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Module 10

Living Terrestrial Resources of the Arctic and Their Use

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Key Terms and Concepts

- terrestrial living resources
- vegetation zones of circumpolar Arctic
- treeline
- boreal forest, or taiga
- environmental impacts of agriculture and forestry in the Arctic
- reindeer herding
- terrestrial wildlife species
- lesotundra zone
- albedo
- carbon sink
- carbon cropping
- forest resources of the Arctic
- impacts of forestry
- agriculture and its impacts
- livestock husbandry
- reindeer husbandry
- terrestrial wildlife and hunting



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Learning Objectives

Upon completion of this module, you should be able to

1. describe the main vegetation zones of the circumpolar Arctic, and name the species of trees that form the treeline.
2. explain the various functions and uses of the boreal forest at global and regional levels.
3. describe briefly the main forest resource in each Arctic country and its economic significance.
4. explain different types of agriculture and the significance of each in the Arctic region.
5. discuss the main environmental impacts of agriculture and forestry in the Arctic, especially in the North Atlantic region.
6. identify the areas and indigenous peoples involved in reindeer herding in the Arctic, and discuss the significance of reindeer herding for these peoples.
7. name the main subspecies/herds of caribou and reindeer in the Arctic region and explain their significance as wildlife.
8. list other major terrestrial wildlife species in the Arctic and discuss their uses.

Reading Assignments

Bernes (1996), *The Nordic Arctic Environment—Unspoilt, Exploited, Polluted*. *Nord* 26: 101–128; read the chapters on agriculture and forestry.

Freese (2000), *The Consumptive Use of Wild Species in the Arctic*, “Part III: A Review of Consumptive Use in the Arctic”; only the parts dealing with terrestrial wildlife and reindeer herding are required reading.



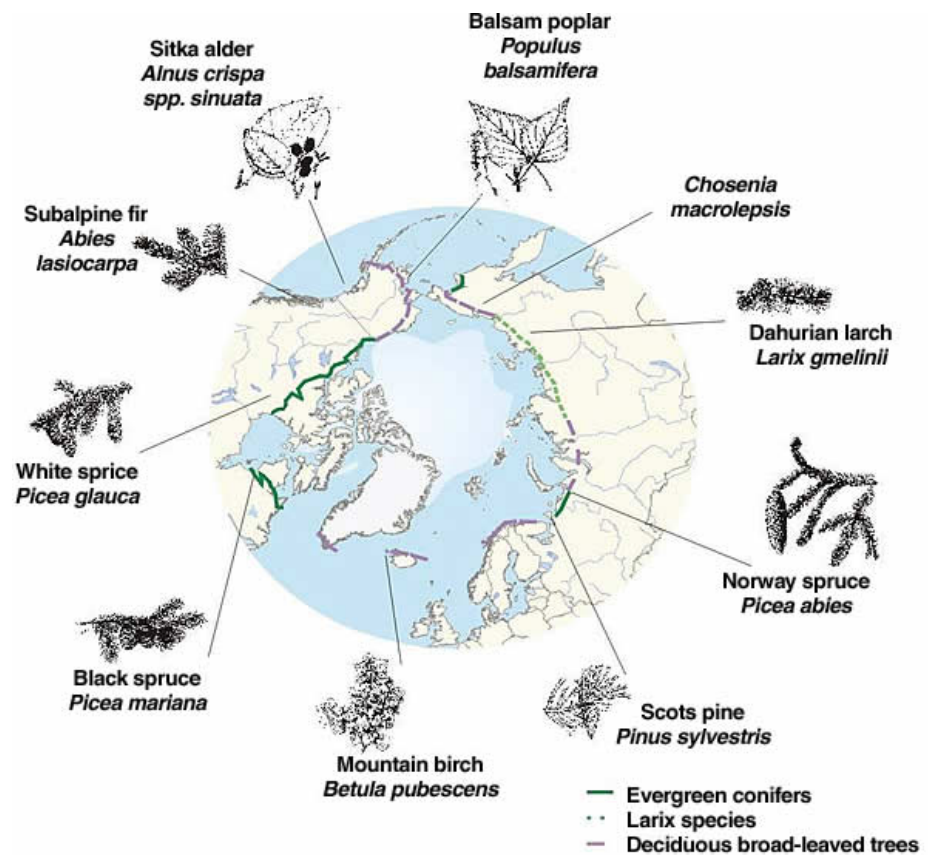
Overview

In this module, we focus on the terrestrial living resources, including the northern boreal forest and its use; the grasslands and lichen heaths and related agriculture and reindeer husbandry; and, finally, the hunt of terrestrial wildlife.

Lecture

The Northern Boreal Forest and Its Use

The *boreal forest* or *taiga* region, which forms a conspicuous belt of forest south of the tundra, is characterized by only a small number of species of spruce, larch, pine, and fir among the conifers and a limited number of species of broadleaf trees, primarily birch and poplar. From a larger landscape perspective, conifers dominate the boreal forest, although broadleaf trees can be locally dominant. The northern *treeline* itself is composed of different species, depending on location (see fig. 10.1).



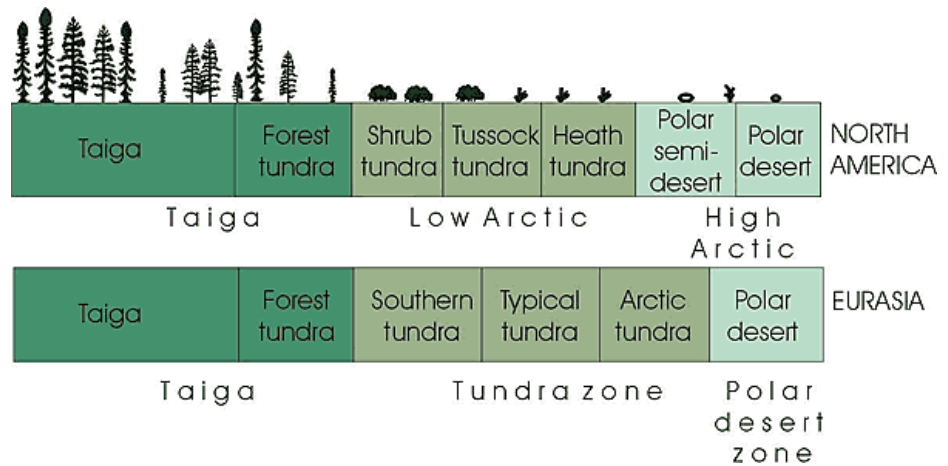
Source: CAFF (2001)

Fig. 10.1 The treeline species of the Arctic



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The southern boundary of the circumpolar Arctic is located at the northern extent of the closed boreal forest. In practice, there is not a clear boundary but, rather, a transition from South to North. This transition zone stretches more than 300 km in flat areas but is compressed to hundreds of metres or less in mountainous areas of the Arctic. The zone has been given various names, including lesotundra, and timberline forest, but we will stick to the term *forest tundra* here (see fig. 10.2). In general, only a few tree species are present in the forest tundra. The discussion in this module, however, tends to downplay the Arctic boundary and to focus in a general way on the northernmost part of the boreal forest.



