



## Introduction

The boreal forest

- is used by nearly half of the birds in North America each year
- contains wetlands that filter millions of litres of water a day

## Description

If you had a clear view of Earth from space, you might wonder at the green band encircling the northern reaches of the globe. You would probably guess that it was an enormous expanse of woodland. What you might not know is that it is called the "boreal forest" and that it makes up almost one third of the world's forests, stretching as it does round the northern parts of North America and Eurasia.

You might also be surprised to learn that it is one of the largest forest ecosystems on the planet, and it shelters thousands of wildlife species.

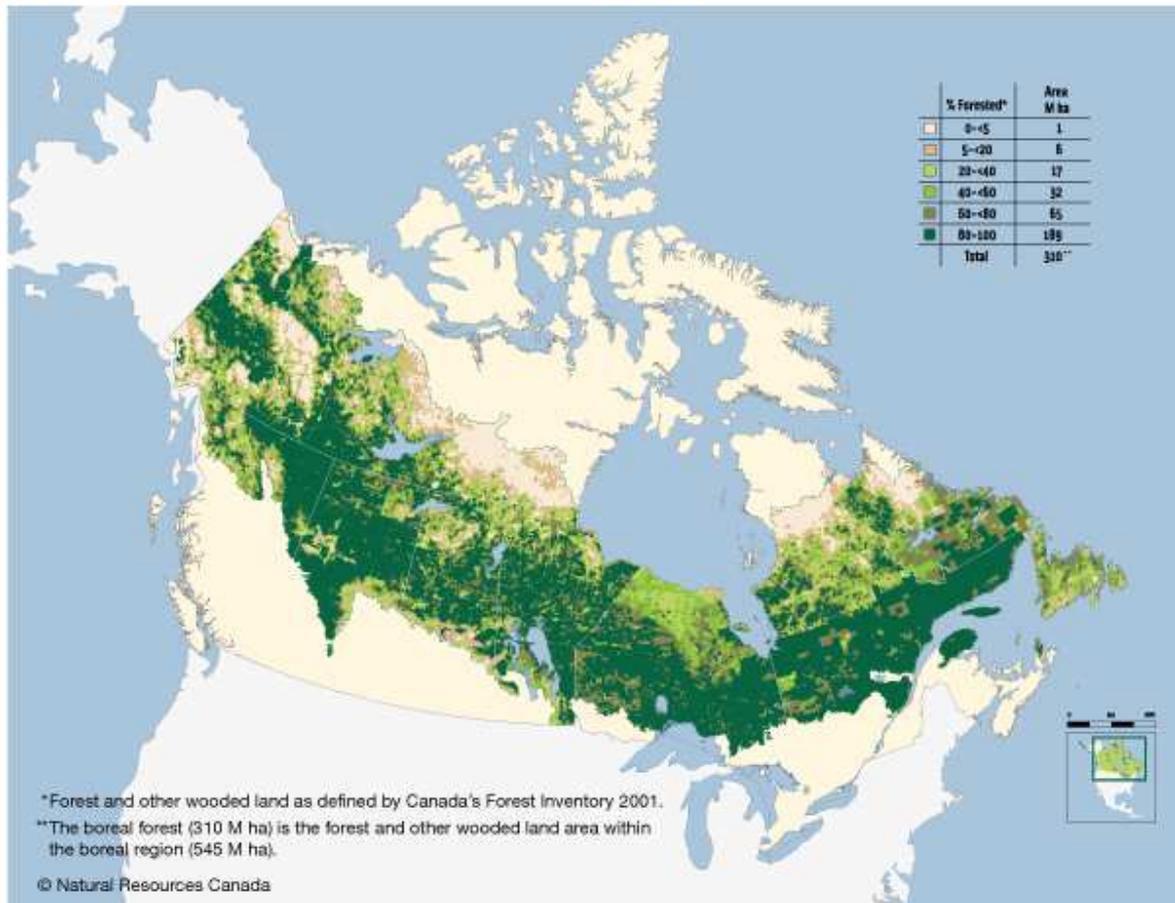
Canada contains about a third of this northern forest, named after Boreas, the Greek god of the North Wind. Stretching more than 5 000 km from Newfoundland and Labrador in the east to Yukon in the west, and extending south 1 000 km from the edge of the arctic tundra, the boreal region occupies more than half of Canada's land area. Many of the species that we think of as being particularly Canadian—black spruce, jack pine, moose, caribou, gray jays, loons, wood frogs, and lake trout—are part of the boreal ecosystem. The boreal region also contains more than 1.5 million lakes and many of the main river systems in the country. It is home to more than four million people, including most of Canada's Aboriginal people. It is rich in natural resources too, with extensive mineral, oil, and gas deposits, as well as waterways for hydroelectric power. The climate in the boreal forest is characterized by long, very cold, dry winters and short, cool, moist summers.



