INDICATOR
#14 Arctic peatlands

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Wetlands are widely distributed in the Arctic, covering about 70% of the region. Of the six Ramsar[1] wetland types represented, the most extensive are forested and non-forested peatlands (Figure 14.1). Peatlands are wetlands where organic matter (peat) derived from dead and decaying plant material has accumulated and remains stored under conditions of permanent water saturation. Those which still have peat-forming vegetation are known as mires, and can be divided into fens (minerotrophic) and bogs (ombrotrophic) on the basis of nutrient status, which is closely related to the quality of the water supply. Freeze-thaw processes play a key role in the development and maintenance of these peatlands by shaping the surface of the landscape, and the types that are exclusive to the Arctic – most notably polygon mires and palsa mires – are associated with permafrost.

Polygon mires are characterized by regular surface depressions surrounded by low ridges ("bolsters"), each with a central crack, and all three of these landscape elements have different characteristic vegetation (Figure 14.2). They occur mostly at the northern edge of North America and in the eastern part of the Eurasian Arctic, and account for 5.6% of the peatland area within the Russian Federation [1].

Palsa mires are complexes of flat, very wet minerotrophic mire and frozen peat mounds with mineral cores and ombrotrophic vegetation (Figure 14.3). They account for 14.6% of the peatland area of Russia [1], where they are also known as "bugristaya" or mounded/patchy tundra; in Canada and Alaska, they are called "pingos". In Siberia, palsa mires occur well south (to 55° N) of the modern permafrost limit, their ice cores having persisted through warm paleoclimatic periods because they are thermally insulated by layers of dry peat.

1. The Ramsar Convention on Wetlands' defininition of wetlands includes ecosystems typical of the Arctic: shallow lakes, rivers and deltas, coastal marshes, shallow sea waters, and non-forested and forested peatlands.

Other Arctic peatland types are the so-called "alases", which are thermokarst lakes undergoing terrestrialization, most typically in eastern Siberia; and various combinations of sedge and forested fens in valleys and on floodplains. Finally, a range of ecosystem types is combined under the name "shallow peat tundra".

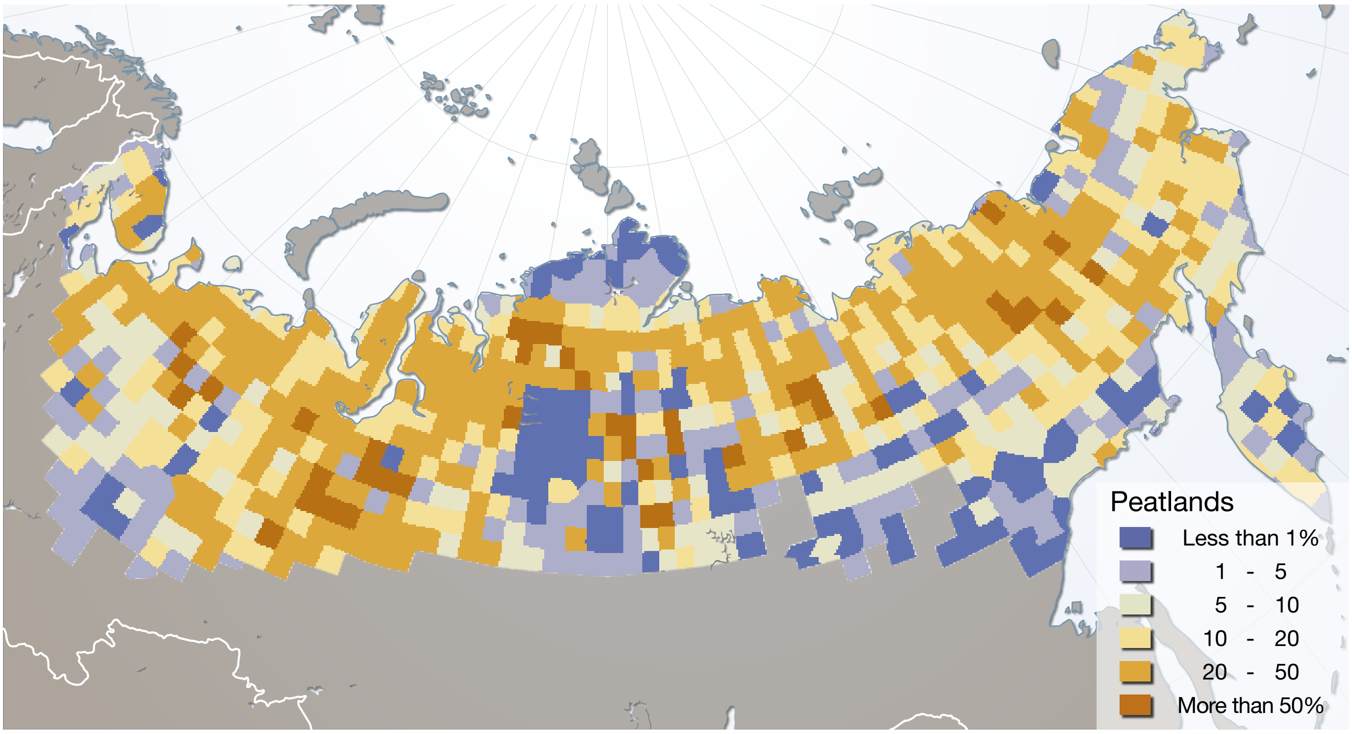

Figure 14.1: The proportion (%) of peatland within Arctic Russia, after [1].

