BRUCE PETERSEN

site, however, will themselves start to sequester carbon at a rapid rate once the young trees become firmly established However, it is mature stands of living trees that are most effective in storing carbon on the forested site.

Even when logging is followed by planting or natural regeneration there is usually a loss of carbon, over and above the fluctuations on the land base as mature forests are removed and replaced by young and rapidly growing trees. In general, the conversion of intact (or "primary") boreal forests into managed "secondary" forests results in a loss of carbon. This happens for three main reasons. First, there is significant deforestation from the creation of a new network of more or less permanent roads. Second, secondary forests are usually logged at a younger age than the average natural lifespan for that species (called the natural disturbance interval), meaning that the average age (and volume) of the forest is reduced. Third, even where the logging (or "rotation") age is similar to the natural disturbance interval (such is in a heavily fire-dominated region) there is still a loss of carbon, because logging targets high-volume stands whereas fire acts more randomly across the landbase, leaving significant pockets of high-volume old growth forests intact.

GREGOR BECK

Forest fires leave a much healthier forest behind compared to logging.

What role are Canada's forests playing?

At present, Canada's forests are estimated to be a significant net source of carbon, meaning that they are emitting more carbon into the atmosphere than they are sequestering. In the early part of the 1900s, the forests are estimated to have been a significant carbon sink. Starting in the 1970s, the net annual storage began to decline sharply, and by the 1980s Canada's forests became a net source of carbon. This dramatic change is likely due to a sharp increase in insect infestations and forest fires, with some of these increases potentially due to climate change itself.

What can be done to ensure that Canada's boreal forests help to mitigate climate change?

In general, one of the best ways to increase the amount of carbon stored in a forest over the long term is to increase the average age of that forest over time. This is because older forests generally store more carbon than young forests, even though the younger trees are growing rapidly and are sequestering carbon. There are several ways to increase the average age of the forest. Protected areas and wilderness reserves, when established in intact forests, usually result in greater carbon storage than would be the case if those same forests were logged and converted to intensively managed second growth forests. In a forest that has already been converted, it is possible to increase the average age by lengthening the rotation age, which is the age at which a forest is considered to be ready for another round of commercial logging. This can also have significant benefits for wildlife that depend on older forests for their habitat requirements. If the rotation age in a managed boreal forest is increased from 80 to 100 years, for instance, this will result in a 60% increase in the amount of forest 60 years or older.

ANDREA MAENZA

Paper mills produce newsprint, toilet paper and other short-lived products from the trees in the boreal forest.

Establishing protected areas and lengthening the rotation age both have significant environmental benefits, in addition to the contribution towards mitigating climate change. There are other proposals that have been made to use forests to help mitigate climate change, but often the benefits have been exaggerated and/or the risks minimized. Intensive forestry can increase the growth of young trees, for instance, but the gains in carbon are usually offset when the trees are logged earlier than would otherwise be the case. Some forest industry advocates are keen on promoting the benefits of using forest products since carbon is stored in those products, but the validity of this strategy depends on the longevity of the products and much of Canada's boreal forests are used to make relatively short-lived products such as newsprint and toilet paper.

There is also considerable interest in encouraging tree plantations, but these also tend to be short-lived forests with low carbon stocks and there are environmental risks when relying on single-species monocultures.

How can I learn more?

Below are some websites that have information relating to climate change and forests.

International
Intergovernmental Panel on Climate Change: www.ipcc.ch
Framework Convention on Climate Change: unfccc.int

Government of Canada
Government of Canada: www.climatechange.gc.ca/english/index.shtml
Environment Canada: www.ec.gc.ca/climate_e.html
Natural Resources Canada: climatechange.nrcan.gc.ca/Index.asp

Non-Governmental Organizations
Canadian Parks and Wilderness Society: www.cpaws.org
Sierra Club of Canada: www.sierraclub.ca
Pembina Institute: www.pembina.org
David Suzuki Foundation: www.davidsuzuki.org

Canada's Boreal Forest
CPAWS
true north, wild & free

This climate change factsheet is one of a series of boreal forest factsheets published by CPAWS.

