The potential for nature-based climate solutions in Canada: A brief overview

by the International Conservation Fund of Canada
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The world is falling far short of being on track to meet its Paris Agreement target to limit global warming to below 2°C, according to the U.N. Environment Program *Emissions Gap Report 2019*. What can be done? Nature-based solutions, also called natural climate solutions (NCS), offer a necessary part of the answer. According to an important synthesis published in 2017, natural climate solutions can help the world achieve 37 percent of the Paris Climate Agreement target through 2030 (while allowing for food and fiber security and avoidance of biodiversity loss).[i] NCS encompasses measures that reduce greenhouse gas emissions (GHG) from changes in land use and coastal ecosystems, plus measures that sequester additional carbon in living organisms and soils, thus *removing* atmospheric CO_2.

Here we outline the potential of NCS for Canada. We have six key points:

1. **Natural climate solutions are not a substitute for reducing fossil fuel emissions.**
We need much stronger action to decarbonize the energy sector along with NCS.

2. **The potential GHG emissions benefits from natural climate solutions in Canada are on the order of 250-320 Mt/year (a third or more of Canada's current GHG emissions).**

The Liberal Party of Canada's election platform included a promise of $3 billion over ten years for natural climate solutions including planting two billion trees. They said this will cut an estimated 30 million tonnes (Mt) of emissions annually. Independently, the Canadian forest products industry is pledging to remove 30 Mt of CO_2 a year by 2030.[ii]

However, the carbon mitigation potential in Canada of NCS from the forest sector and of NCS overall is considerably higher. The global potential from the land sector is 15 billion tonnes (Gt) per year between now and 2050; Canada's potential is reported as 209 Mt[iii], but this figure is incomplete and we believe an estimate in the range of 250-320 Mt CO_2e is more accurate (see Appendix 1). For comparison, Canada's GHG emissions in 2017 were 716 Mt.

3. **Canada should avail itself of expertise on natural climate solutions that is being developed by others, while continuing to share NRCan's expertise on forest carbon accounting.**

Canada has developed a National Forest Carbon Monitoring, Accounting and Reporting System for use within Canada and Natural Resources Canada has trained many countries, from Mexico to Kenya to Indonesia, on the Carbon Budget Model (CBM-CFS3). Similarly, Canada can learn from other jurisdictions about emissions and sequestration in other land use sectors and marine ecosystems. This avoids duplicating efforts and allows resources to be applied to bringing NCS into practice. *We need to start acting now on NCS.*

4. **Forests have a very large NCS potential in Canada but across sectors, priorities for action should be identified based on benefit/cost and ease of implementation.**

Improved forest management involving what is termed "natural forest management" offers large mitigation benefits in Canada (Table 1), as does reforestation. A caveat: trees release volatile organic compounds, some of which have a greenhouse effect (there is little science on this as yet) and forests can reduce Earth's surface albedo (reflectivity of sunlight), leading to warming, an effect more pronounced at higher latitudes and in mountainous or dry regions.[iv] Yet forests – especially tropical ones – also cool the atmosphere by converting solar energy to water vapor, which increases sky albedo via cloud formation. (It's complicated!) What is unquestionable is that existing forests store large amounts of carbon and action to slow forest clearing and degradation is of great importance.

NCS measures related to agriculture, urban areas and wetlands/coastal areas have significant potential and as we explain in Appendix 1, are under-represented in Table 1. Across these sectors, some actions will be relatively quick, easy and inexpensive to implement in relation to emissions benefits and those represent priorities to be pursued simultaneously.

Table 1. Mitigation potential of various terrestrial pathways for Canada, from Roe et al. (2019),[iii] with data from Griscom et al. (2017)[i] and FAOSTAT 2017[v].

NCS pathway		Mt CO_2e per year
Forests ∑ = 182.44 Mt	Natural forest management	127.86
	Reforestation	54.58
Agriculture ∑ = 25.16 Mt	Enteric fermentation	6.4
	Grazing: legumes in pastures	5.32
	synthetic fertilizer	4.95
	manure mgmt.	4.26
	cropland management	4.23
Peatlands ∑ = 1.2 Mt	Peatland restoration	1
	Reduced conversion of peatlands	0.2
	Total	208.8

5. **Canada can complement action at home by strategically supporting NCS in lower income countries.**

Despite Canada's huge size and significant potential for NCS, the potential is very much greater in tropical regions, especially regions with high deforestation. Brazil's potential from the land sector is *more than 13 times* Canada's, and Indonesia's potential is about 9 times Canada's.[iii] Canada can do a lot by supporting lower income countries with nature-based solutions. Here's the rationale:

- Climate change is an unprecedented threat to human well-being and life on Earth. It is an international responsibility and addressing it must be a mutual endeavour.
- International action will not replace domestic action but go beyond it.
- It needn't entail new financial commitments. ECCC and Global Affairs Canada should work to include NCS activities into our bilateral agreements with developing nations, and this can generate Internationally Transferable Mitigation Outcomes. Under the Paris Agreement, Canada committed to helping developing countries adapt to and mitigate climate change. Some—we suggest at least half--of this support should be targeted to nature-based solutions.