Source: CAFF (2001)

Fig. 10.2 Classification of northern vegetative zones (ecozones or biomes) according to North American and European usage

Student Activity

1. How close to the boreal forest or taiga do you live?
 2. Which of the treeline species grow in the region in which you live?
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Global Importance of the Boreal Forest

Forests in the Arctic countries, most of them boreal forest, cover about 1.2 billion ha out of the total global forest of 3.8 billion ha, or about 31% of the world's forest. Russia's forests represent roughly 22% of the world total, which is by far the largest proportion of any nation in the world. Brazil comes next with 16%; and thereafter Canada (6.4%) and the United States (6 %, with Alaska's portion at 0.9%), both of which are Arctic nations (see table 10.1).



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Table 10.1 Forest area and percentage of world forest of Arctic nations in 2000 (adapted from FAO 2001)

Country	Area of Forest Cover (million hectares)	% of world
Russia	851	22.4
Canada	245	6.4
United States (Alaska)	35	0.9
Finland	22	0.6
Sweden	27	0.7
Norway	9	0.2
Iceland	0.1	–
Greenland	–	–
Boreal nation total	1,189	31.3
World total	3,800	100

Besides providing a major economic resource for the Arctic nations, the boreal forest is an instrumental component of the planetary regulation of atmospheric carbon and climate. The cold soils of the boreal forest contain some 40% of the world's soil carbon—an amount similar to that held by the atmosphere. The rough-textured, dark surface of lands covered with boreal forest canopy intercept and absorb a high proportion of sunlight energy, converting it to heat. In contrast, the smooth, snow-covered surface of the tundra is highly reflective. In high-latitude regions, where snow covers the ground for half of the year or more, the albedo (reflective) effect of the tundra, compared to the boreal forest, is magnified. Expansion of the forest into the tundra as a result of a warming climate will thus amplify further global warming.

Overall, the boreal forest region is one of the most intact major vegetation regions on Earth. As such, it represents an enormous global natural asset. However, in Iceland and some regions of Russia it has been extensively converted to other land uses or severely damaged by air pollution and overgrazing. The boreal forests of Finland, Sweden, and Norway and parts of Canada are generally intensively managed for timber production. In such intensively managed stands, tree age structure, tree species, and spacing is controlled.

Being an enormous global carbon sink, the boreal forest has the potential to significantly contribute to planetary management of the carbon cycle. Land and resource managers in the Arctic and boreal region are therefore interested in the concept of “carbon cropping,” that is, land management that specifically aims to enhance the carbon sequestration ability of the land against payment, for example, from industries or countries that release high amounts of carbon (CO₂)



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into the atmosphere. Mechanisms to place values on the various carbon storage methods—such as forest maintenance and establishment—are being developed under the Kyoto Protocol to the UN Convention on Climate Change but are not fully in place. If effective, and if this market-driven system is adopted at an international level, boreal forests could potentially generate a significant flow of wealth into the Arctic and boreal region from other parts of the world through forest and land management agreements designed to store carbon.

Importance of the Boreal Forest to the Arctic

Forests and woodlands cover less than one-third of the Arctic land area, and these tend to be much less productive than the commercially used forests of middle and southern boreal regions. However, forests and woodlands, both within and to the south of the Arctic region proper, provide an additional resource for a variety of uses:

- Residents of the northern taiga and forest tundra zones depend on the products and resources of the forest for a variety of traditional uses, such as reindeer grazing, hunting, wood for house construction, firewood, and berry and mushroom picking.
- Large volumes of driftwood are transported into the Arctic by the major north-flowing rivers of the boreal region. This wood supports microbial ecosystems that decompose the wood and feed organisms in rivers, oceans, and beaches.
- Driftwood transported into the Arctic has been an important resource for people in a naturally treeless environment during prehistoric times and is still a useful and valued resource for many Arctic residents today.
- The boreal forest collects, modifies, and distributes much of the fresh water that enters northern regions as precipitation or river runoff. Changes in forest structure or distribution produced by climate change would modify many of these important functions. All scenarios of climate change predict that the climatic optimum for boreal forest growth will move north and be far within the Arctic region within a century or so.

Student Activity

1. What are the benefits you and your community derive from forests, including northern forests?
 2. What specific changes would you predict would your community experience with global warming?
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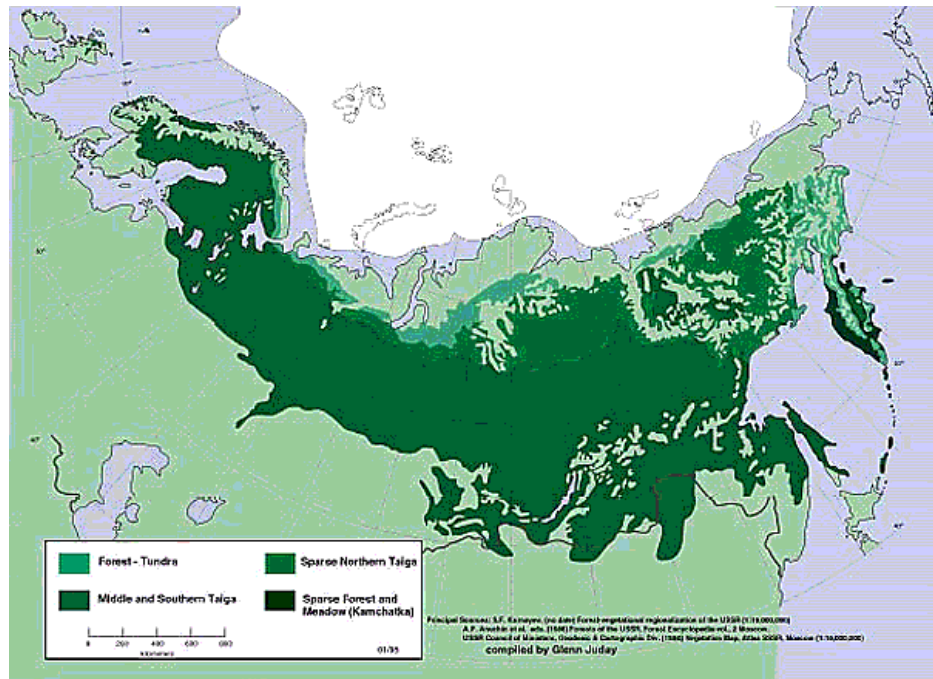


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The Forest Resources of the Arctic Nations

Russia

Russia is the largest nation in the world, and it contains the largest area of forest of any nation, amounting to an estimated 851 million ha (see table 10.1). The boreal forest of Russia is composed of three roughly parallel belts of southern taiga, middle taiga, and forest tundra (see fig. 10.3).



Source: (Juday et al., in preparation)

Fig. 10.3 Distribution of boreal forest in Eurasia

Dominant species of the Russian boreal forest change across Russia from spruce in the west to larch in the centre and east, to pine at various localities. In northern Eurasia, especially in central Siberia and the Russian Far East, as much as to 70–75% of taiga forests appear to be close to a natural state.

For management purposes, Russian forests have been divided into three categories based on economic and ecological characteristics. The first category comprises forests with a protective function—for example, watershed forests and most of the forest tundra (20% of forested land), which are available for intermediate and sanitary tree felling and small (maximum size 10 ha) clear-cutting. The second category is made up of forests in inhabited areas and forests with low productivity (5.5% of forest area). Most of the forest (74.5%) is included in category three, industrially exploitable forests, where clear-cutting (areas up to 50 ha) is the main management practice.



