



FEATURE ARTICLES

CANADA'S BOREAL FOREST

Seen from afar, Planet Earth displays an emerald ring around its northern regions, just below the Arctic Circle. This vast green belt is the world's boreal forest. Interrupted only by the Atlantic Ocean, it sweeps across North America, Scandinavia and Russia, constituting an estimated 10 percent of Earth's land cover and almost one third of its forests.

Named after Boreas, ancient Greek god of the north wind, these forests hold a treasure of dynamic, often unique trees, plants, animals and other wildlife, and a bounty of natural resources.

As the steward of approximately 30 percent of the world's boreal forest, Canada has a vital interest in developing its northern woodlands in a sustainable manner. Part of this responsibility is to ensure that Canadians have unbiased, easy-to-access information about the boreal forest. The articles that follow are part of this endeavour.

The first article discusses the boreal forest as a national and global endowment, the natural forces that created and maintain it, its impact on Canadian life and Canadians' impact on it, and the key players who manage it. The second article looks at three ways the boreal forest contributes to Canadian life—in environmental, economic and social terms—highlighting some of the initiatives under way to advance each of these areas and to strike a balance between them. The third article discusses some of the scientific and other initiatives under way in Canada and elsewhere to learn more about the boreal forest and to apply this knowledge to the forest's sustainable development.

Various terms are used differently, or interchangeably, in discussions about the boreal forest. Because "boreal" simply means "northern," the terms "boreal forest" and "boreal region" are both correct. However, they should not be used interchangeably. The boreal forest is the 310 million hectares of forest that lie within the 545 million hectares of boreal region. The boreal forest comprises about 30 percent of Canada's total land.

In Canada, "taiga" generally refers to the more barren area between the boreal forest and the Arctic tree line, where the transition from forest to tundra occurs. The word "taiga" means "forest" in Russian. In that country, "taiga" refers to the boreal forest itself, and some organizations use the term to describe Canada's boreal forest as well. In the articles that follow, the term boreal forest will be used.

To help inform discussion about the boreal, the Canadian Forest Service has prepared the maps "Canada's Boreal Forest" and "Canada's Boreal Region" presented at the end of the report.

A GLOBAL ENDOWMENT

The Canadian portion of the boreal forest starts in the Yukon and northeastern British Columbia, and stretches across the northern parts of the Prairie provinces, Quebec and Ontario, to Labrador and Newfoundland. It forms a band more than 1 000 kilometres wide between the frozen tundra of the Arctic to the north and the more temperate forests and grasslands to the south. It covers about 30 percent of Canada's land mass, and constitutes 77 percent (or 310 million hectares) of Canada's 402 million hectares of forest and other wooded land.

Some 20 species of trees, mostly coniferous, reside in these northern woodlands. The most common species are spruce, fir, pine and tamarack. This predominance of a few coniferous species contributes to the forest's relatively uniform appearance from afar. At closer range, the boreal forest's composition varies considerably depending on climate, topography, soil, and the effects of fire, insects and disease. The result is a patchwork of stands of trees, large and small, old and young, at different successional stages, each supporting different birds and fur-bearing animals.

The boreal forest contains an abundance of Canada's signature wildlife, vast freshwater resources (including an estimated 1.5 million lakes), and some of the world's richest deposits of natural resources.

It supports a myriad of mammals, such as moose, wolves, caribou, bears, rodents,

rabbits, lynx and mink, including both the largest mammals on the continent—wood bison—and the smallest—pygmy shrews. The birds are the most dynamic of boreal wildlife. While some species, such as finches, chickadees, crows, owls, ravens and woodpeckers, remain year-round, most migrate. About half of Canada's 450 avian species use the boreal forest, and up to 5 billion individual birds migrate south and return north each year.

Winters in the boreal forests are long, cold and dark; the growing period is short, and the seasons change quickly. The ground is snow-covered up to eight months a year, and some areas are underlain by permafrost. These factors largely dictate the type of flora and fauna that live here.

Conifer trees are uniquely designed to weather the boreal climate. Their needles, for example, are narrow, with

thick waxy coatings to prevent water loss during the dry winters and to allow snow loads to slide off. Their dark colour helps them to absorb heat from the sun and to begin photosynthesis early in the spring. In the winter, their trunks hold little sap; consequently, their tissues contain few ice crystals.

Several species of mammals and birds have evolved in shape and colour patterns, as well as in behaviours, to cope with the winters. Some, such as bears, hibernate. Others, such as geese, ducks and many types of songbirds, fly south. The chickadee's black and white feather patterns are designed to absorb heat and ensure optimal insulation for their sleep in snow holes. Some mammals, such as the lynx and rabbit, have adapted to living year-round in the boreal environment. The snowshoe hare, for example, changes colour from brownish or greyish in summer to white in winter, to provide camouflage.

GLOBAL CONTEXT

The western extent of the North American boreal forest covers inland Alaska. According to Alaska's Department of Commerce, Community and Economic Development, the state's boreal forest covers 42.8 million hectares and constitutes about one third of Alaska's forest land (the other two thirds are coastal rainforest). Some 9.1 million hectares of Alaska's boreal woodland are currently considered commercial. The main species are white spruce, black spruce,



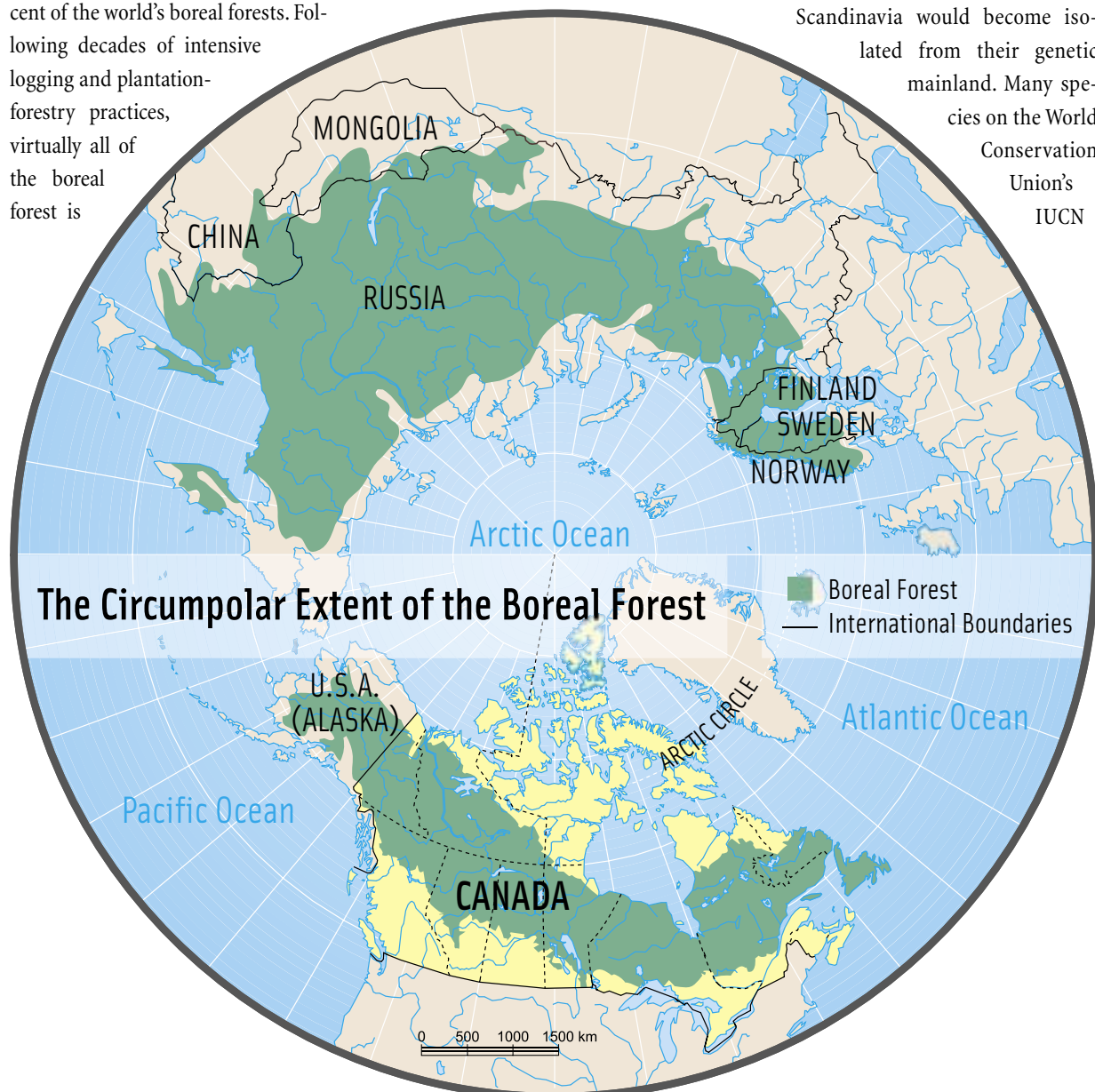
birch, aspen and balsam poplar (cottonwood). Relatively little of Alaska's commercial timber harvest takes place in the boreal area. The industry in this forest is limited to small mills and cottage industries, although interest is increasing and the state legislature has enacted laws that may encourage industry growth. The Alaska Forest Association reports that four landholders manage Alaska's forests: the federal government (51%); state and local governments, including the University of Alaska system (25%); Native corporations (24%); and private landowners (0.4%).

