

Climate mitigation potential of British Columbian forests: Growing carbon sinks

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Ministry of
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Executive Summary

British Columbia has already experienced and will continue to experience the impacts of climate change. Due to forests' ability to absorb and store carbon, B.C.'s forests and forest sector have a role in affecting the atmospheric concentration of carbon dioxide (CO₂) and other greenhouse gases (GHGs) attributed to the cause of climate change. This role presents opportunities to address climate change.

The province supports forest carbon management options that satisfy the diverse values British Columbians seek from their forests. This includes carbon and other ecological values like biodiversity, water, fish and wildlife as well as socio-economic values generated by harvesting, processing and manufacturing wood products.

As with any activity or decision regarding B.C.'s public forest land, forest carbon activities or decisions are subject to the numerous and varied forms of forest management legislation. This includes a sustainable forest management regime; laws that require stewardship of various forest values; laws that protect fish, wildlife, water and more; a monitoring and evaluation program to assess management of forest values; a compliance and enforcement program; and voluntary forest certification.

Carbon is one of the many values our forests are managed for and forest carbon management is subject to the broader suite of environmental legislation and forest management practices legislation. Therefore, publicly initiated action regarding forest carbon is undertaken within the existing forest management framework. For development of forest carbon offset projects, the province has published the Protocol for the Creation of Forest Carbon Offsets in B.C. (FCOP). In addition to adhering to existing management regimes, B.C.'s forest carbon management activities are designed to operate with respect to industry's socio-economic importance.

Forests are important to B.C.'s economy and contributed 5.4% of B.C.'s total GDP in 2011. Many B.C. communities obtain a high proportion of their basic income from timber-based industries. In 2006, 25 of 63 local areas (excluding Greater Vancouver) obtained 20 to 48% of their basic income from the timber and tourism industries. Many of the most vulnerable communities are in areas where timber supplies are at risk due to the mountain pine beetle epidemic.

Proposed forest carbon management activities that consider, respect and potentially bolster regional and local economies are advantageous; these eliminate or minimize potential conflicts between different forest values. Considering the province's regional diversity both economically and biophysically, opportunities and preferred management options are location dependent. Management strategies that impact economic returns to the traditional forest such as forest conservation can still be appropriate forest carbon management solutions that offer some economic benefits. They must be considered within the context of local ecosystem values and regional socio-economic drivers so that the potential trade-offs are understood and the full suite of forest values is considered before management decisions are made.

Forest carbon management is further complicated due to nature's dynamism. Forests interact dynamically with the atmosphere through enormous exchanges of energy, mass (carbon and water), and other gases that affect the earth's energy balance and climate. Forests can be carbon sinks or



sources¹ from year to year depending on the net balance of large fluxes between the atmosphere and the forest. For example, from 1990 to 2002, B.C. forests were a net carbon sink. In 2002, B.C. forests transitioned from a sink to a source.

The carbon cycle in forests is characterized by long periods of slow carbon uptake during growth accompanied by relatively short periods of large carbon losses due to disturbances such as fire or insect infestation. Logging transfers carbon out of the forest system when timber is harvested and used to create harvested wood products. Harvested wood products store carbon over time depending on the type of products (e.g. lumber, paper, bio-energy) and how they are used (e.g. over short or long time scales). Harvested wood products therefore, create an opportunity to provide long-term carbon storage benefits.

Harvested wood products play three important roles in the global carbon cycle and in climate change mitigation: storage of carbon, a substitute for more energy-intensive materials, and a renewable material for energy generation. Harvested wood products store carbon over short and long time scales depending on the type of product. When wood is used to meet societal demands that would otherwise be met with relatively higher greenhouse gas emission materials such as steel, concrete or plastics, a relatively permanent emissions benefit is realized. Scientific assessment has shown the emission reduction benefits of energy substitution: the use of wood in place of fossil fuels. Using living trees for bio-energy in most cases does not offer emission reductions; using dead trees or residual fibre (i.e. fibre left over after processing for other purposes) can have a net carbon benefit.

Harvested wood products play an important role in forest carbon management strategies. The National Forests Sinks Committee (research scientists, natural resource managers and policy makers in the federal, provincial and territorial governments whose work has direct links with forest carbon) assessed six potential forest-based climate change mitigation strategies. They found the best strategy over the long-term (up to 2050) was a combination of forest management strategies and harvested wood products strategies.

Just as harvested wood products can be substituted for more energy intensive materials, products made from biomass can be used in place of products made from conventional fossil fuel-based feedstock. The developing bio-economy is driven by concerns related to fossil fuels, namely rising greenhouse gas emissions, rapid cost increases, declining reserves, security of supply, and negative environmental impacts. Given this, there are considerable synergistic opportunities to manage the forest both for carbon and to take advantage of the growing bio-economy. The province envisions more utilization of what is currently considered “waste” forest fibre to support B.C.’s growing bio-economy. B.C.’s bio-energy industry is already established.

Managing forests for carbon, or any other value, requires forests adapted to a changing climate. Long-term storage of carbon in forests may not be possible if management practices are not appropriately adapted to the changing climate. For example, many B.C. forests that are well-suited to the current climate may not be as productive under new conditions.

¹ A forest is considered a source when, overall, it emits more carbon dioxide and other greenhouse gases than it removes from the air in a given time period. It is considered a sink when it removes more than it emits. For more information see <http://cfs.nrcan.gc.ca/pages/376>.



B.C. is working to maximize the long-term climate mitigation value of forest resources with a variety of activities. This includes: management that supports sustainable harvesting and the carbon storage value of long-term harvested wood products; increasing or maintaining forested area where climatically suitable; and forest carbon investment opportunities. Knowledge is integral to the province's practices and policy development, therefore, participation in and understanding of forest carbon research is a priority. Finally, the province is integrating forest carbon management with other resource values by working collaboratively with stakeholders to align carbon with other economic and environmental values.

1.0 Introduction

British Columbia has already experienced and will continue to experience the impacts of climate change.² Due to the ability to absorb and store carbon, B.C.'s forests can affect atmospheric concentrations of carbon dioxide (CO₂) and other greenhouse gases (GHGs) that are causing the climate to change. This role presents opportunities to mitigate climate change. Forests, however, are also affected by climate change and therefore require adaptation to the changing climate.

Government has formally recognized the importance of B.C.'s forests in taking action on the challenges posed by the changing climate. The 2010 *British Columbia: Climate Action for the 21st Century*³ profiled various forest programs designed to generate atmospheric benefits. The second of six priorities identified in the 2012 *B.C. Forest Sector Strategy*⁴ is "growing trees, sequestering carbon and ensuring that land is available from which to derive a range of forest products" and includes the goal to "pursue opportunities related to climate change and carbon solutions." The *B.C. Forest Stewardship Action Plan for Climate Change Adaptation*⁵ identifies that adapting B.C.'s forest practices to a changing climate is an immediate imperative and long-term proposition and lays out a suite of goals and actions to begin this process.

The ministry's strategic direction on forest carbon management is outlined in Section 6. Overall, the province supports the use of forest carbon management options that satisfy the diverse values British Columbians seek from forests. This includes carbon storage and sinks, socio-economic values provided by forestry and timber production as well as other ecological values such as biodiversity, water, fish and wildlife.

This document describes how B.C. forests, namely with their physical resources and management practices that target forest carbon, can generate atmospheric benefits. Like all forest resource

² For example, the mountain pine beetle infestation, triggered in part by warmer winters, impacted more than 14.5 million hectares of forest in B.C. between 1990 and 2008, having profound effects on ecosystems, community economic viability and the provincial economy. Research suggests climate change will continue to challenge forest health. Additionally, from 2003 to 2009, B.C. experienced the most dangerous and expensive wildfire seasons on record. Climate projections point to longer and more intense wildfire seasons.

³ See section 5 "A Natural Advantage: Forestry" in *British Columbia: Climate Action for the 21st Century* available at http://www.env.gov.bc.ca/cas/pdfs/climate_action_21st_century.pdf.

⁴ See the *Forest Sector Strategy for British Columbia* available at http://www.for.gov.bc.ca/mof/forestsectorstrategy/Forest_Strategy_WEB.PDF.

⁵ See the *B.C. Forest Stewardship Action Plan for Climate Change Adaptation* available at <http://www.for.gov.bc.ca/het/climate/actionplan/index.htm>.



objectives, carbon is managed with respect to existing ecological, social and economic objectives. B.C.'s forests are diverse, as are regional and local economic drivers. Considering this diversity, opportunities and preferred management options are location dependent.

This document begins with a brief overview of B.C.'s forest resource and corresponding management regime, the socio-economic importance of the resource and some biophysical characteristics. The next section describes the forest carbon cycle and the harvested wood product carbon cycle. After that, various forest carbon management strategies are reviewed. These are presented with consideration to the necessity for management practices that include benefits beyond carbon such as other ecological benefits as well as socio-economic benefits. The subsequent section describes the future of forest carbon management with reference to both adaptation as well as the developing bio-economy. The final section provides ideas for moving forward on a forest carbon management strategy for B.C. All information presented is informed by the best available research on forest carbon.