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Canada

Canada is the second-largest country in the world. The Canadian boreal forest covers about 245 million ha (6.4% of world forests). Species such as white spruce, black spruce, aspen, and paper birch dominate. About 46% of Canada's boreal forests are commercially valuable. Canada is one of the world's largest suppliers of wood and paper products. About a million hectares of timber are harvested annually, or less than 0.5% of the total commercial forest area. Thus, forests play a large role in the Canadian environment, economy, culture, and history.

Alaska

Alaska occupies about 20% of the total US land area. Two different types of forests are found: (1) coastal rainforest in southeast and south-central Alaska, and (2) the boreal forest of northern and interior Alaska. The coastal forest covers about 5 million ha. The amount of land in the boreal region of Alaska that supports at least 10% forest cover is about 46 million ha, or 41% of Alaska's total land area. In Alaska, the boreal forest is used for a variety of economic, subsistence, recreational, scientific, and other purposes. Local-scale logging has been a traditional use for much of the twentieth century. The boreal region has only small-scale wood-products facilities, mainly small sawmills and facilities to manufacture specialty products, such as house logs and birchwood items. The indirect ecosystem contributions of forests are important in Alaska and may exceed values from commercial timber operations in most of the Arctic region.

Fennoscandia

Finland, Sweden, and Norway have certain features in common. All three nations extend from the southern Baltic Sea to north of the Arctic Circle. Across that transect, these nations encompass north temperate deciduous forest in the south and an entire gradient of the boreal forest to treeline and tundra in the north. In the boreal region, the most common trees are Scotch pine (*Pinus silvestris*), Norway spruce (*Picea abies*), and birch (*Betula pendula* and *B. pubescens*). Most Fennoscandian productive forests are intensively managed and have been exploited for wood products for hundreds of years. In these countries, forestry is practised closer to the treeline than in any other Arctic country. This is possible because of the well-developed infrastructure in the region. For several decades, the amount of timber harvested in Fennoscandia has been less than the amount growing, so that the forest resource is increasing overall.

Finland is Europe's most heavily forested country, with sixteen times more forest per capita than the European average. Forests cover some 22 million ha, or 74.2% of the land area. Finland is heavily dependent on the forest products



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and ecosystems. One-third of the country's export earnings come from forests, and the forest industry as a whole is second only to the mining industry as an export sector. Sweden is also heavily forested. Closed forest and forest plantations cover a little more than 60% of the nation, or about 27 million ha. Forested shrub land, which is especially common in the transition zone between closed forest and tundra, represents another 3 million ha, or 6.6% of Sweden. Forests and other wooded land cover about 37% of mainland Norway, or 9 million ha. Nearly 23% is regarded as productive forest. Wood and forest products represent about 11% of Norwegian non-oil exports.

Iceland and Greenland

Iceland is a geologically young landform situated along the Mid-Atlantic Ridge and isolated from both Europe and North America. The Icelandic flora is, therefore, naturally species poor. The only forest-forming species is the downy birch (*Betula pubescens*) and a few tall willow species. Rowan (*Sorbus aucuparia*) and aspen (*Populus tremula*) are occasionally found among the birches.

Today, natural birch forests only cover about 110,000 ha (roughly 1% of the country) and 80% of that is classified as shrub land (2 m tall or less). Until quite recently, efforts to conserve and increase the area covered by native woodlands were hindered because of heavy sheep-grazing. Since the mid-twentieth century, serious efforts have been made to protect the remaining native birch forests and to establish forest plantations for eventual commercial use, using introduced tree species from cold regions. Exotic species commonly used include Russian larch (*Larix sukaczewii*), Siberian larch (*Larix sibirica*), lodgepole pine (*Pinus contorta*), Sitka spruce (*Picea sitchensis*), and black cottonwood (*Populus trichocarpa*). Currently, some 20,000 ha have been planted with exotic species.

Greenland has not been forested in historic times. However, limited areas in southern Greenland support downy birch and willow scrublands, and alder is found in some areas.

Forestry Impacts

Fennoscandia

In Fennoscandia and northwest Russia, humans have extensively used the most accessible northern conifer forests along the coasts. The industrial expansion in the nineteenth century, was accompanied by large timber demand in Europe. Steam-powered sawmills rose along the coasts and waterways of Norway, Sweden, Finland, and northwest Russia to satisfy this demand. Initially, the sawmills were primarily interested in large pine logs, and selective logging was practised (i.e., all trees over a certain diameter were harvested). An escalating timber demand, however, led to a more ruthless exploitation. Large tracts of



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relatively virgin forests were bought by the forest companies, stripped of timber, and resold a few decades later in a more or less deforested state.

By the turn of the twentieth century, Nordic nations had realized that legally binding measures were necessary to prevent the wholesale destruction of their forests and began introducing laws to protect them; for example, they requested reforestation of harvested areas and the establishment of protection zones in northern and highland areas, where regeneration was slowest. Such legislation did not, however, prevent a continuing rise in total volume of timber harvested. The newly emerging pulp industry was less dependent on high-grade logs and repeated selective loggings were carried out in many areas. Such logging practices left behind thin and slow-growing stands that were considered worthless from a timber production perspective. By the mid-twentieth century, a discovery was made that clear-cutting, followed by replanting or sowing, led to more rapid regeneration. This method, which opened the way for highly mechanized forestry practices, is now the norm in all Arctic countries. To further enhance forestry production, breeding programs were set in place to ensure high-quality seedling stocks for replanting. Where regeneration from seed is practised, for example, for Scotch pine, selected “seed trees”—which are outstanding trees, selected for their growth form and volume— are left to regenerate the stand. Gradually, forest-management practices have also been refined to ensure optimum growth conditions of the stands.

The Nordic forestry industry has mostly relied on the native species, mainly Norway spruce and Scotch pine, but also birch (*Betula pendula*), which is grown extensively in Finland. Exotic species, such as lodgepole pine, Sitka spruce, and Siberian larch, were planted to some extent in the latter half of the twentieth century, but that practice has been more or less abandoned for conservation reasons.

Although the forest resource of Fennoscandia is growing in volume overall, the modern highly managed forests are far removed from virgin old-growth forests. Managed forests are composed of relatively few tree species—sometimes only one—and individual trees are more or less all of the same age. In contrast, in old-growth forests, there are individual trees of all stage of development and decay, including fallen logs and deadwood, providing a diverse habitat for forest organisms, such as fungi, lichens, insects, birds, and small mammals. These values of old-growth forests have been appreciated only recently and taken into account in modern forest-management practices. Fortunately, despite intensive forestry practices for centuries, Fennoscandia is still blessed with quite significant areas of old-growth forests, especially in highland and northern areas.



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North America and Russia

In North America, there is much less history of intensive forest use in Arctic regions, mostly because there are plentiful mid- and southern boreal forest resources for exploitation, but also because of logistical difficulties in accessing forests in remote northern areas.

Although the same applies overall within Russia, and despite the fact that Russia still has more natural boreal forest than any other nation on Earth, there is room for concern about forestry in northern Russia. Recent system change, with accompanying social unrest and pressure, has increased the development activities in the North. An increased international demand for timber has put further pressure on the Russian forest tundra zone. For example, during 1998–1999, timber production increased by 25–35% in the Archangelsk District and Komi Republic of Russia. Logging practices in the Russian North are often wasteful. It is estimated that 40–60% of the harvestable wood is lost during logging and transport. The World Wide Fund for Nature estimates that illegal logging in northwest Russia amounts to some 20–25% of the total logging in these areas. State forest-management authorities have insufficient funds to perform required inspection, control, and reforestation activities. In addition to illegal logging, vast northern areas have been altered by large-scale industrial development activities, especially oil and gas. In the Archangelsk and Komi regions, the southern border of the timberline forest now lies 40–100 kilometres to the south of the borders as they were defined in 1959. This is owing to low regeneration capacity after logging, exacerbated by permafrost and swamping of the soil.