The highest priority is protecting intact tropical forest, peatlands and coastal ecosystems. Reducing the widespread loss of these carbon-rich and highly biodiverse ecosystems is of unmatched benefit/cost. A link to ICFC's detailed recommendations on this can be found on this page: https://icfcanada.org/about-us/why-the-tropics

6. **Both within Canada and globally, NCS has large co-benefits for biodiversity, soil, air filtration, water filtration and flood control. NCS can benefit livelihoods in rural areas and the urban environment.**

NCS helps in *adapting* to the impacts of climate change. Coastal conservation and restoration are crucial for protecting coastal communities and infrastructure from higher sea levels and increased intensity of coastal storms. Forests, grasslands and wetlands all reduce flooding, hence targeted restoration is another priority along with protection. Tropical forests are crucial for cloud formation and their importance in the hydrological cycle becomes even more important to minimize droughts that are now more frequent. Agricultural systems also become more dependent on adjacent natural ecosystems to counter climate change effects. Connecting natural ecosystems through strategic restoration will allow for movement of pollinators and birds and bats that control insects. Integration of trees and natural ecosystems in agricultural lands improves soil and water conservation. In lower income countries, forest NCS initiatives address many Sustainable Development Goals, delivering on multiple bottom lines.

Making urban and suburban areas greener yields multiple benefits. An estimated 2.4 Mt of carbon is stored in London's trees with an estimated value of £147 million per year.[vi] Trees also make urban areas more livable, filtering air pollution and providing shade and cooling, flood control, habitat for birds and mammals, and amenity value.

Appendix 1: Canada's NCS potential by sector

A recent review of the global land sector potential for natural climate solutions gave figures for the top 25 emitting countries including Canada (Table 1).[iii] Global and national figures are derived from median values for various NCS pathways from published studies. The review study depended on available data which may be sparse for some sectors and regions. There is overlap among sectors; for example, reforestation can include planting trees in croplands, which has a large NCS potential.

Canada clearly has a large potential from the forest sector. With respect to agriculture, a more comprehensive analysis done for the United States reported potential agricultural NCS totaling 505 Mt/yr.[vii] The U.S. has 5.6 times the area of farmland as does Canada, so if the potential per unit area were similar in Canada, the figure would be 90 Mt/yr.

Coastal ecosystems are carbon-rich though much smaller in area than land. Globally, an estimated 450 Mt of CO_2 is released annually from conversion or degradation of coastal ecosystems.[viii] This figure has much uncertainty (90% confidence interval = 150 Mt-1.02 Gt). The total NCS potential includes avoiding loss and degradation of coastal ecosystems plus ongoing carbon sequestration and additional carbon sequestration through restoration of coastal wetlands.

We could not find an estimate for Canada's blue carbon NCS potential but available data give an idea of the scale (Table 1). In British Columbia, a minimum of 180,200 tonnes of carbon (0.66 Mt CO_2e) is sequestered each year in coastal ecosystems, compared with 80,000-220,000 tonnes/year for B.C.'s boreal forests.[ix] Because carbon storage and sequestration per unit area is high relative to many terrestrial ecosystems, conserving remaining coastal ecosystems is a priority, especially since other ecosystem services provided by coastal ecosystems are extremely valuable. Restoration of salt marshes and seagrass has a small but significant potential to add to Canada's 22.95 Mt of "blue carbon" (84 Mt CO_2e). A study of marsh restoration in the Bay of Fundy found carbon accumulation more than five times the rate of a nearby mature marsh.[x] A concern longer term is the expected impact of sea level rise on coastal ecosystems.

Table 2: Carbon stocks and sequestration (accumulation) rates in Canada. Figures are for (organic) carbon (1 g C corresponds to 3.67 g CO_2). For carbon values, confidence intervals and ranges of values (not shown) are large.

