



**ROBBING THE CARBON BANK:  
Global Warming & Ontario's Boreal Forest**



**FORESTETHICS**

### ***Acknowledgements***

ForestEthics would like to thank Sara Wilson for her research, and Christopher Hatch for his advice and editing of this report. We would also like to thank Stewart Elgie, Jim Ford, and many others for their helpful suggestions and additions in the peer review process. We would also like to thank the Canadian Boreal Initiative for their support and the Ivey Foundation for their support and tireless commitment to conserving forests and forest values in Canada.

## Executive Summary

The logging of intact forests is one of Canada's least recognized drivers of global warming. Ontario's Boreal forests store massive amounts of carbon and the industrial logging of these forests is a significant contributor of carbon dioxide, the main greenhouse gas (GHG) that is causing global warming. The government of Ontario has an opportunity to address global warming in part by prioritizing protection of intact Boreal forest and by altering harvest rotations to grow older trees and encouraging increased recycled fibre use. Global warming is now the top concern of the public and government can no longer afford to mismanage the issue. Already, 79 percent of Ontarians believe protecting intact forests and planting trees are the most important measures government can take to address global warming.<sup>1</sup> Forests absorb carbon dioxide, storing carbon in their trees, plants and soils. Intact forests store enormous amounts of carbon, which provide a bank for carbon that would otherwise increase greenhouse gases in the atmosphere, thereby accelerating global warming. As this report shows, the logging industry is systematically cutting into Ontario's carbon bank.

- Logging forests in Canada creates more global warming than all the passenger vehicles in the country.<sup>2</sup>
- The Ontario Ministry of Natural Resources estimates that forests managed for timber contain 25 to 50 percent less carbon than natural intact forests. They also report that conserving intact forests is the most cost-effective way to preserve carbon. Other management strategies are, at best, ten times less effective at storing carbon.<sup>3</sup>
- Canada's Boreal forests store a whopping 47.5 billion tons of carbon -- 7 times the entire world's fossil fuel emissions.<sup>4</sup> The Canadian Boreal stores more carbon than any other terrestrial ecosystem. Yet these forests are still open to business as usual industrial logging.
- Every year, logging in Ontario releases an estimated 15 million tons of carbon dioxide (CO<sub>2</sub>; equal to 4 million tonnes of carbon), approximately equal to Ontario's emissions from all light-duty gasoline trucks.<sup>5</sup>

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<sup>1</sup> McAllister Opinion Research, Environmental Monitor, 2006

<sup>2</sup> Environment Canada. 2006. *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2004*.

Submission to the United Nations Framework Convention on Climate Change. April 2006 Advance Copy.

Logging in Canada releases on average 33 Mt of carbon (122 Mt CO<sub>2</sub>) into the atmosphere each year, which is equivalent to 16 percent of Canada's total GHG emissions. According to current IPCC 2003 methodology, emissions from forest management comprise all the CO<sub>2</sub>-C contained in harvested roundwood and harvest residues. All carbon transferred out of managed forests as wood products is deemed an immediate emission. All light duty cars, trucks & motorcycles running on gasoline, diesel, propane and natural gas combined release 96 Mt CO<sub>2</sub>.

<sup>3</sup> Colombo, S.J., W.C. Parker, N. Luckai, Q.Dang and T.Cai. The Effects of Forest Management on Carbon Storage in Ontario's Forests.(Climate Change Research Report:CCRR-03). 2005, Queen's Printer for Ontario.

<sup>4</sup> Kurz, and Apps 1999. A 70-Year Retrospective of Carbon Fluxes in the Canadian Forest Sector. *Ecological Applications*. 9:526-547. (carbon density 19.7 t/ha for biomass, carbon density 145.1 t/ha for dead organic matter; total ecosystem carbon density 164.8 t/ha). As a whole, Canada's Boreal forest stores an estimated 47.5 billion tonnes of carbon based on the 2001 National Forestry Inventory.

<sup>5</sup> Environment Canada. 2006. *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2004*.

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- According to the recent landmark report by Sir Nicholas Stern: "**Action to preserve the remaining areas of natural forest is urgent.**"<sup>6</sup>

Protecting intact and old growth forests is a win-win for government. By protecting forests, government can address global warming, protect globally important natural areas, save species from extinction and stop using tax dollars to subsidize climate change.

- The Canadian Boreal is one of only three large intact forests remaining on Earth (along with the Amazon and Russian taiga). More than three-quarters of the planet's large intact forests are already lost or degraded.<sup>7</sup>
- The Canadian Boreal is home to a myriad of plant and animal species such as songbirds, grizzly bears, wolverines and caribou many of which are now under threat.

The marketplace is shunning products that are damaging to intact and old growth forests or the global climate. The logging industry is struggling and cannot afford to be rejected by the growing green market.

- Governments that refuse to take action to protect forests do so at their own peril. The public is demanding action to curb global warming and understands the importance of protecting forests to do so.
- 79 percent of people in Ontario believe that protecting our forests and expanding them by planting trees are the most important measures that we can take to address global warming.<sup>8</sup>

The marketplace is rapidly adopting green procurement policies, e.g.: "*The growing controversy about logging in caribou range in Canada is of serious concern to us, and we want to ensure that our paper consumption does not contribute to the demise of endangered species and reflects our commitment to environmental responsibility and leadership. To this end we will not buy from caribou range and we now have a preference for products certified by the Forest Stewardship Council.*". Tom Katzenmeyer, Senior Vice President, Community and Philanthropy Limited Brands. December, 2007.

The Ontario Provincial government has enormous opportunities for action in the arena of forests and global warming: first to protect the province's forest carbon banks and then to manage our natural heritage to cool the Earth and build a sustainable economy. The public is already keenly aware of the effects of industrial logging on the "lungs of the Earth" and is demanding an end to mismanagement of the province's natural storehouses of carbon and biodiversity. Forest Stewardship Council certification

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Logging in Canada releases on average 33 Mt of carbon (122 Mt CO<sub>2</sub>) into the atmosphere each year, which is equivalent to 16 percent of Canada's total GHG emissions. Ontario's share of that is an estimated 12.3 per cent, or 4 Mt C (15 Mt CO<sub>2</sub>) per year (19.5 tonnes of carbon per hectare). According to current IPCC 2003 methodology, emissions from forest management comprise all the CO<sub>2</sub>-C contained in harvested roundwood and harvest residues. All carbon transferred out of managed forests as wood products is deemed an immediate emission.

<sup>6</sup> Stern, N. et al. 2006. Stern Review on the Economics of Climate Change

<sup>7</sup> Bryant, Dirk, et al., 1997. *The Last Frontier Forests: Ecosystems and Economies on the Edge*. World Resources Institute. Washington, D.C.

<sup>8</sup> McAllister Opinion Research, Environmental Monitor, 2006

along with the management changes recommended in this report are the best way to move beyond business as usual.

