

Linking biosphere carbon management to biomass energy.

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Mitigation Options:

- 1. Forest Pest Control.** If implemented in sites with severe pest infestations, biomass carbon would be preserved in the year of application and fewer trees would die, possibly reducing the likelihood of forest fire in future years. It is one of the few forest management strategies that could result in rapid and significant increases in forest C stocks compared with untreated sites.
- 2. Replant after Harvest.** In many ecosystems, it can take 10 years or more for trees to regrow on clear-cut sites left for natural regeneration. Replanting within one year of harvest would increase the carbon stocks and provide an opportunity to choose elite genotypes that would be better adapted to the climate-different and CO₂-different future in which these trees will need to grow. (Possibly use mycorrhizal inoculants to improve establishment of the trees.)
- 3. Precommercial thinning.** In some ecosystems, this will significantly increase the rate of biomass accumulation, and the commercial value of that biomass, but there will be a transient decrease in carbon stock at the time of thinning. If this biomass could be used as an energy resource, the net GHG benefit would be improved.
- 4. Forest Fertilization.** Certain species have been shown to respond favorably – for each kg of N ending up in the wood of the tree, 100 kg or more of carbon can be stored. Care must be taken to avoid excessive use as N₂O (a potent GHG) emissions can result, or other adverse environmental impacts.
- 5. Selective Harvest.** Sustainable yield can be higher than clearcut, and average C stock is higher when integrated over time.
- 6. Afforestation or biomass crops.** On abandoned or marginal farmlands, conversion to forests or perennial biomass crops would build carbon stocks and provide a fibre of biomass energy resource.
- 7. No till Agriculture.** Known to increase soil carbon stocks, especially in Western Canada.
- 8. Improved feed for Ruminants.** The composition of the feed is known to affect the CH₄ emission of cattle and the amount of manure produced.
- 9. Anaerobic Digestion of Manure.** To generate methane that can be used for heat or power production.
- 10. Grow Legumes.** Legumes can fix their own nitrogen and therefore have a much lower demand for fertilizer N, and the GHG emissions associated with its production and use. While the IPCC calculations attribute N₂O

emissions to the process of nitrogen fixation, there is little, if any, scientific evidence to support this assertion.

Best Management Practices for Forest Resource Management in Canada

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A. Reduce Emissions of greenhouse gases:

The forests and forest industry can contribute to a direct reduction in the human caused emissions of greenhouse gases in at least four significant ways.

1. Reduce deforestation.

Deforestation is land-use change that results in 'permanent' loss of forest, with a resulting emission of carbon dioxide (and other greenhouse gases) from the destroyed vegetation and damaged soils, without the recovery of this carbon in regrowing vegetation. In Canada, the causes of deforestation are expanding infrastructure (roads, cities, and pipeline corridors), oil, gas and mineral exploration, and (historically) clearing for agriculture. New policies and practices can easily reduce these sources.

2. Energy Use within the forest sector:

More efficient use of energy and deployment of bioenergy could sharply reduce the use of fossil fuel within the sector. Although traditionally, bioenergy was widely used in mills and processing within the Forest sector, energy pricing policies have led to increased dependency on fossil fuel sources. The forest industry has shown (e.g., in during WW2 when energy was in short supply) that it can rapidly implement bioenergy uses.

3. Bioenergy Production

Use of waste material for co-generation and as bioenergy feedstock has a very significant potential. There are two impediments at this time: energy pricing policies and concerns about pollution. The first of these will disappear if fossil fuel costs rise; the second has easy technological solutions. One impediment to implementation is the need for significant infrastructure development (such has been carried out in FennoScandia over the last decade).

4. Avoided Energy Emissions

When wood products are used instead of steel, iron, concrete or plastic materials, the emissions associated with the energy used in the production of these latter materials (often very high) is avoided. If the wood comes from a sustainable forest, not only is there the carbon stock embodied in that forest ecosystem, but there is the avoidance of emission from the production of the other materials. There needs to be an increased understanding of this important service supplied by forestry and forest use.

