Forest Carbon Mitigation in British Columbia – Policy Issues and Options

Working Paper

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Introduction

Climate change, one of the most important environmental threats of the 21st century, is caused by a global increase in greenhouse gases (GHGs) in the atmosphere[1]. While anthropogenic GHG emissions mainly result from the use of fossil fuels and cement production, land-use changes such as deforestation, have a lesser but nevertheless important role. Between 2004 and 2013, land-use change contributed to approximately 9% of global carbon dioxide emissions (Global Carbon Project, 2014). Forests also represent carbon sinks that remove significant amounts of GHGs from the atmosphere. Between 1990 and 2007 it is estimated that the world's forests captured as much as 30% of the total yearly emissions of GHGs generated by fossil fuel combustion, cement production and land-use change (Pan et al., 2011).

Mitigation of climate change involves actions that reduce GHG emissions or increase carbon sequestration relative to what would occur with the baseline or business-as-usual activity. Because of their capacity to capture carbon, forests offer a great diversity of mitigation opportunities. Mitigation strategies that reduce emissions from forests (e.g. as a result of changes in management practices, reduced harvesting or reduced fires) or increase sequestration (e.g., afforestation or increased use of long-lived wood products) could play a meaningful role in reducing countries' overall GHG emissions (Nabuurs et al., 2007).

Various jurisdictions worldwide have implemented, or are in the process of creating, forest carbon mitigation strategies and policies to reduce their GHG emissions or increase carbon sequestration. For instance, the government of Finland has recently adopted climate change mitigation as one of its forest management goals, leading to the development of new, or modification of existing, policies associated with forest-related activities such as bioenergy, harvesting waste management, forest conservation and silviculture (Makkonen et al., 2015). Similarly, Sweden has also implemented various forest carbon policies, notably in terms of bioenergy, waste management and carbon sequestration in harvested wood products (Jonsson et al., 2011; Lippke et al., 2011; Lundmark et al., 2014). Forest carbon offsets and the trade of carbon credits in carbon market trading schemes are also at the forefront of climate change mitigation in many jurisdictions such as New Zealand (Manley & Maclaren, 2012), Australia (Buizer & Lawrence, 2014), the USA (Kerchner & Keeton, 2015) and various developing countries through the new climate mitigation mechanism of the United Nations known as reducing emissions from deforestation and forest degradation in developing countries (REDD+) (Angelsen et al., 2014; Karsenty et al., 2014; Pistorius, 2012).

While the general opportunities associated with forest carbon mitigation in specific jurisdictions have been discussed elsewhere – see for instance Malmsheimer et al. (2011) for the USA and Carlson et al. (2010); Lemprière et al. (2013) for Canada – no attempt has been made so far to systematically document a jurisdiction's existing forest carbon mitigation policies and policy gaps. Consequently, this paper reviews policies for GHG and forest management in the province

[1] In this paper, "carbon" and "greenhouse gases" are used interchangeably. GHG (or carbon) emissions will be presented in CO_2 equivalents (CO_2eq), a unit calculated by multiplying the amount of emission of a certain gas by its global warming potential (GWP). Such estimates include non-CO2 GHG emitted by forests and the forest sectors such as methane (CH4) and nitrous oxide (N2O).

of British Columbia (BC), Canada, as a case study focusing on the challenges posed by existing policies and the opportunities for policy innovation to more effectively promote forest carbon mitigation[2].

Forests in BC store a vast amount of carbon, and annual changes in stocks are of similar magnitude as greenhouse gas emissions from all other sectors combined GHG. According to BC's GHG inventory, the province's emissions totaled about 62 million tonnes of carbon dioxide equivalent (Mt CO_2e) in 2012, including net emissions of almost 4 Mt from afforestation and deforestation (BC MOE, 2014a). It is these emissions that the province has been including within the scope of its GHG emission reduction targets. The total does not include net emissions from the province's managed forest, which were 39 Mt in the same year. These net emissions from forests are highly variable from year to year, reflecting the impacts of natural disturbances over which there is little human control. For instance, between 1990 and 2012 emissions from managed forests fluctuated from a maximum of 86 Mt in 2010 to a minimum of -38 Mt (a carbon sink) in 1997. Over the past decade, forests in BC have been transformed from a carbon sink to a carbon source, largely as a result of the mountain pine beetle epidemic (Kurz et al., 2008a). Furthermore, these managed forest emission figures assume that all harvested carbon is instantly released to the atmosphere when transferred out of the forest. Thus the estimates exclude carbon sequestration in harvested wood products, which if accounted would considerably reduce net emissions (Dymond, 2012a).

While BC has an ambitious climate action regime for fossil fuel-based emissions, it has few policies explicitly targeting forests or the use of harvested wood products for carbon mitigation. As a result, forest carbon mitigation is an under-exploited opportunity for the province. The government of BC has a variety of policy instruments available to increase carbon mitigation through forest management. The government could pursue voluntary approaches, providing information and encouragement to forest companies to increase carbon mitigation. The government could shift the financial incentives of forest companies by taxing biogenic carbon emissions. BC forest companies pay a carbon tax on their emissions from fossil fuel use in their operations, but not on biogenic emissions created by harvesting timber, forest management activities and manufacturing. The government could also use regulations to require certain outcomes or practices that would improve carbon mitigation. The following review will discuss how these different instruments could be used to influence forest carbon mitigation.

The purpose of this paper is to carry out a systematic policy gap analysis of forest carbon policies in BC. This review focuses only on government policy options, and does not address the market for voluntary carbon offsets provided by the private sector. Furthermore, the paper does not perform a policy analysis comparing different policy options and assessing their consequences for a variety of criteria. To begin with, the paper provides a brief overview of forests' role in the carbon balance and of forest carbon mitigation options available in BC.

[2] A BC government document on the climate mitigation potential of BC's forests provides an overview of carbon mitigation opportunities but doesn't review the BC policy regime for challenges and opportunities. The document does clearly state that "no official strategy exists currently" (BC MFLNRO, 2013b, p. 5). Greig and Bull (2008, 2011) provide more policy context, especially with respect to GHG mitigation policies, but they don't examine the province's forest policy regime in any detail.

Second, we review the province's ambitious climate policies, with a focus on how forests are or are not addressed in those policies. Third, we discuss the BC forest policy regime, including the tenure system, setting harvest rates, and regulating forest practices and wildfires, focusing on the gaps in existing policies with respect to forest carbon. Fourth, policies for increased storage of carbon in harvested wood products and displacing fossil fuels with forest bioenergy are also discussed. Fifth, the potential for linkages with other jurisdictions with active climate policies is examined. The paper concludes by highlighting the opportunities for policy change to increase forest carbon mitigation in British Columbia.

Forest carbon mitigation options in BC

The use of ecological carbon sinks to reduce GHG emissions is globally acknowledged as a valuable mitigation strategy (IPCC, 2014b, 2014c) that can also offer additional benefits such as biodiversity and water conservation (Freedman et al., 2009). That being said, planting and conserving forests only represent one part of the equation and do not consider the mitigation opportunities from the carbon stored in harvested wood products (HWP) (Malmsheimer et al., 2011) or the benefits to the atmosphere that are achieved through the use of HWP which can substitute for more emissions-intensive products (Sathre & O'Connor, 2010; Smyth et al., 2014). Only a systems perspective taking into account all the carbon pools and fluxes allow an understanding of the trade-offs between increasing carbon storage in forest ecosystems and timber harvesting (Hennigar et al., 2008; Lemprière et al., 2013; Nabuurs et al., 2007).

Mitigation strategies in the forest sector enhance carbon sinks, maintain carbon storage or reduce emissions (Nabuurs et al., 2007). An increase in forest area or forest carbon stock density contributes to enhancing or creating new carbon sinks. The maintenance of forest area and its carbon stock, and the use of long-lived wood products, maintain the storage of carbon already removed from the atmosphere. Improving harvest utilization rates, changing product manufacturing processes, or increasing the use of biomass-derived products instead of energy-intensive non-wood products or fossil fuels have the potential to avoid emissions. According to recent studies of forest-related mitigation in Canada, no single strategy alone will maximize climate change mitigation; instead, a mix of strategies offers the biggest potential to mitigate climate change (Kurz et al., 2013; Smyth et al., 2014). In BC, mitigation activities aimed at increasing carbon sinks or reducing carbon sources can be classified into three overarching categories: mitigations involving (1) forest area, (2) forest management, and (3) harvested wood products.