Scandinavia is home to about 10 percent of the world's boreal forests. Following decades of intensive logging and plantation-forestry practices, virtually all of the boreal forest is

intensively managed secondary forest. Some hundred years ago, Finland, Norway, Sweden and Denmark introduced legislation that put restrictions on the harvest and called for regeneration efforts to increase timber production. The result has been a doubling of this production but reduced biodiversity. In Sweden, for example, most of the boreal stands are now younger than 100 years and are dominated by even-aged forest, and the once-large deciduous patches have been systematically removed, leaving most of the remaining deciduous trees to occur in young stands.

Russia grows about 60 percent of the world's boreal forests. Ninety-five percent of Russia's woodland is boreal and slightly more than half (55 percent) is commercially viable. The remaining 45 percent is considered unworkable due to environmental constraints and remoteness from domestic and international markets. The Federal Forest Service of Russia manages about 94 percent of the country's total forest land area.

A green belt runs along the Finnish-Russian border connecting the continental Russian taiga to the more oceanic boreal forests of Scandinavia. Without this ecological bridge the forests of Scandinavia would become isolated from their genetic mainland. Many species on the World Conservation Union's IUCN





Burn Areas Recover on their Own

A study published in *Science* (February 27, 2004) found that wildfires are important ecosystem processes and that burn areas should be left alone to help the area recover.

The article, co-authored by Dr. Fiona Schmiegelow of the University of Alberta, reported that the practice of salvage harvesting to help recoup economic losses following a fire can threaten some organisms when large quantities of biological legacy (such as snags and logs) are removed.

Throughout its life cycle, from standing and downed stages to its inclusion in the litter or soil, dead wood is at the base of ecological processes that involve a wide spectrum of organisms, from vertebrates to decomposer bacteria and fungi.

The study found that catastrophic events, such as wildfire, can help restore an ecosystem that has been depleted by intense human activity, such as certain forestry practices, by re-creating some of the lost structural complexity and landscape diversity. The researchers thus urge more sophisticated management of forests affected by major disturbances. They suggest, for instance, that in areas allocated for timber harvest, the inherent risk of losses due to fire should be factored in, so that the economic consequences of natural disturbances and the perceived need for extensive salvage operations are minimized.

Red List of endangered species for Sweden and Finland still exist in viable populations in the northwest of Russia. This is mainly because Russia's forests in this region have not been subjected to the systematic and intensive forestry methods used in Finland and Sweden.

The boreal forests of North America, Scandinavia and Russia have crowned the planet for millennia. They are the product of natural elements as huge as ice-age glaciers and as minute as insects. Over centuries, these resilient ecosys-

tems have come to welcome major forces such as fire, climate, high winds, drought and floods as part of their life cycle. The important thing now is to ensure that the relatively recent advent of another force—humans—does not constitute an element too powerful for the boreal forest to assimilate.

CREATING A FOREST—FORCES OF NATURE

About 20 000 years ago, a vast ice sheet some 3.2 kilometres thick covered nearly half of North America. Any vegetation

that existed was compressed into the ice-free terrain to the south. As the Earth warmed and the glacier receded, trees and plants gradually spread northward, beginning with the spruce and northern pine (about 18 thousand years ago), followed several thousand years later by fir and birch.

Between 12 000 and 9 000 years ago, all of these species co-existed just south of the glacier, which still covered much of Canada. Rapid warming caused the spruce to decline, leaving the northern pines to dominate. Finally, some 5 000 years ago, Canada's boreal forest began to take on its current identity.

While the glaciers have receded, other massive forces continue to shape the boreal forest mosaic today. Fire, insect attacks and disease occur on a large scale here, much more than in other forest areas, and are the primary sculptors of the boreal forest landscape diversity. These engines of change operate at different times and places across the forest, creating a patchwork or "mosaic" of trees of different size, age and species composition.

Fire is the primary change agent. It is as critical to the health, renewal and survival of the boreal forest as the sun, rain, seasons and other natural phenomena. Forest fires reduce the litter of leaves, logs and needles on the forest floor, and release the nutrients that have been tied up in these materials. The nutrient-rich ash left behind helps to fuel plant growth. Fires also open the canopy to sunlight which, in turn, stimulates regeneration from seeds and roots. Some trees actually require fire to spark their reproductive cycles. The seeds of lodgepole and jack pine, for example, reside in serotinous cones, which are protected by a waxy coating that melts when the heat of a fire affects it, thus releasing the seeds.

The patchy mosaic of plant communities left behind after a fire provides the variety of trees and plant life required to sustain various species of wildlife. The northern caribou, for example, uses jack pine stands of various ages, but tends to over-winter in older stands that maintain high densities of terrestrial and arboreal lichens. Over time and across large landscapes, fire contributes to forest renewal.

Some native insect species too are an important part of boreal ecosystem renewal. They help to decompose litter and eliminate sick or aging trees, thus reducing competition among trees, making the ecosystem more productive, and contributing to the carbon recycling process. Some large insect outbreaks that occur regularly contribute to the boreal forest's life cycle. Outbreaks of spruce budworm occur about every 30 years, lasting varying amounts of time and causing varying degrees of damage depending on the stand. In spite of being part of the forest cycle, pest infestation can have significant economic impacts on the forest sector. Large-scale damage to forest stands can result in increased mortality, fire susceptibility and economic losses for forest-dependent communities. Canada's current pest management strategy for native pests is not to eliminate

them, but to keep the most vulnerable stands alive during the outbreak until the insect's natural enemies can control it.

Like insects and fire, diseases are a normal part of the dynamics of a boreal forest ecosystem. They accelerate the mortality of weakened trees and other plants, and break down dead plant material, thus helping to recycle organic matter. Root diseases are among the most common in the boreal forest. These are often difficult to detect as the fungi that cause them can spread below ground through the root system to other trees, as well as by spores.

CREATING A FOREST—HUMAN FORCES

While nature's forces have been sculpting the boreal forest, a relatively new operative—humans—is increasingly making its mark.

The original human inhabitants of Canada's boreal woodlands viewed the forest not so much as a landscape or resource, but as a world—a complex natural support system on which they founded their lives. It provided food and materials for shelter, clothing, transportation and medicines. It was the substance of their tools and crafts, the source of their spirituality. They often used controlled fires

to manage animals and encourage the renewal that plants needed for survival, and to facilitate hunting and travelling.

When the Europeans arrived in eastern North America in the 1670s, they discovered a New World rich in resources. Among these resources were seemingly endless forests offering unprecedented bounty in fur pelts, and later in wood for the timber trade. By the end of the 1800s, as loggers found they had to penetrate farther and farther north and west to find suitable timber, and as the forces of industry marched alongside them, it became apparent that the forest's resources were not, after all, limitless.

In the late 1880s and early 1900s, the growth of a market in eastern Canada and the U.S. spurred demand for paper. Timber exploitation on a large scale occurred somewhat later along Canada's Pacific coast, in the mid-19th century. The global population growth in the latter half of the 20th century, coupled with industrialization, generated increased demand for lumber and pulpwood. At the same time, technology provided loggers with greater forest access and more efficient harvesting tools to exploit forest resources. Other economic activities, such as mining, oil and gas extraction, tourism and recreation, also saw expansive growth. These activities, individually and in combination, place pressure on the boreal forest.

More recently, another human-induced threat has been identified. As global temperatures rise due to increased greenhouse gases in the atmosphere, the resulting changes in climate could significantly alter the evolution of the boreal forest.

Environment Canada statistical models predict that by the middle of this century Canada's annual mean temperatures could



increase by 3°C to 4°C from the levels they were at in the 1960s, with the most extreme increases (up to 6°C) in the Far North. This increase would have a major impact on the boreal forest—more so than on the world's temperate or tropical forests. These impacts include more frequent and severe disturbances such as fire and insects, changes in the quantity and quality of water resources, and a gradual migration northward of the forest itself.

Soils in parts of the boreal forest are underlain by permafrost. In recent years, researchers have observed that permafrost temperatures in forest and tundra regions have risen and the permafrost zone is receding. Other scientists have observed an increase in vegetation productivity at latitudes between 45 and 70 degrees north, and seed production by boreal tree species along the northern boreal tree line is on the rise.

AN INTEGRAL PART OF CANADIAN LIFE

Canada's boreal forest is integral to the country's history, culture, economy and natural environment. Annual tree rings provide a living record of atmospheric conditions and changes in climate. Much of Canada's history is etched in the trails, roads and campsites that mark the lakes, bogs and hills of the boreal forest. The country's economy is buoyed by its industries, and the climate is moderated by its trees. Millions of Canadians live in or near the boreal forest and depend on the surrounding forest and resources for their social and economic sustenance. For millions more Canadians, the boreal forest is a recreational and spiritual refuge, a place to bike, canoe, bird-watch, camp, fish and take photos, or just to look around and breathe the fresh air. Many of Canada's indigenous peoples live in boreal forest communities. To them, the forest is more than an economic mainstay; it is also



their home, and the foundation of their social structures and cultural values.

