FACTSHEET

Effects of climate change on arctic fish

Background

The Arctic is home to several of the world's largest fish stocks that support valuable commercial fisheries. The vast stocks of Pacific salmon along the costs of Alaska and Canada are well-known from pictures of bears fishing for salmon in fast-flowing rivers. Salmon is also an extremely valuable species of fish in both North America and Russia. Another well-known arctic species is Atlantic cod. The world's last, largest cod stocks are today found in the Barents Sea, living in an ecosystem where they are completely dependent on the availability of capelin and herring for their food. Pollock is another species of white fish belonging to the largest fish stocks in the Bering Sea between Alaska and Russia.

All the fish stocks mentioned above are the target for what are often intensive, industrial fishing operations. Other common species that are fished include halibut, coley, redfish, haddock, king crab, snow crab and Pacific cod.

A wide range of fish species is found in the Arctic, but naturally we are most knowledgeable about the commercially important ones. The deepwater species are less well known and these include the roundnose grenadier and the roughhead grenadier, as well as the Greenland shark - a carnivore that can grow to a length of almost 10 metres and that lives along the edge of the ice in arctic waters.

Arctic lakes and rivers also hold an abundance of fish, but there are relatively few species that live in fresh water containing few nutrients and often under extreme ice and temperature conditions. Char is often referred to as the Arctic's gold fish and it is common in lakes and fjords.

Salmon in the Arctic

Climate change presents a new threat to wild Atlantic salmon living throughout the northern Atlantic. Many salmon stocks on the east coast of the US and Canada have already been decimated, but there are still viable stocks in Norway, Russia and Iceland. Warmer temperatures can be an added stress factor on top of existing problems caused by pollution, HEP developments, escaped farmed salmon, the salmon parasites *Gyrodactylus salaris,* and salmon lice.

Unlike the effects of the aforementioned threats to wild salmon, we know less about the importance of climate change. However, research indicates that warmer temperatures can result in reduced salmon growth rates and survival. A reduction in the ice cover on waterways during the winter can have a highly detrimental effect on the welfare of salmon, particularly in the north.

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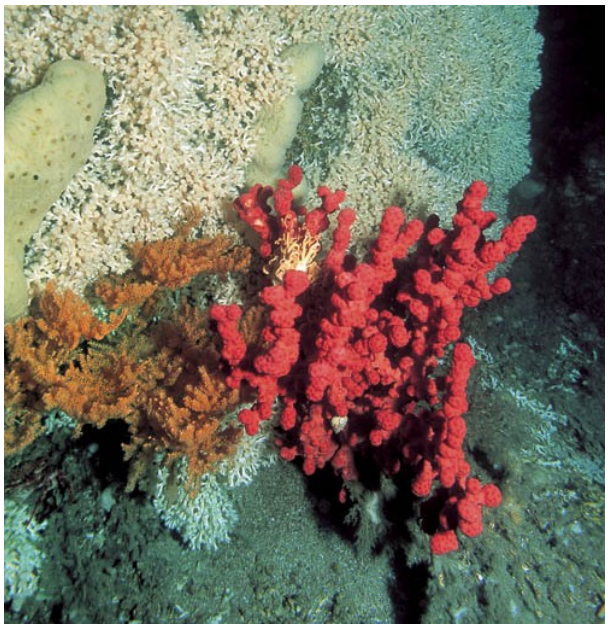
Furthermore, increased precipitation and warmer water can result in rivers becoming more clogged up and increased drainage into rivers, thus creating less beneficial conditions for wild salmon. Higher sea temperatures can have a major impact on the prevalence of salmon lice and can result in such lice thriving much better in northern waters in the future.

Ocean acidification killing coral reefs

Greenhouse gas emissions can result in dramatic consequences in the sea that are not just linked to water temperatures, but also to the chemical properties of sea water. When the atmosphere contains more CO_2, the sea will absorb more carbon and more carboxylic acid will form. This will result in a lower pH (i.e., more acidic water). In a worst-case scenario, the pH level of the sea could become the lowest it has been for 50 million years. More acidic sea water will alter the living conditions of all species in the sea, both directly and indirectly. Those worst affected would probably be calcareous organisms such as corals, certain species of plankton and crustaceans. The acidic water would cause calcareous shells to develop at a slower rate or not at all. Norway has the world's largest cold-water coral reef off Røst near the Lofoten islands. There is often a considerable diversity of species living around coral reefs, and other species could be affected if these reefs slowly disintegrate due to ocean acidification.