Mitigation involving forest area

The first category refers to the conservation of existing or the creation of new forest carbon sinks through afforestation, reforestation and avoided deforestation. In BC, Deforestation is defined as the "the long-term removal of trees from a forested site to permit other site uses" (BC MFR, 2008). This is consistent with international GHG reporting rules (IPCC, 2008). The carbon benefits of avoiding deforestation rest in the avoided emissions from conserving carbon in trees and other ecosystem carbon pools (dead wood, litter, soil) plus future forest carbon sequestration that would have otherwise been lost (Lemprière et al., 2013). Clear-cutting is not considered

deforestation since it is rapidly followed by mandatory reforestation (Nabuurs et al., 2007; UNFCCC, 2001). In contrast, afforestation in BC refers to "the establishment of a forest or stand in areas where the preceding vegetation or land use was not forest," whereas reforestation describes "the re-establishment of trees on denuded forest land by natural or artificial means, such as planting and seeding"[3] (BC MFR, 2008). Afforestation has historically been occurring at a low level in BC (BC MOE, 2014a). Nonetheless, there is national interest in afforestation because of benefits associated with fibre production, environmental conservation and especially revenues from the sale of carbon credits (Dominy et al., 2010; Freedman et al., 2009; Yemshanov et al., 2005). In addition, the increase in not-satisfactorily-restocked (NSR) land (i.e., forest without a healthy number of trees) because of the recent mountain pine beetle infestation (Kurz et al., 2008c; Office of the Auditor General of BC, 2012) offers important reforestation opportunities (Parfitt, 2010).

Mitigation involving forest management

The second category involves the trade-offs between (1) natural forest conservation and reduced harvest strategies, and (2) forest harvesting and intensive sustainable forest management. The total carbon stored in forest areas increases with age; forests either offer a high carbon uptake rate (maturing) or high carbon density (old-growth) (Kurz et al., 2013; Lemprière et al., 2013). Therefore, natural forests typically store more carbon than managed forests because of their longer disturbance cycles and greater proportion of older stands (Kurz et al., 1998; Stinson & Freedman, 2001). In contrast, strategies focused on timber harvesting and intensive forest management offer mitigation potential associated with increased forest carbon uptake rates, improved harvesting techniques and enhanced production of long-lived HWP, which in turn can increase substitution benefits (see next section). The carbon intake of a sustainably managed forest over a rotation period may be equal or superior to carbon loss caused by logging activities and decomposition (Lippke et al., 2010). Consequently, after forests have been converted from old-growth to second growth, they may be carbon neutral over decades or centuries (Lamers et al., 2013).

The frequency of occurrence of natural disturbances represents an important factor to consider when defining forest management strategies, and the impact of climate change on future natural disturbance rates would also need to be considered. While conservation practices to maintain carbon stocks will be challenging in areas facing frequent natural disturbances such as BC's boreal and interior forests (Dymond & Spittlehouse, 2009), better opportunities for conservation to maintain carbon stocks are encountered in ecosystems characterized by infrequent natural disturbance patterns and high carbon density such as the coastal temperate rainforest (Stinson & Freedman, 2001). Consequently, BC's forests could potentially offer mitigation opportunities by conserving forests with low disturbance rates and high carbon density while simultaneously intensifying the productivity of those managed forests

[3] The use of the term "reforestation" in BC is not consistent with that used by the UNFCCC and the IPCC. In fact, the international use of the terms afforestation and deforestation only differ in the length of time for which non-forest land-use did occur. For instance, for the Kyoto Protocol, afforestation is defined as the establishment of forest on land that has not been forested for at least 50 years, whereas reforestation involves the establishment of forests on land that did not contain forest on December 31, 1989, but that was forested 50 years ago (UNFCCC, 2006).

characterized by higher natural disturbance rates. In particular, silviculture strategies (e.g., genetically improved seeds, fertilization; Lippke et al., 2011; Man et al., 2013), wildfire and insect suppression and fuel reduction techniques (e.g., thinning, fuel removal, prescribed fire; Carlson et al., 2010; Malmsheimer et al., 2011) may be able to contribute to mitigation under some circumstances. More efficient harvesting practices, including maximizing utilization at harvest, avoidance of slash-burning and salvage harvesting of trees killed by natural disturbances or climate change impacts, also offer important mitigation opportunities (BC MFLNRO, 2013b, p. 16).

Mitigation involving harvested wood products

The third category of strategies relates to the use of HWP, defined as "wood-based materials that, following harvest, are transformed into commodities such as furniture, plywood, paper and paper-like products or used for energy" (UNFCCC, 2003). Strategies could seek to reduce the emission of the carbon in wood products to the atmosphere, thereby increasing carbon storage in products and landfills. Strategies could also increase the use of wood-based products as a substitute for other products, so as to offset emissions from more energy-intensive products (i.e., material substitution) or fossil fuels (i.e., energy substitution). A condition to effectively identify the most efficient mitigation policy choices, however, is that the carbon stock changes and emissions of forests from which the HWPs originate must be included in the GHG reporting (Lippke et al., 2011; Malmsheimer et al., 2011; Sathre & O'Connor, 2010; Ter-Mikaelian et al., 2015).

To evaluate the impact of wood commodities on atmospheric GHG balances, one has to evaluate a product's whole life cycle, including sequestration and emissions from extraction, manufacturing, transportation, carbon storage, material and energy substitutions and end-of-life management (Lamers et al., 2013; Lemprière et al., 2013). In BC, harvested logs are primarily sent to saw-mills and used for dimensional lumber (Dymond, 2012a). The saw-mill residue is primarily sent to pulp mills, with small amounts ending up in oriented strand board, pellets etc. (Dymond, 2012b). About one-third of the harvested biomass extracted from the forest is emitted shortly after harvest as it is burned for bioenergy, primarily in pulp mills (Dymond & Kamp, 2014).

The time over which carbon is stored in HWP depends greatly on products' life duration. Some HWP have very short useful life, such as paper (2.5 years), whereas others have longer-term carbon storage potential such as the lumber encountered in single family homes (>90 years) and commercial buildings (>75 years) (Dymond, 2012a). In addition, the use of wood instead of more energy-intensive products (e.g., cement, concrete, steel) offsets emissions that would have otherwise ensued (Smyth et al., 2014). Finally, when HWPs are retired, they can be deposited in landfills, recycled back into the product in-use pool or burned to produce energy (Dymond, 2012a) (Apps et al., 1999). Even though some of the wood product found in landfills will never decompose (Micales & Skog, 1997), methane emissions, with much larger impacts on global warming than CO_2 emissions with the same amount of C, could offset a large proportion of the C storage benefits of HWP in landfills. In contrast, reusing and recycling HWP extends their useful life, hence maintaining the stored carbon, and preventing the methane emissions resulting from

decay in landfills (Chen et al., 2014; Lemprière et al., 2013; Malmsheimer et al., 2011). Using retired wood commodities as bioenergy represents another potentially effective mitigation strategy, allowing for energy substitution in addition to material substitution (Lippke et al., 2011).

The mitigation benefit of the production of energy from biomass originating from sustainably managed forests – whether there is a benefit and how long it takes to occur – depends on the specific characteristics of each situation. Identifying situations in which bioenergy has a net positive mitigation benefit requires comparing, on a life-cycle basis, the emissions that would occur in the forest sector and from the use of the baseline energy source with the emissions that would occur if bioenergy displaces the baseline energy source. The mitigation benefits of using biomass-derived energy depend mostly on three factors: (1) the source of the displaced energy (e.g., coal, natural gas), (2) the regrowth rate of the harvested forest, and (3) the source of the biomass (e.g., living trees, harvest waste, mill residues) and its alternate fate had it not been used for bioenergy (Lemprière et al., 2013; McKechnie et al., 2011). First, the substitution effect increases when biomass replaces high emission fossil fuels such as coal. Second, the growth rate of a forest strongly influences the extent and timing of the mitigation potential, and use of biomass from fast-growing trees will tend to lead to mitigation benefits occurring faster. Finally, harvest of living trees in BC typically provides greater mitigation potential when used in long-lived HWP rather than being used for bioenergy, which offers no or very little emission reductions (Lamers et al., 2013; Smyth et al., 2014). However, other sources of biomass can provide important mitigation opportunities, including (1) mill and processing residues, (2) harvesting residues, and (3) salvage logging of deadwood (Dymond et al., 2010), because the carbon in this biomass would, in any case, be emitted relatively rapidly if not used for bioenergy.