The boreal forest provides food and raw material such as timber, wood fibre, game and fish, and cultural and recreational opportunities, as well as aesthetic, artistic and scientific values. Its genetic diversity offers sources of biological materials such as medicines and compounds for research and pharmaceutical purposes. It mitigates floods and drought during times of extreme (too much or too little) water flows, and its wetland acts as a water filter by trapping and removing impurities from flowing water. Its vegetation contributes to soil retention, erosion control, nutrient cycling and soil formation, and purifies the air by removing pollutants along with carbon dioxide from the air and producing oxygen as a by-product.

While forestry is the main boreal forest industry, many other economic activities also take place in the boreal forest. These include mining, oil and gas extraction, hunting, trapping, fishing, tourism and recreation, and the service industries

that support them. Tourism, for example, contributes several billion dollars a year to the economy, and much of the attraction for visitors is the wilderness afforded by the boreal forest.

FOREST MANAGEMENT

Unlike the forests of the United States, Scandinavia and the majority of other nations, most of Canada's forests (93 percent) are publicly owned. The remaining 7 percent are held by private owners.

Slightly more than half of Canada's boreal forest is timber-productive and, of that amount, about half is managed for forestry. The part not managed for timber production is either unavailable because it has been designated as protected areas and reserves, or currently considered inaccessible. About 750 000 hectares—or 0.2 percent of the total boreal forest—are harvested each year. Another 5 to 6 million hectares of boreal forest are disturbed by fire, insect and disease. While the boreal forest, for the most part, regenerates naturally, it is helped when needed by seeding or planting.



Forest management is increasingly undertaken in an open and transparent process. The goal is to provide all members of the forest community with opportunities to voice their views.

Under the *Canadian Constitution Act*, forest management is a provincial/territorial responsibility except on lands such as First Nation reserves, national parks and National Defence sites that are managed by the federal government. Within the boreal forest, the provinces and territories control 92 percent; the federal government, just over 5 percent.

The provinces and territories pursue a balance between the forest's environmental, economic and social values. Based on the concept of "integrated land-use planning," they are moving towards bringing together all parties affected by land use decisions so that they can participate in the decision making and, where appropriate, coordinate their activities and mitigate any negative impacts. These parties include relevant governments, industry sectors, organizations, communities and others who may be affected by the decisions. Taking into account these

various voices, the provinces and territories set the policies, legislation and other regulatory matters in support of the sustainable use of the boreal forest resources. For the forest industry, they grant logging licences, set harvest levels, collect stumpage fees and enforce the other regulatory matters that control harvesting procedures. They also consider other sectors and other management values.

The federal government, through its various departments, plays an important role in forest management. This includes management of federal lands, national and international reporting obligations, forest conservation including habitat protection, protection of endangered species, coordination of Aboriginal issues, provision of reliable information and knowledge on forests, and building of national consensus on forestry matters. The federal government, working with the provinces, territories, Aboriginal groups, and industry, helps provide the foundation for keeping the forest industry competitive worldwide, and develops tools with other nations to help measure forest sustainability around the globe. The Canadian Forest Service (CFS) of Natural Resources

Canada is the federal agency charged with forest responsibilities.

The federal/provincial/territorial forestry relationship is one of coordination, cooperation and partnership. An important coordinating instrument is the Canadian Council of Forest Ministers (CCFM), created in 1985 to provide leadership on national and international issues and set direction for sustainable forest management. For example, it led the development of the first three national forest strategies, starting in 1992. The CCFM continues to work on initiatives such as the National Forest Information System (NFIS) and criteria and indicators (C&I) to access and report information on Canada's forests.

Forest companies share in the responsibility for forest management. Companies with long-term licences to forest land pay cutting fees to the appropriate provincial/territorial government, and produce plans to carry out sustainable management in return for harvesting timber. These management plans must be submitted to the provincial/territorial government for approval before harvesting can take place. The plans detail how forest values will be conserved, and identify, on a map, the areas to be harvested. The plans are updated regularly.

Aboriginal peoples' involvement in sustainable forest management is increasing, shaped by a combination of self-government agreements, land claim treaties, court rulings, and government policies and practices. These processes and activities recognize the historical and fundamental connection of many Aboriginal peoples to forest ecosystems. (For information on initiatives to increase Aboriginal involvement in boreal forest decision making, see text box on page 58.)

BENEFITS OF THE BOREAL FOREST

Canada's boreal forest offers an array of benefits—esthetic, cultural, economic, environmental, historical, recreational and spiritual. It also serves many users, from communities to individual Canadians to industries. The terms “multiple benefits,” “multiple values” and “multiple users” have become inseparable from boreal forest land use discussions.

Several voices speak for these multiple expectations. Environmentalists are calling for increasing amounts of land to be set aside from development. The forest industry requires sufficient timber to meet increased demand and to remain profitable in a world of escalating competition. Other industries, such as mining and energy, are mainly located in the boreal region. For example, 64 percent of the petroleum produced in Canada comes from that region and this percentage increases every year. The people who work in these industries may also wish to have a voice. Millions of Canadians, including the majority of Canada's Aboriginal communities, live in or near the boreal forest, and it is important that these populations share in the responsibilities, decisions and benefits of the land. All Canadians, whether they live in boreal areas or not, increasingly want a say in how their forests are managed.

While the various voices may advocate apparently conflicting views, their demands are not necessarily mutually exclusive. The environmental, economic and social perspectives work alongside each other in the notion of sustainable development, a concept fully embraced in Canada's National Forest Strategy and Forest Accord. And several innovative approaches, from state-of-the-art science and technology to alliances of previously unlikely parties, are emerging to find common ground.

The need, as the Senate Subcommittee on the Boreal Forest (1992) put it, is “to meet the competing realities of preserving the

resource, maintaining the lifestyle and values of boreal communities, extracting economic wealth, and preserving ecological values.” The key to achieving these multiple expectations is innovative management and approaches based on sound science.

ENVIRONMENTAL BENEFITS

Canada's boreal forest, covering 30 percent of its total land area, produces oxygen, filters clean air and water, stores carbon, moderates climate, and protects against soil erosion. It is also a biodiversity reservoir with an abundance of plant, animal and other species that in many cases are unique to this area. To maintain these environmental benefits, the biodiversity of the various species and ecosystems must be protected. And, while the boreal forest is a resilient ecosystem, it faces several threats that could undermine its natural balance.

Three of these threats are outlined below, each with examples of initiatives to minimize and/or adapt to its impacts: habitat loss and fragmentation, insect pests, and climate change. Several measures are in place to address these dangers. They include setting aside more protected areas, developing environmentally benign alternatives to pesticides, and examining the effects of climate change on the boreal forest and finding ways to adapt to these impacts.

Habitat Loss and Protection

Habitat loss is considered by some forest professionals to be the greatest cause of declining biodiversity in the boreal forest. Habitat loss and fragmentation can be the result of the activities of individual resource sectors or the cumulative effect of many sectors. These activities may include large-scale land uses such as oil, gas and hydro-electric development; mining, power and pipeline corridors; agriculture; and roads. Certain forestry activities such as unsustainable harvesting rates can also affect habitat, as can urban growth and air and water pollution.

Conservation may mean different things to different people. Generally it refers to the implementation of measures for the rational use, maintenance and rehabilitation or restoration of natural resources. Protection implies the idea of a threat and refers to regulatory measures, resource management and public education programs aimed at ensuring that ecosystems are maintained in a healthy state.

In Canada, one of the ways that habitat loss is being addressed is through the creation of protected areas—legally established areas, both land and water, that are regulated and managed for conservation objectives. Protected areas include parks, wildlife and forest reserves, wilderness and other conservation areas designated through federal, provincial or territorial legislation. Currently, about 67 million hectares of the total boreal region are protected.

The move to increase the amount of protected land gained momentum in 1992 when the federal, provincial and territorial governments agreed to protect 12 percent of Canada's natural areas in parks or reserves by 2000. While they did not meet the 2000 deadline, they did make considerable progress. In 2002, the federal government made a commitment to significantly expand Canada's national parks system by establishing parks that represent each of the country's 39 natural regions. This National Parks System Plan is just over 60 percent completed.

As of December 2004, Canada had 41 national parks—including 13 located within the boreal region. These parks help to conserve the region's biodiversity. Provincial governments have also created dozens of provincial parks across the boreal forest. Feasibility studies and negotiations are currently under way for the possible establishment of three additional boreal-region national parks, in the Mealy Mountains of Labrador, the Manitoba Lowlands, and the East Arm of Great Slave Lake in the Northwest Territories, as well as for the possible expansion of the region's Nahanni National Park Reserve of Canada. Two other boreal-region national parks have been proposed, one in the Wolf Lake area of Yukon and one in an area still to be determined.