1 Black spruce peatland



2 The world's boreal forests



3 The boreal forest in Canada

## Boreal Species

### Plants

The boreal forest is teeming with life. To describe it, let's begin with the trees that make up the forest canopy. There are about 20 species of them, and most are coniferous, which means that they produce their seeds in cones. Spruce, fir, pine, and tamarack are the main species found in the Canadian boreal forest. Except for tamarack, which drops its needles every fall, they remain green all year. Broad-leaf deciduous trees, such as trembling aspen, balsam poplar, and birch, are also widely distributed across the boreal forest.

Coniferous trees are particularly well suited to the harsh boreal climate. Their conical shapes reduce snow buildup on branches in winter, so that they do not break under the snow load. Their narrow needles have thick waxy coatings which protect the trees from drying winds. These needles have tiny pores which allow gases to move in and out of the trees: this is how they "breathe." These pores are sunken into the waxy layer, to help reduce water loss.

In order to grow, plants need to photosynthesize—a process that converts energy in sunlight into food for the plant. To thrive in the short boreal summers, conifers have adaptations to help maximize photosynthesis. For

example, because their foliage remains green year-round, conifer trees can photosynthesize in the spring without having to grow leaves first. In fact, they can even photosynthesize on warmer days in the winter.

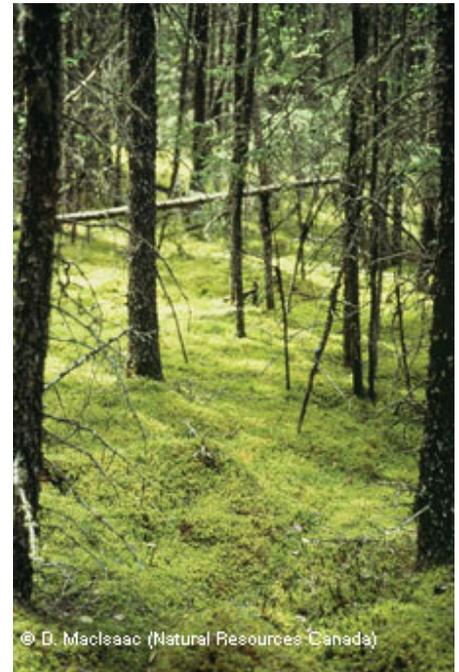
The deciduous trees, such as aspen, are also adapted to the boreal conditions. They grow leaves to photosynthesize in the summer, and then shed them before it gets cold in winter. In this way, the trees are less damaged by heavy snowfalls. Before the leaves fall, the trees take back some of the nutrients from the leaves, to use in the next year's growth. Aspens also have chlorophyll (green cells that are needed for photosynthesis) in their bark, so that they can make some food in winter on warmer days.

All of these tree species support a range of birds, mammals, and other wildlife. They also store large amounts of carbon and produce a great deal of oxygen, so much that in the spring and summer in the northern hemisphere, when the boreal trees are growing most vigorously, worldwide levels of carbon dioxide fall and global levels of oxygen rise.

While trees are the dominant plant species, many other plants thrive in the boreal forest, including shrubs, mosses, and lichens. Some shrubs, such as willow, alder, blueberry, red-osier dogwood, and honeysuckle, produce bright-coloured or conspicuous berries that attract fruit-eating birds and provide food for mammals from small rodents to bears.

Under coniferous trees, mosses grow so thickly that they form a complete carpet on the soil's surface, keeping the soil moist and cool and preventing many other types of plants from growing. Open areas are carpeted with yellow, green, and light grey lichens. Some lichens grow on wood too. Lichens are combinations of fungi and algae that benefit each other: the underlying fungus provides structural support for the lichen, while the algal layer on top has chlorophyll which provides food for the lichen through photosynthesis. Lichens remain intact all year long, and are an important food source in winter for species such as caribou.