Climate Action Policies

Legislated Greenhouse Gas Targets

BC has an ambitious climate policy with legally-mandated GHG reduction targets for 2020 and 2050. The *Greenhouse Gas Reduction Targets Act*, enacted in 2007, calls for a 33% reduction from 2007 emission levels by 2020, followed by an 80% reduction by 2050 (Government of BC, 2007b). The 2007 baseline is approximately 65 million Mt CO_2e (BC MOE, 2014a, 2014b). The government has also established interim reduction targets of 6% (below 2007 levels) by 2012 and 18% by 2016. The provincial government's 2014 climate action Progress Report documents that BC achieved its 2012 interim reduction target (BC MOE, 2014b). Additional progress towards the 2020 target will be challenging without significant new climate mitigation policy initiatives, especially with the province's planned expansion of Liquified Natural Gas developments (BC Ministry of Energy Mines and Natural Gas, 2013).

Forest Carbon in BC GHG Accounting

Forest carbon accounting is complex, and global standards have changed significantly in recent year. The sequential activities of GHG emission and removal estimation, reporting and accounting are clearly distinguished by the international community. Estimation refers to the

process of developing estimates of GHG emissions and removals following the methodological guidance of the IPCC (e.g., IPCC, 2003, 2008, 2014a) or other approaches. Reporting is the presentation of these estimates in tabular or graphical formats following internationally agreed upon templates, such as the Common Reporting Format (CRF) tables used for National GHG Inventory reporting (UNFCCC, 2014). Accounting is the process by which the reported values are applied to determine GHG emission credits or debits and the progress toward meeting national GHG emission reduction targets.

On the one hand, forests can be large natural sinks, but if countries were allowed to claim these to offset emissions in other sectors, this could lead to net increases in global emissions. On the other hand, forests can also become large sources caused by natural disturbances that are uncontrollable (Kurz et al., 2008b; Kurz et al., 2008c; Metsaranta et al., 2011) and, if included in the accounting, such natural emissions could completely swamp any benefits achieved from mitigation activities to reduce human emissions . These two effects have meant that the appropriate way to account for forests in the context of emission reduction targets has been the subject of considerable international debate, with an agreed-upon approach established among those countries that are signatories for the second commitment period of the Kyoto Protocol (IPCC, 2014a; UNFCCC, 2011).

In its most recent reports, BC includes only a small fraction of estimated forest carbon emissions in its accounting for target compliance. As shown in the Provincial GHG Inventory in Figure 1, currently the province only includes the emissions from deforestation minus removals from afforestation. In 2012 these emissions counted for 3.6 Mt CO_2e, 5.8% of BC's emissions.

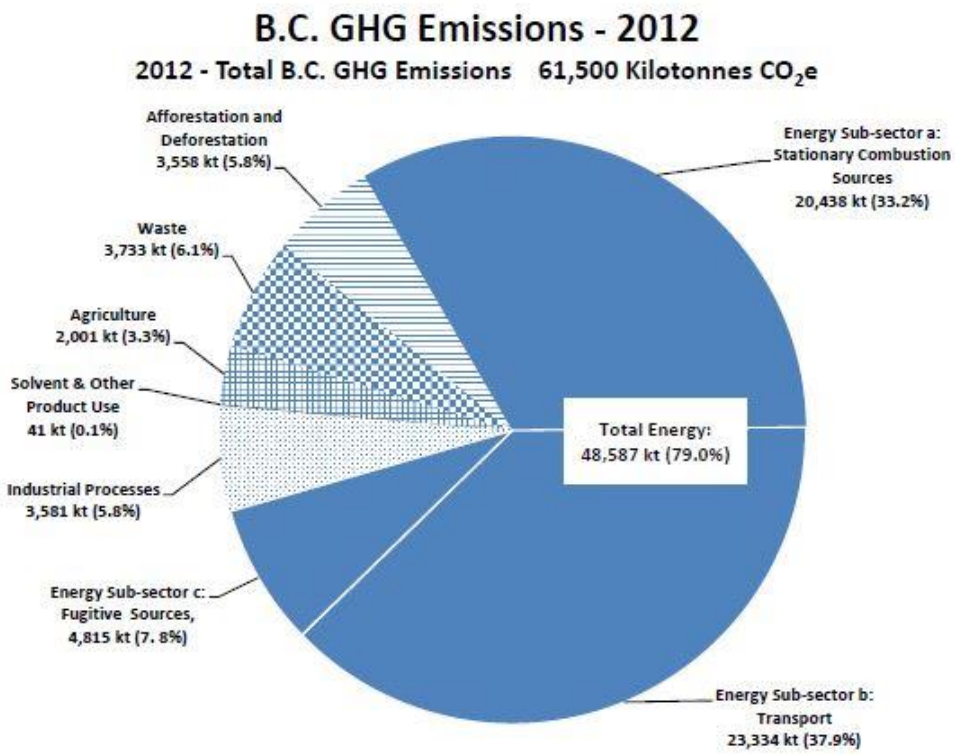

Figure 1. B.C. Reported GHG Emissions in 2012. Source: (BC MOE, 2014a)

The provincial inventory report, however, includes a section titled "memo-items" that are estimated and reported for the purpose of transparency in the province's GHG inventory, but not included in setting of the province's targets or in its accounting against those targets. Furthermore, in accordance with international guidelines, BC has treated all carbon in wood removed from the forest as immediately emitted to the atmosphere and has not calculated the carbon stored in HWP and the emissions associated with HWP in the Provincial GHG Inventory Report.

In 2011, the United Nations Framework Convention on Climate Change (UNFCCC) changed the rules so that, for the post 2012 period, countries will now be required to report and account for HWP and forest management emissions, but can choose to exclude natural disturbance emissions (IPCC, 2014a; Parker et al., 2014). The federal government has applied these new rules in its forest management reporting at the national level when discussing progress towards Canada's Copenhagen Accords commitment of a 17% reduction in emissions below the 2005 level by 2020. Canada's latest Emissions Trends Report projects net credits from forests in 2020 (Environment Canada, 2014). BC has committed to incorporating harvested wood products in its reporting, and is currently weighing its options for excluding natural disturbance impacts and how and whether to include forest management net emissions in its accounting.[4] It is currently unclear if these changes would make it easier or harder for the province to meet its targets.

Starting in July 2015, new reporting guidelines have been implemented and carbon storage in and emissions from HWP manufactured from wood harvested in BC are estimated and reported (this is also consistent with a change undertaken in Canada's national GHG inventory reporting in 2015). The forest land section of the BC GHG Inventory, shown in Figure 2 below, reveal four important features about forest land emissions: (1) forest-related sources and sinks are large in comparison to the 62 MT included in the province's GHG accounting; (2) these emissions fluctuate significantly year to year because of different levels of natural disturbance (particularly fire), (3) historically the provincial forests were a net carbon sink, but since 2002 BC's forests have become a net source of carbon, as a result of increased wildfire and especially the Mountain Pine Beetle epidemic ; and (4) incorporating storage in harvested wood products reduces the magnitude of managed forest emissions when compared to previous provincial GHG reports, but not enough to change the overall carbon balance from source to sink. For the 5 years from 2009-2013, the average emissions from forests were 34 Mt, over half the total from the other sources included in BC's formal emissions accounting.

[4] "Beginning with the release of the 1990-2013 inventory tables in 2015, B.C. GHG inventory estimates will match Canada's production approach to incorporating harvested wood product emissions estimates. B.C. is studying the international accounting method updates that would exclude the impact of natural disturbances and may incorporate these for the 1990-2013 (and subsequent) inventory and/or accounting year estimates" (BC MOE, 2014a, p. 7).