2.0 British Columbia's Forests

At 95 million hectares, British Columbia is larger than any European country except Russia, about four times the size of the United Kingdom, and larger than the combined areas of the states of Washington, Oregon and California. About two-thirds of the province is forested (Figure 1). This makes the province, on a global scale, as important as many forest nations.

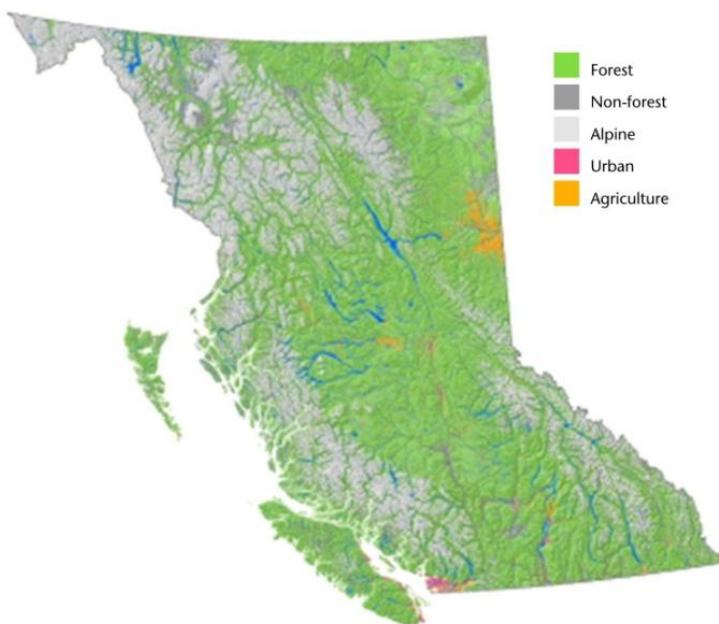


Figure 1 Forest and other land types in British Columbia⁶

Unlike most forested nations, almost all of B.C.'s land is owned by the public. Approximately 60% of B.C.'s land base is forest land; 95% of which is publicly owned. Government control over all public forests provides unique opportunities for management such as consistency in methods for collecting inventory information across the land base. For example, systematic collection of vast amounts of data

⁶ Figure 1-1 in B.C. Ministry of Forests, Mines and Lands. 2010. The State of British Columbia's Forests, 3rd ed. Forest Practices and Investment Branch, Victoria, B.C..



about our forests has occurred for many decades. The analysis of this information provides a foundation for planning sustainably productive public forests.

Sustainable Forest Management

Forest carbon and any activities undertaken pertaining to forest carbon, are managed within the context of the province's existing sustainable forest management regime. Sustainable forest management, a science-based framework, guides the stewardship and utilization of the province's diverse forests. It relies on a dynamic process based on continued learning and improvement. The province is committed to improving this framework as research and new information is generated regarding forest resources. Sustainable forest management aims to ensure forests maintain their biodiversity, productivity, and regenerative capacity. These qualities provide beneficial ecological, social and economic conditions now and for future generations.

There are a number of key strategies and pieces of legislation protecting and nurturing sustainable forestry in B.C. The Protected Areas Strategy, Land and Resource Management Planning, and the *Forest and Range Practices Act* and the *Forest Act* and regulations provide objectives for sustainable forest and natural resource management. The *Land Act* governs the disposition, management and administration of Crown lands, while the *Forest and Range Practices Act* and the *Forest Act* set out rights and responsibilities attached to timber cutting. The suite of legislation designed for environmental and species at risk protection includes the *Wildlife Act*, the *Environmental Management Act*, and the *Drinking Water Protection Act*. Each act governs a specific aspect of the sustainable management of B.C.'s forests. For example, companies are legally required to reforest lands they have logged.

The *Forest and Range Practices Act* and regulations provide for a results-based, forest and range management framework in B.C. that includes professional reliance as a foundational principle. Under the results-based model, government evaluates compliance with the law using the Ministry's Compliance and Enforcement Program⁷ and evaluates the effectiveness of forest and range practices in achieving management objectives, including sustainable resource management, with the Forest and Range Evaluation Program (FREP)⁸.

The FREP conducts monitoring and effectiveness evaluations for the 11 key resource values identified under the *Forest and Range Practices Act*. These evaluations measure the current status of these resource values and assess whether the legislation achieves sustainable management of B.C.'s forest and range resources.

Forest certification is another key component of B.C.'s sustainable forest management framework. Many B.C. forest companies go beyond the requirements of the regulations to have their plans certified by recognized, independent certification bodies. The Canadian Standards Association, the Forest

⁷ Compliance and Enforcement (C&E) is the law enforcement arm of the Ministry of Forests, Lands, and Natural Resource Operations. Its main purpose is to make sure that a variety of resource management laws are being followed on and in B.C.'s public lands, water, and forests and to take action where there is non-compliance. For more information visit <http://www.for.gov.bc.ca/hen/>.

⁸ For more information on the Forests and Range Evaluation Program visit <http://www.for.gov.bc.ca/hfp/frep/>.



Stewardship Council, and the Sustainable Forestry Initiative⁹ are the main forest certification bodies in Canada. British Columbia is a world leader in forest certification; more than 52 million hectares have been certified.

As with any activity or decision regarding public forest, activities or decisions related to forest carbon are subject to the numerous and varied forms of management described above. The only explicit policy regarding forest carbon is the Forest Carbon Offset Protocol (FCOP).¹⁰ The FCOP is a guideline for managing and accounting for carbon under forest management approaches. As with all activity on Crown forest, the protocol and carbon management adhere to relevant legislation governing use of the forest resource.

Socio-Economic Importance of Forest Resources

For over 100 years, forests have been an integral component of the Province's economy. Forests have provided British Columbians forestry jobs and carbon friendly resources for numerous societal needs both at home and abroad. The forest sector includes forest management, harvesting, bio-energy, reforestation and manufacturing and plays a key role in the provincial economy, especially in many rural communities. It is export-oriented, depending heavily on global markets and exchange rates; and cyclical, being affected by the ups and downs of the global forest commodity markets.

The relative share of economic benefits provided by our forests has decreased in recent years and was affected by the severe economic downturn of 2009. Since 2010, the sector has been steadily recovering. The following information is based on 2011 data (Ministry of Forests, Lands and Natural Resource Operations, 2011).

- B.C.'s timber harvest was 69.2 million m³ of timber, up 9.3% from 2010. B.C. forest manufacturing sales were \$11.2 billion, up 4.9% from 2010.
- B.C. forestry GDP was \$8.5 billion chained 2002\$,¹¹ and accounted for 5.4% of B.C.'s total GDP (Figure 2).

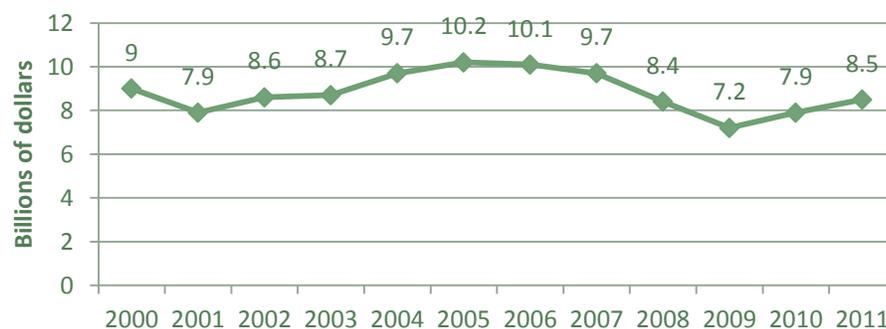


Figure 2 British Columbia forest sector annual Gross Domestic Product in billions of dollars chained 2002\$ from 2000 to 2011

⁹ For more information visit the Canadian Standards Association <http://www.csasfmforests.ca/>, the Forest Stewardship Council <https://ca.fsc.org/>, and the Sustainable Forestry Initiative <http://www.sfiprogram.org/>.

¹⁰ For more information on the Forest Carbon Offset Protocol (FCOP) visit <http://www.env.gov.bc.ca/cas/mitigation/fcop.html>.

¹¹ Chained dollars is an economic tool that minimizes distortions in dollars over a given time to enable more accurate comparison of dollars between years.



B.C.'s forest sector exports primarily go to the USA and China, with Japan and the Euro Zone countries also as important export markets (Statistics Canada, 2013). More robust and diversified global demand would support the recovering B.C. forest sector. Innovations and investments in markets, products and technologies and investments will make the sector more competitive. Opportunities presented by the growing bio-economy suggest B.C.'s forest sector will continue to prosper (see section 5 for more detail).