A New Way of Looking at Boreal Forest Protected Areas

Because Canada's boreal forest, particularly in the northern latitudes, supports some of the world's most extensive forests, it presents an unparalleled opportunity for proactive conservation planning. The Canadian Boreal Ecosystem Assessment of Conservation Networks (BEACONS) Project was initiated to develop a new conceptual framework for conservation planning in the boreal forest and taiga areas. It proposes a reverse-matrix model in which the wilderness forms the matrix, and human communities and industrial activity areas exist as islands within it, connected by roads or other travel routes. This reduces the need for traditional protected-area design issues such as size, representation and connectivity. BEACONS is a project of the University of Alberta and the Canadian Boreal Initiative, an independent organization working with conservationists, industry, Aboriginal groups and other interested parties to conserve Canada's boreal region.

Another way to reduce habitat loss is to make land use decisions based on the multiple values and goals of all members of the forest community; this may include consultation with various members of the community. A case in point is the conservation and land-use planning process currently under way in the Northwest Territories (although it is still too early to know whether this process will be successful in reducing habitat loss). This process is designed to identify and establish a network of protected areas along with the development of the Mackenzie Valley pipeline. The N.W.T. Protected Areas Strategy involves a partnership of eight Aboriginal organizations, the territorial and federal governments, environmental organizations, and representatives of the oil, gas and mining industries. In December 2004, the federal government made a commitment to pay half the estimated \$18-million cost of the collaborative conservation planning process, and the N.W.T. government and ENGOs (Environmental NGOs) have committed to paying the other half.

Reserving representative portions of forest ecosystems under some form of "protection" is a fundamental component of any

biodiversity conservation strategy and even of sustainable forest management.

Protected areas, as defined by the World Conservation Union (IUCN), are the cornerstones of conservation strategies. However, the effectiveness and integrity of these protected areas depend in part on conservation activities beyond their borders.

The integration of protected areas into the surrounding landscape using an ecosystem-based approach that combines adaptive management and economic incentives with conservation and participation of local people is increasingly becoming viewed as a conservation alternative to "islands." These "conservation lands," managed to meet objectives that directly or indirectly contribute to the maintenance of biodiversity, can be mapped and evaluated for their effectiveness in conserving biodiversity.

The designation of World Heritage Sites by UNESCO (the United Nations Educational, Scientific and Cultural Organisation) also protects habitat. This designation helps countries safeguard cultural and natural heritage sites around the world that are considered to be of outstanding value to humanity. Canada

NRTEE Reports on Boreal Forest Conservation and Development

The National Round Table on the Environment and the Economy (NRTEE) is scheduled to release a *State of the Debate* report on Canada's boreal forest in September 2005. The report will summarize the economic, environmental and social importance of the boreal forest; identify key challenges to achieving the balance between conservation and development in the region; and make a set of recommendations aimed at governments and other stakeholders.

As background to the *State of the Debate* report, the NRTEE commissioned a series of case studies to inform the work of the Boreal Forest Task Force. The three areas examined are the Muskwa-Kechika Management Area in British Columbia, the Alberta-Pacific Management Agreement Area in Alberta, and the Abitibi Region in Quebec. Each study examines how regulatory and fiscal policy frameworks can be improved to advance conservation in each region.

The NRTEE also commissioned another background report that looks specifically at Aboriginal peoples' experiences in the boreal forest. It summarizes key challenges and opportunities for Aboriginal peoples in boreal resource planning and management, and makes recommendations for further engaging Aboriginal peoples in the region's future.

Summaries of these background documents are available on the NRTEE web site at <http://www.nrtee-trnee.ca>.

has 13 such designated areas. They are a combination of national and provincial parks and historic sites. Another 11 sites are on Canada's Tentative List (a list of sites that may become World Heritage Sites). In April 2004, the most recent addition to the Tentative List, the Atikaki-Woodland Caribou Wilderness Area, was announced. The area straddles the Manitoba-Ontario border and includes the adjoining Woodland Caribou Wilderness Provincial Park in Ontario and the Atikaki Provincial Park in Manitoba. Typical of Canadian Shield boreal forest, it is a landscape of ancient granite outcrops, lakes, rivers, marshes and muskeg, interspersed with pine, spruce and poplar forest. It is also the traditional home of the Ojibway people. The Boreal Heritage Initiative will provide interim protection for the site.

Insect Pests and Pest Management

Insect pests, too, represent a possible threat to the boreal forest. In these northern woodlands, insect pests cause timber losses exceeding 100 million cubic metres a year, a volume equal to more than five times Quebec's yearly timber production.

While native insects are part of the forest's life cycle, foreign species pose a serious threat, as they generally have no natural predators or parasites in the forest to halt their progress, and the indigenous trees and plants have no resistance to them. One such foreign pest is the Larch casebearer, originally from Europe and now found in the boreal forests of eastern Canada and southeastern B.C. The threats posed by invasive alien species are expected to escalate as the global movement of crops, vehicles and people increases, and as average temperatures rise, making Canada's climate more suitable for the survival of some pests.

Native species, too, can cause considerable harm. An outbreak of the indigenous mountain pine beetle is currently taking place in British Columbia and to a lesser extent in Alberta; it is considered to be the largest mountain pine beetle epidemic in North America's history. Starting in central interior B.C. in 1993 and more recently spreading closer to the boreal forest, the epidemic has, according to B.C. government reports, so far killed some 283 million cubic metres of timber. The outbreak has been exacerbated by a lack of sufficiently cold winters that would have killed, or at least reduced, populations. The province also reports that the economic repercussions will be felt by some 25 000 families in 30 communities.

A large-scale effort has been mounted by federal/provincial governments, research institutes, First Nations, academic institutions and industry to halt the outbreak. The Mountain Pine Beetle Initiative focuses on research and forest management options to improve mitigation efforts, reduce the risk of future epidemics, help rehabilitate affected forest lands, and consider response options in non-commercial forest lands.

The Initiative dovetails with provincial measures such as British Columbia's 2005-2010 action plan, which includes recovering dead timber, reducing damage, and restoring forest resources in affected areas, and a B.C./Alberta agreement signed in April 2005 to cooperate in minimizing the spread of the epidemic into Alberta. British Columbia has set aside more than \$130 million in its 2005 budget to address the pine beetle epidemic.

Other destructive native insect species are the white pine weevil and the spruce budworm. The white pine weevil attacks mainly white pine and Norway spruce in eastern Canada, and Sitka, white and

Engelmann spruce in the west. This beetle has become so prevalent in Quebec that Norway spruce and white pine are seldom used in that province for reforestation. Sitka spruce has suffered a similar fate in British Columbia.

Spruce budworm outbreaks occur about every 30 years. Some trees, such as spruces, are more resistant to attacks than others, such as firs. The last major spruce budworm outbreak began in the late 1960s and at its peak in 1975 resulted in the defoliation of 54 million hectares of forest in eastern Canada. The budworm outbreak continued in the 1990s and later in western Canada. Canadian Forest Service researchers have been studying this insect for almost a century. Current research addresses population dynamics, behaviour, simulation models and decision support systems.

Researchers are investigating environmentally benign ways to control insect outbreaks, in all Canadian forest types. A promising area is biological pest control—the use of living organisms to limit the proliferation or destructiveness

of insects. For example, CFS researchers have genetically altered naturally occurring viruses such as *Bacillus thuringiensis*, or B.t., so that they kill the insect pest more quickly, thus reducing the harm an outbreak can cause. The researchers are now pursuing the next step, which involves finding ways to produce a self-limiting virus that dies with the host insect. Other researchers, such as those at the Pacific Agri-Food Research Centre at Summerland, B.C., have developed molecular technologies to identify and eliminate fungal diseases, which until now have been difficult to detect.

The genetic alteration of trees to enable them to resist insect attacks is another non-chemical approach to controlling outbreaks. The CFS is the main Canadian organization involved in forest biotechnology research, which focuses on biological pest control and tree improvement through genetic engineering. The overall goal is to improve forest productivity, generation and protection. No genetically altered tree has yet been developed in Canada, however, and none are growing outside strictly controlled research areas.

Climate Change

Many scientists believe that climate change could greatly affect the boreal forest. While some impacts could have positive effects (for example, higher temperatures could enhance tree growth), the overall effect, especially when combined with other forest stresses (like fire and pest outbreaks), is expected to be negative. The forest industry and forest-dependent communities may have to adapt to changing conditions as a result of climate change. A significant research effort is under way to assess the nature and magnitude of climate change impacts on the boreal forest and to develop adaptation techniques and strategies.

The Canadian Climate Impacts and Adaptation Research Network (C-CIARN) facilitates the generation of new climate change knowledge by bringing researchers together with decision makers from industry, governments and non-governmental organizations to address key issues related to forestry, agriculture, water resources, coastal zone, health, fisheries and landscape hazards. One of the

Spruce Budworm Decision Support System (SBWDSS)

The SBWDSS is a computer-based system that links inventory data and spruce budworm outbreak information to help foresters plan and carry out management activities to reduce the damage caused by outbreaks. Although developed in 1992 by the Canadian Forest Service, it was first used operationally in Saskatchewan, where it has played a central role in planning for the past three years and where, in 2003, the budworm population was successfully reduced in most areas after treatment. The SBWDSS is also being implemented in New Brunswick and in parts of Quebec, Ontario and Alberta.