## Summary of Policy Recommendations

*Canada's intact forests are an enormous storehouse of carbon but they are being compromised by rapid development. Protecting intact forests and adopting carbon sequestering second growth management practices does not obviate the need to dramatically reduce greenhouse gas emissions from fossil fuels. But as this report makes clear, ignoring the global warming impact of forests makes a mockery of climate policy, something the public is unlikely to excuse.*

1. Protect Ontario's Boreal forest ecosystems to safeguard the carbon stored in forest biomass, soils and peat. This will protect forests from losses in carbon due to logging, road access, resource development and fragmentation.
  - Establish a temporary moratorium on further development approvals in the Northern Boreal until cultural and ecological values have been identified and protected through the adoption and implementation of ecologically sound land use planning (LUP) processes that honour First Nation rights and consider global warming mitigation values and opportunities in the Boreal.
  - Immediately set aside key core areas of caribou range. Protecting the woodland caribou saves a marquee species from extinction and will maintain over a billion tonnes of carbon. Simultaneously this allows Ontario to capture the growing demand for environmentally sound products.
2. Incorporate carbon conservation in forest management and land use planning by implementing longer harvest rotations to attain optimal forest age for forest carbon storage, using less intensive harvest techniques to protect soil carbon stores, minimizing opportunities for fires in forest ecosystems and deforestation due to land use change. FSC certification is a crucial tool in this regard.
3. Invest in recycled fibre technology, development and industries. Forest conservation must be accompanied by the promotion of increases in recycled and reused wood and paper products, to avoid an increase in emissions associated with the production and use of substitutes (i.e. non-wood products) whose manufacture generates higher GHG emissions. The production of newsprint from recycled material rather than virgin material reduces energy consumption and emissions by 40 to 45 percent.<sup>9</sup>
4. Implement policies to reduce fossil fuel greenhouse gas emissions. This will protect the global climate and minimize the impacts of global warming on Ontario's Boreal ecosystems.

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<sup>9</sup> Colombo, S.J., Parker, W.C., Luckai, N, Dang, Q., and Cai, T. 2005. The Effects of Forest Management on Carbon Storage in Ontario's Forests. Climate Change Research Report; CCRR-03. Applied Research and Development, Ontario Forest Research Institute. Ministry of Natural Resources. Ontario, Canada.

## Introduction

The concentration of carbon dioxide (CO<sub>2</sub>) in the atmosphere is determined by the flow among the stores of carbon in the atmosphere, the ocean, land-based ecosystems, and human sources. Forest ecosystems play a critically important role in the global carbon cycle by exchanging carbon with the atmosphere through photosynthesis, respiration, decomposition and burning. As a result, large amounts of carbon are stored in plants, roots and soils, including peat.

Globally, Boreal forests function as the largest terrestrial storehouses of carbon on Earth. They store over one-third of all carbon stored in land-based ecosystems, including nearly half of all soil carbon stores.<sup>10</sup> This rich carbon bank helps hold back increases in the global concentration of greenhouse gases. In effect, it acts as a brake against faster and more intense global climate change.

Forests' role in carbon storage has been well acknowledged by climate scientists and economists. The much publicized report authored by former World Bank economist Nicholas Stern concluded the following:

**"While planting new trees is an excellent long-term policy, trees take decades to absorb the equivalent amount of carbon to that which is instantaneously released into the atmosphere when mature trees are cut down and burnt. Depending on the species, a tree may take 100 years to reach maturity, and much more land would have to be allocated for new forests to obtain the same amount of carbon absorption as would be released from burning an existing forest of mature trees. The biodiversity and other co-benefits of new forests are also likely to be much lower than those for natural forests. For these reasons, international support for action to protect existing forests should be kept distinct from the creation of new forest, though the latter is also important."<sup>11</sup>**

Forest ecosystems are a significant part of Canada's natural capital. They provide numerous ecological goods and services, including protecting our water resources and providing wildlife habitat. A new assessment of Canada's Boreal ecosystem services that estimated the annual benefits of intact Boreal forests and peatlands demonstrated that the most significant Boreal ecosystem value is carbon storage.<sup>12</sup>

The Boreal forest also represents an immense environmental opportunity from the perspective of biodiversity, habitat protection and large wilderness set-asides. In protecting intact Boreal forests, we simultaneously safeguard the habitats of threatened species, protect important ecosystems and reduce greenhouse gas emissions.

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<sup>10</sup> Kashian, D.M., Romme, W.H., Tinker, D.B., Turner, M.G., and Ryan, M.G. 2006. "Carbon Storage on Landscapes with Stand-replacing Fires." *Bioscience*. 56:598-606.

<sup>11</sup> Stern, N. et al. 2006. *Stern Review on the Economics of Climate Change*.

<sup>12</sup> Anielski, M. and Wilson, S. 2007. *The Real Wealth of the Mackenzie Region: An Assessment of a Northern Boreal Ecosystem*. Canadian Boreal Initiative. Ottawa. Canada.

Because nearly two-thirds of Ontario's Boreal region remains as large, intact forest landscapes, there are opportunities to protect the remaining intact forest to protect forest carbon stores and to provide for the migration of species as their habitats move north due to climate change over the next century.

However, present logging of intact Boreal forests is a great threat to the climate and represents one of Canada's great contributions to global climate change.

This report provides estimates of the carbon stored in Ontario's Boreal forests. It examines the impacts of timber harvesting (logging), fire and climate change on the carbon stored in its forests. Lastly, it provides some general strategies for protecting the province's forest carbon stores.

## The Importance of Boreal Forest Ecosystems

Boreal forests represent an enormous carbon bank and play an important role in the global carbon cycle. In addition, Boreal forests are one of the greatest environmental protection opportunities that remain on the planet. The Canadian Boreal is one of only three large intact forests remaining on Earth (along with the Amazon and Russian taiga). In contrast, more than three-quarters of the planet's large intact forests are already lost or degraded.<sup>13</sup>

The Canadian Boreal is home to a myriad of plant and animal species such as songbirds, grizzly bears, wolverines and caribou many of which are now under threat. These species require large areas of intact forest to be protected if they are to survive.

Thus, protection of the Canadian Boreal forest represents an enormous opportunity to deal with the climate crisis and simultaneously protect species and forest ecosystems from environmental degradation.

## Ontario's Boreal Carbon Bank

Ontario's Boreal forest is an enormous storehouse of carbon that, if released through activities such as logging, would accelerate global warming. Ontario's Boreal spreads across more than 50 million hectares and covers more than half the province. It is home to nearly a million people.<sup>14</sup> This vast forest stores about 8.5 billion tonnes of carbon in its biomass and soils, or 165 tonnes of carbon per hectare; about 17.5 percent of the total carbon stored in Canada's Boreal forest.<sup>15</sup>

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<sup>13</sup> Bryant, Dirk, et al., 1997. *The Last Frontier Forests: Ecosystems and Economies on the Edge*. World Resources Institute. Washington, D.C.

<sup>14</sup> Statistics Canada. 2000. (Total population is 981,567. 973,823 in Ontario's Boreal Shield eco-region and 7,744 in Ontario's Hudson Plains eco-region).