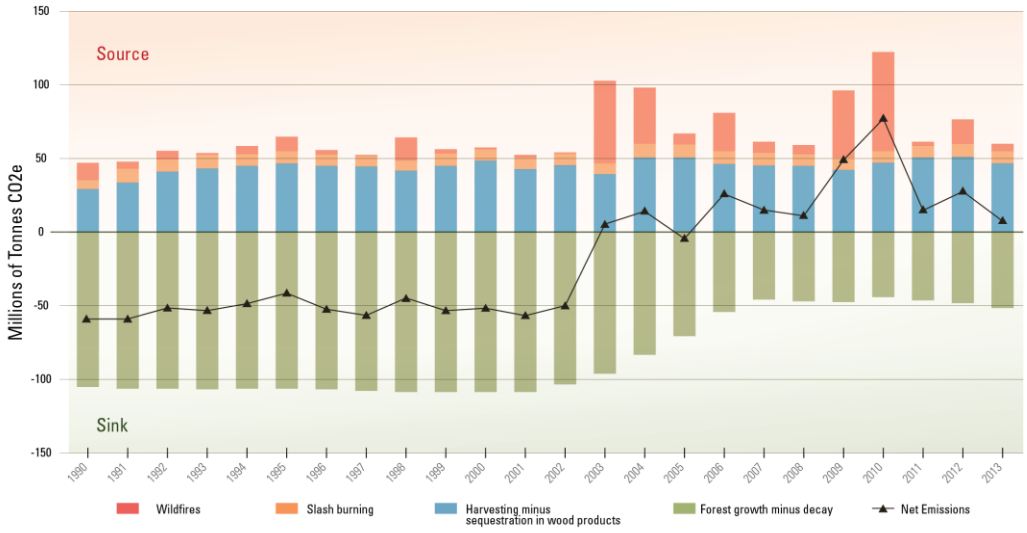

Figure 2. Forest-related emissions and sinks by category. Source: BC MOE (2015a)

The BC government's 2014 Progress Report also took the step of including 1 Mt for forest carbon offsets (BC MOE, 2014b), allowing it to state that the province had achieved its 2012 interim target of a 6% reduction in emissions. These offsets represented about one-quarter of the reported emission reductions between 2007 and 2012. Their inclusion in the accounting raises sensitive issues, because one of the forest carbon projects was strongly criticized by the provincial auditor general in a 2013 report (Office of the Auditor General of BC, 2013).

Carbon Pricing

The BC Carbon Tax, legislated through the *Carbon Tax Act*, is a revenue-neutral tax enacted by the BC government in 2008 as part of its Climate Action Plan (Government of BC, 2008a). The tax aims to aid BC in meeting its GHG reduction targets by encouraging reductions in fossil fuel use through price signals that increase the cost of combustible fuel sources (BC Ministry of Finance, 2015). The tax is broad-based, applying to all sources of fossil fuel consumption, and applies at the retail level on fuel consumption (BC Ministry of Finance, 2015). The tax started at a modest level of $5/tonne CO2e, so as to allow consumers to adjust to the price change, and was increased by $5/year to $30/tonne in July of 2012. In 2012, the government initiated a review of the carbon tax. The government chose to retain the tax and its revenue-neutral structure, but due to concerns about economic competitiveness, given that few other jurisdictions were pricing carbon, the decision was made to keep the tax at the 2012 level of $30/tonne (BC Ministry of Finance, 2014). Revenue neutrality of the tax is mandated by legislation and has resulted in substantial reductions in corporate and personal income taxes.

The carbon tax does not apply to forest carbon emissions. Hypothetically, applying the carbon tax to forest carbon emissions would be one way to create additional incentives for cost-effective emission reductions. However, given the complexity of forest carbon fluxes, challenging design questions exist, among them: what categories of emissions to include, how to consider harvested wood products, and how to treat removals that follow from actions that initially create emissions.

This paper cannot address these complexities, and it may be the case that for some types of forest carbon emission, a taxation approach is unworkable. However, for some areas of forest management, slash burning being one example, those design issues may be more manageable.

Carbon Neutral Government

In addition to the legislated target and carbon tax, BC also requires that public sector organizations be carbon neutral. Carbon Neutral Government requirements are outlined in the *Greenhouse Gas GHG Reduction Targets Act* (Government of BC, 2007b). The requirement for carbon neutrality covers not just provincial government operations, but other public sector organizations including schools, universities, and hospitals. The Act requires that public sector organizations minimize their GHG emissions, and for those emissions that they cannot eliminate, they must purchase offsets (Government of BC, 2007b). Local governments could voluntarily sign on to the program, and most did so. To support the reduction in emissions, the Government established funding (14.5 M$/yr) for energy efficiency upgrades to buildings and other emissions sources. In addition, it has provided training, community-scale reports, and support (http://toolkit.bc.ca/).

BC reports meeting its Carbon Neutral Government requirements, with all public sector organizations achieving carbon neutrality for the past four years (BC MOE, 2014b). BC is the first government in North America to achieve carbon neutrality (Office of the Auditor General of BC, 2013). While the public sector is a small fraction of provincial emissions (1.4% in 2012), the policy has several important effects. First, it communicates the government's commitment to climate action through "leading by example." Second, it required development of a carbon offset trading platform, protocols, and purchaser (see regulating carbon offsets section). Third, because the policy requires offsets to be purchased from BC projects, it provides a market for carbon offsets in BC, including those from forests.

Regulating Carbon Offsets

When BC first rolled out its climate program in 2007 and 2008, it intended to implement a cap and trade program to supplement the carbon tax as a policy instrument. It enacted the *Greenhouse Gas Reduction (Cap and Trade) Act* in May 2008. The government completed much of the policy and regulatory work necessary to put a framework in place by enacting regulations on emission reporting, trading, and offsets. But due to the uncertainty surrounding how carbon trading evolved in other jurisdictions, BC decided to postpone the implementation of a cap and trade program indefinitely. The Reporting Regulation has been implemented and applies to industrial emitters (over 10,000 tonnes per year) but the rest of the cap and trade framework has not been activated (Government of BC, 2009a). In November 2014, the legislation brought in to regulate GHG emissions from liquefied natural gas (LNG), the *Greenhouse Gas Industrial Reporting and Control Act*, removed the legislative basis for the cap and trade framework. In the new act, emissions rates are capped for coal-based electricity and LNG. Operators may meet their emissions limits through offsets.

In the absence of broad industrial cap and trade, there is still some demand for offsets from the Carbon Neutral Government requirements, and if LNG projects go forward, demand is likely to rise dramatically. Carbon offset projects, including those in forestry, must be planned and implemented following the regulation and protocols associated with both the BC Emission Offset Regulation and the Protocol for the Creation of Forest Carbon Offsets in British Columbia (FCOP) (Government of BC, 2011b).

As with most offset regulations that exist, the BC regulation and protocols require that a project meet six general criteria:

1. A project baseline must be established that is deemed conservative;
2. The proposed project must be deemed additional, meaning that the project reduces emissions or sequesters carbon relative to what would occur under a business–as-usual scenario (the project baseline);
3. Existing law or regulation must not already require the actions undertaken in the project;
4. The project must face significant financial, technical, or other barriers in its implementation that the offset project helps to overcome;
5. The project must not have started before November 29th, 2007; and
6. The emissions are required to be removed from the atmosphere for at least 100 years (Government of BC, 2007b, 2008b, 2011b; Office of the Auditor General of BC, 2013; PCT, 2012).

The Forest Carbon Offset Protocol outlines four project types considered acceptable in providing forest carbon offsets. Each of these projects has different implications in terms of the baseline estimate methodology, as well as the verification and validation of the project and how risk is managed.

1. ***Afforestation*** projects involve planting, seed-inducing, or encouraging natural seed production in an area that has not been forested for at least 20 years.
2. ***Reforestation*** involves replanting, seeding, or encouraging of natural seed sources in areas that were forest land within the past 20 years but have been subject to natural or other disturbance. For these projects to be eligible, reforestation must not be required by law.
3. ***Improved forest management (IFM)*** includes increased sequestration, reduced emissions, or increased long-term storage through changes in practices like fertilization, conservation, extended rotation ages, or increased storage in harvested wood products.
4. ***Conservation/avoided deforestation*** entails preventing the conversion of forested land to non-forest land use.