The integration of inventory data and spruce budworm outbreak information allows managers to plan spraying programs and optimize harvest schedules. The SBWDSS determines a budworm loss value (m³/ha) for each forest stand. This information is then used to improve harvest schedules to reduce the amount of loss in the next outbreak. The information also guides protection programs (insecticide spraying) by providing protection priorities. The system also allows forest managers to evaluate the effects of different protection policies and practices.

Currently, researchers at the University of New Brunswick are using the SBWDSS to quantify the effect of outbreaks on carbon sequestration directly associated with pesticide applications, and to design management strategies for the emulation of natural disturbances.



ECOLEAP



ECOLEAP



FLUXNET

many forestry projects that form part of this national network is Climate Change Impacts on the Productivity and Health of Aspen (CIPHA).

The CIPHA study is examining the impact of disease, insect and other disturbances on aspen, a commercially important poplar species that is prevalent in the boreal forest. The project involves a network of 150 research plots in 25 climatically sensitive areas across western Canada, where the health of aspen forests is assessed yearly. At a Saskatchewan study area, researchers are examining how aspen forests respond under a drought-prone climate, and the results of these initiatives are being used to develop a computer model of aspen growth and die-back that can be applied over time periods of up to one century. Increased frequency and severity of drought are one of the predicted impacts of climate change for parts of the boreal forest. How these forests respond to the stress of changing climate will be important to both forest health and the forest economy.

Other examples of impact research are the CFS ECOLEAP project (Extended

Collaboration for Linking Ecophysiology and Forest Productivity), which studies the effects of climate change on forest productivity, and the Fluxnet Canada Research Network, which is examining the effects of climate and disturbances on the exchange of carbon between the atmosphere and forests and peatlands. Researchers use computerized instruments mounted on towers in the forest to record the exchange of carbon dioxide, water vapour and energy, in order to better understand the effects of climate variability on ecosystem production.

By gaining a better understanding of climate-ecosystem dynamics and the vulnerability of forests to climate change, researchers will be better able to inform policy makers, industry and communities of the impacts of climate change. This in turn can lead to the development of better adaptation strategies.

Some forest management activities required to address climate change are already part of current actions. The options are many and varied, ranging from developing new technologies to introducing new tree species to relocating forestry

operations. In other cases, new strategies and management plans will need to incorporate the changes brought on by climate change. Planned adaptation, whereby future changes are anticipated and forestry practices such as harvesting and silviculture are adjusted accordingly, could significantly reduce losses from climate change. Such activities could include planting more drought-tolerant species in a region where climate change is predicted to increase the degree and severity of drought, or selecting seeds from provenances that are adapted to wide temperature range to reduce plant susceptibility to extreme weather fluctuations. But uncertainties regarding the timing, location and magnitude of climate change impacts present a challenge to incorporating this knowledge into forest management planning and practices.

More research to improve our understanding of the impacts of active forest management on the effects of climate change is needed. Examining options to reduce the vulnerability of forests to fire and insect disturbances, improving the adaptive capacity of forest managers and other stakeholders; identifying

new opportunities for forestry, such as enhancing the commercial value of forests in northern areas and the potential role of biotechnology; and improving communication of knowledge and research—all of these will help ensure that the forest and forestry community will be prepared to address probable climate change.

ECONOMIC BENEFITS

While Canadians want their boreal forest protected, they also want to enjoy the products and economic returns that flow from it. These benefits emanate from several sectors operating in the boreal forest (oil and gas, minerals, metals and hydro-electricity); however, this section focuses on the forest industry. It discusses the economic importance of the industry, two significant challenges facing forest managers (meeting increased consumer demand and escalating global competition), and some of the initiatives under way to address these challenges.

The forest industry is one of Canada's most important economic engines. While about 0.3 percent of Canada's commercial forest is harvested, the economic return on this harvest is considerable. In 2004, the forest industry constituted \$35.9 billion (or 3%) of Canada's gross domestic product. It exported \$44.6 billion in wood, pulp and paper products, and employed over 900 000 individuals in direct and indirect jobs. About half of the country's wood harvest comes from the boreal forest.

The forest industry constitutes the economic backbone of many rural, remote and forest-based communities. An estimated 2.5 million people live in approximately 522 boreal-forest-dependent communities (where at least 20 percent of the community's economy comes from the boreal forest).

The wood and paper products that emanate from the boreal forest are an integral part of daily Canadian living. While lumber and paper are by far the most economically significant products (earning almost \$17 billion and \$15 billion respectively in 2004), others range from railway ties and hockey sticks to paperboard boxes and mousetraps, and countless more.

The challenge for forest managers is to ensure that the forest industry continues to provide products and economic benefits for Canadians while, at the same time, protecting the environmental integrity of the forest and the social and other values it offers. For industry, this means finding ways to meet the rising global demand for products and remaining competitive in the global market, while accommodating the need for increased forest protection and conservation.

The increased global demand for wood and paper products poses a particular threat to the boreal forest. For many decades, the relatively small size of boreal trees made this forest less attractive than some other forest types as a source of timber. However, as world demand for pulp, paper and wood products grew, particularly over the past 50 years, so too did the demand for boreal timber. This increased demand coincided with escalating demands for other resources in the boreal forest, such as oil and gas, minerals, metals and hydro-electric power, and the use of forests for recreation. The result has been a continued pressure on the boreal forest.

Another challenge facing Canada's forest industry is increased competition. Countries such as Finland, Sweden, New Zealand, Chile, and increasingly China, are developing new sources of wood, growing it faster and selling it cheaper. China, for

example, which now accounts for more than 20 percent of the world's plantations, produces more than twice the amount of paper and paperboard that Canada produces. In the solid wood products sector, imports of logs, predominantly from Russia, are increasingly furnishing a Chinese remanufacturing capacity that now exceeds domestic demand in products such as plywood, flooring and wooden furniture. Another region that is significantly changing the dynamics of global wood competition is the Baltic States and the Russian Federation. With more forested area than any other country, including about 60 percent of the world's boreal forest, the Federation is home to a vast and largely untapped forest resource, including almost 55 percent of the world's softwood.

To maintain Canada's position as the leading exporter of forest products, the federal, provincial and territorial governments are working with wood-product associations and the forest industry to diversify Canada's wood-product exports, and to expand offshore market opportunities. Particular emphasis is currently being directed towards China, a growing market that now represents Canada's fourth most important wood-product customer, and an important market for Canada's pulp and paper products. Canadian governments and industry associations are working to further develop this outlet through marketing endeavours such as trade shows, media campaigns, technical training seminars, and initiatives to reduce trade barriers to Canadian wood products.

Canadian officials are also working to reduce the non-tariff trade barriers that could prevent Canadian wood and paper products from entering certain markets. Reducing these barriers has taken

Non-Timber Forest Products

Another way to extract wealth from the boreal forest while protecting its environmental integrity and building on social values is through non-timber forest products (NTFPs). NTFPs are botanical items growing in forests, other than trees, that can be used for food or medicinal, ornamental or industrial purposes. They include, for example, conifer boughs, wild rice, blueberries, medicinal herbs and hundreds more items—possibly as many as 500 across the country. Maple sap products, wild mushrooms and wild fruits are the most important NTFPs for consumption in Canada and abroad.

The current estimated economic output of forest-based foods in the Canadian economy ranges from \$725 million to \$1.33 billion. Additional future economic potential of forest-based food is between \$2 and \$7.4 billion per year. Some experts predict that, as entrepreneurs gain increased access to international markets and as international demand for NTFPs grows, it may be possible to double or triple Canada's harvest of NTFP items. Only in recent years has the potential of NTFPs to national and local economies been recognized. Governments and partners are increasingly looking into how the cottage industry can be developed, particularly in boreal forest communities. (For more information, see special article on page 74.)

on new importance since several multi-lateral trade negotiations have resulted in the reduction of customs tariffs. Non-tariff barriers include codes, standards and eco-labelling requirements, policies regarding recycled content, building codes and factory health regulations. The most powerful tool for fighting these barriers is the framework provided by international agreements.

Another key endeavour for attracting and maintaining customers, both at home and abroad, is certification. In the past two years in particular, certification has become a critical marketing tool and an important part of boreal forest management. Certification allows consumers to buy wood from companies that have demonstrated that their woodlands are sustainably managed. Some governments support certification as part of sustainable management, and may require companies to become certified within a specified number of years. The government of Ontario, for example,

insists that forest company licence holders be certified by 2007. The Forest Products Association of Canada requires that all lands under its members' management be certified by one of the three internationally recognized standards in use in Canada by the end of 2006.

Within Canada, there are three certification systems designed specifically for forests, and one generic system that applies

to several industries, including forestry. (For more information on the number of companies certified under each system over the last year, see page 14.) All of the standards promote sustainable forest management, each in its own way.