<sup>15</sup> This estimate is calculated using Ontario's Boreal forest lands area in the Boreal Shield and Hudson Plains ecozones as reported by the 2001 National Forestry Inventory (CANFI 2001; [http://nfi.cfs.nrcan.gc.ca/canfi/data/index\\_e.html](http://nfi.cfs.nrcan.gc.ca/canfi/data/index_e.html)), and carbon content estimates for the Boreal East ecoclimatic province from: Kurz, and Apps 1999. A 70-Year Retrospective of Carbon Fluxes in the Canadian Forest Sector. *Ecological Applications*. 9:526-547. (carbon density 19.7 t/ha for biomass, carbon

In addition, it is possible to estimate the area of forested peatlands and, therefore, the additional carbon stored in peat soils in Ontario's Boreal forests. An estimated 4 million hectares of forested peatlands are found in the Ontario Boreal forest region. Using average peatland carbon estimates, the peat soils hold about 5.2 billion tonnes of carbon.<sup>16</sup>

In total the Ontario Boreal forest region stores an estimated 13.7 billion tonnes of carbon in its trees, roots, soils and peat. The World Resources Institute has developed maps of the world's carbon in forest ecosystems (figure 1), which clearly demonstrate the global importance of Ontario's carbon storehouses<sup>17</sup>:

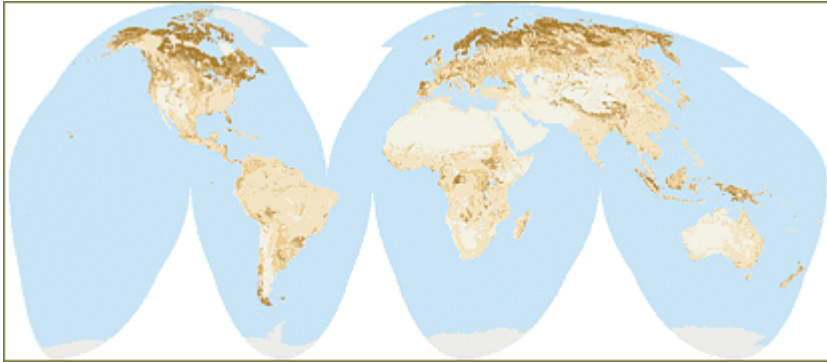


Figure 1: World Forest Carbon Concentrations

## The Value of Ontario's Boreal Forest Ecosystems

The carbon stored in Ontario's Boreal forest provides an ecosystem service in terms of climate regulation that can be valued in several ways. Most ecosystem services are non-market values, but as action to protect the climate is mounting, carbon is becoming a marketed commodity. The value of carbon can be estimated based on the average price for carbon emissions trading in Europe. **Following such a calculation, the carbon in Ontario's forests is worth \$83 billion.**<sup>18</sup> However, current prices do not include the global costs and economic risks associated with climate change. If these global costs are included then, the carbon in Ontario's Boreal forest could be worth an estimated \$386 billion per year.<sup>19</sup>

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density 145.1 t/ha for dead organic matter; total ecosystem carbon density 164.8 t/ha). As a whole, Canada's Boreal forest stores an estimated 47.5 billion tonnes of carbon based on the 2001 National Forestry Inventory.

<sup>16</sup> The carbon stored in peatlands and tundra was calculated based on an average depth of 2.2 m, mean bulk density of 112 g/L, and carbon content of 51.7% of dry biomass. Source: Gorham, E. 1991. "Northern Peatlands: Role in the Carbon Cycle and Probable Responses to Climatic Warming." *Ecological Applications*. 1:182-195.

<sup>17</sup> Matthews, Emily, et al. *Pilot Analysis of Global Ecosystems: Forest Ecosystems*. World Resources Institute. Washington, DC. 2001

<sup>18</sup> Stern 2006 gives range of 10 to 25 euros per tonne of CO<sub>2</sub> for EU price of allowance trading. Median value is 17.5 euros per tonne of CO<sub>2</sub> (64.23 euros/t CO<sub>2</sub>) or Cdn\$101.48 per tonne of carbon (2005 dollars). Converted to an annual value of \$1,598.17 per hectare of boreal forest using an annuity coefficient of 0.08 (based on a 20 year annuity at 5% interest rate to calculate an annual stream of benefits from stored carbon).

<sup>19</sup> Carbon value is based on the global cost of carbon from Britain's Stern Review on the Economics of Climate Change. The Review makes a calculation of the damage done over time by a tonne of CO<sub>2</sub> emitted this year, if the world continues on a

## Source or Sink: Annual Carbon Absorption by Ontario's Boreal Forests

The Boreal forest is most important as a massive storehouse of carbon that, if released through activities such as logging, would otherwise drive global warming in the atmosphere. In addition to the existing carbon storehouse in forests, scientists are interested in the forest's yearly absorption of carbon dioxide (CO<sub>2</sub>) from the atmosphere, which can be estimated using computer models. The net annual uptake of carbon takes into account the amount or flux of carbon absorbed and released by forest ecosystems. This calculation determines whether a forest is a net "source" or "sink" of carbon.

An overview of the science reveals that there is no scientific agreement on whether the Boreal is a source or sink. The preliminary results of the most recent Canadian carbon cycle model by Canadian scientists report that the average annual net absorption of carbon by Ontario's Boreal region (forests and peatlands) was estimated to be 13.4 million tonnes (Mt) of carbon (49.2 Mt CO<sub>2</sub>) per year between 1994 and 2003 (0.23 tonnes of carbon per hectare).<sup>20</sup> The spatial distribution of the net carbon uptake across the Ontario Boreal landscape is shown in figure 2.

The preliminary results of this model also show that Canada's Boreal region, as a whole, provides a carbon sink. These results differ from other national-scale studies<sup>21</sup> because this model includes the interactive factors of climate, increases in CO<sub>2</sub>, nitrogen deposition and a hydrological module, which simulates soil temperature and moisture, in addition to disturbance factors (fire, harvest, insects).

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business-as-usual scenario. The estimate of the social cost of carbon under the business as usual (BAU) is estimated at US\$85/tCO<sub>2</sub> (US\$311.95/tC; 2000\$) now, and rising over time. Here it is converted to an annual value of \$7,474.16 per hectare of boreal forest using an annuity coefficient of 0.08 (based on a 20 year annuity at 5% interest rate to calculate an annual stream of benefits from stored carbon).

<sup>20</sup> (J. Chen, *personal communication*); updates to: Ju, W., Chen, J.M., Black, T.A., Barr, A.G., McCaughey, H. and Roulet, N.T. 2006. "Hydrological effects on carbon cycles of Canada's forests and wetlands." *Tellus*. 58B:16-30.