The Forest Carbon Protocol also establishes the criteria and procedures that project developers need to go through to qualify for certified offsets. For example, the protocol describes how to ensure an appropriate baseline is selected to demonstrate additionality.

In the absence of a cap and trade program, the primary demand for forest carbon offsets in the province thus far has come from the Carbon Neutral Government requirement that public sector organizations must purchase offsets for emissions they cannot eliminate. The province's forest-

related carbon offsets are listed in Table 1. In the first four years of the program's operation (2010-2013), 2 Mt of forest-related carbon offsets have been purchased, accounting for 68% of the province's total offsets purchased for the program. 80% of these offsets involved sequestration through conservation or improved forest management, the remainder were fuel switching.

In 2013, the government's offset program was scrutinized when the Auditor General released a very critical report challenging the legitimacy of two of the province's largest offset projects, one of which was a forest project (Office of the Auditor General of BC, 2013). The government challenged the criticisms and defended the integrity of the offsets. But it also responded by committing to greater transparency and accountability and eliminated the controversial Pacific Carbon Trust, the provincial crown corporation established to purchase and manage carbon offsets for the Carbon Neutral Government requirements. The functions of the Pacific Carbon Trust were moved into the Climate Action Secretariat of the Ministry of Environment (Office of the Auditor General of BC, 2014).

Table 1 – Forest Carbon Offset Projects in British Columbia. Source: (BC MOE, 2015b)

Organization and Project Title	Type of Project	Total offsets (t CO_2eq.)	Year(s) of purchase
Interfor, Adams Lake	Fuel Switching	73,442	2010-2013
Darkwoods, NCC	Sequestration - Conservation	403,112	2010
Canfor, Pulp RB #1 Prince George	Fuel Switching	100,221	2011-2013
Kruger Products, New Westminster	Fuel Switching	69,54	2010-2013
Neucel, Fuel Switching	Fuel Switching	7,111	2012
Great Bear Initiative, IMF	Sequestration - Improved forest management	300,699	2012-2013
Nanowakolas, IMF	Sequestration – Improved forest management	255,471	2012-2013
TimberWest, Vancouver Island	Sequestration – Improved forest management	590,754	2010-2013
Canfor, Pulp RB #4 Prince George	Fuel Switching and Energy Efficiency	58,141	2010-2013
Canfor, Chetwynd	Fuel Switching	24,435	2012-2013
Canfor, Fort St. John	Fuel Switching	54,530	2010-2013
Canfor, Mackenzie	Fuel Switching	33,068	2011-2013
Canfor, Prince George	Fuel Switching	35,735	2011-2013
Total		**1,936,719**	**2010-2013**

Implications of Carbon Markets Outside BC

One of the primary goals of establishing forest carbon offset opportunities in British Columbia is to diversify and strengthen the BC economy while helping to meet climate targets (BC MFLNRO, 2013b; BC MFML, 2010; Government of BC, 2012d, 2013; Parfitt, 2010). These

goals can be facilitated through carbon markets, the selling and buying of carbon offsets on local or international markets. These markets can be voluntary, or they can be government-regulated. At present, carbon credits generated through different management strategies in BC are being sold through voluntary markets to carbon emitters in different carbon markets around the globe, or are otherwise being used abroad. However, the marketability of BC forest carbon offsets outside the province depends on the rules of other jurisdictions. Other jurisdictions might not permit offsets from outside their own borders, and if they do, offsets need to meet specific criteria established by the home jurisdiction. It is therefore very important that related jurisdictions be assessed for their viability in providing a carbon market beyond BC's borders.

Alberta's Specified Gas Emitters Regulation, which allows carbon emitters to purchase offsets if they exceed their emissions intensity limit, only allows offsets from within Alberta. California, with its ambitious cap and trade regime, is a potentially significant market. Emitters are allowed to use offsets for 8% of their compliance obligations (California Air Resources Board, 2012), and the legislation in principle allows offsets to be purchased from markets in other U.S. states, Mexico, and Canada provided they meet California regulatory requirements (California Air Resources Board, 2013). At present, however, offsets from BC are not eligible for the California market, and BC has not decided whether it would allow government-sanctioned carbon credits to be sold abroad. If BC wanted to market offsets to California, it would either have to become a full member of the cap and trade system under the Western Climate Initiative like Quebec has (Vaiciulis & Fluker, 2013) and Ontario intends (Ontario's Ministry of Environment and Climate Change, 2015), or find another mechanism to get approval from California authorities. California has already endorsed forest carbon offsets projects from outside the state (Hamrick, 2013), but only because they are compliant with the California forest carbon offset protocol that covers the lower 48 states, but does not include Canadian provinces (California Air Resources Board, 2011).

Atmospheric Benefit Sharing Rights

Atmospheric Benefit Sharing Agreements (ABSAs) are the central policy tool currently in place to mitigate forest carbon on Crown Lands in BC. These agreements between the government and a proponent allocate entitlement to emission offsets for a certain area (Government of BC, 2015c). To reach an ABSA, an offset project proponent needs to have the right to perform activities on Crown Land. Often, that access may be through an existing tenure. If not, a License of Occupation may be granted if appropriate

Prior to a Treasury Board Directive in 2014 ABSAs were established between the Government of British Columbia and First Nations that allow First Nations to generate and sell carbon credits from a specific area. Specifically, these agreements determine the ownership of and the right to sell carbon credits from the First Nations ancestral territory on local or international markets (Government of BC, 2015b). To date, three First Nations have signed such agreements: the Coastal First Nations, the Haida Nation, and the Nanwakolas First Nation (Government of BC, 2011a, 2012a, 2012b). In April of 2015 the Cheakamus Community Forest was the first non-First Nation proponent to sign an ABSA (BC MFLNRO, Apr 28, 2015).

Forest carbon estimates for the areas under agreement are modeled following FCOP. After the amount of carbon in the ecosystem is calculated a percentage of the atmospheric benefits is determined to belong to the First Nation that signed the agreement. The benefits are distributed on an annual basis. For example, the Haida Nation has been allocated 81% of atmospheric benefits from each previous year, and the central and north coast atmospheric benefits for the Coastal First Nation that have been allocated are 79% the annual allotment of the previous calendar year (Government of BC, 2011a, 2012b). Additionally, every fifth year after the agreement is signed there are to be negotiations to reach an agreement with respect to the new distribution of atmospheric benefits in relation to the total past atmospheric benefits sold, the gross revenue the project proponent in question derived from the selling of atmospheric benefits, as well as the expected price of distributed atmospheric benefits (Government of BC, 2011a, 2012a, 2012b).

British Columbia has always been unique in its forestry operations and market due to the uncertainty arising from the unsettled land claims made by First Nations across the province (Tindall et al., 2013). Only three ABSA have been established with First Nations, representing a small fraction of the BC forestland base and a small fraction of First Nations with unresolved land claims. In addition, the existing benefit distributions in agreements are to be re-negotiated every five years. This short time frame could be problematic if these projects are going to be used for forest carbon offsets, which typically require a demonstration of 100 year permanence (Government of BC, 2011b). For instance, who will be responsible if there is a reversal of carbon storage as a result of fire or insects outbreak?

Zero Net Deforestation

As part of its Climate Action Plan, BC also committed to a policy of zero net deforestation – that areas of land converted from forestland to other uses would be compensated for by afforestation of other areas of the same size. The *Zero Net Deforestation Act* of 2010 (Government of BC, 2010), stipulates that the government must achieve zero net deforestation by December 31, 2015. The rate of deforestation is small, (about 6,200 ha/year) relative to the size of forest in the province, about 55 million ha. The largest drivers of deforestation in the province of BC are agriculture, clearing for settlement construction, and oil and gas development. It is important to note that the actions that occur through timber harvesting are not considered equivalent to deforestation because reforestation of harvested areas is legally required and generally successful (Government of BC, 2010).

The zero net deforestation statute authorized the development of implementing regulations and required biannual progress reports, starting in 2012. However, the Act has not yet been brought into force by regulations, so the government has taken no (direct) actions to pursue the goals. One option to reduce forest-based emission would be to implement this policy.