One of the forest-specific systems was developed by the Canadian Standards Association (CSA), in consultation with the forest industry and other stakeholders. The CSA takes public land ownership into consideration and therefore requires a rigorous public participation process. The Canadian Council of Forest Ministers' framework of criteria and indicators of sustainable forest management helps define the requirements of this standard.

The second forest-specific system is the Sustainable Forestry Initiative, developed by the United States forest industry, which takes private land ownership into consideration and addresses associated issues of training, outreach and procurement for private land suppliers.

The Forest Stewardship Council (FSC) system has developed a standard formulated specifically for Canada's boreal forest. The FSC's National Boreal Standard consists of the Council's 10 principles and 56 criteria, with many indicators and verifiers customized



to reflect conditions in the Canadian boreal forest, including recognition of the rights of indigenous peoples.

The generic certification system was developed by the International Organization for Standardization (ISO).

SOCIAL BENEFITS

As well as environmental and economic benefits, the boreal forest bestows social benefits. This term embraces concepts as intangible as spiritual and heritage benefits and as concrete as the survival of boreal communities.

This section discusses the social perspective in terms of Canadians' values regarding their boreal forest and, more specifically, the needs and views of communities that rely on the forest's natural resources for their economic well-being. The task for forest managers is to address these sometimes divergent perspectives while, at the same time, maintaining the environmental integrity of the forest. An important part of achieving this goal is to ensure that individual Canadians and boreal communities have the opportunity

to participate meaningfully in decision-making processes.

People's views of the "value" of the boreal forest have evolved considerably. Sustainable development has taken on new dimensions. It has evolved from an expectation of social, economic and environmental benefits, to one that embraces the more intangible benefits associated with non-consumptive forest uses, such as heritage or bequest values and spiritual benefits. It has also moved from the notion of equity between current and future generations to one that embraces the fair distribution of benefits within the current generation and that embodies all forest-related species and the planet as a whole. Also gaining emphasis is the shift from centralized government regulation to community-based solutions and increased public involvement in decision making.

This shift in public values is a central factor in the move by governments to expand decision-making processes so that all parties, including the public, have opportunities to contribute. Management

decision making is increasingly "hands-on": most stakeholders, including interested citizens, are demanding and getting a say in the decisions that affect their forests.

Enhanced public involvement is now set out in forest policies and legislation across the country, and public consultations are an understood part of the decision-making process. For example, Quebec's 2004 examination of the management of its public forests involved 39 days of public hearings over two months in 15 cities and three First Nation communities.

However, land use managers are increasingly recognizing that while mechanisms such as public hearings, local citizen committees, sector councils and regional round tables encourage community involvement and provide a platform for outspoken stakeholders, they do not allow all individuals to express their views and they do not always encourage large-scale public dialogue. Many forest experts agree that an important next step in public engagement is to provide mechanisms that allow individual Canadians to present their views and to

Study of Forest Management in Quebec's Public Forests

The Commission for the Study of Public Forest Management in Quebec tabled its report in December 2004, after a year of extensive public hearings and technical meetings. Among its key findings were that the province's public forests are over-harvested, and that the methods used to assess them and to evaluate the maximum sustainable yield in a particular area are inadequate. It proposed five major changes: a move towards ecosystem-based management and completion of the protected area network, allocations that consider tree quality and the accessibility of forest stands in given areas rather than volume-based wood allocations, better-planned silviculture treatments, preparation for the "inevitable consolidation" of the wood product industry, and decentralized forest management.

The Commission recommended that the suggested corrective actions be integrated into the next set of management plans and that the implementation of these plans be postponed for a year (to 2008) to allow this to be accomplished. In the meantime, it recommended that the maximum sustainable yield for fir, spruce, jack pine and larch be reduced by 20 percent across the province. The Commission stated that while caution should be exercised in setting harvesting volumes, care should also be taken to ensure that companies continue to have access to a stable supply base of timber. The Commission also recommended that the government promptly appoint an implementation committee and a Chief Forester. The government of Quebec is already following through on this recommendation.

participate in decision-making processes. These experts also recognize the importance of timely, unbiased and relevant information that allows other stakeholders to explore and understand the implications of various management options.

The views of people living in boreal communities have additional significance, as their lives and livelihoods are directly affected by land use decisions. Hundreds of long-standing communities, ranging from small settlements to cities, exist in Canada's boreal forest. These communities, particularly the smaller ones, need the resources and capacity to contribute to these decisions.

Governments are facilitating involvement of small communities in land use decisions through programs such as the Sustainable Communities Initiative. This program uses the Internet to transmit government information, with a focus on sustainable development and land use, to indigenous and other communities, so that the citizenry has the information necessary to contribute meaningfully to pertinent decisions. One example is the collaboration between the Initiative, Keewaytinook Okimakanak and the Fort Severn First Nation to increase their capacity to utilize computer-generated maps for land use planning, forestry, and mineral exploration. The Initiative

is a partnership of eight federal departments and agencies, provincial/territorial and community governments, the private sector and voluntary organizations.

Another way that a number of communities contribute to forest management is through the Model Forest Program. Each model forest is a partnership of groups and individuals, including local communities, representing diverse forest values, with each partner having equal say in the future of the resources they oversee. (For more information on Canada's Model Forest Program, see page 62.)

Initiatives to Increase Aboriginal Involvement in Boreal Forest Decision Making

It is crucial that Aboriginal heritage have a place in land use decisions and that Aboriginal peoples share in the responsibilities, decisions and benefits of boreal forest lands and resources. Innovative partnerships and agreements have made significant inroads in increasing the involvement of Aboriginal people as stakeholders, partners, managers, owners and workers in the boreal forest.

Land claim agreements are a primary tool for increasing Native involvement in the management of Canada's boreal forests. While some land claims are in the negotiation process or in preliminary stages, several have been achieved. For example, in January 2005, the Newfoundland and Labrador government and the Labrador Inuit signed a land claim agreement creating a region of self-government in northern Labrador. The Inuit will own 15 800 square kilometres of land and limited resource and management rights in another 56 700 square kilometres. The land features three distinct sub-Arctic zones, from boreal forest in the south, to taiga in the middle, and tundra in the north. It is also home to the world's largest caribou herd.

Another example is the agreement-in-principle signed between the Yukon government and the Kaska First Nation. The landmark solution will ensure a secure supply of timber and manageable economy of scale, create a local market buoyed by long-term tenures, provide new and lasting jobs, and, at the same time, help to ensure the long-term health of the forest ecosystem in the southeast Yukon.

Where agreements could not be reached, the courts have further defined and institutionalized Aboriginal rights and responsibilities in the boreal forest. In November 2004, for example, the Supreme Court of Canada ruled that governments (but not companies) must consult with Aboriginal people about projects that could infringe on disputed land, even if the land claim has not yet been proven. It further ruled that Aboriginal groups cannot veto a government decision made after proper consultation.



Government policies and programs have made important inroads in providing business opportunities and jobs for First Nations. The First Nation Forestry Program (FNFP), for example, helps First Nations build capacity and assume control of the management of their forest resources, establish partnerships with provinces and industry, and participate in off-reserve forestry and other economic development opportunities. The FNFP is a joint initiative of the CFS and Indian and Northern Affairs Canada, managed in partnership with First Nations management committees in each province and territory except Nunavut.

Sustainable Aboriginal Communities research, led by the Sustainable Forest Management Network, helps Aboriginal communities integrate Aboriginal knowledge, values, rights and institutions into sustainable forest management. It also studies the role of sustainable forest management in the social and economic well-being of Aboriginal peoples, and devises structures to foster sustainable Aboriginal communities in forest lands.



The Enhanced Aboriginal Involvement Initiative supports and strengthens the participation of First Nation, non-status Indian and Métis communities in Canada's Model Forest Program to better incorporate Aboriginal knowledge and perspectives into the goals of model forests. It is also designed to increase the participation of Aboriginal Peoples in model forests and socio-economic partnerships that foster sustainable forest management. Projects include documenting traditional ecological knowledge, launching non-timber forest product ventures, and developing Aboriginal forest management plans.

The Waswanipi Cree Model Forest, Canada's newest model forest and the only one led by Aboriginal people,

covers more than 209 000 hectares of boreal forest in Quebec's James Bay area. The 13 partners in the model forest include representatives of First Nations, government, industry, academia and non-governmental organizations. The goal is to maintain and enhance the quality of the area to benefit Aboriginal and other users, and to ensure the economic, social and cultural development of the Waswanipi First Nation.

However, while progress is being made, significant impediments (for example, provincial systems of tenure) still hinder the recognition and protection of Aboriginal rights in forest management. The exact nature of the Aboriginal and treaty rights retained by Aboriginal groups on both treaty and non-treaty lands remains a subject of controversy between governments and First Nations. Over the past 25 years, the courts have been asked to define the nature and scope of Aboriginal and treaty rights, and governments' obligations to Aboriginal peoples. These court decisions, as well as the outcome of ongoing treaty negotiations, will have a significant impact on resource developments in the boreal forest.

International bodies and agreements also address the involvement of Aboriginal people in sustainable forest management. These include, for example, the Convention on Biological Diversity, the United Nations Conference on Environment and Development (UNCED)—Forest Principles, and the Draft United Nations Declaration on the Rights of Indigenous Peoples.