<sup>21</sup> Note: The Canadian Forest Service forest carbon budget model for Canada's forests is only available for 1920 to 1989. Further analysis by the Canadian Forest Service and the Ontario Ministry of Natural Resources has been completed but has not been released. Estimates for Ontario's managed Boreal forests is a net removal (sink) of 9.06 Mt CO<sub>2</sub> based on the 1996 National GHG Inventory data, equal to 4.5 percent of Ontario's total GHG emissions, or roughly equal to Ontario's total GHG emissions from the production of metals

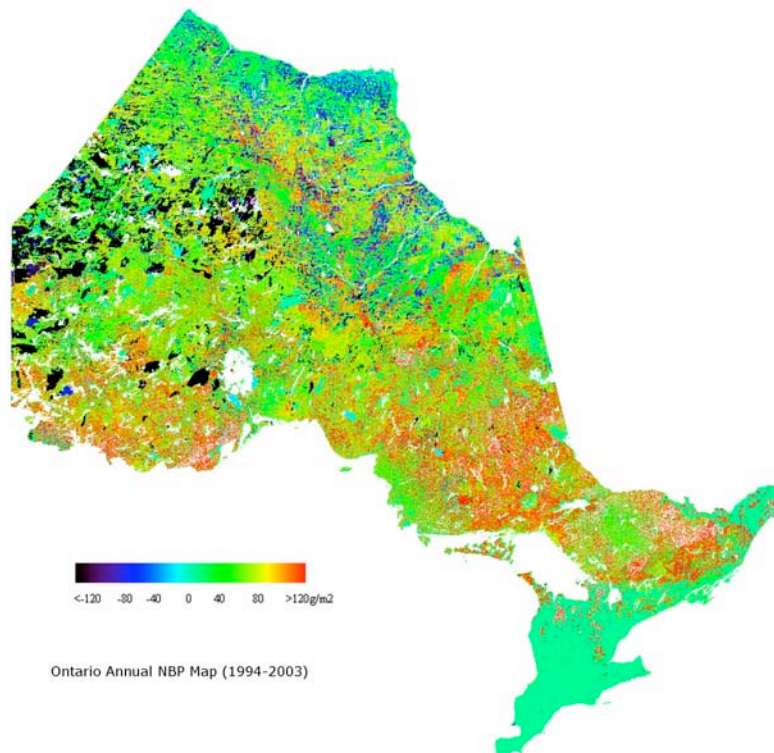


Figure 2: Spatial distribution of carbon sources and sinks in Ontario's forests and wetlands from 1994 to 2003. Positive values indicate carbon sinks (net absorption of carbon), and negative values indicate carbon sources (net release of carbon).<sup>22</sup> Source: Chen et al., 2006 preliminary results.

Ontario's Boreal region may have one of the best *potential* to remain a carbon sink in the Canadian Boreal. Fire and climate models predict that the area burned annually in Ontario forests is likely to remain relatively stable if the increase in temperature is on the low-end of projected climate change (i.e. 2 x CO<sub>2</sub> environment).<sup>23</sup> This is because increases in precipitation and humidity will occur, in addition to increases in temperature, due to global warming in eastern Canada. This is in contrast to central and western Canada where drier conditions are predicted. As a result, parts of Ontario's Boreal may become wetter, which can deter fire. Regions where increases in precipitation are expected are most likely to continue to provide a carbon sink.<sup>24</sup> If the emissions of CO<sub>2</sub> are not reduced and CO<sub>2</sub> in the atmosphere reaches higher concentrations (i.e. 3 x CO<sub>2</sub> environment), then the fire weather index is predicted to increase across Canada causing larger areas of forest to burn.

<sup>22</sup> Net biome productivity (NBP) values computed using the methodology described in Chen et al. 2003, "Spatial distribution of carbon sources and sinks in Canada's forests." *Tellus*. 55B:622-641. Positive NBP values indicate carbon sinks, and negative NBP values indicate carbon sources. NBP includes the total carbon absorption (positive) through photosynthesis and the total carbon release (negative) through autotrophic and heterotrophic respiration and disturbance (fire, insect, harvest).

<sup>23</sup> Flannigan, M., Campbell, I., Wotton, M., Carcaillet, C., Richard, P., and Bergeron, Y. 2001. "Future fire in Canada's boreal forest: paleocology results and general circulation model – regional climate model simulations." *Canadian Journal of Forest Research*. 31: 854-864.

<sup>24</sup> Lavoie, M., Paré, D., Bergeron, Y. 2005. "Impact of global change and forest management on carbon sequestration in northern forested peatlands." *Environmental Reviews*. 13:199-240.

Whether Ontario's boreal forest is ultimately determined to be a source or a sink on an annual basis, what is clear is that it is a massive storehouse of carbon. If Ontario is to address global warming, we must maintain this storehouse.

## Carbon Emissions From Logging, Fire and Land-Use in the Boreal

Although the largest source of greenhouse gas emissions is from fossil fuels, land-use activities also have very significant carbon emissions.<sup>25</sup> Activities such as agriculture, timber harvesting and building roads and settlements (termed "land use, land use change and forestry" in climate policy jargon) affect the carbon stored in our land-based ecosystems and the carbon, in the form of CO<sub>2</sub>, which is released to the atmosphere. These CO<sub>2</sub> emissions must be minimized or reversed in order to minimize climate change.

It is important to note that, contrary to claims by timber industry lobbyists, countries cannot claim to sequester carbon in wood products. This sort of "creative accounting" is disallowed by international accounting guidelines: "*UNFCCC and Kyoto Protocol reporting requirements for the first commitment period assume that the carbon contained in harvested wood products is at steady state and that additions merely replace losses from existing carbon stocks. For the first commitment period, and in accordance with the reporting guidelines, it is assumed that carbon in harvested biomass is released when the trees are removed from the ecosystem.*"<sup>26</sup>

## Impacts of Logging and Fire on Carbon Stores

The impacts of logging on Canada's forests are very severe from a global warming perspective. **Logging intact forests in Canada creates more global warming than all the passenger vehicles in the country.**<sup>27</sup>

In Ontario's Boreal, forests are impacted by natural and human disturbance. Fire, insect outbreaks and logging shape the age structure of forests.<sup>28</sup> Logging and fire affect similar areas of the region's forests.

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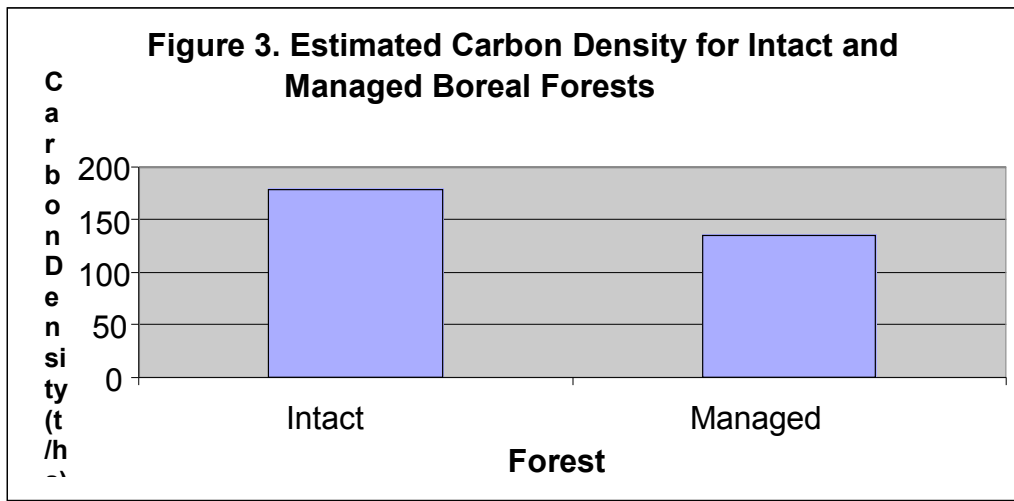
<sup>25</sup> (IPCC) Intergovernmental Panel on Climate Change. 2007. Annual fossil carbon dioxide emissions increased from an average of 6.4 GtC per year in the 1990s to 7.2 GtC per year between 2000 - 2005. CO<sub>2</sub> emissions associated with land-use change are estimated to be 1.6 GtC per year over the 1990s.