B. Increase sinks

1. Manage existing forests for increased carbon stocks.

Binkley et al (1997) outlined 12 different strategies to increase the carbon stocks in managed forests such as those of Canada. They included such

actions as: reducing the loss to fire, insects and similar disturbances (a short-term benefit only); increasing forest productivity (e.g., through silvicultural practices such as fertilizing); getting the jump on regeneration after disturbance or harvesting; and choosing the appropriate mix of species to plant.

2. Introduce new forests

By planting forests where non previously existed (afforestation) or where previous land management practices had lead to degraded cover (reforestation), the total carbon stock held on land (and thus withheld from the atmosphere) is generally increased. Forest ecosystems have much higher carbon density (carbon per hectare) in the vegetation and soils than most other managed land types (peatlands excluded).

3. Agroforestry

By using the same piece of land to provide multiple goods and services (e.g., food and fibre), not only can that piece of land have higher carbon density (increased sink), but in addition, the practice can reduce the pressure on other land areas, allowing them to be managed for increased carbon storage.

4. Increase carbon retention in forest products

Carbon in forest products, and material derived from organic materials is carbon removed from the atmosphere. But such organic material will eventually decompose, releasing the carbon back the atmosphere in the form of carbon dioxide or other carbon based greenhouse gases. By simply increasing the lifetime of such forest products, or recycling them (including their retention in well designed land-fills), this to the atmosphere return can be delayed, leading to an increased stock of carbon retained on the ground, and removed from the atmosphere.

**NORTHERN PEATLANDS:
PROTECTING LARGE CARBON POOLS THROUGH MITIGATION**

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THE PROBLEM: Across the boreal region, large amounts of carbon are sequestered in lake sediments, forests, agricultural land, and wetlands especially peatlands. Carbon buried in lake sediments is effectively permanently removed from the global carbon cycle. In Alberta, Campbell et al. (2000) estimated that about 2.3 Pg of carbon was sequestered in this long-term sink. Forests and croplands, on the other hand, sequester new carbon that is mostly released back into the atmosphere within a few hundred years. These two ecosystem types have carbon stored largely in living biomass and in the uppermost soil profile and are highly managed and utilized by modern industry. Northern peatlands contain considerable old (Holocene) carbon (13.5 Pg C in Alberta [Campbell et al. 2000]). This large carbon stock is extremely sensitive to climate change. Effects of Global Climate Change on peatlands may change these historical carbon sinks to carbon sources, releasing this vulnerable old carbon to the atmosphere. The loss of this old carbon to the atmosphere could add up to 200 ppm of CO₂ to the atmosphere. Peatlands and their ability to sequester carbon are sensitive to disturbances; these include wildfire, road building, drainage, oil-sands overburden removal, and peat harvesting. Disturbance has two possible consequences 1) Direct Effects – The actual removal of carbon from the peatland through direct action of the disturbance. 2) Indirect Effects -- through microbial respiration, previously stored carbon is released to the atmosphere as CO₂, CH₄, and/or N₂O and through reduced photosynthesis and/or increased decomposition, current carbon sequestration is either reduced or does not occur.

IN GENERAL: The first order priority should be the protection of the large boreal peatland carbon pool by attempts in maintenance of stable water tables and reduction of nutrient influxes.

SPECIFICALLY:

- -Nutrient influxes should be reduced through retention of adequate buffer zones around large complex peatland areas when uplands are disturbed.

- -Protection, where possible, of bogs from wildfire.

- -Maintenance of stable water levels to as near the surface of fens as possible. Drainage of fens should be avoided.
- -Maintenance of boreal peatlands in their natural state, especially the ground layer when access right-of-ways are built on organic soils.
- -Develop a long-range plan of corridors and reserves that includes predicted future occurrences of peatlands.
- -The oil sands industry should undertake to restore wetlands to the oil sands area as soon as possible in order to reduce the large carbon loss due to indirect effects.
- -The peat-harvesting industry should endeavor to minimize the time that peat fields are barren in order to reduce the indirect effects.
- -The peat-harvesting industry should be proactive in establishing protocols for fen re-establishment as soon as possible on abandoned fields.