Wetlands—bogs, fens, and marshes—occupy 30 percent of Canada's boreal forest. Boreal wetlands are often referred to as muskegs or peatlands. These peatlands are usually on poorly drained, flat terrain. Plant material decomposes slowly in the cool, wet soil conditions, forming a blanket of material that is often several metres thick. Sphagnum and other mosses, sedges, and low shrubs make up the peatland vegetation. Treed peatlands, composed mostly of tamarack and black spruce, are also widespread. Some mosses, such as sphagnum, are especially important in peatlands where they can create acidic environments.



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4 Black spruce and feathermoss



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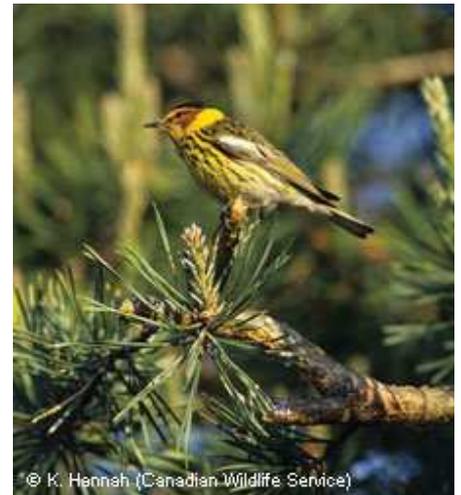
5 Aspen

These wetlands are invaluable: they filter millions of litres of water every day, and they provide breeding, moulting, and staging (resting and feeding) habitat for more than 13 million ducks—about 40 percent of the North American duck population.

### Birds

Nearly half of the birds in North America rely on the boreal forest at some time during the year. It is estimated that at least 3 billion landbirds, water birds, and shorebirds breed in the boreal forest each year, representing more than 300 species. Another 300 million birds, including several species of shorebirds, swans, and geese, breed farther north and travel through the boreal forest during migration.

Many of the birds that we see in our communities have bred in the boreal forest or passed through it travelling north or south, and many of these are the singers of the forests—small birds such as warblers, vireos, thrushes, kinglets, grosbeaks, sparrows, and flycatchers—which are hard to see but wonderful to hear. Ducks, loons, grebes, rails, gulls, kingfishers, and cranes depend on Canada's boreal waters for nesting and for food.



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6 Cape May Warbler

Other bird species, such as woodpeckers, finches, nuthatches, chickadees, owls, grouse, and ravens, can live in the boreal forest year-round, having adapted to the climate. Black-capped chickadees, for example, have black and white feather patterns that are designed to absorb heat and provide the best insulation when they are sleeping. They can also sleep in holes in the snow which act like tiny igloos to keep them warm. In winter, Great Gray Owls use their extremely sensitive ears and silent flight to locate and capture small mammals under the snow, and Ruffed Grouse grow scales on the sides of their toes that turn their feet into snowshoes.

### Mammals

The boreal forest shelters more than 85 species of mammals, including some of the largest and most majestic—wood bison, elk, moose, woodland caribou, grizzly and black bears, and wolves—and smaller species, such as beavers, snowshoe hares, Canada lynx, red squirrels, lemmings, and voles.

Of these, the snowshoe hare is the most ecologically important. It is a food source for many of the boreal forest's predators (both mammals and birds) and feeds on the forest's various plants and shrubs, linking all of these species in a tight food web.



© D. MacIsaac (Natural Resources Canada)

7 Beaver dams

Like other species, many mammal species have adapted to conditions in their boreal home. For example, the snowshoe hare turns from brown-grey in the summer to white in the winter, so that it always blends with its surroundings. Moose, wood bison, and other large

mammals have a low surface area-to-volume ratio, which minimizes the amount of body heat they lose in winter.

The beaver is one of the most important animals in the boreal forest. Using its ever-growing front teeth, it fells trees and eats the leaves, twigs, and bark, using the wood to build dams and lodges. Beaver dams flood parts of the forest, creating ponds and wetlands that are used by fish, waterfowl, and amphibians.

### **Reptiles and amphibians**

The boreal forest is a challenging home for reptiles and amphibians, which depend on environmental conditions to regulate their body temperatures. Spring and summer temperatures likely limit how far north many species are found, since temperatures must be high enough for eggs to hatch and young to grow. In summer, reptiles and amphibians choose appropriate habitat and bask in the sun to reach body temperatures that allow them to hunt effectively and digest prey. In winter, most amphibians and reptiles that hibernate on land seek out sites underground where temperatures consistently remain above freezing, although wood frogs and chorus frogs simply burrow in the leaf litter and depend on chemicals to make them freeze-tolerant; during hibernation, more than 40 percent of their body fluids can consist of ice. Other frogs and turtles hibernate at the bottom of ponds and lakes.