Iceland

Although not the result of timber harvesting in the conventional sense, the Icelandic birch forests and woodlands are more affected by human use than any other forests within the Arctic. At the time of settlement in AD 874, it is estimated that birch forests and woodlands covered approximately 3 million ha, or about one-third of the island. Today, only some 110,000 ha are left, or 3% of the original resource.

Agriculture

The world's population relies for its food supply on two basic agricultural systems. The first is mass commercial production and trade. The products that dominate this system are cattle, hogs, and poultry for meat; dairy animals for milk products; grains for animal feed and direct human consumption; and oilseeds. These products move through a complex network of international trading, transportation, and processing machinery before reaching the final



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consumer. Major population centres within the Arctic are served by this agricultural and trading system.

The second type is subsistence agriculture. This system is generally regional and largely self-reliant. It does not rely on a complex infrastructure to move products to the final consumer. Each region has its own products. Regions with subsistence agriculture usually have low population density and/or low economic profiles. Most of the area of the Arctic, but a minority of the population of the Arctic, are served by subsistence agriculture, but many examples are also found of a mixture of the two food systems.

Agriculture is a relatively small industry in high-latitude regions, owing to climate limitations that include short growing seasons (not enough time to mature or to produce high yields of harvestable crop); lack of heat energy (too few growing-degree days during the season); long, unfavourable winter weather (which can limit survival of many perennial crop); and moisture stress in some areas. Thus, northern agriculture consists mostly of cultivating cool-season forage crops, vegetables, and small grains; raising traditional livestock (cattle, sheep, goats, pigs, poultry); and herding reindeer.

Now, we will have a closer look at the livestock husbandry in the North Atlantic region and the reindeer herding of northern Fennoscandia and Russia.

Student Activity

Which vegetables, if any, are grown in your region? Is there potential for enhanced agricultural production in your area?

Livestock Husbandry in the North Atlantic Region

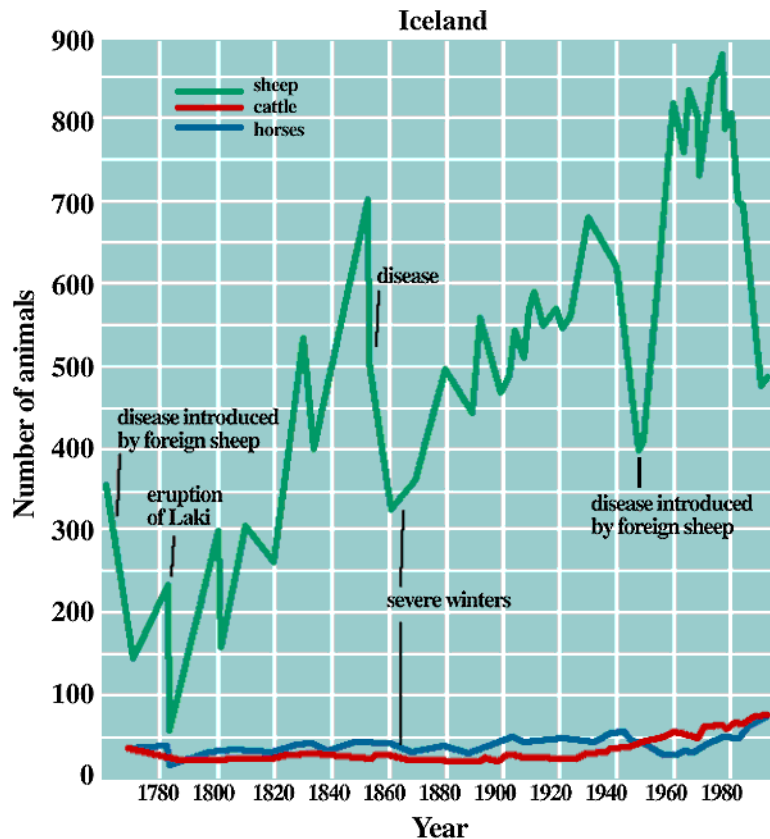
The non-indigenous settlers of northern Fennoscandia brought with them livestock—mainly cattle and sheep—which formed an essential basis for their subsistence. Until the mid-twentieth century, the growing population demanded an ever-increasing food supply and more farmland. However, agriculture in these northern areas combined several characteristics, such as small-scale production, low yields, and high transportation costs, that made it unprofitable compared with the mass commercial agriculture of the South. As a result, in Finnish and Swedish Lapland, many small farms were abandoned in the latter half of the twentieth century and the area of cropland was more or less halved. In northern Norway, farming historically faced less competition from the South than in Finland and Sweden and, thanks to government subsidies, the agricultural expansion continued through the 1970s. In economic terms, cattle



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are the most important livestock in all of these areas, but sheep farming has also been important in northern Norway, especially in cultural terms.

Through the ages, sheep farming was the mainstay of Icelanders. Although historical records are fragmentary, all evidence suggests that there have been hundreds of thousands of sheep on the island for most of the 1,100 years of human settlement. Arable land area and livestock numbers continued to increase until the early 1980s, owing to an agricultural policy of the Icelandic government that focused on boosting the national agricultural production. Sheep farming peaked in terms of numbers in the late 1970s (see fig. 10.4) and has since been on the decline—owing to, among other things, less demand for sheep meat locally, the introduction of livestock quotas, and a changed subsidy system. On the other hand, cattle husbandry (for milk and meat) has grown more or less with the population and is quite viable. Raising horses is also on the increase, mostly for equestrian sports and export. Modern agriculture in Iceland is becoming concentrated on fewer and fewer farms and increasingly mechanized; the quota system in use allows trade of quotas between farmers.



Source: Bernes (1996)