Wood First Act

BC has an initiative to promote the use of long-lived wood products in building construction. The initiative is supported by the *Wood First Act* which stipulates that all newly constructed,

publically-funded buildings first consider wood as the primary building material (while also adhering to the *BC Building Code*) (BC JTST, 2015; Government of BC, 2009b). Furthermore, the Government changed the building code to allow 6 story wood structures (BC Office of Housing and Construction Standards, 2015), a step that has been followed by other provinces and discussions are underway for a similar national building code change. After the 2010 Olympic Games in Vancouver, where wood was used extensively in buildings and podiums, the Wood First program was transferred to the Forest Innovation Investment (FII) agency. In addition to their own programs, 2.4 M$ are available annually through a competitive process (Forestry Innovative Investment, 2015). In their 2009-2014 report, FII notes 53 communities in BC have adopted policies to encourage the use of wood in building construction (Forestry Innovative Investment, 2014). Furthermore, they report on 153 mid-rise wood-frame residential construction projects since the building code change in 2009. Outside of North America, FII spends considerable resources promoting wood frame construction and educating builders, with its climate-friendly credentials as part of the marketing campaign, e.g. naturallywood.com. Wood First is supplemented by non-governmental initiatives. Wood Source BC attempts to facilitate networks between small tenure holders and small mill operators. Wood Works! BC is part of a national program run by the Canadian Wood Council to encourage the use of wood in commercial, industrial, and institutional settings.

Gap in Forest Management Policies

Tenures

One of the foundations of policies for forest management in BC is the tenure system under the *Forest Act*. Tenure is the transfer of specific rights relating to government-owned land ("Crown" land in Canada) from the government to a third party for the use of the resources on the land. Timber tenures, for example, specify the rights, obligations, and duration of the tenure agreement, as well as how the tenure will be administered (BC MFLNRO, 2012). Timber tenure holders are obligated to follow the *Forest Range and Practices Act* (FRPA) and other laws and regulations guiding forest management.

In BC there are more than a dozen types of tenure, but the most common and important are Forest Licences and Tree Farm Licences (TFLs). Forest Licences account for 60% of provincial harvest rights; Tree Farm Licences account for about 16% (BC MFLNRO, 2015). The most important distinguishing feature of these tenures is that TFLs are "area-based" while Forest Licences are "volume-based." TFLs are area-based tenures that award the licensee a right to harvest timber and manage forests within a certain area. These tenures last for 25 years, and may be renewed every 5-10 years. In contrast, Forest Licenses are volume-based tenures, and only grant the rights to harvest a specific volume of timber in a Timber Supply Area (TSA). These tenures last up to 20 years. About one-third of Forest Licences are non-replaceable, the other two-thirds may be renewed every 5 to 10 years (BC MFLNRO, 2012).

Specific tenures were recently introduced to, in part, mitigate carbon emissions through burning of harvest residues: the *Fibre Forestry License to Cut* (FFLTC) and the *Fibre Supply License to Cut* (FSLTC) (Forest Tenures Branch, 2012). These fibre tenures are a secondary tenure that are

issued on active cutting areas to promote the use of wood residues that are left behind on landings and roadsides by the primary licensee (or primary harvester). These secondary tenures can work jointly alongside any other tenure that involves timber harvesting (Forest Tenures Branch, 2012).

Tenures and Carbon Management

Tenures can differ in their "comprehensiveness," which refers to the extent to which a tenure grants rights to multiple resources flowing from the forest asset. Licensees have little opportunity to manage resource rights not specified in their tenures (Luckert et al., 2011). The largest gap in regards to carbon management with the current tenure system is in terms of comprehensiveness. Virtually all tenures in BC grant only rights to manage timber. The only broader tenures are the Community Forest Agreement and First Nations Woodland Licences, both of which create the possibility of getting rights to "botanical forest products and other prescribed products." It may be possible to include carbon as an "other prescribed product." However, these two types of tenure make up less than 2% of harvest rights in the province (BC MFLNRO, 2015).

It is also possible to expand the rights, or comprehensiveness, associated with the larger tenures such as Tree Farm Licenses and Forest Licenses by enacting regulations to expand the definition of "timber." Section 151(3) of the *Forest Act* grants the Lieutenant Governor the authority to "expand the meaning of 'timber' to include any or all special forest products" (Government of BC, 1996). If the meaning of timber was expanded to include carbon, opportunities would be created for licencees to benefit by managing more explicitly for carbon. Such an approach might be hard to implement, however, particular on volume-based tenures that are not granted a specific area to harvest.

Another issue to consider when analyzing the implication of forest carbon management and the tenure system is the duration of tenures. A general expectation for forest carbon offset policy requires that the carbon storage lasts at least 100 years (Government of BC, 2011b). The majority of BC tenures are not valid for more than 25 years, not considering their possible renewal. Community Forest Agreements and First Nations Woodland Licences allow terms for up to 99 years, but that provision has rarely been used. The issue of duration would need to be effectively addressed if carbon offsets are going to be a significant part of BC forest carbon mitigation strategy.

Annual Allowable Cut

Annual allowable cut (AAC) is the designated harvest rate set by the Chief Forester in accordance with Section 8 of the *Forest Act*. It is based on a series of calculations the results of which are manipulated to account for multiple socio-economic factors, as well as any other related issues currently affecting BC forestry. AAC is determined for multiple management units including Timber Supply Areas, Tree Farm Licenses, Woodlot License areas, and Community Forest Agreement areas.

When setting the AAC, the Chief Forester must determine "the rate of timber production that may be sustained on the area" taking into account, among other things, the expected growth rate, the forest composition, the anticipated regeneration time, the probable silvicultural treatments

and their effects, the use of timber, the constraints on the area's timber production, and the allowances made for decay, waste, and breakage. The Chief Forester must also consider both the short and long-term impacts of alternative harvesting rates on British Columbia's overall wellbeing, the economic and social objectives of the government, and any abnormal disturbances (such as infestations or fire). While AAC determination involves complex calculations it is, in essence, an independent decision of the Chief Forester given the consideration of these required elements (BC MFLNRO, 2014; Office of the Chief Forester, 2014).

AAC Determination and Carbon Management

While AAC determination has not historically referred to forest carbon as an element in the decision-making process, there is some indication that carbon is receiving more attention, for example the most recent Lillooet AAC determination had a discussion of climate impact. To support this decision-making process, the Ministry has a staff member with carbon expertise in the Forest Analysis and Inventory Branch who conducts analyses on behalf of the Chief Forester. However, to date no AAC determinations have modified allowable harvest rates to explicitly address forest carbon mitigation opportunities or climate change more generally. The Chief Foresters' "Guiding Principles" acknowledge the reality of climate change but state that its implications are too uncertain to incorporate into AAC determinations at this time.[5] , The principles do state that "Where forest practices are implemented to mitigate or adapt to the potential effects of climate change on forest resources, we will consider related information in our determination." (Office of the Chief Forester, 2014, p. 6). The Forest Act requires that one of the factors that the Chief Forester is required to consider is "the constraints on the amount of timber produced from the area that reasonably can be expected by use of the area for purposes other than timber production." If carbon were incorporated as a value in the Forest Range and Practices Act, or land use orders (see discussion below), the Chief Forester would be required to consider them in AAC determinations.

Forest Range and Practices Act

The FRPA governs the actions of forest and range licensees on Crown land (Government of BC, 2014). FRPA aims to shift practices towards a more results-based form of operations, as opposed to the previous prescriptive regime under *The Forest Practices Code*. The framework associated with FRPA can be seen as being composed of three pillars, (i) objectives, (ii) plans and practices, and (iii) compliance and enforcement, supported by two foundations, (a) professional reliance and (b) effective monitoring (Forest Practices Board, 2014; Hoberg & Malkinson, 2013).

There are eleven values associated with FRPA: timber, soils, water, fish, wildlife, biodiversity, resource features, recreation features, visual quality, forage and associated plant communities, as well as cultural heritage (Government of BC, 2015a). The government sets FRPA objectives, which support the different forest and range values. The licensees are required to meet these objectives. However, the licensees are able to decide through their plans how they wish to meet

[5] "While some controversy appears to remain on the causes of climate change, there is substantial scientific agreement that climate is changing, that the changes will affect forest ecosystems, and that forest management practices will need to be adapted. Nevertheless, the potential rate, amount, and specific characteristics of climate change in different parts of the province are uncertain. As research provides more definitive information on climate change, we will consider the findings in AAC determinations (Peterson, 2015, p. 8).

these objectives. They can adopt default standards provided by government. If the licensee decides to deviate from the default standards they must be able to convince relevant decision-makers through their Forest Stewardship Plans (FSPs) that their proposed alternative will satisfy the objectives set out in regulation, and uphold the related value(s) (Hoberg & Malkinson, 2013). FSPs are valid for 5 years, but may be extended by the Minister, who generally delegates this function to the district managers (Government of BC, 2014). The plans need to be completed and submitted by a professional forester, and given approval by the district manager. Site plans must also be completed but do not need to be submitted to government for approval.