UNLOCKING THE SECRETS OF THE BOREAL FOREST

While demands on the boreal forest have increased, so too have forest research and other initiatives to better understand how the forest works, how its values can be maintained, and how harvesting and other uses can be accommodated in an environmentally sound way. This article discusses some of these initiatives, from scientific research to forest inventories to international agreements and innovative partnerships.

The key to unlocking the secrets of the boreal forest and its riches, while protecting its environmental integrity, lies in a knowledge-centred, innovation-based approach. Forest practitioners have expanded the parameters of forest science research to embrace a wider range of environmental, social and economic considerations.

The quest for more information, such as national inventories, has gained momentum. Foresters are developing increasingly detailed inventories for boreal timber and non-timber resources. Such data will be used to develop computer models and evaluate the impacts of various activities. Forest managers are also working to integrate natural and social sciences, and the traditional scientific knowledge held by Aboriginal and other boreal communities.

Sustainable forest management is so complex and the knowledge needs are so great that no single sector or organization can address the requirements on its own. Innovative partnerships have therefore become key to garnering knowledge, managing activities and sharing information. These partnerships extend not only across sectors and across provinces/territories, but also across borders to other nations.

SCIENCE AND INNOVATION

In Canada, many organizations and agencies pursue forest science and technology. The federal government encourages research in forest management, wildlife, hydrology, fisheries and remote sensing,

and other areas. Several provinces and territories conduct research into operational forest management. Academic research is also important: a number of universities have forest chairs and forestry faculties, and many others (including colleges) contribute to forest S&T in engineering, biology, chemistry, mathematics, computer sciences, physics and the social sciences.

The University of Alberta emphasizes boreal research as an important area of study. In March 2005 an NSERC-Université

Laval industrial research chair in silviculture and wildlife was created to develop silviculture systems adapted to the boreal forest. Université Laval also holds a Canada Research Chair on Long-term Dynamics and Natural Disturbances of Boreal Forests. This research supports the development of strategies for integrated management of natural and commercial forests and of plans to restore ecosystems affected by human-made disturbances.

The main federal organization conducting forest research is the Canadian

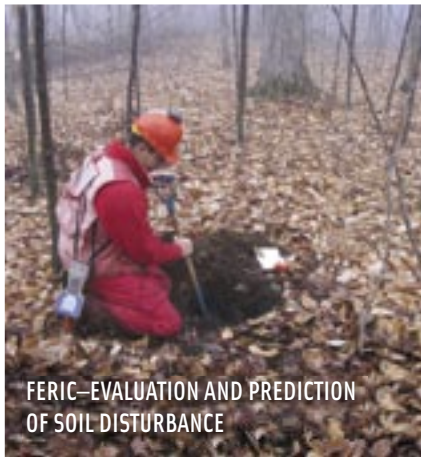


Centre for Northern Forest Ecosystem Research

Ontario's Centre for Northern Forest Ecosystem Research (CNFER) in Thunder Bay is an applied research unit focusing on the effects of forestry practices on boreal ecosystems. Built in 1990, CNFER conducts long-term research on the impacts of full-tree harvesting and on the effects and effectiveness of guidelines designed to protect moose and other wildlife habitat, fish habitat and tourism values. CNFER is now evolving to meet new issues and priorities in forest, fish and wildlife, and water science, with an emphasis on cross-disciplinary approaches.



FORINTEK—CT SCANNER



FERIC—EVALUATION AND PREDICTION OF SOIL DISTURBANCE



PAPRICAN—ROLL TESTING FACILITY

Canada's National Forest Research Institutes

Canada has three national industrial forest research institutes. Funded by governments and the private sector, they conduct research and development into wood product development, forest engineering, and pulp and paper technology. All three institutes conduct research that has implications for the boreal forest.

- Forintek Canada Corp. is Canada's national wood products research institute. Its research centres on innovation and technological advancement to enhance the value of Canada's wood products and to keep the forest industry profitable and sustainable. Its research covers forest resource characterization, lumber manufacturing (optimized bucking, sawing, drying, wood protection), wood building systems, composites and value-added products. For example, Forintek examines the impact of forest management decisions on lumber quality and financial return of species grown in the boreal forest. Forintek's research program provides objective information, in an understandable way, about the life-cycle environmental impact of wood as compared to other competing products.
- The Forest Engineering Research Institute of Canada (FERIC) is a private, non-profit research and development organization, and a world leader in the field of operational forest research and development. It works to improve methods of harvesting, tree growth and wood transportation. Its mission is "to provide its members with technology and knowledge to conduct cost-competitive quality operations that respect the environment." Its areas of research focus on the environmental impacts of forest operations, harvesting and regeneration systems, stand tending, and bioenergy in the boreal forest and other forest types.
- The Pulp and Paper Research Institute of Canada (Paprican) is a non-profit research organization, funded principally by Canada's pulp and paper producers. Paprican is a global leader in pulp and paper research, development and application of technologies, and environmental science. Its research program encompasses the fibre value chain, process technologies, product innovation, and sustainability. Areas of focus include system closure, fibre and product quality, pulping, and paper and board manufacture. New research is being directed towards exploiting the characteristics of fibres from the boreal forest in various board and paper products and novel nano-materials, and as a source of biofuels.

Forest Service (CFS) of Natural Resources Canada. For more than a hundred years, the CFS has been studying the nation's forests and providing the sector with leading-edge science and expertise. CFS research focuses on understanding forest ecosystems and developing strategies for advancing sustainable forest management.

Areas of research include biotechnology, climate change, forest fires, forest and landscape management, pathology, silviculture and regeneration, and socio-economics. The CFS works with industry, provinces/territories, Aboriginal people and others to develop innovative approaches to sustainable forest

management practices; to advance technologies and systems for collecting and integrating information; and to provide scientific, technical and policy advice for national and international initiatives.

In order to successfully apply basic forestry principles, boreal-specific knowledge is

required. For example, to make balanced decisions concerning conservation, it is important to know how the concept of connectivity applies in the boreal setting. The effect of climate change is another area requiring boreal-specific study.

Environment Canada's Western Boreal Conservation Initiative (WBCI) looks specifically at the western and northern boreal forest. The western boreal forest has seen an explosive rate of development in the past 15 years, and commercially productive forest lands in Alberta, Saskatchewan and Manitoba have been almost completely allocated to large-scale forestry and other uses, such as oil and gas exploration in Alberta and hydro-electric development in Manitoba. The WBCI is one of seven Ecosystem Initiatives across the country working to achieve ecosystem conservation and protection, especially with regard to migratory birds. It conducts scientific research and monitoring; provides science-based advice; undertakes conservation activities for important habitats and species at risk; and collaborates with universities, industry, governmental and non-governmental agencies, Aboriginal groups and communities.

The Canadian Model Forest Program is particularly successful in partnering for scientific research and sustainable forest management. Seven of the eleven model forests in Canada are located fully or partially in the boreal region. Each model forest is a giant, hands-on laboratory, managed by a group of partners with different perspectives working in close collaboration. The model forests share their information with the forest community and the public across Canada and with model forests in other nations. The research conducted by the seven model boreal forests focuses on the effects of climate change on the levels of sustainable timber harvest in the boreal forest; the ecological and economic impacts of a multi-cohort system for sustainable forest management in coniferous and mixed-wood forest types; the impacts of natural disturbances, insects, disease, fire, floods and wind on the boreal forest; and the monitoring and assessing of woodland caribou, bear and moose habitat requirements and management.

Research into the social and economic consequences of actions in the boreal environment is an important and relatively new

area of investigation. As in other sectors affecting the natural resource base and environment, Canadians and forest stakeholders must increasingly weigh questions of equity, public good, and aspirations of individuals and communities.

A leader in this area is the Sustainable Forest Management Network (SFM Network), one of 18 Centres of Excellence across the country. The SFM Network delivers new scientific insights into forest sustainability through a comprehensive university-based research program that crosses scientific disciplines and sectors. Hosted by the University of Alberta, the SFM Network has supported extensive research on the boreal forest, focusing on natural disturbance management, policies and institutions for sustainable forest management and Aboriginal communities, and emphasizing integration of social and natural sciences. Several provinces have used Network findings in formulating their forest policies. To ensure its research moves easily into the hands of end users, the SFM Network produces synthesized research documents, maintains a web site, and sponsors workshops that facilitate collaboration between researchers and users.

INDUSTRY, AN ACTIVE RESEARCH PARTNER

The forest industry, through individual companies and through associations such as the Forest Products Association of Canada (FPAC), is an active participant in the quest to unlock the secrets of the boreal forest. For example, FPAC reports that its members, which constitute 75 percent of the industry, spend over \$350 million a year on research and development in-house, at industry research institutes (see text box on page 61), and at colleges and universities.



