a greater threat than climate change. On the other hand, polar bears are dependent on the sea ice in order to hunt seals. The massive reduction in the extent of arctic sea ice coverage will limit access to seals and could rapidly result in polar bears experiencing survival problems. (For further information, see the factsheets on polar bears and reindeer.)

It is difficult to predict what will happen to birds. The main reason for this is that few birds stay in the Arctic for longer than three months per year. Their living conditions depend on what happens elsewhere. However, it is likely that the climatic changes underway in the Arctic will not exceed the adjustment capacity of the birds that nest there. Earlier snow-melting and increased summer temperatures will be beneficial for successful nesting.



Common guillemots (*Uria aalge*) on Bird Mountain in Svalbard, Norway. © WWF-Canon / Miriam GEITZ

On the other hand, further increases in cloud formation and greater precipitation will have a negative impact. However, the most serious consequences for migratory birds will probably depend on climate change in places outside the Arctic. For example, the weather conditions at their stop-over sites are extremely important because successful nesting is dependent on the condition of the birds when they arrive at their nesting areas. Their stop-over sites along the coast are at risk of disappearing due to rising sea levels, while similar

inland areas are under threat from an increased frequency of drought. (For further information, see the factsheet on migratory arctic birds.)

## Life in arctic seas

Fish stocks in the Arctic are dependent on algae blooms during the spring that provide food for small crustaceans and animal plankton. These in turn provide the basis for the enormous stocks of fish that live in arctic seas. Climate change would increase sea temperatures, a factor that is extremely important for the survival, spawning and distribution of young fish. Scientists anticipate that several species could migrate northwards, but it is not certain that they would be able to adapt to new areas due to the considerable variations that exist in respect of ocean depths and seabed conditions.

Furthermore, there are concerns that the nature of algae blooms along the ice edge could change as the ice retreats further inwards. Imbalances could also arise in respect of timing and locations that would be detrimental to fish stocks that are dependent on animal plankton for their food. (For further information, see the factsheet on arctic fish.)

The sea has a tremendous ability to absorb CO<sub>2</sub>, but this also results in a reduction in the pH of the sea which becomes more acidic. Ocean acidification has a detrimental effect on calcareous organisms such as coral reefs and crustaceans.

There are six different seal species that live in arctic waters (in addition to walrus that are a fully protected species). Climate change affects seals as the ice cover becomes increasingly reduced during the summer. Several seal species use the ice during their breeding season and when moulting. As ice melts, their habitat will become considerably reduced. It is possible that whales living in the Arctic might benefit slightly from increasing temperatures and a reduction in ice because this would serve to extend their habitat. However, even this is not certain.

Attempts during recent years to chart environmental toxins have revealed high levels of toxicity in arctic sea mammals. These toxins are stored in the fatty tissue and are transferred from small animal plankton to fish and then onwards to sea mammals and sea birds. Environmental toxins affect the reproductive abilities of animals. Recent research shows that climate change can potentially alter the transport of pollution to polar areas and exert an even greater burden in the form of environmental toxins on the arctic ecosystem. As climate change warms arctic waters, higher temperatures can increase the uptake of toxins in marine organisms.



Walrus (*Odobenus rosmarus*), Svalbard, Norway.  
© WWF-Canon / Wim VAN PASSEL

## Conclusion

A warmer climate will have a major impact on the Arctic and result in major changes for plant and animal species. Melting permafrost will cause large quantities of methane and carbon dioxide to be released, boosting global temperatures already on the rise. There will be major changes in the composition of plant communities. Southern plant species will migrate northwards and suppress existing plants, affecting the species that depend on them. Insects responsible for pollination are one example of the coexistence that will be threatened. Changes in access to nutritious plants (both in time and space) will be decisive for herbivores such as musk oxen and reindeer. Changes in the success of birds' nesting patterns will be decisive for how migratory birds cope with climate change. The future for fish stocks depends on sea temperatures and algae blooms that are an essential source of food. Arctic waters will become more acidic as CO<sub>2</sub> uptake increases, negatively affecting calcareous organisms. Retreating sea ice is a major threat to most seal species and walrus. These predictions aside, scientists cannot describe exactly how climate change will affect the Arctic. We will only obtain precise knowledge about climate change effects as they occur, by which time it will be too late. Only immediate cuts in greenhouse gas emissions can prevent catastrophic and irreversible change, so action is required now.

This factsheet and others in a series related to climate change impacts on the arctic environment were made possible through the generous support of NorACIA. The factsheet series can be found on the Internet at: <http://www.panda.org/arctic>



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