FRPA includes a strong role for government monitoring and enforcing compliance. The government's compliance and enforcement staff have the ability to inspect and enforce actions that were laid out in the licensees FSP, or other plan. The Minister is authorized to stop or mitigate any activity that is not beneficial to public health and safety, or poses a significant delay or barrier in establishing a free growing stand, as well as any activity that may seriously alter or negatively affect the ecosystem in question.

Even though FRPA does not explicitly address it, professional reliance is considered a foundation of the regulatory framework. The use of a professional forester by a licensee can demonstrate due diligence. Professionals' actions are regulated by specific acts related to the practice of their chosen profession. For example, registered professional foresters (RPFs) are registered and regulated under the *Foresters Act*, and registered professional biologists (RPBios) are managed under the *College of Applied Biology Act*. Furthermore, foresters are compelled to follow standards and behaviour set out by the Association of BC Forest Professionals (ABCFP, 2008). In 2014 the ABCFP and three other professional associations issued a joint position paper highlighting that carbon management should be included in the professional considerations (ABCFP et al., 2014).

Effectiveness evaluations of FRPA are meant to enhance the utility of the policy through the science-policy feedback loop. The effectiveness evaluations lie outside the scope of FRPA and are carried out by the Ministry of Forest Land and Natural Resource Operations (MFLNRO) *Forest and Range Evaluation Program* (FREP). The purpose of the FREP is to evaluate whether the objectives set out through FRPA values are being achieved (Forest Practices Board, 2014).

Carbon Management and FRPA

The most prominent gap that exists when considering carbon management under FRPA is that none of the eleven FRPA objectives explicitly considers carbon. As a result, licensees do not have any reason to design or implement strategic planning that considers this resource.

There are several possible mechanisms by which forest carbon could be integrated into the existing FRPA framework. The most direct way would be simply to amend section 149 of the legislation to establish a twelfth FRPA value pertaining to forest carbon. Alternatively, objectives under the existing values could be amended by regulation under Section 149 of FRPA to include carbon. Perhaps the best candidates for this approach are the values for timber and soils. The FRPA value of soil could be reinterpreted to include forest carbon because harvesting practices that affect soil conditions will also have an effect on forest carbon management. At

present, the objective for soils states "to conserve the productivity and the hydrologic function of soils." That could be expanded to include the management of carbon (Government of BC, 2004a). Similarly, the timber value, now stated in terms emphasizing economic competitiveness,[6] could be redefined by regulation to include carbon management.

If consideration is to be given to regulating carbon under FRPA, it would be necessary to also develop a climate-effective objective for forest carbon management. Would it be to focus on carbon storage in forest ecosystems or through the entire forest sector including HWP pools? How would carbon be weighted when trade-offs with other natural resource management objectives need to be made?

Carbon values could also be introduced into the forest management process by establishing carbon-specific land-use objectives under the *Land Act*. Once those objectives are established, forest operators would be required to ensure their management practices were consistent with the objectives.

Wildfire Regulation

Forest fires have significant implications for carbon management because combustion releases the carbon in the wood. Between 2005 and 2013, as shown in Figure 2 above, annual direct emissions from forest fires in the province ranged from a low of 6.9 Mt (11% of accounted emissions) to a high of 64.6 Mt (more than all the of accounted emissions) (BC MOE, 2014a). Wildfires also kill large amounts of biomass and this dead organic matter will decompose in post-fire years, thus contributing further indirect emissions. Wildfire management in BC, including fire mitigation, control, and post-fire rehabilitation, is governed by the *Wildfire Act* and *Regulation* (Government of BC, 2012c). Fire policies and regulation most often interact with forestry when dealing with planned burns, such as slash pile burnings and burns prescribed for management purposes, or with wildfires that occur on Crown land.

Currently, forest managers are required, under the *BC Wildfire Act*, to assess fire hazard created through industrial activity, and reduce high levels of hazard. This legislation does not require the burning of harvest residues (Forest Practices Board, 2015). However, burning slash is often the most cost-effective way for licensees to remove harvest residues and decrease the amount of fuel on site. Additionally, if a wildfire starts forest companies are theoretically held liable if their pre-fire actions increased the chance of that wildfire occurring, creating the potential for significant economic losses to implicated companies (Government of BC, 2004b, 2005). To manage this risk, and avoid the expense of physically redistributing or removing the harvest residues from the site, or changing harvest systems to produce less residues, or making the fibre available to secondary users, the majority of the companies choose to deal with the harvest residues on their sites conservatively, burning most, if not all, piles on site (Forest Practices Board, 2015).

[6] The timber objectives states to licencees and regulators must "maintain or enhance an economically valuable supply of commercial timber from British Columbia's forests," and that they should "ensure that delivered wood costs, generally, after taking into account the effect on them of the relevant provisions of this regulation and of the Act, are competitive in relation to equivalent costs in relation to regulated primary forest activities in other jurisdictions" (Government of BC, 2004a). The timber objective has not been legally implemented (Office of the Auditor General of BC, 2012).

Fires are also used in forestry operations as a forest health management tool. Fires can help restore some nutrients to soil, enhance seed dispersal for some species, increase forest biodiversity, and control pathogens. In the *Wildfire Act* and *Regulation* a 'resource management fire' is a fire that is either the burning of a slash pile of any size, or is an open fire lit and fuelled for silviculture, forest health, wildlife management, ecological restoration, fire hazard abatement, or range improvement. Controlled burns are regulated under section 23 of the *BC Wildfire Regulation*, which requires advance notice and approval permit.

Deforestation, or land conversion is also subject to the wildfire regulation. Large piles of green wood, bark and leaves are burned as a matter of routine operations (e.g., Hamilton, 2012). Project operators do sell some wood, but expect to make a profit, so anything not profitable is simply burned. The emissions from these fires are part of the BC GHG inventory report and mitigation accounting. Other approaches, such as requiring the operators to haul logs over a certain diameter to mills at their own cost, could be considered. Alternatively, carbon emissions resulting from residue burning could be subject to the same emissions tax as fossil fuel emissions, which may increase the incentives to find alternative uses of harvest residues.

Carbon Management and Wildfire Policy

Current wildfire policies do not consider or incorporate managing forestland for carbon. The Forest Practice Board found that licensees were not even doing a hazard assessment, or considering non-burning options for mitigating the hazard (Forest Practices Board, 2015). Rather than burning as a matter of standard practice, it could be changed to the option of last resort through education, cultural shifts, incentives, or regulation. It may be that the wildfire hazards generated under the current whole-tree to roadside harvesting are simply too high, and changes need to be made to the harvest systems. One place to start would be to require that wood and biomass in the harvest residue piles are measured before they are burned to improve estimates of wasted fibre, air quality impacts, and GHG emissions.

Current wildfire policy could be adapted in order to assimilate forest carbon offset considerations. For example, in the *Wildfire Act* Section 18 considers that government may use fire for certain purposes in order to uphold values tied to forests or grassland, including reducing the chance of unwanted fires, and enhancing forestland resources and values. Although this section does not specifically reference carbon one could consider carbon a "forestland resource and value", and thus forestland could be managed with carbon in mind under this act. Furthermore Section 72 in the *Wildfire Act* gives the Lieutenant Governor in Council the capability to make regulations with respect to fire control in order to protect forestland resources, including regulation relating to fire use, prevention, and rehabilitation, fire precautions and activities related to timber harvesting, respecting the abatement and assessment of fire hazards, as well as the mechanisms for allocating compensation in the case of damage from a wildfire. These sections of *The Wildfire Act* may be used to integrated forest carbon values into the policies governing the mitigation and management of wildfires on Crown land.