<sup>26</sup> Kurz, W.A., and Apps, M.J. 2006. "Developing Canada's National Forest Carbon Monitoring, Accounting and Reporting System to Meet the Reporting Requirements of the Kyoto Protocol." *Mitigation and Adaptation Strategies for Global Change*. 11: 33-43.

<sup>27</sup> Environment Canada. 2006. *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2004*. Submission to the United Nations Framework Convention on Climate Change. April 2006 Advance Copy. Logging in Canada releases on average 33 Mt of carbon (122 Mt CO<sub>2</sub>) into the atmosphere each year, which is equivalent to 16 percent of Canada's total GHG emissions. According to current IPCC 2003 methodology, emissions from forest management comprise all the CO<sub>2</sub>-C contained in harvested roundwood and harvest residues. All carbon transferred out of managed forests as wood products is deemed an immediate emission. All light duty cars, trucks and motorcycles running on gasoline, diesel, propane and natural gas combined release 96 Mt CO<sub>2</sub>.

On average, 210,000 hectares of forest are harvested per year (22 million cubic metres in volume).<sup>29</sup> Logging in Ontario releases an estimated 4 Mt C (15 Mt CO<sub>2</sub>) per year,<sup>30</sup> or approximately 19 tonnes of carbon per hectare (12.3 per cent of Canada's total harvest).<sup>31</sup> That is roughly equivalent to the carbon emitted from all light-duty gas-powered trucks in Ontario.

The conversion of intact forests to a managed forest zone results in very significant carbon losses. According to surveys by the Ontario government, managed forests store 25 to 50 percent less carbon than an intact forest (see figure 3).<sup>32</sup>



<sup>28</sup> Forest age structure is important because intermediate-aged trees have the highest annual net uptake (sequestration) of carbon and mature forests store the most carbon. Whereas, young regenerating forests made up of trees that are less than 10 years old are net emitters of CO<sub>2</sub>. Intermediate-aged Boreal forests absorb the most carbon on a yearly basis while the ancient Boreal forests, with trees aged from 120 to 200 years, are the best long-term carbon banks. Because intermediate-aged forests are strong annual sinks of carbon and older forests are large carbon stores, it is optimal to maintain a mosaic of natural Boreal forests based on the region's historic range of natural disturbance.

<sup>29</sup> OMNR(Ontario Ministry of Natural Resources). 2005. *Minister's Council on Forest Sector Competitiveness. Final Report.* [http://www.mnr.gov.on.ca/mnr/forests/industry/woodsupply/ministers\\_council/forestsector\\_report.pdf](http://www.mnr.gov.on.ca/mnr/forests/industry/woodsupply/ministers_council/forestsector_report.pdf) [accessed January 14, 2007]

<sup>30</sup> Ontario's harvest was 25.2 million cubic metres in 2004; from: Natural Resources Canada. 2006. *The State of Canada's Forests 2005-2006: Forest Industry Competitiveness.* Natural Resources Canada – Canadian Forest Service. Ottawa, Canada. Logging in Canada releases on average 33 Mt of carbon (122 Mt CO<sub>2</sub>) into the atmosphere each year, which is equivalent to 16 percent of Canada's total GHG emissions. Ontario's share of that is an estimated 12.3 per cent, or 4 Mt C (15 Mt CO<sub>2</sub>) per year (19.5 tonnes of carbon per hectare).

<sup>31</sup> Environment Canada. 2006. *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2004.* Submission to the United Nations Framework Convention on Climate Change. April 2006 Advance Copy. Logging in Canada releases on average 33 Mt of carbon (122 Mt CO<sub>2</sub>) into the atmosphere each year, which is equivalent to 16 percent of Canada's total GHG emissions. Ontario's share of that is an estimated 12.3 per cent, or 4 Mt C (15 Mt CO<sub>2</sub>) per year (19.5 tonnes of carbon per hectare). According to current IPCC 2003 methodology, emissions from forest management comprise all the CO<sub>2</sub>-C contained in harvested roundwood and harvest residues. All carbon transferred out of managed forests as wood products is deemed an immediate emission.

<sup>32</sup> Colombo, S.J., W.C. Parker, N. Luckai, Q.Dang and T.Cai. *The Effects of Forest Management on Carbon Storage in Ontario's Forests.*(Climate Change Research Report:CCRR-03). 2005, Queen's Printer for Ontario.

Fire is the predominant natural disturbance across Canada's Boreal forest. Between 1959 and 1999, an average of 2 million hectares burned each year across Canada, releasing on average 27 Mt C per year (13.5 tonnes of carbon per hectare).<sup>33</sup> In the 1990s, the average area burned increased to 3 million hectares.<sup>34</sup> However, in Ontario, the area burned appears not to have increased. According to Ontario government studies, the average area burned is currently 245,000 hectares (estimated 3.3 Mt C per year).<sup>35</sup>

These estimates demonstrate that logging and fire both have significant effects on Ontario's Boreal forests, and therefore impact the region's ability to store carbon. It is important to note that although carbon is released following logging and fire, carbon begins to accumulate again in the regenerating forest after about 10 to 15 years. However, the rate of disturbance can upset the carbon balance over the forest at a landscape level.

Analysis of Ontario's Boreal forest shows that logging, rather than disturbances from fire and insect damage, was the primary disturbance event that affected changes in average forest age between 1920 and 1990.<sup>36</sup> This means that harvest levels had a significant impact on the region's ability to store carbon as the age of its trees had changed. For example, the average age of Ontario's Boreal forests declined between 1940 and 1950, and between 1970 and 1990. During both of these time periods, the net amount of forest carbon stored annually declined. Conversely, the average forest age increased from 1920 to 1940, and from 1950 to 1970, and the amount of carbon stored increased 0.1 Gt C per year for every extra year in the average age of the trees in the forest.

**By reducing the area harvested, government can increase forest carbon conservation.** A report by the Ontario Forest Research Institute found that reducing the annual harvest by 10,000 hectares per year (an overall 5 percent reduction in harvest) would retain about 190,000 tons of biomass carbon annually (19 tonnes of Carbon per hectare), which is equivalent to taking 1.5 million cars off the road for one year.<sup>37</sup> The authors of the report also found that for every 10,000 hectares of forest harvested annually north of the current managed area, carbon emissions will increase by about 0.009 Mt of carbon, due to deforestation from roads and landings.