Managing the forests for carbon uptake and storage is a new element in the province's forest management and is undertaken within the context of the importance of the full set of forest related benefits that British Columbians value. As with all values for which the forests are managed, social, ecological and economic balance must be struck. This is expanded upon with respect to forest carbon in section 4.

Biophysical Attributes of B.C.'s Forests

From the islands on the Pacific coast to the Rocky Mountains and from hot dry grassland to moist coastal forest, B.C. encompasses a great diversity of ecosystems and geography. The coastal environment maintains Canada's wettest climates and most productive forest lands. To the east, coastal mountains transition to broad, rolling interior plateaus and the steep ranges of the Columbia and Rocky Mountains along the B.C.-Alberta border. Through the interior, the climate is more continental, with correspondingly larger extremes of temperature and precipitation than the coast. Forested ecosystems range from Ponderosa pine savannas, to more productive spruce, pine and Douglas-fir forests, to highly productive cedar/hemlock forests. The northeast corner of the province is more typical of the boreal forests found across Canada.

B.C. is home for 49 native tree species (eFlora B.C., 2013). B.C.'s diverse lands support over 300 species of birds and 190 mammals ranging from predator bird species like bald eagles, ospreys and peregrine falcons to wild populations of grizzly bears, caribou, grey wolves and Rocky Mountain big horn sheep (State of B.C. Forests, 2010). B.C.'s 55 million hectares (ha) of forests, contain 6-7 billion tonnes of carbon in above-ground biomass.¹²

Climate change poses both risks and opportunities for B.C.'s forest ecosystems and the services they render (e.g. wildlife, water, habitat, carbon storage, timber and much more). Risks include issues like increasing wildfires and insect disturbances. Opportunities include the potential for increased growth rates in currently colder ecosystems and expanding markets for climate-friendly forest resources such as harvested wood products.

As the name says, carbon dioxide consists of one carbon and two oxygen molecules. With the extra two oxygen molecules, carbon dioxide has a greater molecular weight. It is possible to convert between carbon and carbon dioxide by using the ratio of carbon in carbon dioxide. One tonne of carbon is equivalent to $44/12 = 3.67$ tonnes of carbon dioxide. Therefore, 11 tonnes of carbon dioxide contains 3 tonnes of carbon. This calculation is only appropriate for biologically-stored carbon in terrestrial ecosystems because the exchange with the atmosphere is typically in the form of carbon dioxide. This conversion is not applicable to other systems such as fossil fuel burning.

¹² Above ground biomass is 4.97 billion tonnes of carbon from standing live trees and 0.77 billion tonnes of carbon from standing dead trees. Carbon is also stored in roots, soils, non-tree plants, and dead wood and litter on the forest floor. Data are from 2007. Source: Stinson et al. 2010.



3.0 Forest Carbon Background

Forests and Carbon

Forests interact dynamically with the atmosphere through enormous exchanges of energy, mass (carbon and water), and other gases that affect the earth's energy balance and climate. Since 1990, the world's forests have annually removed from the atmosphere about 30% of the global emissions of CO₂ due to fossil fuel combustion, cement production, and land-use change such as deforestation (Pan et al., 2011). Forests in British Columbia are important to the global carbon cycle because of their size and vast quantities of stored carbon.

It is important to note that carbon and carbon dioxide are different metrics used in the context of climate change discussions (see the green call out box on this page). Carbon is generally used when referring to either the carbon cycle or carbon stored in wood and other plant material. Carbon dioxide is the gas emitted to the atmosphere and absorbed via biological processes like photosynthesis. Within plants, it is converted to complex molecules such as the cellulose and lignin of wood. Businesses and the public use carbon dioxide equivalents to report their emissions or offsets – greenhouse gases converted to their proportionate effect on the atmosphere but standardized to carbon dioxide units.

The forest ecosystem can be thought of as a system of pools or reservoirs with the capacity to accumulate or release carbon. Live biomass, soil, and dead organic matter are three general carbon pools in forests. The absolute quantity of carbon held within a pool at a specified time is defined as a carbon stock. Transfers of carbon from one pool to another are referred to as a carbon flux. For example, carbon will move from the live biomass pool to the dead organic matter pool due to logging. Calculating the net carbon balance of a forest at the landscape level requires complex accounting. It is determined by many factors: the growing conditions, natural disturbance events, decay rates, and forest management activities.

A forest is considered a source when, overall, it emits more carbon dioxide and other greenhouse gases than it removes from the air in a given time period. It is considered a sink when it removes more than it emits (CFS-NRCan, 2007). For example, from 1990 to 2002, B.C. forests were a carbon sink. In other words, they stored more carbon than they released. However, in 2002, B.C. forests transitioned from a carbon sink to a carbon source (Figure 3). This means they began to release more carbon dioxide and other GHGs into the atmosphere than they took up while growing. This transition is attributed to the mountain pine beetle outbreak (which peaked in 2006) killing trees and resulting in less growth and more decay, large wildfires (in 2003, 2004, 2006, 2009, and 2010), and increased harvest.



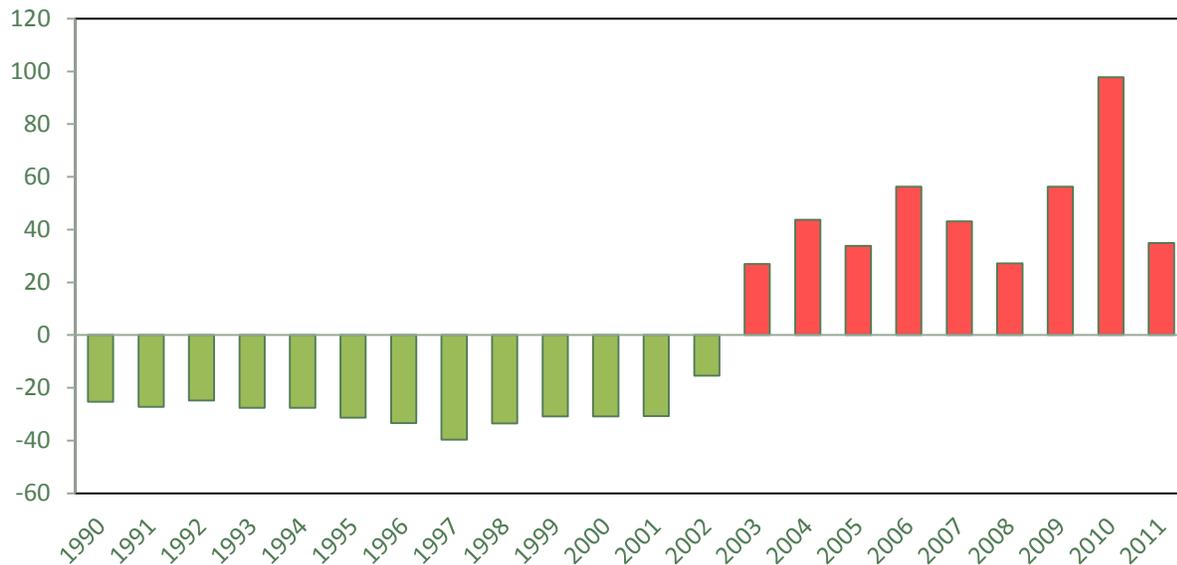


Figure 3 B.C. Forests' Net GHG Emissions in Mt CO₂e/ year from 1990 to 2011

This figure shows the approximate annual balance of CO₂e (carbon dioxide equivalent) in B.C. forests based on the accounting rules of the Intergovernmental Panel on Climate Change, an internationally recognized scientific authority. Between 1990 and 2002, forests were a net sink for carbon (green). They took up more carbon than they released to the atmosphere. In 2002, this changed and they became a net source for carbon (red). They released more carbon into the atmosphere than they could take up.¹³

The carbon pools of a forest stand are often characterized by long periods of slow carbon uptake during growth followed by relatively short periods of large carbon losses due to disturbances such as logging, fire, or insect infestation (Figure 4). These types of disturbances are naturally occurring, and in many ways, part of healthy ecosystem functioning. However, due to climate change, these impacts and disturbances may be more pronounced and reduce the ability of the forests to provide ecological goods and services.

In a managed forest, carbon is transferred out of the forest system when timber is harvested and used to create harvested wood products. Harvested wood products store carbon over time depending on the type of product (e.g. lumber, paper, bio-energy) and how they are used (e.g. over the short or long time scales). For this reason, harvested wood products constitute another pool of carbon and an opportunity to provide additional carbon storage benefits as will be described below.

¹³ Data for this graph is from Stinson et al. 2010.