### **Insects**

Insects are critical components of boreal food webs and play important ecological roles as pollinators and decomposers, yet as a group, they are among the most poorly understood organisms in the boreal region. Except for relatively few species, mainly those considered "pests" because of the economic losses they cause by damaging or killing trees, or highly conspicuous groups such as butterflies, little more than the names and general habitat preferences is known.

It is estimated that 32 000 insect species inhabit Canada's boreal forest, although about one third of these species have yet to be described. Among the known species, several are particularly well adapted to their habitat. For example, black fire beetles have infrared sensing organs on their bodies that allow them to track the heat of forest fires as they search for freshly burned trees on which to lay their eggs. Other species, like the white-spotted sawyer beetle, use their long antennae to sense chemicals in smoke and charcoal to achieve the same goal. Like many other insect species, in addition to starting the decomposition of fire-killed trees, these two beetle species are an important part of the diet of several bird species commonly found in burned forests.

### **Fish**

Canada's boreal forest is home to about 130 species of fish. Most fish species in the boreal region are small, like minnows and stickleback. Larger species, including walleye, northern pike, lake trout, Arctic grayling, yellow perch, brook trout, whitefish, and burbot, are some of the most common game fish.

Fish living in the boreal forest are a hardy bunch, as they have to contend with long winter months and cold temperatures. Numerous fish species also migrate between different areas of rivers and lakes at different times of the year. For instance, many populations of bull trout live in different areas of the river during the winter, summer, and fall. Perhaps the largest migrations are completed by chum salmon and chinook salmon in the most northwestern portion of the boreal forest. These species are born in small streams, but migrate to the

ocean, where they grow and mature, before migrating back into rivers to reproduce and die. The majority of them return to the same area where they were hatched, and migrations of several hundred kilometres are common.

Some fish, like northern pike and walleye, feed on other fish species; species such as lake trout, white sucker, lake sturgeon, and lake whitefish eat aquatic insects and other invertebrates; still others, such as yellow perch, cisco, and many minnow species, feed on tiny zooplankton in the water. In turn, fish are food for eagles, osprey, herons, loons, mergansers, bears, and otters.

## Benefits

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The boreal region not only supports the species that live within it; it also provides benefits that extend beyond its borders. The forest's extensive wetlands lessen the effects of floods and droughts by storing and moderating the flow of water between upland areas and lowland regions. Its wetlands also act as water filters by removing impurities from the water that flows through them.

The boreal forest's trees and other vegetation help to control erosion, improve the cycling of nutrients, and promote the formation of soil. Sometimes natural disturbances, such as forest fires, contribute to plant growth. Fires release nutrients that were tied up in leaves, logs, and needles on the forest floor, which can aid in the vigorous regeneration of vegetation following fire. The forest also helps to regulate the earth's climate by storing carbon in peat deposits, soils, lake sediments, and trees. This prevents atmospheric carbon from being released as carbon dioxide and methane, two gases linked to climate change.

As one of the few remaining relatively intact ecosystems on our planet, the boreal forest helps to preserve biodiversity, or the variety of life on Earth. Every living thing plays an essential role in maintaining a balance in Earth's natural processes. That's why biodiversity is so important. And that is why the boreal forest is important too. The Canadian boreal forest is home to about two thirds of Canada's 140 000 species of plants, animals, and micro-organisms.

Economic activity in the boreal forest sparks other benefits. It brings products to people around the world and supports the people who live and work in the boreal region. Much of the world's forestry, mining, oil and gas production, hydroelectric generation, tourism, and harvesting of natural products occur in the boreal forest. About 14 percent of Canadians living in hundreds of communities located in the boreal region rely on these industries. Others make their livings on land at the southern edge of the boreal forest that has been converted into farmland. The boreal forest is home for about 80 percent of Canada's Aboriginal peoples, whose rich heritage is strongly linked to the forest.

