GBA Series: 5

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Arctic Biodiversity

Globally Linked

The Arctic is linked through:

- Oceanic Currents
- Air Currents (including the Jet Stream)
- Bird Migration Routes
- Cetacean Migration Paths
- Fish Stock Ranges

Global Biodiversity Agenda

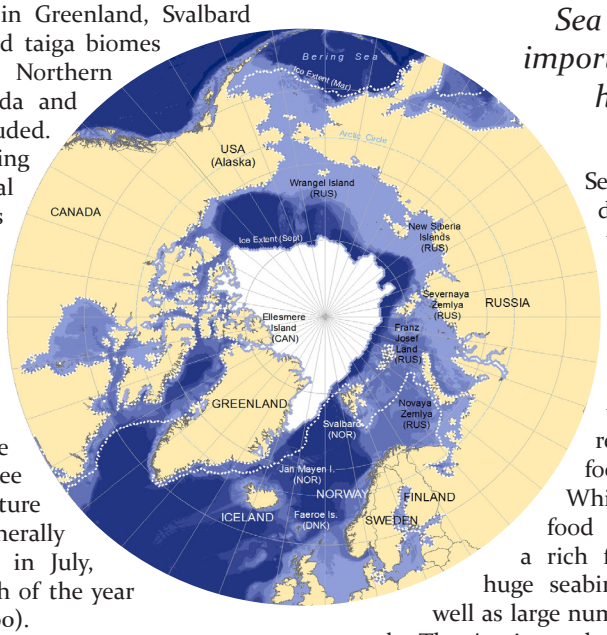
The Last Frontier

The Arctic is one of the last frontiers of wilderness and exploration, scientifically and for natural mineral resources. The Arctic region plays a key role in the physical, chemical and biological balance of the globe. Arctic environments are considered the most pristine on earth and, within these relatively untouched areas, the indirect impacts of humans in terms of climate and pollutants can be assessed and distinguished from the effects of direct impacts. Therefore the Arctic serves as an ideal global barometer in monitoring changes in biodiversity, climate and the impacts of humans.

Arctic marine ecosystems are influenced by changes in the global flux of water, air, nutrients but also pollutants. The Arctic Ocean is fed by warmer waters and nutrients of the Atlantic and Pacific Oceans and also directly influence marine ecosystems of the Atlantic Ocean as waters and sea ice exiting the Arctic Ocean affect the physical, chemical and biological characteristics of the North Atlantic. The Arctic seas are connected with almost every corner of the globe through the annual migration of birds and marine mammals.

Habitats

Most of the Arctic consists of the marine environment with the only terrestrial component being the coastal margins of the Arctic Ocean in Greenland, Svalbard and the tundra and taiga biomes of Arctic Russia, Northern Scandinavia, Canada and Alaska are included. Often, the Bering Sea and its coastal tundra ecosystems are also considered to be part of the Arctic. The exact definition of the arctic varies. From an ecological perspective it is often defined as the land north of the tree line, the temperature of which is generally below about 10°C in July, the warmest month of the year (Jonasson *et al.* 2000).



Sea ice is an important Arctic habitat

The terrestrial areas are composed of tundra, a treeless habitat with low growing vegetation such as lichen. Vast Arctic tundra wetlands are created by the freshwater lakes and pools, perched on impermeable permafrost soil, making up about 70% of the terrestrial area.

Sea ice supports microbial communities which are important primary producers. Sea ice cover and daylight drive the primary and secondary production in the marine environment, creating the basis for relatively simple food chains. While simple, these food chains support a rich fish fauna and huge seabird colonies, as well as large numbers of marine mammals. The Arctic tundra is home for a short period of 2-3 summer months to huge numbers of migratory waterbirds, taking advantage of 24 hour summer daylight, feeding on huge amounts of mosquitoes and other insects such as craneflies.

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Climate Change

Climate change, habitat fragmentation, contaminants and industrial development were highlighted by the Arctic Biodiversity assessment as the most far reaching and significant stressors on Arctic Biodiversity.

Climate change is the most significant threat to biodiversity and it exacerbates all other threats

The warming in the Arctic is about twice the global level. This is due to a shallower atmosphere at high latitudes which means more of the trapped energy goes directly into warming rather than evaporation.

A variety of positive feedback responses accelerate the warming process. For example, as snow and ice melt, and as particles of black carbon (soot) settle on white surfaces, the land and ocean becomes darker. These dark areas absorbs more solar energy than the reflective white snow and ice thus further increasing warming and snow melt. Finally heat is also transported to the Arctic by the atmosphere and waters, so alterations in their patterns can also increase Arctic warming.