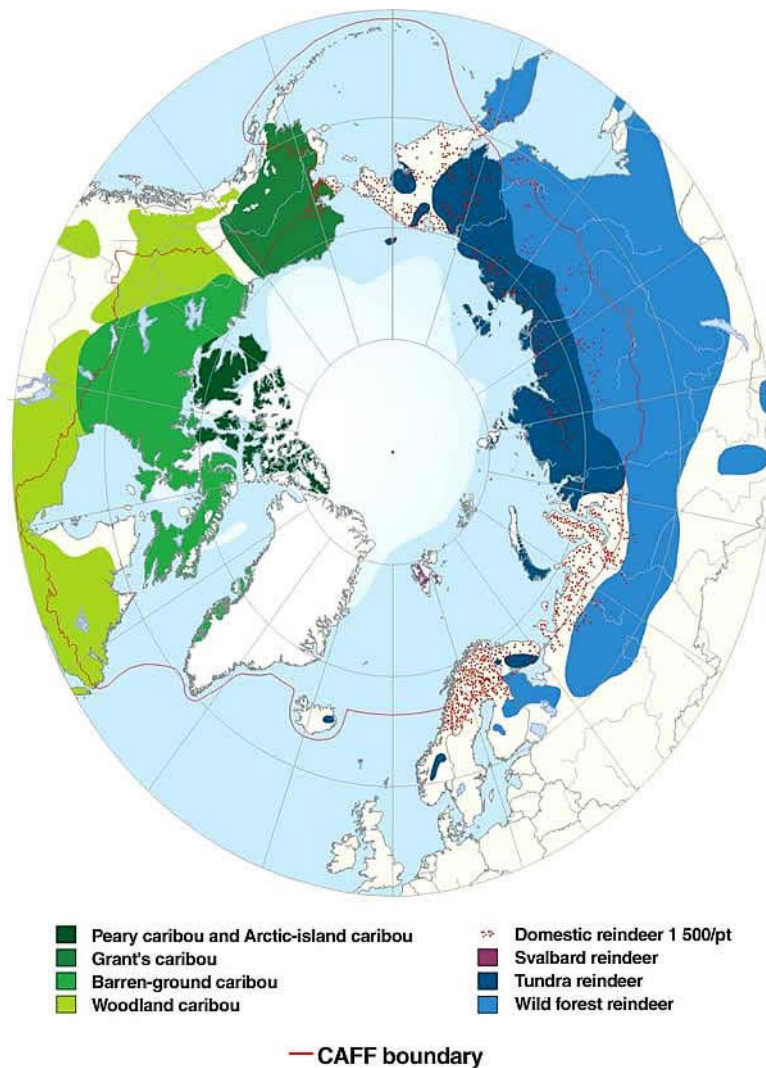
Fig. 10.4 Trends in livestock numbers in Iceland (in thousands) since the late seventeenth century. Legend: green line: sheep; red: cattle; blue: horses.



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Reindeer Husbandry

Caribou and reindeer look somewhat different but belong to the same species, *Rangifer tarandus*. Wild caribou are distributed over the entire North American Arctic and parts of Greenland, while the slightly smaller wild reindeer occupies the European and Eurasian Arctic. Both caribou and reindeer are found in several distinct herds within their ranges (see fig. 10.5). Reindeer were domesticated in northern Eurasia about 2,000 years ago. Today, they are herded by many Arctic peoples in Europe and Asia, including the Sami in Fennoscandia and northwestern Russia, and the Nenets, Dolgans, Chukchi, Even, and others in Russia.



Source: CAFF (2001)



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Fig. 10.5 Distribution and main types of wild reindeer, caribou, and domesticated reindeer in the Arctic

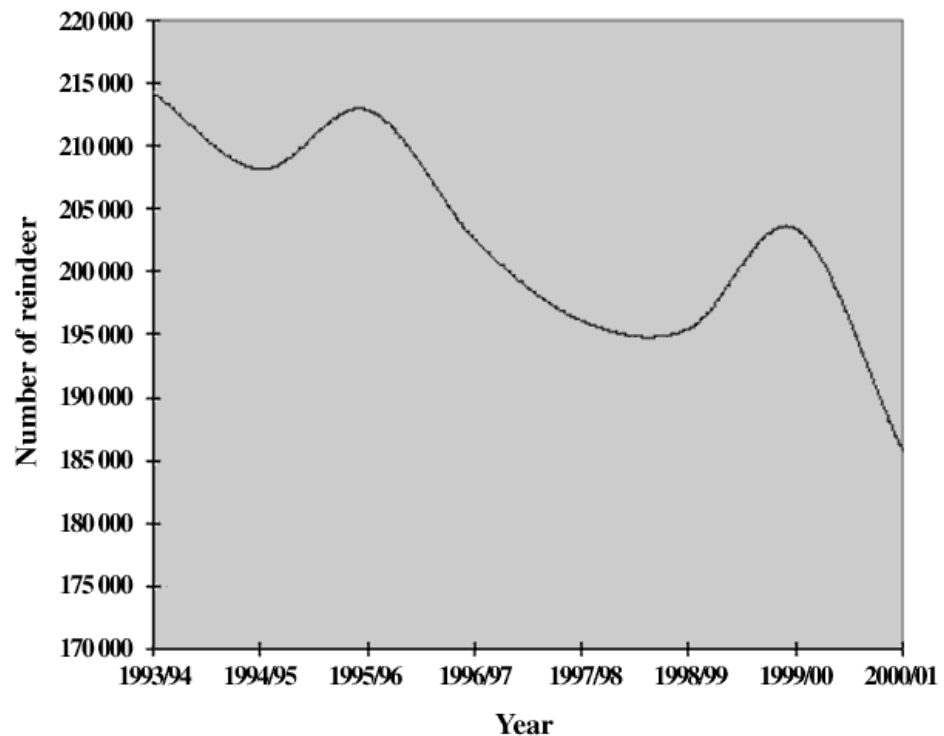


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Fennoscandia

About 14,000 people, mostly of Sami origin, are involved in reindeer herding in Fennoscandia. The number of reindeer and owners has been declining for the past decade owing to, among other things, conflicts with other land uses, overstocking of pastures, and severe climate.

Lapland and the Province of Oulu are the main reindeer herding areas of Finland. They cover about 114,000 km², or 33% of the country. Reindeer husbandry is conducted by both Sami and Finnish people. The size of the Finnish reindeer herd has declined from some 215,000 animals in the early 1990s to 185,000 in the year 2000 (see fig. 10.6). This herd is divided among roughly 5,600 reindeer owners. Also, reindeer owners have declined in number since the early 1990s, when there were around 7,000.



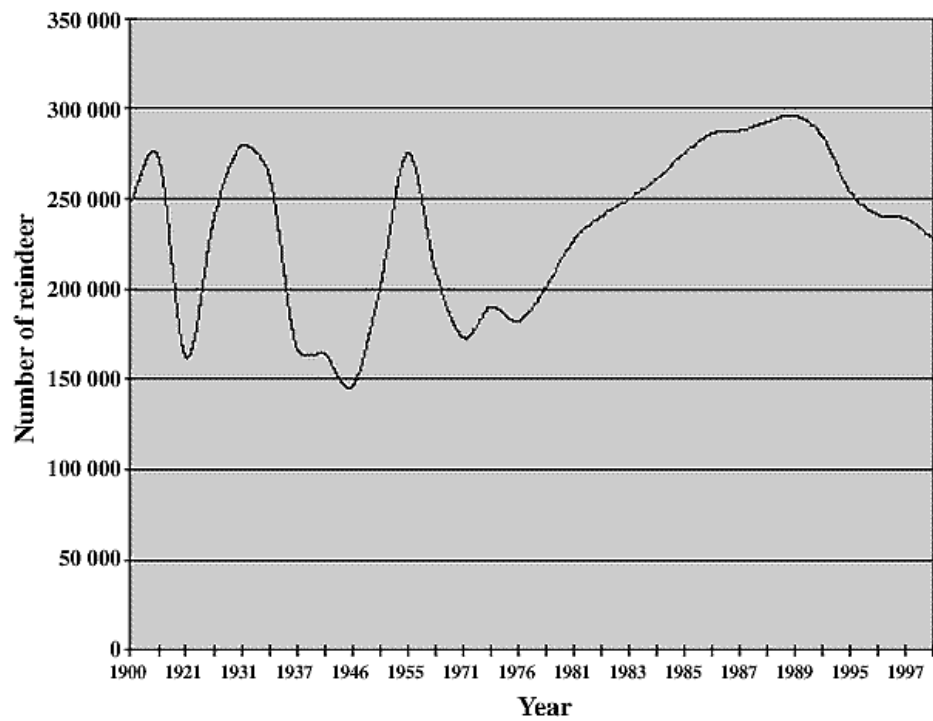
Source: Jernsletten and Klokov (2002, 132)

Fig. 10.6 Trends in the Finnish reindeer herd, 1993–2000



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In Sweden, reindeer are herded over an area of approximately 160,000 km² in the Norrbotten, Västerbotten, and Jämtland districts in northern Sweden. All reindeer herding activity in Sweden is regulated by the Swedish Reindeer Husbandry Act, which grants the Sami people exclusive rights to reindeer herding. The Swedish reindeer herd has fluctuated between 150,000 and 300,000 animals for the last century (see fig. 10.7). It peaked in the late 1980s but is currently at approximately 230,000 animals. The number of reindeer owners peaked in the mid-1990s at 4,830. Today, there are some 4,650 owners.