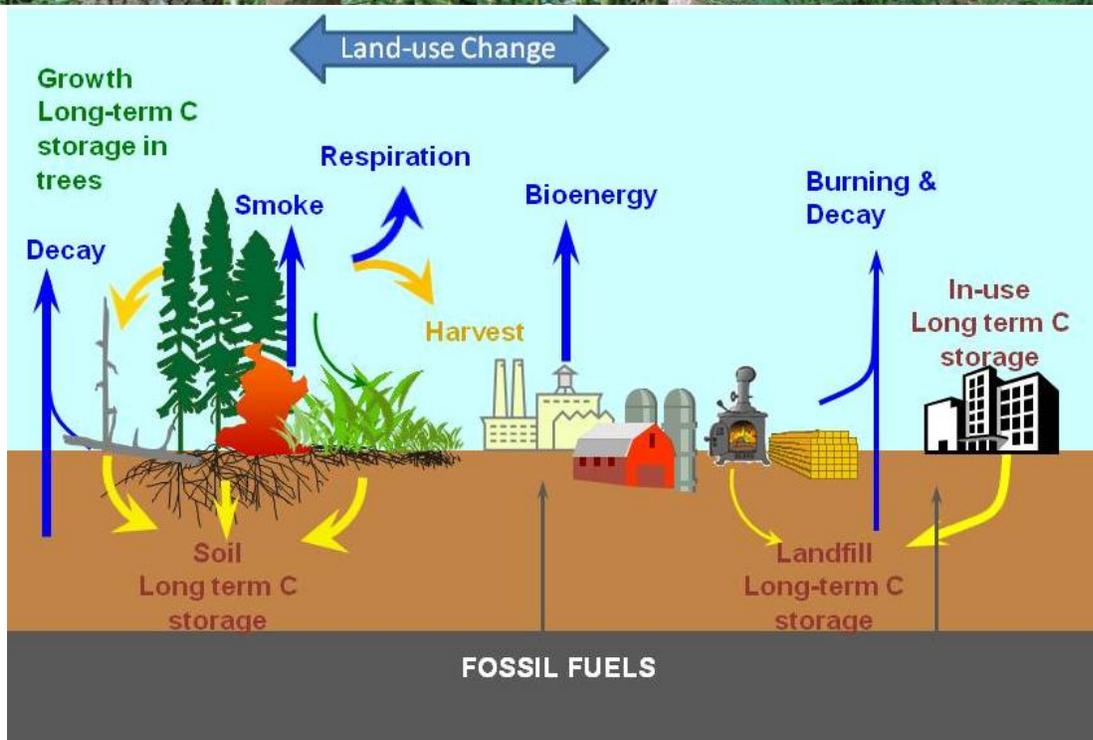


Figure 4 The forest and wood product carbon cycle

Carbon is taken up by trees and other plants and stored in wood or other plant material. The yellow arrows illustrate the transfer of carbon from one pool or reservoir to another. The blue arrows show the major pathways where carbon is converted to carbon dioxide or other gases and released back to the atmosphere. The land use change arrow refers to the conversion of land away from forests. Land conversion has consequences for carbon uptake and emissions. On the left of the diagram, the forest is taking up and emitting carbon. On the right side of the diagram, the developed land is not taking up carbon. It is emitting carbon and storing it long-term in wood products (Dymond and Spittlehouse, 2009).

Harvested Wood Products and Carbon

During logging, 40-60% of the carbon in cut trees remains in the forest and the rest is removed and transported to mills to generate products used by society (CFS-NRCAN, 2007). Harvested wood products play three important roles in the global carbon cycle and in climate change mitigation: a physical pool of stored carbon, a substitute for more energy-intensive materials, and a renewable material for energy generation. Collectively, the various roles of harvested wood products are a mitigation option endorsed by the Inter-governmental Panel on Climate Change, an international authority on climate change science, adaptation and mitigation.¹⁴

Harvested wood products store carbon over short and long time scales depending on the type of product as shown in the table below (Table 1). There are many buildings with substantial wood content that have already lasted for over 100 years. The amount of carbon stored by harvested wood products in-use declines over time, however, many products continue to store substantive amounts of carbon for

¹⁴ Mitigation is a reduction in the emission of greenhouse gases (GHG's) or an increase in sinks of carbon dioxide. Chapter 9 in the Inter-governmental Panel on Climate Change's Fourth Annual Report (Nabuurs et al. 2007, IPCC AR4), four options for forest sector mitigation are noted. Option four is: increase carbon stored in products, reduce fossil emissions through product substitution and through bio-energy use.



over 100 years (Figure 5). Once retired from use, carbon in paper and wood products are not necessarily released back to the atmosphere. Some products are burned or composted for disposal. Recent scientific analysis of landfills has determined that 44% of carbon in paper and 77% of carbon in wood products are stored for decades or centuries (Dymond, 2012). Overall, each year, more and more carbon is stored in the harvested wood products carbon pool as B.C.'s harvest has been continuing and because of the long-term storage in landfills (Dymond, 2012a and personal communication with C. Dymond).

Table 1 Half lives of harvested wood products¹⁵

This table describes a harvested wood product's 'life expectancy'. The half life represents the point where 50% of the population has been retired. Single-family homes, for example, have a half life of 90. This means 50% of the wood in family homes has been removed through demolition or renovation and 50% is still in use.

| Harvested Wood Product | Half Life |
|---|-----------|
| Single-family homes | 90 |
| Multi-family homes and commercial buildings | 75 |
| Residential upkeep and moveable homes | 30 |
| Furniture & other manufactured products | 38 |
| Shipping | 2 |
| Paper | 2.5 |

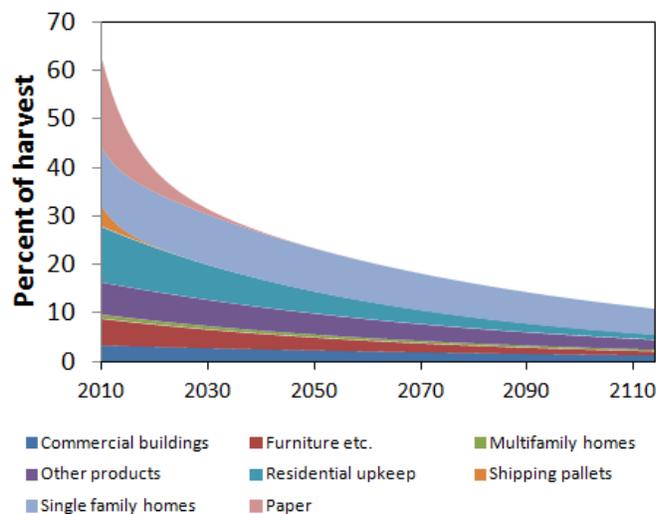


Figure 5 Percent of B.C.'s 2010 harvested wood carbon that will be stored in-use over the next 100 years

The graph shows the use of the 2010 harvest for different products and how the carbon they store is expected to decline over the next 100 years. A short-term product, like shipping pallets stop storing carbon in-use after approximately 10 years. Although short-term in nature, paper continues to store carbon for over 20 years because of the high rate of recycling. About 11% of the harvested wood carbon is still stored after 100 years (Dymond, 2012a).

Recent scientific analysis of B.C.'s harvested wood fibre indicates that in 2010/2011, approximately 1/3 of B.C.'s wood/bark ends up in longer-lived building products (including panels, plywood, veneer, lumber, logs); 1/3 is used in pulp and paper, sawdust and pellet products; and 1/3 generates bio-energy from waste wood (Figure 6) (Dymond, 2012b and personal communication with C. Dymond). It is

¹⁵ This table was adapted from Table 8 in Dymond, 2012a.



important to note that the harvest used for bio-energy is a byproduct generated from processing of timber into lumber and paper. Live trees are not harvested for bio-energy in B.C..