Areas of forest will continue to burn in managed and protected areas of the Boreal forest because this is part of the Boreal ecosystem's ecology. Wildfire in the Boreal is a renewing force that maintains the region's biodiversity. While stands that are protected may burn in the future, fire impacts the carbon

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<sup>33</sup> Amiro, B.D., Todd, J.B., Wotton, B.M., Logan, K.A., Flannigan, M.D., Stocks, B.J., Mason, J.A., Martell, D.L., Hirsch, K.G. 2001. "Direct carbon emissions from Canadian forest fires, 1959-1999." *Canadian Journal of Forest Research*. 31:512-525.

<sup>34</sup> Flannigan, M., Campbell, I., Wotton, M., Carcaillet, C., Richard, P., and Bergeron, Y. 2001. Future fire in Canada's boreal: paleoecology results and general circulation model – regional climate model simulations. *Canadian Journal of Forest Research*. 31:854-864.

<sup>35</sup> OMNR. 2001. *State of the Forest Report, 2001*. Ministry of Natural Resources. Ontario.

<sup>36</sup> Liu, J., Peng, C., Apps, M., Dang, Q., Banfield, E., and Kurz, W. 2002. "Historic Carbon Budgets of Ontario's Forest Ecosystems." *Forest Ecology and Management*. 169: 103-114.

<sup>37</sup> Colombo, S.J., Parker, W.C., Luckai, N, Dang, Q., and Cai, T. 2005. The Effects of Forest Management on Carbon Storage in Ontario's Forests. Climate Change Research Report; CCRR-03. Applied Research and Development, Ontario Forest Research Institute. Ministry of Natural Resources. Ontario, Canada; GHG equivalency was calculated using GHG Equivalency Calculator on the U.S. Climate Technology Cooperation Website, <http://www.usctcgateway.net/tool/> [accessed January 15, 2007].

stored in Boreal forests less than clearcut logging. According to a recent Ontario government report, there are about 10 tonnes of carbon per hectare less emitted following fire when compared with clearcut logging.<sup>38</sup>

## Land Use Change

Although deforestation, defined as a change in land use, is lower in Canada than the tropics, it is still significant. Geographically, the highest rates of forest conversion have occurred in the Boreal Plains and the Boreal Shield East reporting zones; the latter includes a significant part of Ontario's Boreal forests. Forest conversion within these two ecozones accounts for 33 to 71 percent of the total forest area converted between 1990 and 2004.<sup>39</sup> Although provincial estimates are not available, it can be estimated that forest conversion in the Boreal Shield East and the Boreal Plains resulted in between 5.3 Mt and 11.4 Mt of CO<sub>2</sub> in 2004.

**Forest access roads also contribute to land conversion. Just under 1 Mt of carbon will be released between 1990 and 2012, from deforestation due to the building of forest access roads and landings in Ontario<sup>40</sup> (the equivalent of about 800,000 cars on the road for one year).<sup>41</sup>**

## Adapting to a Changing Climate

Current and future climate change will have an impact on Ontario's Boreal forests. International studies have reported that northern forests and the Arctic region are, and will continue to be, the ecosystems most affected by the changing climate.<sup>42</sup> Already the climate in the Boreal is warming at a faster rate than the average global warming, and it is predicted to continue to warm more rapidly and experience greater changes than the global average into the next century.<sup>43</sup> This will have significant impacts on Boreal biodiversity as habitats will move northward.

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<sup>38</sup> Ibid

<sup>39</sup> Environment Canada. 2006. *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2004*. Submission to the United Nations Framework Convention on Climate Change. April 2006 Advance Copy.

<sup>40</sup> Ibid.

<sup>41</sup> EPA (2003). *U.S. Inventory of Greenhouse Gas Emissions and Sinks 1990-2001*. Office of Atmospheric Programs, U.S. Environmental Protection Agency, Washington, DC. EPA 430-R-03-004; GHG equivalency was calculated using GHG Equivalency Calculator on the U.S. Climate Technology Cooperation Website, <http://www.usctcgateway.net/tool/> [accessed January 15, 2007].

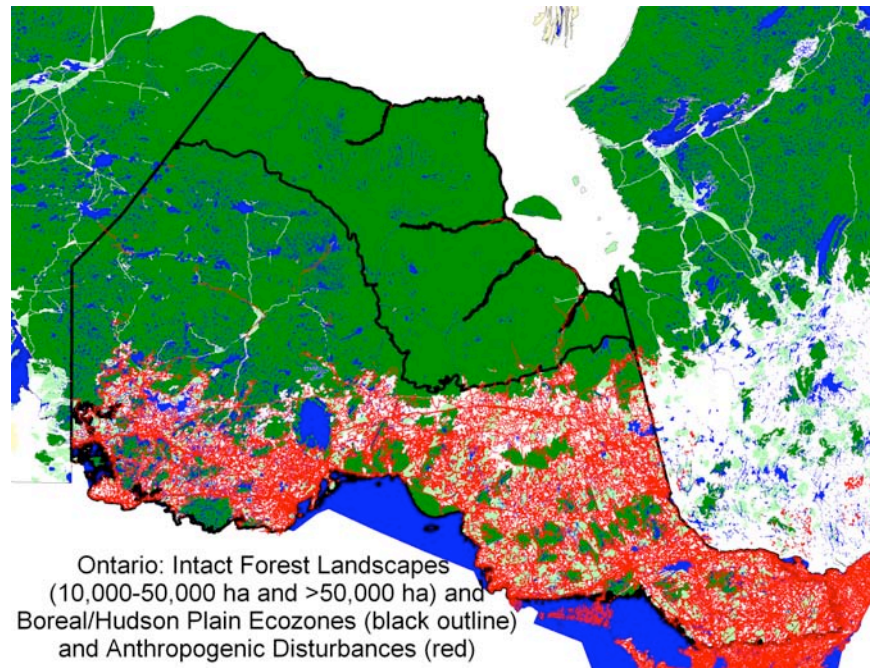
<sup>42</sup> (IPCC) Intergovernmental Panel on Climate Change. 2001. *Climate change 2001: the scientific basis*. Contribution of Working Group I to the Third Assessment Report of the IPCC. *Edited by* J.T. Houghton, Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, and D. Xiaosu. Cambridge University Press. Cambridge, U.K; Bhatti J.S. et al. 2003. Carbon balance and climate change in boreal forests. Chapter 20. *In* *Towards Sustainable Management of the Boreal Forest*. *Edited by* P.J. Burton, C. Messier, D.W. Smith, and W.L. Adamowicz. NRC Research Press. Ottawa, Canada.

<sup>43</sup> IPCC. 2001. *Climate Change 2001: The Scientific Basis*. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge, U.K.

The Boreal region of Canada is one of the few regions remaining in the world with large areas of intact forests. Ontario's Boreal forests contain 14 percent of the remaining intact forest landscapes in Canada, with just over 60 percent of the region's forest landscape intact.<sup>44</sup> However, the region's ecosystems are becoming increasingly fragmented due to forestry and industrial development (see figure 4).