Source: Jernsletten and Klokov (2002, 117)

Fig. 10.7 Trends in size of the Swedish reindeer herd, 1900–1998

Student Activity

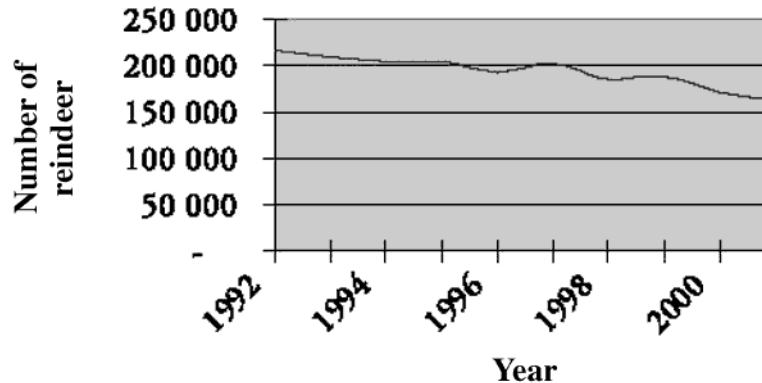
In your opinion, should governments subsidize northern agriculture? Discuss the pros and cons.

In Norway, reindeer are herded over an area of approximately 140,000 km² (about 40% of Norway) in the provinces of East Finnmark, West Finnmark, Troms, Nordland, North Trøndelag, and South Trøndelag. As in Sweden, all reindeer herding activity is regulated by legislation; in Norway, the Norwegian



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Reindeer Herding Act secures exclusive rights to the Sami people. The number of reindeer owners has stabilized at about 2,700 since 1990. However, reindeer numbers have declined from approximately 218,000 animals in 1992 to 165,000 animals in 2001 (see fig. 10.8).



Source: Jernsletten and Klokov (2002, 89)

Fig. 10.8 Trends in reindeer numbers in Norway, 1992–2001

Russia

Russia has about two-thirds of the world's population of domesticated reindeer. They are herded on more than 3 million km² of land, including tundra, forest tundra, taiga, and mountain areas. Today, reindeer husbandry in Russia is in rapid decline and has completely disappeared from some areas. The total number of domesticated reindeer has decreased from almost 2.5 million to 1.2 million in recent years. The recession of reindeer husbandry, which is owing primarily to the collapse of the Soviet infrastructure and fall in meat prices, is dramatic for the reindeer herding peoples that depend on reindeer herding for subsistence and as a way of life.

Unlike Fennoscandia, there are many different indigenous peoples engaged in reindeer husbandry in Russia: the Nenets, Komi, Sami, Evens, Evenks, Chukchi, Koriaks, Khants, and Dolgans all have cultural traditions closely connected with reindeer herding. Although reindeer herding practices vary significantly among the different peoples and cultures of northern Russia, roughly speaking one can distinguish between two main types, the “tundra type” and the “taiga type.” Reindeer herding in almost all of the tundra and forest tundra regions is of the former type. The tundra type of herding practices are characterized by frequent, long migrations of the reindeer from wintering areas in the forest taiga and taiga, to the summer grazing areas in the northern tundra. Herds are usually large (1,000–3,000 animals or even more), and intensive herding—that is, more or less constant control of the herd—is practised. Meat



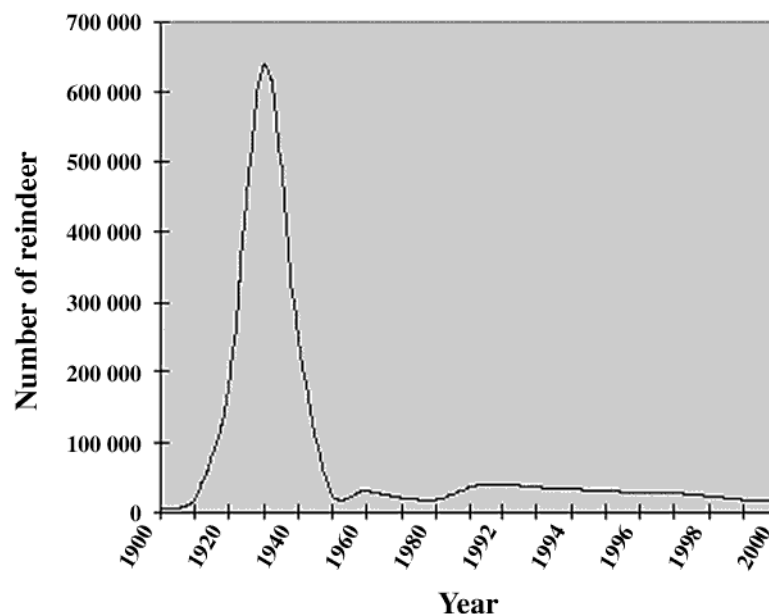
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and, to a lesser extent, soft antler production for subsistence and cash income are the main objectives.

Much smaller herds that do not migrate long distances characterize the taiga type of reindeer husbandry. Herding is less intensive, with the animals grazing without human care for extended periods of time. The main objectives of the taiga type of reindeer keeping are subsistence and transportation during hunting, which provides most of the income.

Reindeer Husbandry in Other Arctic Countries

The ability of reindeer herding to reliably provide food has spurred reindeer introduction programs to the North Americas, Greenland, and Iceland. Usually, Sami herders were brought along with the herds from Fennoscandia to teach the trade to the indigenous peoples. Reindeer were introduced to Iceland in the 1730s. Icelanders, however, failed to learn the trade properly and the herd went wild. Initially, it multiplied rapidly in a pristine (for reindeer) environment; but it soon overstepped the carrying capacity of the Icelandic highlands and the population crashed to less than 200 individuals. Currently, the herd is concentrated in the south-central highlands of Iceland and is tightly managed at about 3,000 animals through regulated hunts. Fennoscandian reindeer were introduced to Alaska and Canada in the early twentieth century. The Alaskan herd expanded rapidly and counted roughly 600,000 animals at its peak, around 1933, but then crashed soon after that (see fig. 10.9). Today, only a few domesticated herds remain in North America and Greenland, but they are important for several villages.