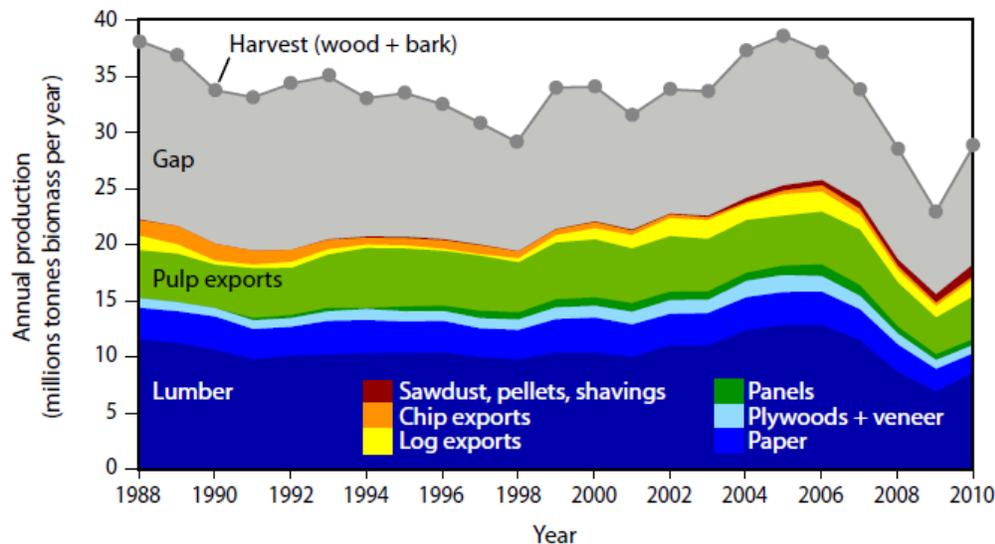


Figure 7 Harvested biomass, including wood and bark, relative to the cumulative annual manufacturing and export output in British Columbia, 1988–2010

2010 values estimated for plywood and veneer and panels. New survey results indicate that the “Gap” is fibre used for bio-energy.¹⁶

When wood is used to meet societal demands that would otherwise be met with relatively higher greenhouse gas emission materials such as steel, concrete or plastics, a relatively permanent emissions benefit is realized.¹⁷ This is known as wood product substitution and creates emissions avoidance; emissions that would have been generated by using greater GHG producing non-wood sources are avoided by using wood instead. As noted previously, there are two types of substitution: replacing more energy-intensive materials (material substitution) and replacing fossil fuels for energy generation (energy substitution). Life cycle assessment (LCA) allows objective comparison of different materials from the beginning to the end of their lives: from resource extraction through manufacturing, distribution, use and finally, disposal.

Scientific assessment has also shown the emission reduction benefits of energy substitution: the use of wood in place of fossil fuels. The biomass used for bio-energy can result in positive atmospheric benefits (i.e. have lower net emissions within a specified time) depending on the fossil fuel being replaced, the source of the biomass, and regrowth rate of the biomass. Using “green trees” (i.e. living trees), for bio-energy does not offer emission reductions; however, using dead trees or residual fibre (i.e. fibre left over after processing for other purposes) can have a net benefit.

¹⁶ This figure appears as Figure 8 in Dymond, 2012b.

¹⁷ A recent study analyzed data from 21 different international studies on the displacement factors of wood products substituted in place of non-wood materials (Sathre & O’Conner, 2010). A displacement factor is a measure of the amount of emission reduction achieved per unit of carbon in wood products. The average displacement factor for buildings is 2.1tC. This means that for each metric tonne of carbon in oven-dry wood products (2 tonnes of oven-dry wood) substituted in place of non-wood products in building construction, there occurs an average GHG emission savings of approximately 8t CO₂ eq.



In B.C., as a result of the mountain pine beetle outbreak, harvesting in the interior includes extensive salvage of standing dead trees. In recent years, B.C. has become a major supplier of wood pellets, generated from dead trees and residual fibre, exported primarily for bio-energy to Europe.

A recent study suggests current practices (e.g. burning logging residue and only using sawdust for pellet production) require 20-25 years to accrue a net carbon benefit. Using logging residue to make pellets (a small but growing part of the industry) to replace coal for electricity generation, would shorten the time it takes to reach pre-harvest carbon levels by 9-20 years. Also, this would instantly result in a net carbon benefit from areas most severely impacted by the beetle because large amounts of wood would displace coal instead of being burned on site. Logging beetle-impacted sites for lumber and using harvest residue for bio-energy created a greater carbon benefit than forest conservation. Logging stands exclusively for bio-energy led to a net carbon source to the atmosphere unless they contained a high proportion of dead trees (>85%). Stands or landscapes with more than 15% living trees provide the largest atmospheric benefit when primarily used for lumber or similar long-term wood products (Lamers et al., 2013).

4.0 Forest Carbon Management in British Columbia

Forest carbon management refers to actions or practises aimed at increasing the carbon sinks of the forest ecosystem or reducing or avoiding emissions from forest management practices. Forest carbon management and practices are informed by scientific analysis of the carbon benefit of various management options (see references and additional resources for more information). Continued research and improvement to forest carbon science better enable decision makers to manage for carbon in forest ecosystems.

B.C. balances forest carbon management with all social, economic and ecological natural resource values. Social values such as forestry jobs in communities and economic values such as revenue from forest sector manufacturing and GDP are measurable components for which there is current accounting. Carbon is an example of an ecological value that has become measurable due to advances in forest carbon science and the emergence of carbon offset markets. In this document, other ecosystem goods and services are discussed in a qualitative fashion with recognition that more attention is needed to better assess the broader suite of ecosystem services forests provide.

There are numerous forest carbon management options that can result in a range of carbon and ecosystem benefits. Options will vary according to local factors such as site productivity, forest growth and yield, and the costs of implementation. The province recognizes that there is not one option or a specific mix of options that can be uniformly implemented on a large scale. Regions will have different portfolios of mitigation options to best suit their local or regional needs. The following section provides a brief overview of broad scale forest carbon management options that can be considered at different local and regional scales.

Managing Forests for Carbon Benefits

Forest management can influence the sinks and sources of carbon from the forest carbon pools. Approaches are available that can increase the uptake of carbon dioxide in forests, reduce emissions from forest management practices (e.g. burning of logging waste) and potentially reduce or avoid



emissions from natural cycles within forest ecosystems where appropriate. The Intergovernmental Panel on Climate Change notes that “in the long-term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fibre or energy from the forest, will generate the largest sustained mitigation benefit” (Nabuurs et al., 2007).

In the past few decades, scientific progress has been substantial and has supported B.C.’s forest carbon policy development. Considerable uncertainties still exist and therefore policies need regular review and revision to incorporate ongoing research. Information summarized below provides a snapshot of a national scientific analysis completed by leading forest carbon scientists. This work informs the province’s current forest carbon management policies.

The National Forests Sinks Committee (NFSC) examines issues of common interest related to forest carbon by conducting analyses and facilitating ongoing discussion among its federal, provincial and territorial participants. The group consists of research scientists, natural resource managers and policy makers in the federal, provincial and territorial governments whose work has direct links with forest carbon. In 2011, the NFSC developed and assessed six potential forest-based climate change mitigation strategies (Stinson et al., 2011). Three of these are based on changes to forest management; two are based on changes to the flow of harvested wood products derived from the forest. The sixth is a combination of forest management strategies and harvested wood products strategies. These strategies were developed in consultation with forest management agencies from across Canada including B.C.’s Ministry of Forests, Lands and Natural Resource Operations (MFLNRO).

Forest management strategies

1 - Carbon smart harvest – take a greater proportion of the trees off the cutblock, leaving less to be burned as waste or decay, and increase the proportion of wood derived from salvage harvesting. Salvage harvesting is the practice of logging trees in forest areas that have been damaged by wildfire, flood, severe wind, disease, insect infestation, or other natural disturbance.

2 - Harvest less – increase the amount of conservation areas and reduce the amount of timber harvested.

Harvested wood product strategies

3 - Bio-energy harvest – increase the amount of timber harvested, and use that additional harvest for bio-energy.

4 - Wood substitution – increase the proportion of the harvest that is used for long-term wood products (e.g. lumber, panels) that could substitute for more emissions-intensive non-wood products, and reduce the proportion used for short-term products (e.g. pulp, paper).

5 - Bio-energy – increase the recovery rate of the sawdust and shavings from sawmills and use for bio-energy that could substitute for fossil fuels.

Combined forest management and harvested wood products strategy

6 - Carbon smart harvest and wood substitution – a combination of the assumptions used for *Carbon smart harvest* and *Wood substitution*.



The six mitigation strategies were examined relative to a base case (i.e. business as usual) scenario, to determine the emissions reductions that could be realized with each strategy. The emissions reduction is the difference between the base case emissions and the strategy emissions.

$$E_R = \sum(E_B - E_S)$$

Where E_R is the cumulative emissions reduction, E_B is base case emissions and E_S is mitigation strategy emissions. The difference is calculated annually and summed over time.

The analysis determined there is not one single best forest sector strategy for climate change mitigation (Figure 8). The best strategy depends on the time period over which benefits are assessed. Some strategies are good in the long-term but cause net emissions in the short-term. The strategy with the highest mitigation benefit by 2020 is not the best strategy to 2050. The best strategy over the long-term is a combination of carbon smart harvest and wood substitution. This suggests that if sector activities were tailored more toward carbon objectives and the production of long-term wood products, then substantial emissions reductions could be achieved. It is also important to point out that the mitigation potential of each strategy will be variable according to local/ regional forest ecosystem characteristics. This study does not factor in potential socio-economic benefits and impacts, or other benefits from ecosystem services. It is focused solely on carbon management (Stinson et al., 2011).