Corals along the Norwegian coast *(Lophelia)*
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Plankton species are essential for the ecosystems in arctic seas and they can suffer considerably from both more acidic seas and warmer temperatures because they have calcareous shells. One example in the North Sea is *Calanus finmarchicus*, which is suffering a decline, and it is assumed that the main reason for this is warmer temperatures. If many calcareous organisms are pushed to extinction due to lower pH levels, the structures of large marine ecosystems could change and the consequences could be enormous.

Disturbances in a vulnerable ecosystem

The arctic ecosystem is characterised by species that are specially adapted to extreme environments. Unlike other ecosystems, the Arctic has relatively few species, but conversely it has large quantities of each species. Plankton blooms along the ice edge and in arctic seas during the spring provide food for billions of fish and fish larvae that in turn sustain larger species of fish such as cod, coley, haddock and pollock.

Annual stocks of a given species are largely determined by how well the spawning season corresponds with access to food by young fish. The risk of so-called "mismatch" effects is the most serious and frightening aspect of climate change. Put in simple terms, it means that interdependent natural processes fail to coincide. For example, the failure of algae blooms to occur at the right time along the ice edge during the spring could result in a lack of important food for animal plankton such as *Calanus finmarchicus*. This could result in the disappearance of basic food for small species of fish such as capelin and herring, negatively impacting the entire ecosystem.

Scientists believe that climate change could affect the Arctic by altering the speed and pattern of ocean currents that could in turn affect fish stocks. Changes in the speed and direction of ocean currents would affect access to nutrients and the distribution of larvae and growing organisms. This would affect stock recruitment, growth and mortality.

Temperature is one of the most important factors determining the extent of large fish stocks and their access to food and spawning areas. Most species and stocks only thrive under specific temperature conditions. Major migrations or substantial changes in stock sizes are often directly related to changes in sea temperatures.

Thawing ice produces sea changes

The huge decline in perennial ice in arctic seas would probably have an extremely negative effect on the microscopic life forms that are associated with the ice since their habitat would literally melt away. The Bering Sea and Hudson Bay in Canada are included among those areas that would suffer most from such changes (i.e., areas in the southern Arctic where the ice is already disappearing earlier during the spring and returning later in the autumn).

Research has already shown that melting ice has created a 30 metre thick layer of fairly fresh water beneath what is left of the ice. This water is one-third deeper that it was 20 years ago.

As the Arctic gradually warms, the sea ice will melt faster and over greater areas of the continental shelf during the spring and extend towards the deep sea in the central Arctic. Moderate warming would result in better access to food for species such as cod and herring because higher temperatures and less ice would probably result in higher productivity of their prey. However, since the Arctic is experiencing the strongest and fastest warming on the globe, these temperature increases would no longer be moderate ones, and there are no guarantees that warmer arctic seas - with depths of up to 4,000 metres - would be a suitable habitat for demersal fish such as cod.

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Stocks depleted by overfishing

Overfishing is currently a major problem for many fish species, and the depletion of Canadian cod stocks due to overfishing during the early 1990s is an alarming example of how wrong things can go when overfishing occurs. These stocks suffered a total collapse. Today fishing in the northeast Atlantic is still banned, and there are signs that the cod are starting to return. Other species in the Arctic are also suffering from overfishing - both Barents cod and Bering pollock are suffering from comprehensive illegal fishing activities in addition to severe pressure on the fish.

Cod drying on racks in Henningsvær, Lofoten, Norway

Conclusion

Climate change will be an added factor along with the threats that already apply to fish stocks. Sturdy fish stocks that have not been depleted by overfishing or pollution threats will serve as the best insurance we can have as climate change impacts become more prevalent.

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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