Northern permafrost regions contain approximately 1.5 trillion tones of carbon, equivalent to half the CO_2 in the entire atmosphere

(Tarnocai *et al.* 2009)

Arctic peatlands on tundra soils have formed over millennia and have stored vast amounts of carbon. The huge carbon sinks have several global repercussions. Of particular concern is the thawing of permafrost soils which has the potential to release carbon stored thousands of years ago (Walter *et al.* 2007, Abnizova *et al.* 2012).

A recent modelling study highlighted that up to 500 billion tonnes of carbon could be released from permafrost thawing by the end of this century, contributing to global temperature increase by 0.8 degrees (MacDougal *et al.* 2012).

The Arctic contains considerable freshwater reserves in the Greenland ice sheet, huge rivers and glaciers. Since 1980 an acceleration of river discharge into the Arctic Ocean has been observed which alongside the thawing of the Greenland Ice sheet, contributes additional freshwater to the Arctic Ocean. The additional freshwater could potentially lead to major shifts in Ocean currents and global weather systems by altering the thermohaline circulation* (THC). It is also estimated that the melting ice sheets in the Arctic could alone contribute to an approximately 5cm sea level rise (IPCC 2007).

**themohaline circulation: large-scale density-driven circulation in the ocean, caused by differences in temperature and salinity (IPCC 2007).*

Picture above shows black carbon (soot) deposits on snow which lowers reflectivity and causes increased melting of snow and ice.

Global Repercussions of Arctic Warming

There is increasing evidence that rapid Arctic warming is already shifting weather patterns and causing extreme weather events at lower latitudes (AMAP 2011, Francis & Vavrus 2012).

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Arctic warming is changing weather patterns in the northern hemisphere

As the Arctic is warming faster than regions further south, the difference in temperature between the Arctic and mid-latitudes is getting smaller.

The jet stream, steers weather systems from west to east around the northern hemisphere (Francis & Vavrus 2012).

The jet stream has slowed by 14% since 1980

A slower jet stream is resulting in weather systems lingering, creating "blocking" formations that result in more intense and longer periods of rainfall, drought, summer heat waves and winter cold snaps (Francis & Vavrus 2012, Hanna *et al.* 2012).

The consequences for Arctic biodiversity can be dramatic for marine species, such as seals, walruses, polar bear and others as the sea ice they rely on for rest, access to hunting grounds and food sources is diminished.

There has been an increase in the production of green plants by 20% since 1982 (Epstein *et al.* 2012), which leads to changes in the tundra habitat, increasing bushes and tree growth and the loss of lichen and other typical tundra plants. These tundra habitats are crucial for reindeer and the nesting of migratory waterbirds among other species.

Red knot nesting in low growing lichen

Local People and Threats

Approximately four million people live in the Arctic, about half of them in Russia; like the Chukchi fisherman, pictured (SDWG 2004). A tenth of the population comprises indigenous peoples. Almost all pursue either a nomadic lifestyle in reindeer herding or hunting sea mammals and fishing. Indigenous people are highly dependent on the integrity of coastal and tundra ecosystems.

Indigenous people are faced with numerous threats especially the exposure to concentrated pollutants, sea-ice reduction and, habitat fragmentation faced by the species on which they rely.

The Arctic environments do not allow cultivation of vegetables and therefore, with increasing latitudes, the proportion of meat in the diet is increasing to almost 100%, a fact

that is also mirrored in many wild mammals (Chernov 1985). The high meat diet brings with it risks including the increasing issues of chemical bioaccumulation as pollutants become concentrated at the top of the food chain (AMAP 2009).

Climate change is an ongoing issue for indigenous populations. The changing weather patterns and temperatures are affecting the land and sea on which they live. The melting of ice, and defrosting of permafrost, is causing transportation difficulties as the ground becomes dangerously soft reducing access to hunting areas. Temperature changes are also causing the movement of the fish or crustacean ranges away from the local areas. This results in longer journeys or migration of human communities as they follow their food.

Permafrost

Permafrost is permanently ground; soil, rock and ice (TAGA 2013). Permanently means the ground is below 0°C for more than two years. However, most permafrost was formed thousands of years ago (IPA 2013).

The Arctic Ocean is the only marine area with subsea permafrost. This formed in the last ice age, more than 11,000 year ago when the land below the Arctic Ocean was not covered by water (NSIDC 2013).

The ancient nature of some permafrost means that it stores historic biological information about the planet, including remains of extinct species such as mammoths (Stone, 1999).

Permafrost in Siberia has been found to contain the oldest authenticated ancient DNA sequence. The plant DNA was frozen 400,000 year ago (Willerslev *et al.*, 2003).