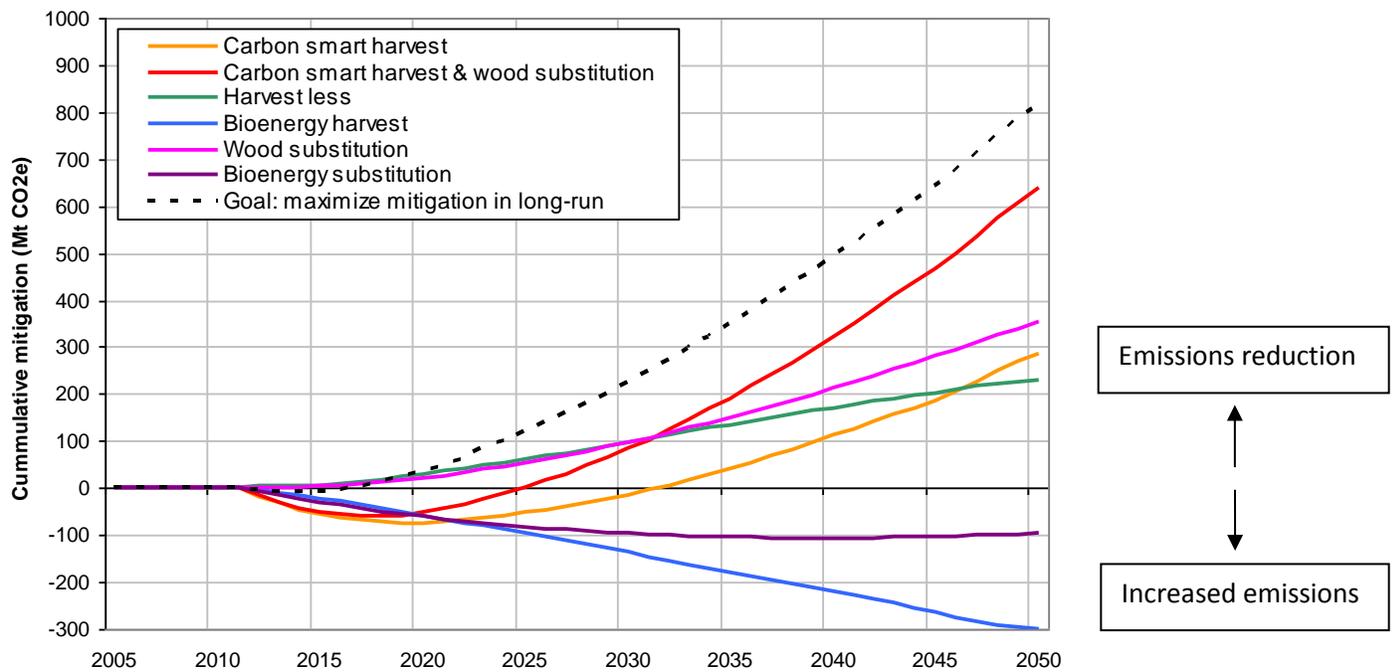


Figure 8 Summary of cumulative climate change mitigation benefit or loss of six forest management options relative to a base case business as usual (Stinson et al., 2011)¹⁸

¹⁸ These results are for the managed forests of Canada which includes BC’s managed forests.



Managing Forests for Benefits Beyond Carbon

While significant, carbon is not the only benefit forests bestow upon British Columbians. As previously noted (section 1), B.C.'s forests are managed within a sustainable forest management framework which seeks to balance multiple objectives including ecological, economic and social benefits. The most appropriate forest carbon management strategy is the one that fits best with an area's biophysical and socio-economic environment. Strategies, therefore, vary according to the unique regional context. This section elaborates on how forest carbon management can complement management for environmental and socio-economic benefits other than carbon storage and also identifies the potential trade-offs of managing forests with a singular focus on carbon.

The *Forest and Range Practices Act* recognizes the co-dependence of the social, economic and cultural value of B.C.'s forests and identifies 11 key values that must be maintained in B.C. forests.¹⁹ These are biodiversity, cultural heritage, fish/riparian/watershed, forage and associated plant communities, recreation, resource features (e.g. protection of salt deposit or eagle wintering area), soils, timber, visual quality, water and wildlife.

Forest management strategies to increase sinks or reduce emissions fall into four broad categories:

1. Increase (or maintain) forest area,
2. Increase stand-level carbon density,
3. Reduce emissions associated with forestry operations and,
4. Increase landscape-level carbon density.

Increasing or at least maintaining forest area is a central component of forests and climate change mitigation. When forests are converted to other land-use, such as industrial or agricultural use, the carbon stocks left on the site gradually decay and are not replaced by the carbon sink of new growth. By reducing the rate of conversion to non-forest use then the carbon storage can be maintained. Planting currently non-forest areas that are suitable for trees can increase the local sink for decades. All of the values listed in FRPA would benefit from this category of forest management strategies because they all depend on the maintenance of forest ecosystems in B.C.

Increasing stand-level carbon density can be achieved through a variety of silviculture methods, e.g. species selection, fertilization, or increased rotation length. It is complex to speculate on the potential benefits to other values. Timber production and jobs may increase due to fertilization, but may decrease with greater rotation length. Forage may depend on a relatively low density of trees. Visual quality (beauty) and water quality would potentially improve with greater tree growth and density.

Reducing emissions associated with forestry operations refers both to fossil fuel and forest emissions. Reducing the number of trips to a site; upgrading the diesel engines on equipment to be more efficient; and reducing tree damage during partial harvesting or thinning, the amount logging waste that must be burned, soil damage and on-site erosion, are all part of this category. The FRPA values that would likely also benefit from the forest carbon emission reductions are: soil, fish/riparian/watershed, and water.

¹⁹ For more information on the 11 Forests Range and Practices Act values see <http://www.for.gov.bc.ca/hfp/frep/values/index.htm>.



Increased landscape-level carbon density can be achieved by conserving old-growth areas with high carbon stocks; reducing the amount of harvesting where it lowers forest carbon stocks; reducing the impact of wildfires, pests, and disease; or broad application of the stand-level strategies mentioned above. The NFSC “Harvest Less” strategy fits within this category. Areas with a high degree of biodiversity, culturally valuable areas, resource features, and unique wildlife may be appropriate for this kind of forest carbon management to get the greatest co-benefit. It may not be appropriate to apply these strategies to areas where biodiversity, wildlife, fish, forage, recreation, and cultural heritage depend on frequent low intensity wildfires. These fires are relatively easy to suppress, causing carbon stocks to increase, but doing so may not be in the best interest of a balanced approach to natural resource management (Daigle and Dymond, 2010).

While there are ecological and cultural benefits to forest carbon management regimes that reduce harvest, corresponding socio-economic disadvantages may also exist. Reducing harvest can result in a net loss of direct and indirect employment generated by the forest sector. There may also be reductions to timber revenue and fibre supply for manufacturing. Demand for harvested wood products formerly supported by the land, may be met with non-wood products, resulting in greater emissions overall.

In some cases the loss may be mitigated with the socio-economic benefits now accessible as a result of reducing harvest; for example, an increase in tourism and recreational opportunities or the generation of carbon offset revenues. However, jobs created for recreation and tourism are often seasonal and lower paying than jobs in forestry. Areas with a heavy dependence on forestry could see considerable impacts to their communities from a reduction in harvest.

Forest carbon management regimes involving harvest are important to B.C. communities because they contribute substantive socio-economic benefits. Many B.C. communities obtain a high proportion of their basic income from timber-based industries. In 2006, 25 of 63 local areas (excluding Greater Vancouver) obtained 20 to 48% of their basic income from the timber and tourism industries. These 25 areas include 47 communities with a total population of 303,000, not including surrounding rural areas. The map of forest sector vulnerability (Figure 9) shows relative sensitivities of the 63 local area economies to downturns in timber-based industries (State of British Columbia’s Forests, 2010).²⁰ Many of the most vulnerable communities are in areas where timber supplies are at risk due to the mountain pine beetle epidemic.

²⁰ Figure 9 appears as Figure 18-3 in the State of British Columbia’s Forests, 2010.



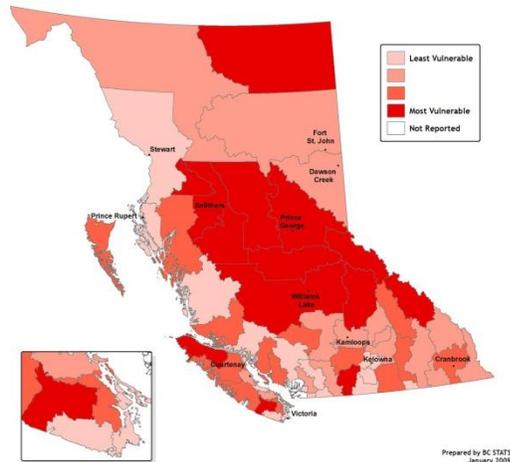


Figure 9 Regional Sensitivity to Forest Sector Economic Downturn²⁹

Vulnerability is high where a large share of local income derives from the forest sector and the local economy is not highly diversified.