Harvested Wood Products

Because of their capacity to store carbon, HWP are inextricably linked to forest carbon management. Policies with direct implications for carbon management in manufacturing include

the *Pollution Control Act* (1977) which, over time, prevented pulp mills from disposing of their waste products (black liquor) in streams, rivers and oceans. This carbon-rich material is now widely used for bioenergy in those mills (Dymond & Kamp, 2014).

There are inherent limits to how much the BC government can induce an increase in the use of wood products. Even if the government was more willing to take a more direct regulatory approach in specifying one construction material over another, the fraction of wood products harvested and manufactured in BC that are consumed within BC, and therefore potentially subject to provincial regulations, is relatively small. However, incentives have and can help develop a more diversified manufacturing sector, and it could also be possible to increase the use of wood in the province in place of other more emissions-intensive materials[7] (e.g. as should happen as a result of the change in the building code that now allows 6-storey wood buildings). Moreover, under international guidelines, BC has to report emissions from HWP manufactured from wood harvested in BC, regardless of where in the world these occur. Thus efforts to train wood consumers in countries that import BC wood to incorporate more of the wood in long-lived uses can improve BC's GHG balance.

Bioenergy

Forest bioenergy may be able help contribute to GHG mitigation by displacing fossil fuels, although care must be taken to ensure that the forest bioenergy options chosen do indeed have a net mitigation benefit within a reasonable period of time (Smyth et al., 2014; Ter-Mikaelian et al., 2015). At present little legislation exists that mandates or regulates the use of bioenergy in certain circumstances in BC. BC has enacted the *Renewable and Low Carbon Fuel Requirements Act* as a part of the *GHG Reduction Targets Act* in 2008, but at present there is limited economic opportunity to convert forest fibre into biofuels. The province has taken modest initiatives to make forest fibre, especially salvage wood from the mountain pine beetle (MPB) epidemic, available for bioenergy use by entrepreneurs.

The BC Bioenergy Strategy, a component of BC's Clean Energy Plan, attempts to diversify and increase the competitiveness of the forest sector by promoting the use of MPB waste wood (Government of BC, 2007a). Other initiatives include BC Hydro's two part *Call for Clean Energy* (the second of which only calls for wood waste projects) and the goal to have 10 community energy projects fueled by biomass in 2020; There are currently 21 commercial biomass projects providing 725 MW of capacity to the BC Hydro system (BC Hydro, 2014).

Conclusion

British Columbia has ambitious climate policies, but they do not yet fully leverage mitigation opportunities of the province's immense forest sector. At the same time, strategic documents of the Ministry of Forests, Lands, and Natural Resources Operations commit to "integrating climate

[7] FPInnovations, the Innovative Clean Energy (ICE) Fund, the First Nations Clean Energy Business Fund and the BC Bioenergy Network are examples of forest product research, development or start-up agencies or programs supported whole or in part by the BC Government.

change action into our core business" (BC MFLNRO, 2013a), yet there remain many unrealized opportunities for carbon mitigation in the provincial policy framework. Only a small fraction of forest-related emissions are included in the provincial inventory in recognition of the risks associated with the impacts of natural disturbances. New international reporting and accounting guidelines in the land sector under the Kyoto Protocol allow for the exclusion of emissions and subsequent removals resulting from natural disturbances. By reducing the risks from natural disturbances, greater incentives and opportunities are created to include forest carbon management as a mitigation option.

The province's forest tenure system does not officially recognize carbon as a resource, although there are several short-term agreements with First Nations on the coast and one community on Vancouver Island that provide for sharing of carbon benefits. The elaborate system of forest practices regulation does not explicitly include carbon, nor do the regulations for forest fires, although there are growing efforts to understand the potential for mitigation actions. The province enacted legislation committing to net zero deforestation, but it has not yet been enabled.

The only formal policy for forest carbon mitigation is the Forest Carbon Offset Protocol. It provides a way to increase confidence in the integrity of forest carbon offsets, but its implications are limited unless the province develops more demand for forest carbon offsets by internal policy changes or effective linkages with other trading jurisdictions. In 2012, these offsets were 1 Mt, 1.7% of the province's officially accounted emissions.

The purpose of this paper is to examine BC's policy regime in order to identify challenges and opportunities for forest carbon mitigation. The paper does not perform a policy analysis comparing different policy options and assessing their consequences for a variety of criteria. As a result, any specific policy recommendations would be premature. However, the paper did identify a number of significant policy gaps that, if the province is committed to using forests to help mitigate greenhouse emissions, it should seriously consider addressing:

1. *More fully incorporate forest emissions in provincial accounting*. While BC reports on forest emissions and removals in its GHG inventory report, at present, it only includes net deforestation emissions in its accounting towards it emission reduction targets, a small fraction of measurable forest-related emissions. The province has made improvements in its inventory reporting on forest-related emissions: starting in 2015, the province includes carbon stored in and associated emissions from harvested products in the reporting. These are not yet included in accounting, and nor are biogenic emissions resulting from forest management, although the province has indicated it may consider this if a way can be found to exclude natural disturbance impacts. Under international rules of the Kyoto Protocol, to which Canada is not a signatory, reporting emissions from forest management is mandatory, but it is possible to exclude emissions and subsequent removals associated with natural disturbances. Adopting internationally-agreed approaches to report on GHG emissions in BC may increase incentives to pursue cost-effective mitigation strategies across all of the province's emission sources. However, national reporting of GHG emissions and removals, and the selection of reporting methodologies, is a federal responsibility.

2. *Explore extending the carbon tax to include emissions from specific forest management activities*. At present, the carbon tax applies to fuel combustion, but not biological emissions from forest operations. If forest companies were charged for biogenic emissions that result from their actions, e.g. the burning of harvest residues, they would have a direct financial incentive to reduce emissions. The complexities of carbon fluxes do present immense design challenges, for example if all fluxes were taxed then would government have to repay taxes where growing forests remove carbon from the atmosphere? However, for some specific practices, like slash burning, applying a carbon tax might be manageable.

3. *Implement the Net Zero Deforestation requirement*. The province has a law on the books requiring net zero deforestation, but has not enacted regulations to bring it into effect. Doing so could eventually reduce emissions by several million tonnes annually and could yield co-benefits from new forests. The province could also change the Net Zero Deforestation policy to require those responsible for deforestation to purchase offsets to counteract those emissions, increasing the demand for forest carbon offsets from within the province.

4. *Include carbon among the rights of tenure holders, and extend the terms of tenures to be more in line with the permanence criteria for forest carbon projects.* At present, the tenure system ignores carbon, and as a result, licencees have fewer incentives to manage for it.

5. *Include carbon as a value for which licencees are required to manage forests*. The Forest Range and Practices Act requires licencees to manage for a eleven forest values, but not carbon. Incorporating carbon values into FRPA, or through land use orders, are two opportunities to require forest operators to manage for forest carbon. However, as previously discussed, management goals as well as criteria and indicators to measure progress will have to be clearly identified.

These opportunities reflect quite different types of options for mitigating forest carbon. Increasing the use of forest carbon offsets would be more consistent with an approach that encourages voluntary initiatives by the private sector. Taxing forest carbon emissions for selected forest management activities would reshape the economic incentives of forest operators and wood users. Regulating practices that influence forest carbon through FRPA might be the most direct way to change behavior, but increasing the legal requirements to reduce carbon, might reduce the opportunities for forest carbon offsets which have to go beyond legal requirements. Given the magnitude of carbon embodied in wood harvested from BC's forest every year, it is also crucial that wood users be integrated into mitigation strategies.

All of these approaches would need to be considered carefully to weigh their climate effectiveness, economic efficiency, social impacts, implications for other forest values, administrative feasibility, and political effectiveness. The impact of each would also need to be considered using a systems approach that quantifies net emissions resulting from

emissions/removals in the forest, harvested wood products emissions, and avoided emissions through substitution of wood-based products for other products (Lemprière et al., 2013). Ongoing and future research will explore the consequences of alternative policy approaches. Throughout history, forest management policies have evolved in response to changing social values, such as protection of fresh water, fish and wildlife, and biodiversity. As this case study of BC illustrates, it is time for jurisdictions to renew their forest policies to more effectively incorporate opportunities for carbon mitigation.

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