CPAWS National Office
1 (800) 333-WILD / www.cpaws.org / info@cpaws.org

What can I do?

Reduce your energy "footprint". Walk, cycle, take transit or car pool. If you need a vehicle, buy one that is fuel efficient. Explore ways to reduce the amount of energy you use to heat, cool and light your home.

Think about the wood and paper you use. Avoid unnecessary use, which helps to increase pressure on the world's dwindling forests. Reuse and recycle whenever you can. Used properly, high quality wood products can perform a valuable service for a long time, and store carbon at the same time.

Speak for the trees! Help to protect the boreal forest in Canada by encouraging the government and industry to adopt better forest practices. Look for wood and paper that has been certified by the Forest Stewardship Council as coming from well-managed forests.

Think big! Support CPAWS' conservation vision that seeks to adequately protect significant forested areas in Canada. Large protected areas are important in conserving biodiversity and important wildlife habitat. They also store carbon effectively, and help to create the conditions that will allow forests to adapt to a changing climate.

Written by Martin Von Mirbach – Sierra Club of Canada. Thanks to the Climate Action Network for their support of this project.

CANet ResACC

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Canada's Boreal Forest
CPAWS
true north, wild & free

Boreal Forest Factsheet

FOREST: GREGOR BECK; LIGHTNING: J. FOSTER.

Climate Change and Canada's Boreal Forests:

What's the Connection?

Canada's boreal forests span the country, sweeping down and across Canada from the Yukon to Labrador and Newfoundland. This magnificent landscape is home to hundreds of species of plants and animals, some found nowhere else in the world and many of which are already at risk for extinction. Most Canadians take this forest for granted; it has always been a part of the fabric of Canada and most assume that it always will be. Also taken for granted are the benefits derived from its air-filtering, water-filtering and climate-mitigating properties, all of which are essential functions for our overall well-being.

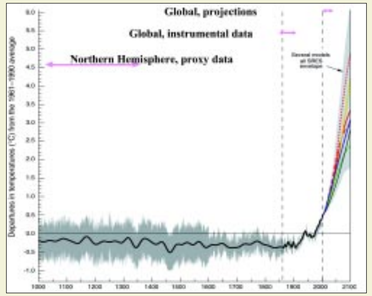
The Canadian Parks and Wilderness Society (CPAWS) is an advocate for the protection of significant, connected boreal forest ecosystems in order to preserve both the animal species which rely on the forest and the ecological processes that provide us with clean air and water. The need to protect our forests has become pressing since resources in other parts of Canada and the world are being exhausted and industry is now turning to the more economically "marginal" forests of the north to feed their need for timber. At the same time the industrialization of the earth has caused an imbalance in the amount of carbon that is being released into the air, ultimately leading to climate change. Now more than ever, we need the boreal forest to perform the valuable job of removing carbon from the atmosphere to help slow the potentially devastating effects of severe climate change.

Canada's boreal forest plays a key role in modifying the impacts of climate change, but climate change still threatens boreal species like wolvernine (top).

AERIAL: EVAN FERRARI; WOLVERINE: CLINTON D. LONG, THE WOLVERINE FOUNDATION INC.

What is causing the climate to change?

The global climate is being affected by human-induced releases of certain greenhouse gases in the atmosphere, especially carbon dioxide, or CO_2. The prime source of these anthropogenic (human-origin) greenhouse gas emissions is the burning of fossil fuels, although at a global scale deforestation is also a significant factor.



This graph shows long-term temperature trends for the northern hemisphere. It combines information about historical trends with the projected results of various scenarios developed for the Intergovernmental Panel on Climate Change's *Special Report on Emissions Scenarios*. The period from 1860-2000, which is based on direct measurement and is therefore the most reliable, shows the striking upward trend in temperature that has triggered concerns about climate change. The historical trend shows that this rise in temperature is unprecedented over the past millennium. The various future projections all predict a continuation of the sharp upward trend recorded over the previous hundred years.

Why should we be concerned?