	Source	total area in Canada (km^2)	stored carbon (tonnes/km^2)	total carbon stocks (Mt)	carbon sequestration (tonnes/km^2/year)	total carbon sequestered per year (tonnes)
seagrass (Canada)	CEC 2016[xi]	645	14,000	9.03	(83 global)	
tidal marsh (Canada)	CEC 2016	546	25,500	13.92	(91 global)	
seagrass & tidal marsh (Canada)	CEC 2016	1,191		22.95		
Bay of Fundy	ECCC 2019[xii]	101		14.2		
BC salt marshes	Chastain et al. [xiii]		8,060		146	
BC estuaries	Campbell 2019ix	745			242	180,200
Bay of Fundy	Chmura et al. 2003[xiv]				259	
Bay of Fundy marsh under restoration	Wollenberg et al. 2010[x]				1,329	
seagrass, British Columbia, Oregon, Washington	Prentice et al. 2020[xv]		7,168 (sediments, 1 meter depth)		24.8	

Urban and suburban areas are extensive and could be made much greener. A recent study of the UK's urban parks showed that they could store as much carbon as a tropical rainforest.[xvi] Based on information from the US[1], Canada's urban areas, if similar in carbon storage, would store about 73 Mt C (258 Mt CO_2e) with annual sequestration of about 3 Mt C (11 Mt CO_2e). If tree planting in urban and suburban areas quadrupled stored carbon over a 30-year period, that plus current levels of sequestration would amount to about 37 Mt per year of CO_2e sequestered.

Table 2: Estimates of Canada's NCS potential in various sectors. The urban/suburban figure depends on assumptions, including the rate of "greening" (tree planting).

sector	Mt CO_2e/yr
Forests	182
Agriculture	37-90
Coastal ecosystems	1-3
Urban/suburban	30-45
Total	250-320

[1] Total tree carbon storage in U.S. urban areas (c. 2005) is estimated at 643 Mt ($50.5 billion value) and annual sequestration is estimated at 25.6 Mt C ($2.0 billion value).[xvi] The U.S. has 8.82 times the population of Canada (2018 figures).

Appendix 2: Some key pathways in various NCS sectors

Forest Pathways:

- natural forest management and improved plantations (increased) carbon sequestration)
- reforestation and restoration of degraded forests (significant carbon sequestration)
- improved fire management

Agricultural Pathways:

- avoiding nitrogen oxide emissions through reduced fertilizer use and improved application methods on croplands
- additional carbon sequestration through integration of trees in croplands at levels that do not reduce crop yields.
- additional soil carbon sequestration by planting cover crops

Marine/Coastal/Wetland pathways

- tidal marsh and seagrass restoration
- avoided loss of salt marsh and seagrass
- peatland restoration (peatlands extend over 170 million hectares in Canada's arctic/subarctic and boreal regions, some have been impacted by the peat moss industry)

Urban/Suburban pathways

- planting trees and other vegetation
- vertical farming to supply the local markets with fresh produce

Cultural pathways

- encouraging decreased meat consumption, especially of grain-fed beef
- encouraging nature-friendly practices on private land (urban and rural)

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[iii] Roe, S. et al. (2019) Contribution of the land sector to a 1.5 °C world. Nature Climate Change 9:817-828.
[iv] Popkin, G. (2019) How much can forests fight climate change? Nature 262: 280-282.
[v] FAOSTAT is a database provided by the Food and Agriculture Organization of the United Nations. http://www.fao.org/faostat/en/#home
[vi] Treeconomics: https://www.treeconomics.co.uk/wp-content/uploads/2018/08/London-i-Tree-Report.pdf
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[xi] Commission for Environmental Cooperation (2016) North America's Blue Carbon: Assessing Seagrass, Salt Marsh and Mangrove Distribution and Carbon Sinks
[xii] https://www.arcgis.com/apps/MapJournal/index.html?appid=dfa52f8f91754c24804b6d63e782fb7f
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[xiv] Chmura GL, et al. (2003) Global carbon sequestration in tidal, saline wetland soils. Global Biogeochemical Cycles. Global Biogeochem. Cycles, 17(4), 1111, doi:10.1029/2002GB001917

[xv] Prentice, C. et al. (2020) A synthesis of blue carbon stocks, sources and accumulation rates in eelgrass (*Zostera marina*) meadows in the Northeast Pacific. Accepted for publication. doi: 10.1029/2019GB006345

[xvi] https://www.ucl.ac.uk/news/2018/jun/uk-urban-forest-can-store-much-carbon-tropical-rainforests