5.0 Forest Carbon and the Future of British Columbia's Forests

Forest Carbon Management and Adaptation to Climate Change

Managing forests for carbon and adapting forests for a changing climate are inextricably linked. Long-term storage of carbon in forests may not be possible if management practices are not appropriately adapted to the changing climate. For example, many B.C. forests that are currently well-suited to the climate may not be as productive under new conditions. Climate change may increase the impacts from natural disturbances such as insects (e.g. Mountain Pine Beetle), disease, and wildfires. Consequences of climate-related impacts filter through the economy through such things as fluctuation in timber supply to feed mills, required adjustments to milling technology to deal with salvage wood, and disruption to communities as employment is affected. A longer fire season and thaw period will also affect forest business operations.

Effective forest management in a changing climate requires understanding what climate changes are occurring now and in the future both regionally and locally,²¹ how this will affect forest growth and productivity, and strategies for addressing climate change impacts. For example, some strategies include enhancing tree species diversity, matching planting stock to potential future climatic environments, and addressing the anticipated impacts of fire, insects and disease. These factors speak to the overarching need for forested landscapes that are resilient to management actions and a range of potential future climates.

There are opportunities to increase the forest area and productivity in some areas and expand the range of high-value species. For example, warming of cold soils may enable forests to grow in areas where no forests now exist. Longer growing seasons and higher carbon dioxide concentrations in the atmosphere may contribute to increased productivity for a period of time in some parts of the province. In addition,

²¹ Free web-based tools, ClimateWNA, <http://www.genetics.forestry.ubc.ca/cfcg/ClimateWNA/ClimateWNA.html>, ClimateB.C. <http://www.genetics.forestry.ubc.ca/cfcg/ClimateB.C./ClimateB.C..html> and Plan2Adapt, <http://pacificclimate.org/tools-and-data/plan2adapt> provide regional projections of future climate.



the area of the province suitable for high-value species (e.g. Douglas-fir) is expanding (Coops et al., 2010). Even where increased productivity is expected, gains may be offset by losses due to forest health damage or wildfires.

The 2012 provincial wildfire management strategy is to “deliver effective wildfire management and emergency response support on behalf of the government of British Columbia to protect life and values at risk and to encourage sustainable, healthy and resilient ecosystems.” A primary change in wildfire management is the shift towards “modified responses” to wildfire rather than full suppression; this allows fire back into the landscape and encourages the natural fire cycles to promote healthy and resilient ecosystems.²²

Trees planted today need to be adapted to a range of potential future climates. Approximately 200 million seedlings are planted in B.C. each year (Silviculture Facts, 2011). In the past, the seedlings were well-adapted to the climate of their planting locations. Seedlings planted today and harvested 60-80 years from now could face a climate 4 degrees Celsius warmer creating very different climatic conditions that exist today. Reducing the risk of maladaptation is a priority for the MFLNRO. Research and development are underway to provide all licensees with the best available science to guide their reforestation decisions. More information about how government plans to address this in the short-term is found in the *B.C. Forest Stewardship Action Plan for Climate Change Adaptation* and the MFLNRO Climate Change Adaptation website.²³

Carbon and the Developing Bio-economy

The bio-economy encompasses the sectors and related services that produce, process or use biological resources (e.g. starch, sugar, wood, cellulose, lignin, proteins and more) in whatever form (Bio-economy Council, 2010). Biomass has supported humanity for millennia with practices like crop farming, forestry, and livestock domestication. The current and future bio-economy includes these traditional practices as well as new knowledge, processes and technology based in sectors such as chemistry, wood processing, pharmacology and biotechnology. The emphasis of the bio-economy initiative is using renewable and sustainably managed biomass-derived inputs in place of petroleum/ fossil fuel based inputs in production and manufacturing of consumer based products.

The bio-economy’s renewable nature supports both ecological and economic sustainability. A long-term and sustainable market can be envisaged for technologies that produce chemicals, materials and pharmaceuticals from plant-based feedstocks (Sanders, 2007). The impacts of a greater reliance on bio-resources include:

- Reduced demand for fossil fuels;
- Reduced greenhouse gas emissions;
- Development opportunities for rural areas, including employment;
- Reduced toxicity and enhanced health implications (Langveld et al., 2010);

²² For more information see the Wildfire Management Branch Strategic Plan 2012- 2017, Ministry of Forests, Lands and Natural Resource Operations, Province of British Columbia available at http://BCwildfire.ca/Strategic_Planning/docs/Wildfire%20Management%20Strategic%20Plan%202012_17.pdf.

²³ To view the *B.C. Forest Stewardship Action Plan for Climate Change Adaptation* and the MFLNRO Climate Change Adaptation website visit <http://www.for.gov.bc.ca/het/climate/actionplan/index.htm>.



Recent work from the Forest Products Association of Canada (FPAC), FPIInnovations, Natural Resources Canada and numerous economic and scientific experts investigated the opportunities to produce a wide range of bio-products from wood fibre and identified a global market opportunity of \$200 billion. The potential for bio-chemicals, for example, is \$62 billion. Figure 9 highlights the dynamic growth how market price for bio-based products is inversely proportional to the market volume (FPAC, 2011). Opportunities that focus on products with more value added (i.e. at the top of the pyramid) could yield greater returns.

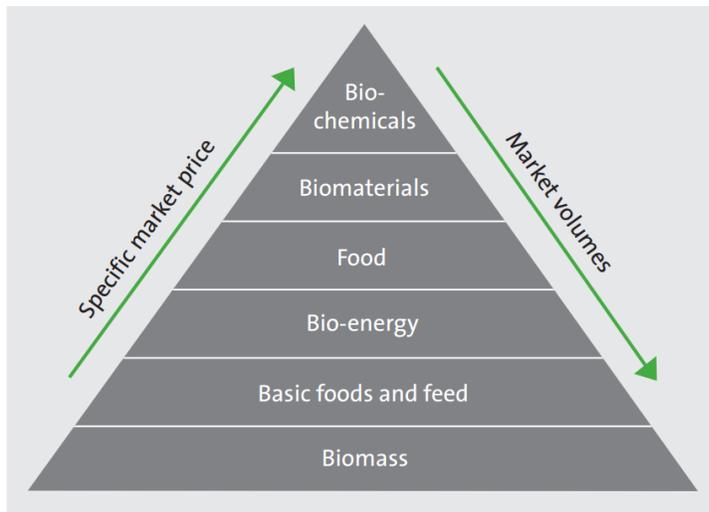


Figure 9 Market prices versus market volumes of bio-based products²⁴

Just as harvested wood products can be substituted for more energy intensive materials, products made from biomass can be used in place of products made from conventional fossil fuel-based materials. Concerns about rising greenhouse gas emissions, declining and insecure fossil fuel supplies and negative environmental impacts (e.g. waste generation, biodegradation, toxic by-products, contamination, detrimental impacts to air and water quality) have led to relatively recent interest in substituting biomass for fossil fuels in the production of all manner of synthetic materials.

Understanding both the positive and negative impacts of bio-based products is important to appropriate policy design. MFLNRO envisions more utilization of what is currently considered “waste” forest fibre to support B.C.’s growing bio-economy. B.C.’s bio-energy industry is already established. Expanding to create longer-term and higher value products is desirable from both economic and climate change mitigation perspectives.

A recent study analyzed the trends in environmental impacts by assessing 44 scientific life-cycle assessment studies (Sathre and O’Connor, 2010). These studies covered approximately 60 individual bio-based materials and 350 different life cycle scenarios. The study found that using bio-based materials saves substantial energy and greenhouse gas emissions compared with conventional fossil or mineral based materials. However, eutrophication and stratospheric ozone depletion was greater for

²⁴ Appears in Bio-economy, 2010. Adapted from De Jong, E., Sanders, J., and Langveld, J. 2010. *The biobased economy: Biofuels, materials and chemicals in the post-oil era. Biorefinery*. 111-130. Earthscan, London.



bio-based versus conventional materials.²⁵ This work highlights that there are costs and benefits to any material used. Analyzing trade-offs relative to outcomes is an important part of choosing appropriate materials.

6.0 Forest Carbon Management Strategic Direction

The province supports the use of forest carbon management options that satisfy the diverse values British Columbians seek from their forests. No one approach is suitable for the diverse forest ecosystems or diverse community needs across the province. The full suite of potential benefits needs to be considered such as options to enhance the carbon storage properties of forests and minimize emissions from the forest land base, and maintain socio-economic values provided by forestry and timber production as well as other ecological values such as biodiversity, water, fish and wildlife.