Figure 14.2: Polygon mire photographed from the air **(A)** and from ground level **(B)** (Yakutia).

Population/ecosystem status and trends

Peatlands are significant for the floristic diversity of the Arctic because peatland species comprise 20–30% of the Arctic (e.g., Yamal Peninsula) and sub-Arctic (eg., Komi) flora [2]. Moreover, of the more than 60 bird species with conservation priority in the European Arctic, 75% are strongly associated with tundra and mire habitats. Indeed, Arctic peatlands – often referred to as 'the source of all flyways' – support biodiversity worldwide through bird migration routes. They also provide crucial ecosystem services such as habitat maintenance, permafrost protection, water regulation, greenhouse gas exchange, primary production, and accumulation of biomass.

Arctic peatlands are highly-integrated ecosystems which are extremely vulnerable to both natural and human-induced perturbations. Although their status has not yet been described comprehensively in the scientific literature, certain trends are clearly evident [2–4]. These are dominated by direct and indirect effects of climate change arising from global warming, which has multiple and sometimes subtle implications for Arctic peatlands.

Over recent years, the southern limit of permafrost in northern peatlands has retreated by 39 km on average and by as much as 200 km in some parts of Arctic Canada. Although regional warming by 1.32°C has accelerated permafrost thaw in northern Manitoba, Canada, these changes are not exclusively linked to temperature rise. The loss of permafrost in Quebec has been attributed to the insulating effect of increased snowfall since the late 1950s rather than to temperature, which did not

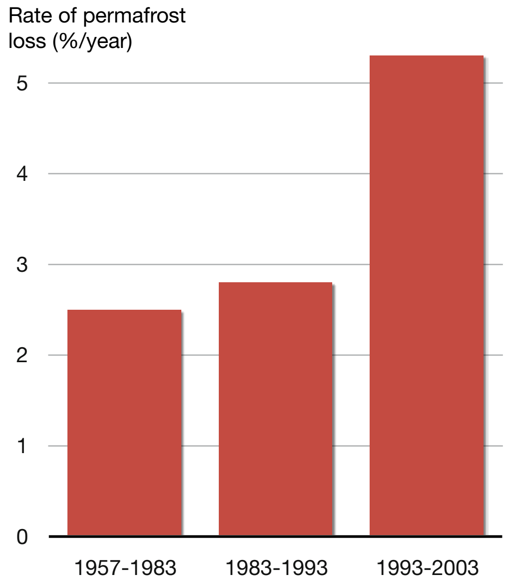

Figure 14.4: Permafrost decay rates for frozen peatlands in northern Quebec [5].