Source: Jernsletten and Klokov (2002, 76)



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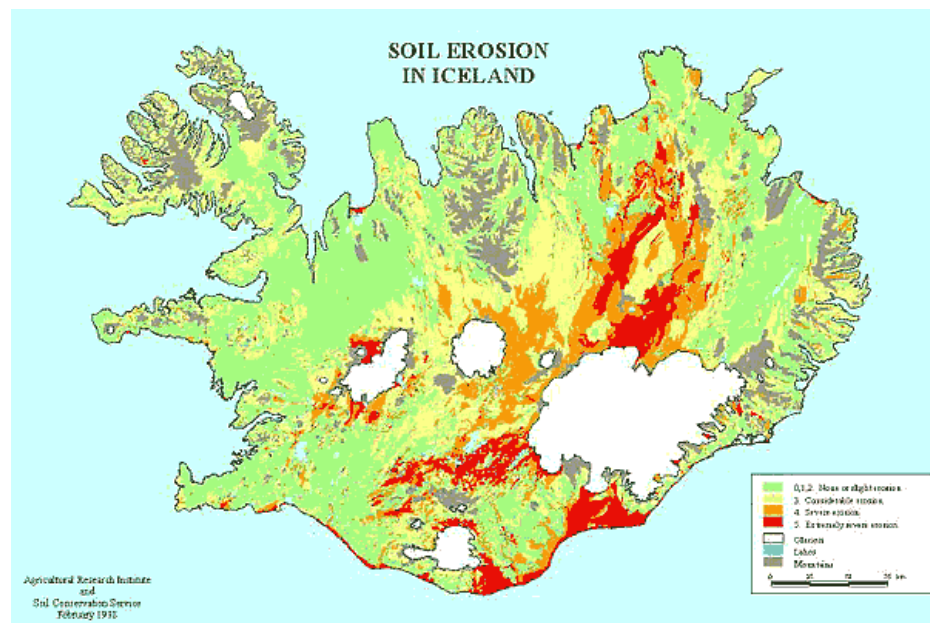
Fig. 10.9 Development of the introduced reindeer herd in Alaska, 1900–2000



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Agricultural Impacts

The landscapes of the Nordic countries have been greatly influenced by agricultural practices, including forest clearance for pasture, sheep and horse grazing, and wetland drainage. As mentioned above, of all the Arctic countries, Iceland has suffered most in terms of environmental impacts. It is estimated that, by the settlement of Iceland in the late ninth century, two-thirds of the country was vegetated, with close to one-third of the countryside covered with birch and willow woodlands. Currently, natural birch woodlands only cover roughly 1% of the country and the rest of the vegetation is in suboptimal state. Downy birch was often sought as feed for sheep; therefore, sheep grazing effectively prevented the regeneration of the native forests and the forests were gradually lost. When the protective woodland was gone, and especially as heavy sheep-grazing continued, the light volcanic soils were exposed to the elements (wind and water) and, as a result, soil erosion has rampaged, helped along by eruptions and volcanic ash deposits of the many active volcanoes found in the rift zone that runs through Iceland from southwest to northeast (see fig. 10.10). Some estimates suggest that up to 40% of Icelandic soils have eroded since the settlement. Erosion is still Iceland's most serious environmental problem.



Source: Agricultural Research Institute

Fig. 10.10 Soil erosion in Iceland. Legend: green: little or no erosion; yellow: considerable erosion; orange: severe erosion; red: extremely severe erosion; white: glaciers; blue: lakes; grey: mountains

Overgrazing is also a problem in some parts of the extensive reindeer herding areas of northern Fennoscandia. The reindeer's summer diet consists of a great



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variety of graminoids (grasses), herbs, and leaves of deciduous trees. In winter, reindeer prefer to feed on reindeer lichens (*Cladina* sp.). Free of human influence, reindeer populations are limited by food availability, specifically, lichen in winter. Sometimes, even if lichen sources are abundant, ice crust formation can prevent the deer from obtaining food. Natural population controls, however, do not function in many parts of the reindeer husbandry areas because reindeer herders supplement reindeer feed in winter and give their reindeer anti-parasite treatments; these practices ensure survival of the animals. This has resulted in overstocking, trampling, and overgrazing in many areas.

Terrestrial Wildlife and Hunting

The harvest of wild animals (wildlife) is common all across the regions and peoples of the Arctic. The harvest can be for immediate subsistence, for cash income, for sport, or a combination of these reasons. In this section we will look at terrestrial wildlife as a resource for Arctic residents. The hunting of wild reindeer and caribou provides an important source of food and income in many parts of the Arctic. Other species hunted include birds, fur-bearers, and a variety of larger terrestrial mammals.

Wild Reindeer and Caribou: *Rangifer tarandus*

Caribou, or wild reindeer, are an important source of meat and hides throughout most of their circumpolar range. Close to 200 herds of several distinct types exist in the Arctic (see fig. 10.5). Most wild populations of *Rangifer* have been stable in size or have increased in the last few decades, after a prolonged period of decline, especially in Eurasia during the buildup of domesticated herds.

In Fennoscandia, wild reindeer were entirely displaced by domesticated reindeer in the Arctic regions of Finland, Sweden, and Norway (though some exist in more southern areas). The archipelago of Svalbard, however, supports a unique subspecies of reindeer. This population was almost hunted to extinction by whalers, sealers, trappers, and miners before the population was given legal protection in 1925.

Wild reindeer populations declined throughout the Russian Arctic as the size of domestic herds increased during the last two centuries. However, around the mid-twentieth century, when the size of the domestic herds began to stabilize, the wild populations began to grow rapidly. The total population grew from 200,000–250,000 in the early 1960s to around a million in the 1980s. Most are found in the Taimyr region and northern Yakutia. On Taimyr, during the 1970s, some 700,000 wild reindeer were harvested. Despite this harvest level, the wild reindeer population grew from around 350,000 in 1970 to more than 600,000 in the early 1990s. About 44,000 reindeer were harvested in Yakutia in 1988–89. Wild reindeer now occur on most of the domestic reindeer farms in Yakutia and



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recently accounted for 45% of the total meat production on some farms. Herders are generally tolerant of wild reindeer because of the profitability of selling their meat and because the production of wild meat is cheaper than the production of domestic reindeer meat. Although herds on Taimyr and in Yakutia are generally in good shape, there are concerns about the protection status of hundreds of scattered small herds all across the Russian Arctic.

In Greenland, Inuit have hunted caribou for subsistence and to supply meat and hides for sale and export. Currently confined to western Greenland, Greenland's caribou population has historically fluctuated widely. For example, it numbered around 100,000 in the early 1970s and then dropped to 9,000 in 1993. The introduction of two non-indigenous reindeer parasites—the skin warble and the nasal blot—as well as the overgrazing of lichens may have contributed to this decline. Although the Greenland Home Rule government has reduced harvest quotas, it invests little in monitoring and control. As a result, the herd is probably currently overexploited.

The caribou herds of Arctic North America have also been hunted by indigenous peoples for thousands of years and today are a crucial subsistence resource for many communities. In addition, caribou meat and hides are marketed in Canada to a limited extent, and in both Alaska and Canada caribou are hunted recreationally, which generates income for guides, outfitters, and various sectors of the service industry. Table 10.2 summarizes the location, population size, and management regime of the major North American caribou herds. All of these herds have undergone significant growth over the last two or three decades and are at near peak levels or have recently begun to decline.

Table 10.2 Location and management regime of the largest caribou herds of North America (Freese 2000).