Scientists are working to learn more about the actual and predicted impacts of climate change on boreal forests, but the most significant impacts include:

a) changes in climatic zones, so that much of the land currently in boreal forest will have a climate now found in warmer regions and better suited to temperate forests;

b) increased forest growth, due to warmer temperatures, longer growing seasons and the "fertilization" effects of enhanced levels of atmospheric CO_2

c) shifts in the geographic distributions of boreal species;

c) increased outbreaks of insects and diseases, which can migrate quickly into new areas where the climate has become more conducive to them;

d) increased frequency and severity of fires, especially in regions that see reduced precipitation; and

e) increased damage due to extreme weather events, such as freak windstorms and the like.

There is growing evidence that we are already experiencing these impacts. There's been a significant increase in the number and extent of forest fires in the past two decades, as well as outbreaks of insect infestations in regions where they were not previously found to the same degree. World-wide, recent reports indicate that hundreds of species already are responding to the increased warming, showing changes in breeding seasons and shifts in geographic ranges.

These impacts are caused by greenhouse gas emissions, whether they result from deforestation or from the burning of fossil fuels. Solutions must come not just from the forestry sector but must include intense efforts to reduce emissions through energy efficiency, reduced demand and conversion to appropriate renewable energy sources.

CARIBOU: WAYNE SAWCHUK

The heavy use of fossil fuels is affecting the planet's climate – and impacting wildlife such as woodland caribou..

How can boreal forests adapt to a changing climate?

Forests can't simply pick up and move when the climate moves northward. Nor would it be practical for us to play a significant role in relocating the thousands of species that these climatic changes would affect. Canada's forests currently cover over 400 million hectares, an area so great that it is unthinkable to manage direct interventions on any significant portion of that vast landscape.

Over the long term, effective adaptation to climate change will require plant and animal species to migrate and relocate to areas better suited to them. Industrial developments and forest fragmentation tend to restrict this migration, however. Therefore it will be especially important to establish large interconnected protected areas in the boreal forest; wild landscapes that offer opportunities for species to migrate *en masse* into new habitat. Narrow corridors do not do this, but visionary approaches like the Yellowstone to Yukon Initiative (Y2Y – see CPAWS' website at www.cpaws.org for more info on the Y2Y Initiative) will become especially important as the impacts of climate change become more prevalent.

FIRE'VEL FILES: MILL, DEBORAH FREEMAN

Deforestation and the increase and severity of forest fires have contributed to climate change.

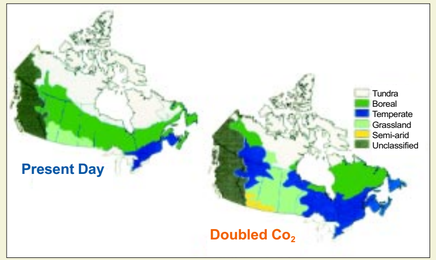
Can boreal forests help to solve the problem?

When carbon is stored in forests (in living trees [biomass], dead biomass or soils) or in forest products, it is not in the atmosphere. Loss of forests on a global scale contributes significantly to climate change. On the other hand, the possibility of expanding carbon storage in forests (i.e., creating "sinks") has been identified as a potential short-term measure to mitigate climate change.

Forests are significant reservoirs of carbon. The process of photosynthesis removes carbon dioxide from the atmosphere and stores the carbon in a solid form, in the trunks, branches, leaves, needles and roots of growing trees. When those trees eventually die much of that carbon gets released back to the atmosphere, either immediately as a result of fire, or more slowly through decay. A portion of the carbon absorbed from the atmosphere, however, may be incorporated into the soil and kept out of the atmosphere. This is especially true in Canada's boreal forests, where the steady deposit of litterfall and dead branches from trees helps to build the organic richness of the soil and locks in the carbon.