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<sup>44</sup> 55.5 million hectares of intact Boreal landscapes within the total Boreal region of 88.7 million hectares; (63 percent). Calculated from Global Forest Watch Canada's geospatial dataset: "Canada's Forest Landscape Fragments: A First Approximation." All Ontario polygons greater than 50,000 ha were extracted. Dataset available at <<http://www.globalforestwatch.ca/datawarehouse/datawarehouse.htm>>



**Figure 4: Remaining intact forest landscape (green) greater than 10,000 hectares, and human disturbed areas (red) in Ontario's Boreal region.**<sup>45</sup>

Source: Global Forest Watch Canada, 2006.

A recent study showed that by the year 2050, Ontario is expected to warm by 1.4 to 3.4 degrees Celsius. The results of this analysis demonstrated that such an increase in temperature has the potential for significant change in suitable habitats for Ontario's current plant and animal distributions.<sup>46</sup>

Reed Noss, the elder statesman of conservation biology, warns that today's fragmented and degraded forests are more vulnerable to climate change than forests in the past, which proved quite resilient. Noss finds the following nine practices most successful in adapting to the changing climate: (1) representing forest types across environmental gradients in reserves; (2) protecting climatic refugia at multiple scales; (3) protecting primary forests; (4) avoiding fragmentation and providing connectivity, especially parallel to climatic gradients; (5) providing buffer zones for adjustment of reserve boundaries; (6) practicing low-intensity forestry and preventing conversion of natural forests to plantations; (7) maintaining natural fire

<sup>45</sup> Calculated from Global Forest Watch Canada's geospatial dataset "Canada's Forest Landscape Fragments: A First Approximation." All Ontario polygons greater than 10,000 ha were extracted. Dataset available at <http://www.globalforestwatch.ca/datawarehouse/datawarehouse.htm>

<sup>46</sup> Malcolm, J.R. Shi, H. and Puric-Mladenovic, D. 2005. "Implications of climate change on disturbance regimes, carbon stocks, management and biodiversity of Canada's boreal forests." In: *Implications of a 2° Celsius Global Temperature Rise for Canada's Natural Resources*. Edited by T. Tin. WWF-World Wide Fund for Nature (formerly World Wildlife Fund). Gland, Switzerland.

regimes; (8) maintaining diverse gene pools; and (9) identifying and protecting functional groups and keystone species.<sup>47</sup>

Given that global warming will continue to exert pressure on the Boreal ecosystems throughout this century, protection for all remaining intact forest areas is very important as it will create corridors, enabling Ontario's plants and animals to adapt and migrate as the climate changes and their habitats migrate north.

Management to maintain species and forest ecosystems as the climate warms is very similar to management to retain carbon. **By protecting the range of key species such as caribou we protect the carbon in the intact forests. When we cease the logging of intact forests for conversion to managed tree farms, we simultaneously protect habitat from being lost or fragmented, and maintain the higher carbon levels in intact forests.**

## Strategies to Conserve Carbon Storage in Ontario's Forests

The good news is that Ontario's Boreal carbon stores can be maintained to some degree through forest protection and the development of carbon-sensitive management practices:

Because nearly two-thirds of Ontario's Boreal region remains as large, intact forest landscapes, there are opportunities to protect the remaining intact forest to protect forest carbon stores and to provide for the migration of species as their habitats move north due to climate change over the next century. Protecting these intact forests is the most important step government can take.

In addition to protecting intact forests, government can change management practices to conserve carbon. A longer rotation age for managed forests (i.e. the average time between timber harvest) results in more carbon storage in forest ecosystems. In other words, maintaining older stands and trees as part of the Boreal landscape increases the carbon stored. This can be achieved by lengthening the rotation age in managed forests, and by decreasing the rate and extent of human and natural disturbances such as harvesting, fire and insect damage. For example, as we reviewed earlier,

- According to the Ontario government, reducing the total Ontario forest harvest by 10,000 hectares can reduce Ontario's direct forest carbon emissions by about 2 Mt of carbon (190 tonnes of carbon per hectare), or the equivalent of 1.5 million cars on the road for one year. Current wood supply surpluses would allow for a significant reduction at this time.<sup>48</sup>

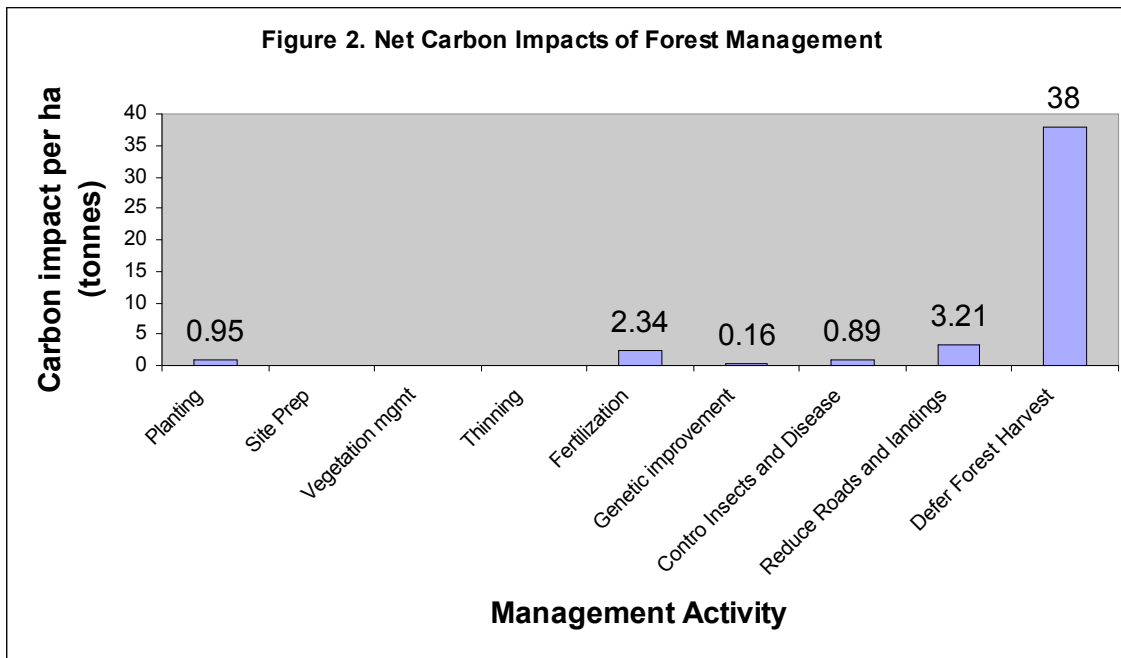
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<sup>47</sup> Reed F. Noss (2001) Beyond Kyoto: Forest Management in a Time of Rapid Climate Change Conservation Biology 15 (3), 578–590.

<sup>48</sup> Colombo, S.J., Parker, W.C., Luckai, N, Dang, Q., and Cai, T. 2005. The Effects of Forest Management on Carbon Storage in Ontario's Forests. Climate Change Research Report; CCRR-03. Applied Research and Development, Ontario Forest Research Institute. Ministry of Natural Resources. Ontario, Canada; GHG equivalency was calculated using GHG Equivalency Calculator on the U.S. Climate Technology Cooperation Website, <http://www.usctcgateway.net/tool/> [accessed January 15, 2007].