Boreal Criteria and Indicators

A leading innovation in forest management is the criteria and indicators framework. Criteria are the forest values, goods and services that Canadians wish to enhance and sustain. These go beyond traditional timber values to embrace aspects such as wildlife habitat, water quality, community stability, Aboriginal involvement, recreation and biodiversity. The indicators are scientific factors used to assess progress in achieving the criteria. Together, the criteria and indicators provide a framework for describing and measuring the state of forests, the values associated with them, forest management practices, and progress in sustainable forest management. By tracking changes, they provide a valuable tool for targeting research and formulating sustainable forest management policies.

In January 2004, FPAC announced a commitment of \$1 million over five years, plus resources in kind, to projects that advance conservation in the boreal region and promote greater understanding of boreal ecosystems. Projects are under way and others continue to be developed in partnership with the Canadian Boreal Initiative (CBI) as part of broader efforts between the two organizations to expand dialogue and jointly identify initiatives to advance boreal conservation. Among the initial projects developed and producing results are research and conservation activities led by World Wildlife Fund Canada and Ducks Unlimited Canada.

The CBI is an ENGO-led example of the innovative partnerships that are increasingly characteristic of boreal forest research. The CBI is an alliance of conservation organizations, resource companies and First Nations that have joined forces to articulate a joint vision and plan for Canada's boreal forests and wetlands. In December 2003, the 11 lead organizations that constitute the Boreal Leadership Council released the Boreal Forest Conservation Framework, which calls for an interconnected network of large-scale protected areas and conservation lands, state-of-the-art sustainable development practices on the remainder of the landscape, and local community

and Aboriginal groups engagement on land management decisions.

In September 2003, representatives from the Government of Canada, provincial governments and the forest industry established the Canadian Forest Innovation Council (CFIC), with the endorsement of the Canadian Council of Forest Ministers (CCFM) and the Forest Products Association of Canada. The CFIC is an executive-level body that aims to improve the innovation capacity of the Canadian forest sector, by influencing the research agenda and setting strategic priorities. Since its creation, the CFIC has supported several activities towards the creation of a national forest innovation system that responds to the sector's needs.

INVENTORIES

Credible boreal forest research requires detailed, up-to-date, boreal-specific information. Boreal-specific data are also required to monitor the progress of sustainable development efforts, and to meet national and international reporting commitments. Two initiatives that will contribute to the cache of boreal-specific knowledge are the National Forest Inventory and the National Forest Information System.

Canada's National Forest Inventory (CanFI) is compiled from provincial and territorial inventories aggregated to national standards. The current version, CanFI 2001 (released in 2004), represents the data from 57 agencies. These data have helped define the area of forest and other wooded land in the boreal region, as well as forest type composition and age structure, and the area currently protected in this region.

While this approach is cost-effective and well established, it does not reflect the most current state of the forests and cannot be used as a satisfactory baseline to monitor change. CanFI lacks information on the nature and rate of change to the resource and does not permit projections or forecasts.

To address these limitations, the Canadian Forest Inventory Committee—a subcommittee of the CCFM National Forest Database Program Steering Committee—developed a new approach for a national forest inventory. The new National Forest Inventory (NFI) consists of a plot-based system of permanent observational units located on a national grid.

The new NFI will enable the extent, state and sustainable development of Canada's forests to be monitored promptly and accurately. It will allow for consistent reporting across the country and establish baselines that indicate where the forest resources are and how they are changing over time. In addition, the NFI will support collection of additional data reporting progress towards sustainable development (e.g., socio-economic indicators), as well as data related to forest health (e.g., insect damage, disease infestation), biodiversity and forest productivity. Both these aspects are key to understanding boreal forest dynamics.

Keeping track of Canada's forests means pulling together information from across the country. Governments, First Nations, industry and non-governmental organizations all collect data about the forests in their area. Under the CCFM, a new National Forest Information System (NFIS) brings together all of this information on Canada's forests and make it universally available. It will report information on topics such as forest cover, including species, age, volume and disturbance history, transportation infrastructure, silviculture activities, protected areas, relief, and administrative boundaries. The NFI will be available to collaborators, clients and the general public on the internet through the NFIS.

INTERNATIONAL INITIATIVES

Many countries, both boreal and non-boreal, recognize the need to sustainably develop this global resource. Research initiatives cross national and regional boundaries, and emanate from governments, multinational organizations, scientific networks, environmental groups and others. Some are boreal-specific;

others are broader, with applications in all forest types.

Indicative of the increasing world attention on the planet's circumpolar forests was the recommendation passed in November 2004 by the World Conservation Union (IUCN), which called on Canada and Russia to protect the health of the boreal forest, undertake conservation planning before development, and respect the rights and interests of Aboriginal people in land use decisions. Canada and Russia endorsed the recommendation as members of the 78-nation IUCN, which includes 112 government agencies, 735 NGOs, and thousands of experts and scientists from 181 countries.

The Model Forest Program, which originated in Canada in 1990, now forms a scientific and information-sharing network in 17 nations and covers a total area of more than 25 million hectares. Several of the 32 model forests that constitute the International Model Forest Network reside in circumpolar forests, and more are planned. The Gassinski Model Forest in the boreal forest of Far Eastern Russia, for example, was created in 1995 and over

the past decade has set aside protected habitat for the endangered Siberian tiger, established protected areas for threatened flora, and designed the region's first long-term development strategy focused explicitly on sustainability. Russia is currently developing two more boreal model forests. Another recent addition to the network is Sweden's Vilhelmina Model Forest, officially announced in spring 2004. This new entry is the first of a planned network of model forests in the Barents Region across the northern parts of Sweden, Norway, Finland and Russia. It covers 120 000 hectares, including 58 000 hectares of forest land, northern ecosystems and several indigenous communities. Nine other countries are either in the process of developing model forests or have expressed a strong interest in doing so.

Canada is involved in a range of international forest science and technology initiatives. These include formal collaborative research programs with other nations and working arrangements between individual scientists. For example, Canada participates in the International Boreal Forest Research Association, formed in 1991, to promote



MODEL FOREST, ARGENTINA



MODEL FOREST, CHILE

and coordinate research into the role of the boreal forest in the global environment, and the International Union of Forestry Research Organizations (IUFRO), a non-profit network that promotes international research related to the well-being of forests and the people who depend on them. The Working Party on Temperate and Boreal Forest Restoration coordinates research aimed at developing new techniques and management approaches for restoring the sustainability of degraded forest landscapes, thereby increasing their environmental, social and economic value.

Canada has taken several steps to advance the international dialogue on key forest issues. These include the Montréal Process on criteria and indicators for the sustainable development of boreal and temperate forests outside Europe. Launched in 1994, the Montréal Process is the largest of nine regional and international C&I systems to guide the monitoring, assessment and reporting of forests and improve forest policies and practices. Its 12 member countries (including Canada, the U.S. and the Russian Federation) span six continents, and account for 90 percent of the world's temperate and boreal forests.

International agreements can make significant contributions to change, and Canada is signatory to several such agreements that pertain to forest management. These include the Convention on Biological Diversity, Framework Convention on Climate Change, Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES), Kyoto Protocol, UNCED forestry principles and trade agreements.

The United Nations is an important forum for discussion of international forest issues. Canada participates in several UN-sponsored forums, conventions

and other initiatives that impact directly or indirectly on boreal forests. For example, Canada participates in the North American Forest Commission (NAFC), one of six regional forestry commissions under the FAO (the UN Food and Agriculture Organization). The NAFC provides a policy and technical forum for Canada, Mexico and the United States to discuss and address forest issues on a North American basis. As these countries contain a mix of boreal, temperate and tropical ecosystems, the results of the commission's work can be applied more broadly to assist other countries and regions facing similar conditions.

Canada is also a member of the United Nations Forum on Forests (UNFF), established in October 2000. The UNFF is considering the parameters of a mandate for developing a legal framework for all types of forests. Canada has long been a leading proponent of a framework, such as an international forest convention (IFC), that would integrate economic, environmental and social considerations with forest management. Currently, no single international binding agreement exists. Canada's position, shaped in partnership with provincial/territorial governments and considering the views of Aboriginal groups and major Canadian stakeholders, is that an IFC would accelerate progress towards the sustainable management of the world's forests.

Several countries agree that an IFC would be the best way to achieve the sustainable management of the world's forests and increase financial resources for forests. At the 5th UNFF session in May 2005, Canada expressed its desire to achieve an IFC; however, no agreement was reached at the meeting. In the end, it was agreed to postpone negotiations until the next UNFF meeting in February 2006.

LOOKING AHEAD

Much has been discovered about forests in general and the boreal forest in particular, but much remains to be learned. Research is continuing into areas such as the role of old-growth forests in maintaining ecological processes, the effects of silvicultural regimes and fire suppression, strategies for controlling fire, disease and insects, how species interact with each other and the landscape, how the concept of connectivity applies in the boreal setting, and the effects of climate change in the boreal setting.

Ultimately, Canada's boreal forest needs to continue to provide both habitat for wildlife and a sustainable resource base for people long into the future. All Canadians—from individual citizens to large corporations to governments—need to work together to make wise decisions.

The process for achieving this has already begun: the quest for knowledge, especially boreal-specific knowledge; the building of partnerships and cooperation; and the welcoming of all stakeholders, including the public, into the decision-making processes. The opportunity awaits us.