Current activities undertaken by the MFLNRO, focus primarily on maximizing the long-term climate mitigation value of our forest resources. Our strategy to achieve this relies on the following objectives:

- A. Promote carbon friendly forest management options that
 - support sustainable harvest rates and create synergies between carbon and timber management to take advantage of carbon storage value of long-term harvested wood products;
 - increase or maintain forested area where climatically suitable; and
 - provide and facilitate forest carbon investment opportunities.
- B. Improve knowledge through research, and develop new policies and practices that
 - increase awareness of forest carbon sinks, and of storage and management under a changing climate; and
 - increase awareness of harvested wood products carbon storage and optimize management.
- C. Integrate forest carbon management with climate change adaptation work and the management of other natural resource values through
 - collaborative work with stakeholders to align carbon values with other economic and environmental values;
 - promotion of forest carbon management options suited to local conditions and opportunities.

As noted in this document, disturbances and impacts from the mountain pine beetle and wildfire have transitioned forests from a net carbon sink to a source of carbon over the last decade. Therefore, the Ministry is concentrating efforts on restoring these forests in the province's interior to a more productive condition so they again take up more carbon than they release.

Forests present enormous climate risks and opportunities for forest carbon management. Restoration of disturbed forest may transition forests back to a net carbon sink over time; this has minimal to no

²⁵ The study found that one metric tonne (t) of bio-based materials saves, relative to conventional fossil or mineral based materials, 55 gigajoules of primary energy and 3 t carbon dioxide equivalents of greenhouse gases.



trade-offs with the other values forests provide British Columbians. In addition to providing long-term carbon benefits, restoration will generate socio-economic benefits in the form of direct forestry and silviculture jobs. It also supports a sustainable long-term timber supply which provides carbon-friendly wood products.

Goals:

- I. Restore damaged crown forest lands to help return our forests to a net carbon sink
- II. Collaborate with communities and stakeholders to share knowledge and better inform stakeholders and resource managers of the benefits and potential trade-offs of carbon management options to help provide the best local climate solutions.
- III. Continue research efforts to improve understanding of forest carbon dynamics and inform policy development that will support the integrated decision making model for natural resource management

Forest Carbon Programs and Related Initiatives Underway in B.C.

Forests for Tomorrow:

The Forests for Tomorrow Program²⁶ was established in 2005 to respond to the catastrophic wildfires that occurred in the southern and central interior and to the mountain pine beetle epidemic. Current reforestation investment is aimed at improving the future timber supply and addressing risks to other forest values through the re-establishment of young forests on land that would otherwise remain under-productive.

The program focuses on land that is primarily within the timber harvesting land base yet outside of forest industry reforestation obligations. Program emphasis is on surveying, site preparation and tree planting with these treatments being guided by strategic-level program planning, seed supply planning, silviculture strategies and timber supply analyses. The up-front overview surveys and program planning will formulate a clear and full picture of a cost-effective program and budget profile.

Forest Carbon Partnership Program:

In spring 2013, the Forest Carbon Partnership Program was launched. The program supports restoration of public forests by utilizing their carbon value. This program goes beyond the Forest for Tomorrow Program to restore and reforest additional lands that have been impacted by wildfire and/ or mountain pine beetle infestations. B.C.'s partner, the Prince George-based Carbon Offset Aggregation Cooperative (COAC), is undertaking restoration work and coordinating activities required to generate atmospheric benefits resultant from restoration.

In exchange for restoring Crown forest, COAC is entitled to ownership of the atmospheric benefits (i.e. GHG emissions reductions) resulting from the trees planted. Once verified and validated by third party review, atmospheric benefits can become carbon offset credits with monetary value on the carbon offset market. COAC's restoration work is financed by various private investors who will be able to use

²⁶ For more information on Forests For Tomorrow visit <http://www.for.gov.bc.ca/hcp/fia/landbase/fft/index.htm>.



carbon offset credits to improve their own carbon footprint or to generate revenue through sale to any other entity.

The program goes beyond demonstrating climate action and replenishing the carbon stored in our forests:

- There is no taxpayer burden for reforestation funded via private sector involvement in replanting Crown forest damaged by forest fires and pine beetle infestations.
- The trees planted and land used for forest carbon projects remain public assets.
- Forest carbon projects create near-term direct forestry jobs and support the forest sector by providing medium to longer term job opportunities for the management and manufacture of climate friendly forest products from forest resources.
- Adaptation to climate change is incorporated. Areas that were previously dominated by pine trees are reforested with a diversity of tree species. This fosters greater resilience to the impacts of climate change and improves the age class structure at the landscape level.
- Numerous environmental benefits result from restoring forests such as habitat creation and slope stabilization.
- This program offers socio-economic benefits such as rural community jobs and opportunities for First Nations partnerships.

The program was successfully launched at the end of May 2013. The first 19,000 trees were planted on naturally disturbed provincial forest in Quesnel. The province and COAC have agreed to plant a minimum of 1,100 ha over the next five years. Tree Canada, funded by private corporations, has also become a partner under the program. Tree Canada will restore 44 hectares of forest land in Vanderhoof District beginning spring 2014.

Forest Carbon Research:

Utilizing innovative methods and an interdisciplinary approach, staff at the MFLNRO Competitiveness and Innovation Branch, which includes economists, research scientists, professional foresters, and climate change policy experts, continue to research forest management strategies that include forest and land carbon amongst other forest values. Research centres on GHG accounting of forest practices, harvested wood product GHG accounting, forest carbon management practices, climate change projections and resultant implications for forests, forest adaptation and the forest bio-economy including bio-energy.

The branch is connected to the following ongoing research initiatives in B.C. and Canada:

- The National Forests Sinks Committee (NFSC) examines issues of common interest related to forest carbon by conducting analyses and facilitating ongoing discussion among its federal, provincial and territorial participants. The group consists of research scientists, natural resource managers and policy makers in the federal, provincial and territorial governments whose work has direct links with forest carbon. The NFSC is currently working on a multi-phase analysis of Forest Management Mitigation Potential in Canada to which B.C. contributes.
- The Pacific Climate Impacts Consortium (PCIC)²⁷ is a regional climate service centre at the University of Victoria that conducts quantitative studies on the impacts of climate change and

²⁷ For more information on the Pacific Climate Impacts Consortium (PCIC) visit <http://www.pacificclimate.org/>.



climate variability in the Pacific and Yukon region. Results from this work provide regional climate stakeholders with the information they need to develop plans for reducing the risks associated with climate variability and change. In this way, PCIC plays an important bridging function between climate research and the practical application of that knowledge by decision makers.

Initiatives that promote use of wood based on carbon and environmental benefits:

Work undertaken contributes to and benefits from existing initiatives by the province designed to promote the usability and climate change friendly properties of wood.

Naturally-wood²⁸ is a comprehensive information resource that brings together the latest, most reliable data about wood performance, green building and life cycle assessment, as well as British Columbia's wide variety of forest products, manufacturers, sustainable forest practices, forest certification, wood products and more. Links to related topics provide architects, builders, wood, pulp and paper manufacturers and their customers the ability to explore further resources on wood products. A product supplier directory and certification search engine provides convenient access to information to support informed choices when sourcing wood, pulp and paper products.

Naturallywood.com, is a product of Forestry Innovation Investment (FII)²⁹, a provincial Crown Agency that works with the Government of British Columbia, Government of Canada, independent academic and research institutes, trade associations and wood product companies to support an environmentally sustainable and globally competitive forest sector in B.C. Naturallywood.com's "Tackle Climate Change, Use Wood" initiative features multi-media resources that inform general audiences on the climate benefits of using wood with non-technical easy to understand resources informed by science.

The Wood First Initiative,³⁰ led by the Ministry of Jobs, Tourism and Skills Training, also has significant ties with this program. The overall goal of the Wood First Initiative is to encourage a cultural shift toward viewing wood as the first choice for construction, interior design and daily living. In October 2009, the provincial government moved to facilitate this cultural shift by passing the *Wood First Act*, which requires wood to be considered as the primary building material in all new publicly-funded buildings, such as schools, libraries or sports complexes. B.C.'s Wood First Initiative aims to build on that reputation by promoting the use of B.C. wood products.

²⁸ For more information on Naturally:wood, including the "Tackle Climate Change, Use Wood" Initiative, please visit <http://www.naturallywood.com>.

²⁹ For more information on Forestry Innovation and Investment please visit www.bcfii.ca.

³⁰ For more information on the Wood First Initiative please visit <http://www.jtst.gov.bc.ca/woodfirst/index.html>.



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Additional Resources

B.C. Forest Carbon Offset Protocol (FCOP) <http://www.env.gov.bc.ca/cas/mitigation/fcop.html>

B.C. Forest Stewardship Action Plan for Climate Change Adaptation
<http://www.for.gov.bc.ca/het/climate/actionplan/index.htm>

Blueprint for Forest Carbon Science in Canada: 2012–2020. Natural Resources Canada, Canadian Forest Service, Ottawa <http://cfs.nrcan.gc.ca/publications/?id=34222>