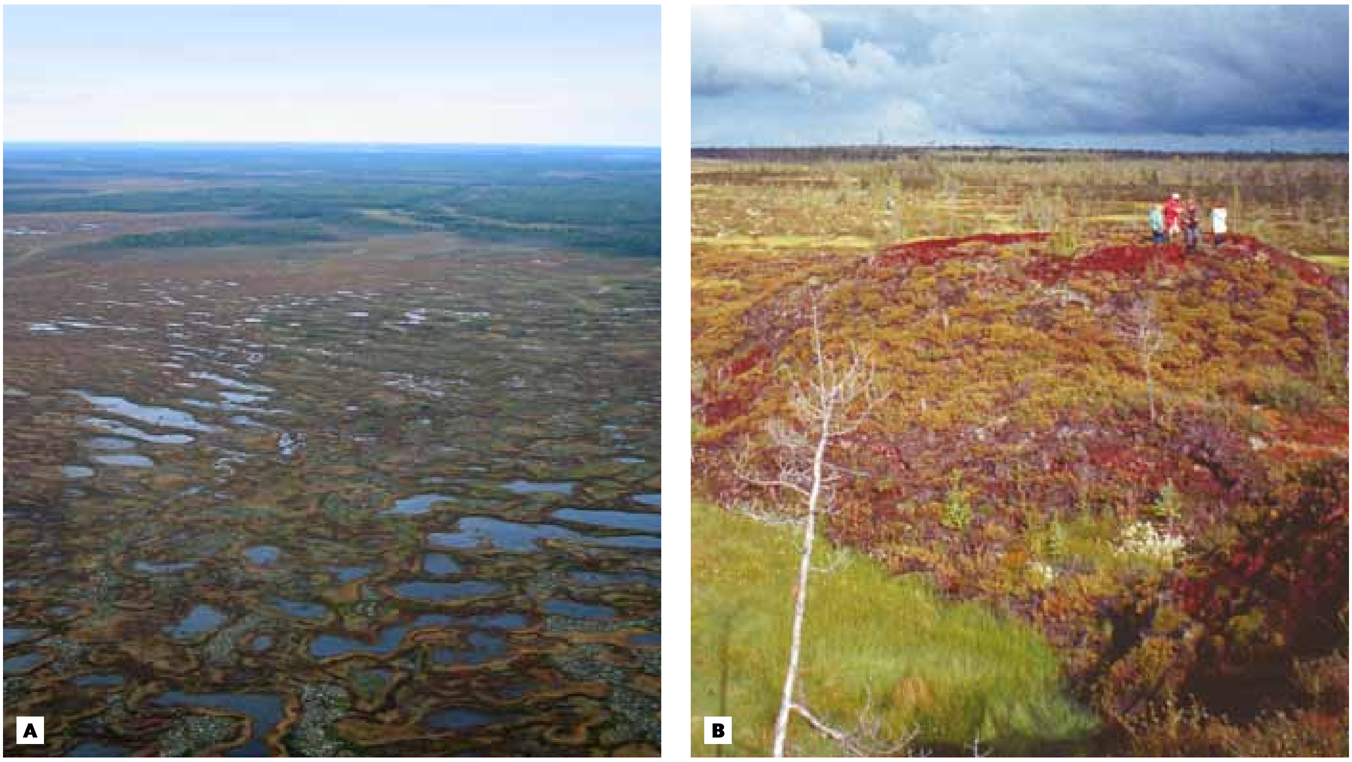

Figure 14.3: Palsa mire photographed from the air **(A)** and from ground level **(B)** (West Siberia).

rise until the late 1990s, and has been accompanied by new peat accumulation on thawed areas (paludification) and in thermokarst ponds (terrestrialization) (Figure 14.4). Thus, small changes in weather conditions can cause abrupt changes in the direction of peatland system development. The distinctive polygonal patterns and palsa mounds of permafrost peatlands can exist only where the ground is permanently frozen. The thicker snow cover of the progressively milder Arctic winters (with increased precipitation) already threatens the persistence of these remarkable peatland systems. Moreover, it is anticipated that trees and other boreal species will colonize Arctic peatlands as the northern treeline migrates to higher latitudes in response to rising summer temperatures [3, 4]. This will not only affect biodiversity but also reduce albedo (surface reflectivity), further enhancing warming of the atmosphere. In locations such as the high Arctic, where low temperatures currently limit primary production and thus peat growth, non-frozen peatlands are likely to expand in topographically suitable locations as temperature rises. Peatlands in floodplains and lake basins are particularly susceptible to the increasingly dynamic river flow regimes that are expected as the intensity of rainfall and droughts continues to increase. The biota of surface water bodies are in turn vulnerable to changes in the load of dissolved and/or particulate organic matter (DOC, POC) in drainage water from any peatlands within their catchments that are degrading, regardless of the cause.

Concerns for the future

Although the Ramsar Convention and the Convention on Biological Diversity have acknowledged that special action to conserve peatlands is urgently required [2, 6–8], they are still under-represented in conservation strategies and seldom recognized as specific targets for management.

The vast undisturbed peatlands of the Arctic and sub-Arctic zones are amongst the last remaining wilderness and natural resource areas of the world. Development in such areas often ignores the special hydrological and ecological characteristics that are central to the productivity of these areas.

Traditional uses of Arctic peatlands, such as grazing, hunting, and berry-picking were sustainable for many years, and even in the recent past were still largely within natural ecosystem capacity. Now, new technologies have provided the means to overcome the challenges presented by the harsh Arctic environment, leading to renewed development of the oil and gas industry and a supporting infrastructure for transport which significantly fragments the landscape and disrupts its hydrology. Even traditional land uses such as reindeer herding are being industrialized, and the increased human presence means that wild mammals and birds are increasingly threatened by recreational hunting [9]. Thus, there is a need to promote sustainable practices.

These impacts are superimposed on those of climate change, which alone is expected to transform Arctic peatlands through loss of permafrost. This will in turn reduce their ecosystem diversity and thus their biodiversity value, and create a positive feedback for climate change by releasing the greenhouse gas methane [2]. The resulting changes in peatland status will in turn restrict use of the land by the indigenous people who have traditionally depended on peatlands for food including herded reindeer, game, and fish.

Arctic ecosystems are characterized by low species diversity, and typical species are highly specialized and intimately linked to their habitats. The short growing season limits annual production and the ecological niche capacity of these species, so that communities have low resistance to disturbance and extremely limited potential for natural recovery. Thus, there is already a need for the development of restoration technologies for Arctic peatlands which, in order to be effective, must be designed specifically for permafrost systems.