## Disturbances and Threats

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Unfortunately, there are negative aspects to development in the boreal forest. The main consequences are habitat loss and fragmentation. These occur when land is cleared for farmland or flooded to make reservoirs for hydroelectric generating stations or when seismic lines, pipeline rights-of-way, forestry roads, and mine sites are cut into the forest. These activities in some cases weaken its natural systems and disturb wildlife species that depend on large, intact areas or require a specific habitat to survive. These impacts or changes to

boreal ecosystems, along with pollution from some of these industries and the diversion of water flow sometimes caused by hydroelectric and mining developments, can have serious consequences for wildlife.

While the boreal forest harbours few species at risk, some species are being affected by human disturbances. The most well-known species at risk found in the boreal region are some populations of woodland caribou, the wood bison, the Peregrine Falcon, the Yellow Rail, and the Whooping Crane. Maintaining boreal habitat in protected areas has helped in the slow recovery of the wood bison and the Whooping Crane, both of which almost disappeared in the first half of the twentieth century.

Conversion to agricultural land modifies or destroys wildlife habitat and may greatly change the amount of carbon that can be held in the ecosystem. Forests hold between 20 and 100 times more carbon than do agricultural crops, and they keep the carbon for longer periods.

Another threat is climate change. Global increases in temperatures could bring more frequent and severe disturbances from fire and insects, for example, changes in the quantity and quality of water, and a gradual migration northward of the forest itself. In western Canada, many of the species found in boreal lakes are near their thermal limits in normal conditions; a few degrees of warming could cause them to decline or disappear. Climate change is also likely to decrease biodiversity by filtering out species that do not move or spread easily and by favouring less diverse and more aggressive, invasive, species.

The boreal forest is strongly influenced by natural disturbances, such as wildfires, insects, and disease, as well as human ones. Some of these disturbances can be positive. For example, many species are adapted to thrive after fire in the boreal region. Pine trees release seeds when a fire's heat opens their cones, and species such as fireweed and aspen regenerate right after fire, often from roots and shoots that survive in the soil.

## Action

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Many people are taking steps to help the boreal forest remain healthy. Governments are examining the combined effects of development pressures and are trying to find ways to reduce the impacts. Environmental organizations are working to raise awareness about the boreal forest and conducting programs to help maintain the forest's health. Industry is making efforts as well. The forest sector is reducing the impact of forestry on boreal water resources and is identifying areas critical for biodiversity. Although overall exploration activity is increasing, some oil and gas companies are working to decrease their impact by reducing the size of seismic disturbance when they look for oil and gas, and the electricity industry is working to maintain healthy populations of fish and wildlife during the design, operation, and maintenance of facilities. Finally, individuals are getting informed about the boreal forest and are taking action, like reducing, reusing, and recycling paper products, and adopting alternative energy sources.

While all of these actions will help reduce the impacts on the boreal forest, a big challenge is managing the boreal region in a sustainable manner. To do this, scientists are working to increase our knowledge, trying to understand how boreal ecosystems function, how human activities affect the forests, and how we can make better decisions about those activities. Greater scientific understanding, along with a wealth of traditional knowledge, can be used to sustain our magnificent boreal forest now and for generations to come.

## Resources

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### Online resources

Bird Studies Canada

<http://www.bsc-eoc.org/>

Boreal Songbird Initiative

<http://www.borealbirds.org/>

Canadian Boreal Initiative

<http://www.borealcanada.ca/>

Environment Canada, Ecological Assessment of the Boreal Shield Ecozone

<http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=1F4C0C47-4E18-4988-8514-A842EED6F774>

Protecting Canada's Boreal Forests and Northern Ecosystems: Developing Biological Methods to Assess and Preserve Canada's Soil Environments of the North

<http://www.ec.gc.ca/scitech/default.asp?lang=En&n=4B40916E-1&xsl=privateArticles2.viewfull&po=3AB28EB3>

Lakehead University Faculty of Forestry and the Forest Environment

<http://www.borealforest.org/index.php>

Model Forest Network

<http://www.imfn.net/canadian-model-forest-network>

Natural Resources Canada, Canadian Forest Service

<http://cfs.nrcan.gc.ca/>

### Print resources

Farrar, J.L. 1995. Trees in Canada. Natural Resources Canada, Canadian Forest Service, Ottawa. (May be ordered online at [www.fedpubs.com/subject/natres/trees.htm](http://www.fedpubs.com/subject/natres/trees.htm).)

Henry, J.D. 2002. Canada's Boreal Forest, Smithsonian Institute Press, Washington.

Nelson, J., and M.J. Paetz. 1992. The fishes of Alberta, second edition. University of Alberta Press, Edmonton.

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