- Total carbon loss due to road building for timber harvest since 1990 will total almost 1 Mt by 2012, the equivalent of about 800,000 cars on the road for one year.<sup>49</sup>

Protecting the intact forest ecosystems is the most cost-effective strategy to conserve carbon stored in Ontario's Boreal region (see figure 5).<sup>50</sup>



**Figure 5: Net Carbon Impacts of Forest Management.**

Once intact forests are protected, the logging plans and management for other areas must work towards the goal of carbon conservation in managed forests by:

- increasing the rotation age (i.e. longer harvest rotations) to maintain the forest age structure within the traditional historic range of variability (i.e. switch management practices away from traditional sustained yield/even-aged systems to management based on natural dynamics);<sup>51</sup>

<sup>49</sup> EPA (2003). *U.S. Inventory of Greenhouse Gas Emissions and Sinks 1990-2001*. Office of Atmospheric Programs, U.S. Environmental Protection Agency, Washington, DC. EPA 430-R-03-004; GHG equivalency was calculated using GHG Equivalency Calculator on the U.S. Climate Technology Cooperation Website, <http://www.usctcgateway.net/tool/> [accessed January 15, 2007].

<sup>50</sup> Colombo, S.J., W.C. Parker, N. Luckai, Q.Dang and T.Cai. The Effects of Forest Management on Carbon Storage in Ontario's Forests.(Climate Change Research Report:CCRR-03). 2005, Queen's Printer for Ontario.

<sup>51</sup> For more information see: Didion, M, Fortin, M-J., and Fall, A. 2007. "Forest age structure as indicator of boreal forest sustainability under alternative management and fire regimes: A landscape level sensitivity analysis." *Ecological Modelling*. 200: 45-58.

- b. using less intensive harvest methods that protect the carbon stored in forest soils (i.e. careful logging, minimize scarification);
- c. reducing overall timber harvest;
- d. reducing the area of new roads and landings in Ontario's managed forests;
- e. providing protected forest corridors for plants and animals to migrate through as the climate changes;
- f. avoiding carbon losses by minimizing the potential for increases in the rate of fire and insect damage due to climate change through suppressing fire where appropriate; and,
- g. minimizing the impacts of climate change on Ontario's Boreal by reducing greenhouse gases due to fossil fuel burning.

## Conclusions

The IPCC's Fourth Assessment Report on the science of climate change by international experts states that global atmospheric concentrations of carbon dioxide (CO<sub>2</sub>) have increased dramatically. These increases in CO<sub>2</sub> now far exceed the natural range over the past 650,000 years. Warming of the earth's climate is already occurring at a rapid rate. Such warming is evident from observations in global average air and ocean temperatures, widespread melting of snow and ice, and rising global sea levels. This warming will have a significant impact on the ecosystems of Ontario's Boreal region.

The dire situation of our changing climate needs immediate action. Action taken now to protect the carbon stored in our forests and to reduce the rate of GHG emissions into our atmosphere will reduce the extent and speed of global warming and therefore result in lower temperature increases and slower ecosystem change. All possible actions to prevent additional emissions of CO<sub>2</sub> and other GHG emissions need to be considered. Protecting the carbon stored in forests and peatlands is a cost-effective approach for carbon conservation, as well as for the conservation of biodiversity and their ecosystem services.

The economic costs of climate change will increase if we do not take action to curtail the growing GHG emissions. The recent study by Sir Nicholas Stern assessed the economic impact of climate change for the British government. His team found that if we do not take action now to halt the ongoing increase of atmospheric carbon dioxide, the overall costs and risks will be equivalent to at least 5 percent of global gross domestic product (GDP) each year, and may be even more - costing human society as much as 20 percent of its yearly gross domestic product.<sup>52</sup>

The impact of the logging industry in Ontario is very significant. **As we have seen in this report, the Ontario logging industry is responsible for as much global warming as gas powered trucks in Ontario.** Across Canada as a whole the logging industry is responsible for more global warming than all

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<sup>52</sup> Stern N. et al. 2006. *Stern Review on the Economics of Climate Change*.

passenger vehicles in the country. Moreover, these calculations address only the carbon emitted from the cut forests and do not account for the fossil fuel emissions from logging operations, transport or mills. Clearly, any government serious about combating global warming must deal with the impacts of logging in Ontario's Boreal forest.

## Policy Recommendations

1. Protect Ontario's intact Boreal forest ecosystems to safeguard the carbon stored in forest biomass, soils and peat. This will protect forests from losses in carbon due to logging, road access, resource development and fragmentation.
  - a) Establish a temporary moratorium on further development approvals in the Northern Boreal until cultural and ecological values have been identified and protected through the adoption and implementation of ecologically sound land use planning (LUP) processes that honour First Nation rights and consider global warming mitigation values and opportunities in the Boreal.
  - b) Immediately set aside key core areas of caribou range. Protecting the woodland caribou saves a marquee species from extinction will maintain over a billion tonnes of carbon. Simultaneously this allows Ontario to capture the growing demand for environmentally sound products.
2. Incorporate carbon conservation in forest management and land use planning by:
  - a) increasing the rotation age (i.e. longer harvest rotations) to maintain the forest age structure within the traditional historic range of variability (i.e. switch management practices away from traditional sustained yield/even-aged systems to management based on natural dynamics);<sup>53</sup>
  - b) using less intensive harvest methods that protect the carbon stored in forest soils (i.e. careful logging, reduced impact logging, minimize scarification);
  - c) reducing overall timber harvest;
  - d) reducing the area of new roads and landings in Ontario's managed forests;
  - e) providing protected forest corridors for plants and animals to migrate through as the climate changes;
  - f) avoiding carbon losses by minimizing the potential for increases in the rate of fire and insect damage due to climate change through fire prevention and suppression where appropriate;

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<sup>53</sup> For more information see: Didion, M, Fortin, M-J., and Fall, A. 2007. "Forest age structure as indicator of boreal forest sustainability under alternative management and fire regimes: A landscape level sensitivity analysis. *Ecological Modelling*. 200: 45-58.

3. Forest conservation must be accompanied by the promotion of increases in recycled and re-used wood and paper products to avoid an increase in emissions associated with the production and use of substitutes (i.e. non-wood products) whose manufacture generates higher GHG emissions. The production of newsprint from recycled material rather than virgin material reduces energy consumption and emissions by 40 to 45 percent.<sup>54</sup>
4. Implement policies to reduce fossil fuel greenhouse gas emissions. This will protect the global climate and minimize the impacts of global warming on Ontario's Boreal ecosystems.

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<sup>54</sup> Colombo, S.J., Parker, W.C., Luckai, N, Dang, Q., and Cai, T. 2005. The Effects of Forest Management on Carbon Storage in Ontario's Forests. Climate Change Research Report; CCRR-03. Applied Research and Development, Ontario Forest Research Institute. Ministry of Natural Resources. Ontario, Canada.