Herd (source)	Location	Population	Management Regime
George River (1)	Ungava Peninsula of Labrador and Quebec	700,000	Provincial governments
Leaf River (1)	Northwest Ungava Peninsula of Quebec	150,000	Quebec government
Qamanirjuaq (2)	NWT west of Hudson Bay and northern Manitoba and Saskatchewan	496,000	Co-management
Beverly (2)	NWT west of Hudson Bay and northern Manitoba and Saskatchewan	286,000	Co-management
Bathurst (1)	North of Great Slave Lake and east of Mackenzie River	500,000	Co-management
Bluenose (1)	North and west of Great Bear Lake and east of Mackenzie River	65,000	Co-management
Porcupine (3,4)	NWT, northern Yukon and northeastern Alaska	170,000	Co-management in Canada and government in Alaska
Western Arctic (5)	Northwestern Alaska	463,000	Federal and state governments

Note: Numbers in parentheses refer to data from different sources.



Student Activity

What are the uses of caribou/reindeer in your area?

Bears

Three bear species are found in the Arctic: polar bear (*Ursus maritimus*), grizzly (or brown) bear (*Ursus arctos*), and black bear (*Ursus americanus*). The polar bear, being mainly a marine species, is discussed in Module 11. It is the only bear species that is almost exclusively Arctic and is by far the most important in terms of consumptive use.

Brown bears are found in many regions in southern parts of the Arctic in both North America and Eurasia, but not in Greenland or Iceland. Where monitoring exists, populations generally appear to be in good conditions with sustainable levels of off-take; the situation in Russia, however, is not known. Brown bears are hunted for their meat, fur, medicinal uses, and sport in Russia, Fennoscandia (Finland and Sweden only), Canada, and Alaska. Cash income from licensed brown bear sport hunting provide significant cash income to some communities.

Black bears are found only in southern parts of the North American Arctic, where they are occasionally taken for subsistence use of their meat and fur.

Muskox

Muskox (*Ovibos moschatus*) inhabits only Arctic tundra and desert. While not nearly as important a resource as reindeer (caribou), muskox are important for subsistence and sport hunting in some areas of Greenland, Alaska, and the Canadian Arctic. Muskox products include meat; hides; horns for local handicrafts; and the fine, soft wool from the underbelly of a muskox (qiviut), which is renowned.

Muskox had a nearly circumpolar distribution until 3,000–4,000 years BP, when probably both climate change and hunting eliminated them from most or all of Eurasia (some populations may have persisted until a few hundred years ago). Then, in the mid- to late-1800s, overhunting by indigenous peoples, commercial whalers, explorers, commercial hunters, and fur traders—stimulated in part by the trade in muskox hides—appears to have caused the disappearance of muskox from Alaska and much of the mainland Canadian Arctic. By the 1920s, muskox were found on only a fraction of their original range in Canada, and the mainland population perhaps numbered less than 500. The Canadian mainland population has since grown to some 24,000 animals.



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Currently, the world population of muskox is estimated at 150,000, having increased from very low numbers in the early twentieth century. Canada has by far the largest numbers: some 130,000 animals divided into 17 populations. More than 70% of Canadian muskox are found on Banks and Victoria islands. In the early 1990s, estimates of population size were about 9,500 to 12,500 for the indigenous herds of north and northeast Greenland and about 2,700 for introduced herds in western Greenland. Muskox has been reintroduced to Alaska (currently some 3,300 animals) and Russia (currently some 2,500 animals). Thus, in spite of historical overexploitation, the current status of muskox is satisfactory and indeed a success for conservation.

Fur-bearers

In the Arctic, several species of animals are harvested in large part or exclusively for the value of their fur. These include, apart from the three species of bears already discussed, the wolf, Arctic fox, red fox, lynx, wolverine, ermine, marten, mink, muskrat, and beaver.

The international fur market in the 1800s and early 1900s and the resultant expanding network of Russian and Euro-American fur-trading posts had a major influence on the economies and the patterns of human settlement in North America and Russia. In many cases, the fur trade represented the first point of Euro-American contact with indigenous peoples in the North. The fur industry, particularly that of wild furs, has been depressed for several years because of an oversupply of ranched furs; increasing anti-trapping and animal rights sentiments in fur-market countries; and changes in fashion. The Arctic fox is probably the species most widely trapped for its fur on a circumpolar basis. In the 1960s, trappers in the former Soviet Union, where the Arctic fox accounts for 90–99% of the fur trade in the tundra regions, took an average of 83,000 animals annually; harvests in some years exceeded 100,000. The number of Arctic fox trapped in Canada frequently exceeded 40,000 annually from 1920 to 1960, but generally has declined since then. The recorded number of Arctic fox pelts sold in Canada's Northwest Territories in 1997 was nearly 10,000. Smaller numbers are caught in Alaska, Greenland, and Iceland. Despite centuries of attempts to control or eradicate the Arctic fox in Iceland, where it is considered a pest because it preys on eiders and sheep, the population remains healthy there, and several thousand are killed annually. The Arctic fox is fully protected in Fennoscandia, where populations were severely reduced in the early 1900s.

Birds

Also a high diversity of bird species is harvested throughout the Arctic, including waterfowl, seabirds, shorebirds, ptarmigan, and occasionally other groups. A large part of the harvest is for subsistence and recreational use, although commercial markets have been, and continue to be, an important factor affecting the harvest of some bird populations. Overharvesting has been a



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problem for some groups and regions (e.g., seabird harvest in Greenland; see Module 11); while overprotection has also created problems, as in the case of the Arctic-nesting Lesser snow geese in North America, which have experienced a population explosion in recent years and the resulting overgrazing problems in some of its breeding and staging areas in the Arctic.

Student Activity

What are the main wildlife species in your area? How important are they for the economy and identity of your community?

Summary

The boreal forest, which forms a conspicuous belt of forest south of the tundra, only extends partly into the Arctic region. The boreal forest is an important factor in controlling global carbon balance and climate and provides an important source of economic wealth to northern nations. With global climate warming, the boreal forest is expected to spread even farther north into the current tundra regions. The northernmost boreal forest is only moderately productive compared to lower boreal and southern regions and, therefore, has remained relatively intact from human industrial use. The most intensely managed northern forests are those of Fennoscandia. Currently, there are concerns over unsustainable forest practices in parts of Russia. In Iceland, the natural birch forest was almost totally erased early on through unsustainable land-use practices, with severe soil erosion resulting. Icelanders now try to rectify some of this damage through extensive afforestation efforts. Within the Arctic region, agriculture in the conventional sense is mostly conducted in the North Atlantic region and consists primarily of sheep and dairy farming. Reindeer husbandry is an important source of income, subsistence, and cultural identity for several indigenous peoples' groups, especially in Fennoscandia and Eurasian parts of the Arctic. The harvest of wild animals (wildlife) for subsistence, cash income, or sport is common all across the regions and peoples of the Arctic. On land, the hunting of wild reindeer and caribou provides the most important source of food and income. Other species hunted include birds, fur-bearers, and a variety of larger terrestrial mammals.

Glossary of Terms

afforest	1 convert into forest. 2 plant with trees.
carbon sink	a natural feature, such as a forest, other vegetation, soil, or ocean, that sequesters and stores carbon.



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clear-cutting	the removal of all trees from an area.
Mid-Atlantic Ridge	a submarine ridge system extending the length of the Atlantic Ocean from the Arctic to the Antarctic. It is seismically and, in places, volcanically active; the islands of Iceland, the Azores, Ascension, St. Helena, and Tristan da Cunha are situated on it.
off-take	killed by hunters.
sanitary tree felling	(Russian usage) cutting individual sick or damaged trees.
sequesterate	<i>verb</i> confiscate, appropriate.
vegetate	(usually in <i>passive</i> tense) be covered or provided with vegetation or plant life (especially of a specified kind).

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