Fisheries and the Effect of Climate Change

Economic sectors in the Arctic include fisheries, extractive industries, tourism and logistics (including shipping). The first two primary industries based on natural resource extraction currently dominate (Lloyds 2012).

Fisheries are one of the four key economic sectors working in the Arctic

The oil, gas, mining and shipping industries are projected to be the biggest drivers and beneficiaries of Arctic economic development (Lloyds 2012). However, fisheries can be more important to local economies because they have higher participation rates and support higher levels of employment and residential income (Glomsrød & Aslaksen 2009). Commercial Arctic fisheries are found in the productive Barents, Bering, Norwegian and Greenland Seas and around Iceland, harvesting millions of tones of fishes annually, for an economic value reaching billions of US dollars (CAFF 2013). Regionally fisheries can be very important, for example fish generates 90% of Greenland's export earnings (Lloyds 2012).

Climate change is likely to have a huge effect on fisheries. The reduction in sea ice means a larger fishing area which could result in greater pressures on the stocks. The number of voyages by fishing vessels in the Canadian Arctic increased sevenfold between 2005 and 2010.

Temperature changes, and warmer waters, may see a boom in fish populations in the Arctic. One modelling study projects that, by 2055, fish catches in high latitudes, including the Arctic, could increase by 30-70 per cent. However this increase is likely to be offset by decreases of potentially 40% in tropical catches (Cheung *et al.* 2010). In addition, cold water specialists may become commercially extinct with the change in habitat. Some species are already shifting northwards in response to changing ecological conditions (Meier *et al.* 2011).

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Migratory Species

For most of the Arctic species the Arctic winter is too harsh to survive. Only a few species (<10%) stay for the entire year. The majority of the vertebrates are migratory. This not only refers to over 400 bird species, but also to many fish and mammals, including most of the whale species and the reindeer.

An estimated 2 billion birds are involved in the annual spring and autumn migration to and from the Arctic.

Of these 2 billion, 153 water bird species alone contribute 125 million individuals, migrating to and from the Arctic every year (Zöckler 2012). The Arctic is the origin of all major global migration flyways, connecting almost all corners of the world through migration routes.

As most birds usually have to stop over on their migration, the protection of these stop over sites is crucial in the conservation of Arctic species. International Conventions such as the Bonn Convention on Migratory Species (CMS) and its agreements, the African Eurasian Waterbird Agreement (AEWA) and the East Asian Australasian Flyway Partnership (EAAFP), have been put in place to provide conservation cooperation at international flyway level.

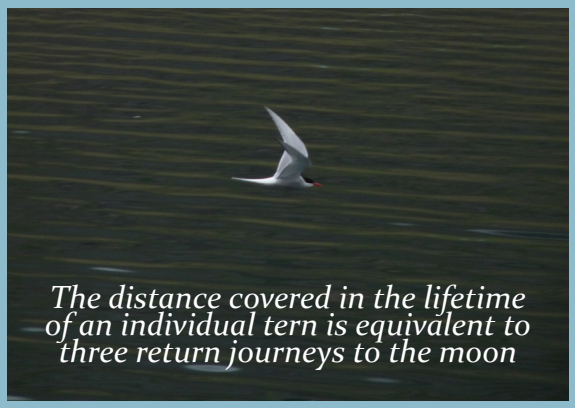
Migratory mammals in the Arctic include Humpback Whales which winter in tropical waters to reproduce but migrate to the food rich Arctic waters to fatten up in summer

Most marine mammals migrate, some covering thousands of miles. The Arctic draws migratory marine mammals because of its high seasonal productivity which often results in spatially concentrated areas of food. The coastlines, ice margins and river deltas and offshore river plumes provide particularly important feeding locations and attract large concentrations of marine mammals.

The coastal zones are a particular focus for development, both for extractive activity and human settlement and transportation infrastructure. These areas could become key conflict zones and thus have been highlighted as areas where conservation activity needs to be focused in order to avoid harm to marine ecosystem services while managing development. Underwater acoustic pollution is one area which requires management (CAFF 2013).

Arctic Tern Migration

A famous example of long range migration is the annual journey of the Arctic Terns (*Sterna paradisea)*. These birds probably experience more sunlight than any other creature on earth as they spend the boreal summer breeding in the Arctic and then fly to the Antarctic for the austral summer, traversing more than 80,000 km on their round trip (Egevang *et al*., 2010).



The critically endangered spoon-billed sandpiper, which nests in Siberia, is the only species of bird which hatches complete with a spoon shaped beak (Donald *et al*. 2010). This species migrates down the east Asian-Australasian flyway where threats include hunting.

For full document references see: www.proteuspartners.org

Except where identified all photos from Christoph Zöckler

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Date of Publication July 2013

UNEP WCMC