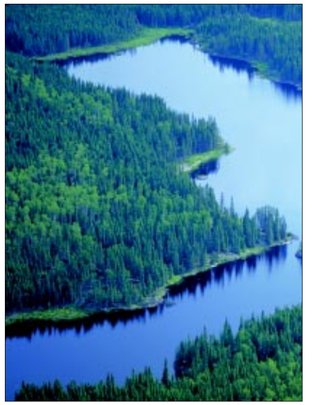
This build up of soil carbon is a very slow process. It has taken roughly 10,000 years since the last ice age to develop the soils of Canada's boreal forests, but the total amount of carbon stored in the soil is immense, and the amount could continue to increase as long as ecosystem processes are carefully maintained.

Changes in Forest and Grassland Boundaries



The map on the left shows the approximate current boundaries of land cover types in Canada (although forest types in British Columbia and the Yukon and lands north of the forested regions were not factored into this scenario modeling exercise). On the right is a map showing the projected land cover changes after a doubling of atmospheric carbon dioxide, which is currently thought to be a conservative estimate of where CO_2 levels are heading. It shows that large areas of the boreal forest across Canada will no longer be in the climatic zone best suited for boreal forests. That doesn't mean that the existing forests will suddenly be replaced by temperate forests or grasslands, but rather that the forests currently there will be under particular stress. (Source: Environment Canada)

Disturbances – whether natural such as fire or insect attack or human-caused such as logging – result in carbon being released back to the atmosphere through the processes of combustion or decay. Over the long term much of that lost carbon can be regained by the regrowth of a new stand of trees on the same site, but there are many factors that must be carefully considered. When the gain of carbon in a forested landscape is considered to be greater than the natural and human-caused losses then the forest is considered to be a carbon *sink*. There has been a great deal of interest in forest sinks ever since their inclusion in the Kyoto Protocol.



Canada's forests act as a significant carbon sink.

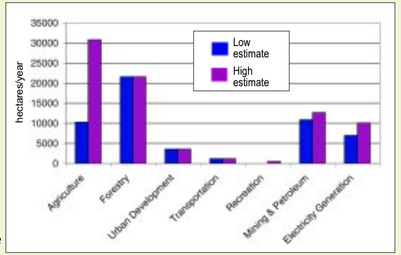
BRUCE PETERSEN

Logging and other industrial activities can disrupt the natural carbon cycle. When the land is removed permanently from forest cover, such as for building roads, seismic lines, hydroelectric reservoirs and power lines, the resulting deforestation means that less carbon is absorbed in forests and more is released to the atmosphere.

Besides the deforestation that results from road building, forestry activities have other impacts on the amount of carbon stored in forests. Logging activity results in significant releases of carbon to the atmosphere, through the decay of leaves and branches, and in some cases, soil carbon. Forest products themselves may store carbon in a solid state for a period of time, with the actual length of that period depending on the product made as well as the purpose for which it is used. When boreal forests are used to make newsprint, the result is usually a fairly rapid return of the carbon to the atmosphere. Lumber and solid wood products generally last longer, but there can be wide variations here, with some lumber used to make high quality furniture that will be treasured for generations, while other wood is used to make plywood that might be used for a construction hoarding and then discarded. Clearcutting and post-harvest site preparation (such as scarification) expose the soil to sunlight, which dries it out and speeds up the decomposition of soil organic matter, resulting in a release of carbon to the atmosphere. The trees that grow back on the

Estimated Annual Deforestation, by Source

This chart shows the estimated extent of annual deforestation in Canada. The low and high estimates for the total area deforested annually are 54,600 and 80,500 hectares respectively. This is a small percentage of the entire area of Canada's forests (418 million hectares), but in absolute terms it is nevertheless a significant amount.



In some regions of Canada the impacts of deforestation are particularly intense. In northern Alberta, for instance, there is increasing concern about the cumulative impacts from the construction of seismic lines, well sites, pipelines and roads.

As well, Québec Hydro is currently carrying out an environmental assessment for a new phase of the James Bay hydroelectric project, which could see the creation of a new reservoir as large as 950,000 hectares. Proponents of hydroelectric megaprojects often overlook the considerable deforestation impacts when they promote these projects as providing "climate-friendly" electricity alternatives to fossil fuels. (Source: ESSA Technologies, 1999)

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