



Improving Canada's forest carbon estimates

CANADIAN FOREST SERVICE SCIENCE-POLICY NOTE

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Why do forest carbon estimates change over time?

Forests are complex ecosystems that sequester carbon as they grow and emit carbon when they die, decay, and are disturbed. They are also affected by both natural processes and human activities. These factors make calculating forest carbon a complex task.

As new data and science become available, our understanding of forest carbon and the processes that affect it improves. Incorporating this improved understanding increases the accuracy of our estimates, causing them to change over time (Figure 1).

Natural Resources Canada (NRCan) and Environment and Climate Change Canada (ECCC) collaborate with external partners to continuously improve Canada's forest carbon estimates. Each year, Canada's revised forest carbon estimates and a description of the improvements that have been implemented are published in a [National Greenhouse Gas \(GHG\) Inventory Report](#). This report is submitted annually to the United Nations Framework Convention on Climate Change (UNFCCC).

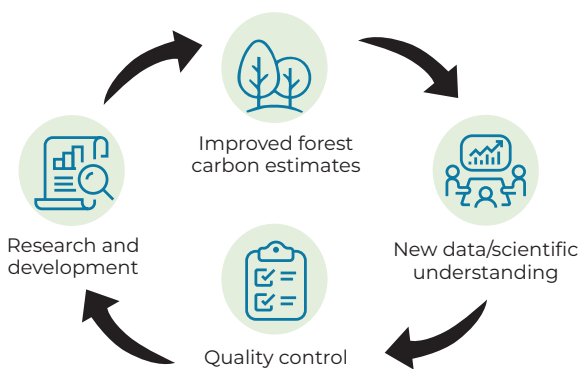


Figure 1. The continuous improvement cycle for forest carbon estimates.

UNFCCC

United Nations Framework Convention on Climate Change

The treaty that sets out the framework and principles for international climate change cooperation. Its ultimate goal is to stabilize GHG concentrations "at a level that would prevent dangerous anthropogenic (human caused) interference with the climate system" (UNFCCC, 1992).

How does Canada estimate the amount of carbon in its forests?

With over 200 million hectares of [managed forest](#), it is not possible to monitor every inch of Canada's forests to directly measure carbon sequestration and emissions. Instead, NRCan uses its [Carbon Budget Model \(CBM-CFS3\)](#) to simulate carbon dynamics in Canada's managed forest. Compliant with international standards, CBM-CFS3 incorporates the best available data and scientific understanding of processes involved in forest carbon cycling.

The model relies on millions of forest measurements across the country to produce Canada-wide estimates. This includes nearly three million inventory records that describe forest conditions. CBM-CFS3 estimates forest growth using over 100,000 growth curves (mathematical equations that represent tree growth). The growth curves are developed from millions of tree measurements and tens of thousands of plot measurements maintained by provincial, territorial, and federal governments and industry over many decades. NRCan's methods for estimating forest carbon have been published in over 100 peer-reviewed scientific articles.



Why does Canada need to improve its forest carbon estimates?

Modelling always involves a degree of uncertainty. In particular, the uncertainties in forest carbon estimates are high given the number and complexity of factors leading to carbon sequestration and emissions from forests. In some cases, there are natural processes and human activities affecting forest carbon that are not currently reflected in Canada's calculations due to lack of data or insufficient scientific understanding. Uncertainties apply in both directions: Canada's forests could be either emitting more carbon or sequestering more carbon than currently estimated.

The international community, led by the Intergovernmental Panel on Climate Change (IPCC), encourages the improvement of the quality of GHG estimates on a continuous basis as good practice. NRCan and ECCC are committed to upholding this principle and continuously improving forest carbon estimates as new data and science become available.

Where do the recommendations for improvements come from?

Collaboration is key to identifying opportunities to improve Canada's forest carbon estimates. NRCan and ECCC collaborate with academia, non-governmental organizations, forest industry, provinces and territories, and others to determine opportunities to improve forest carbon estimates. These research collaborations allow us to stay informed about the latest science to support

improvements, identify knowledge gaps, and conduct collaborative science to support improvements.

Recommendations also come through Canada's participation in the UNFCCC. Each year, Canada's National GHG Inventory Report is reviewed by international experts through a process coordinated by the UNFCCC. These reviews include recommendations on ways that Canada can improve its approach.

Identifying new or improved data on Canada's forests is another crucial part of GHG inventory improvements. For example, provinces and territories are responsible for managing most of Canada's forest lands. They collect vast amounts of data on forests and how they are managed. Collaboration with provinces and territories is key to identifying new or improved data sets that can inform improvements.

What is the process to improve forest carbon estimates?

It is not possible to implement all the recommended improvements at once. Some improvements can be put in place relatively quickly, while others require years to develop the necessary science and data.

IPCC

Intergovernmental Panel on
Climate Change

United Nations body responsible for assessing the science related to climate change. The IPCC sets scientific standards and provides guidance for countries' GHG estimation under the UNFCCC.

MAJOR COLLABORATION EFFORTS ON FOREST CARBON ESTIMATION ARE OFTEN PUBLISHED IN REPORTS. EXAMPLES INCLUDE:

- [*A Blueprint for Forest Carbon Science in Canada*](#) (NRCan, 2012)
- [*Climate Science 2050*](#) (ECCC, 2020)
- [*The 2019 Carbon Workshop*](#) (ECCC, 2020)
- [*Nature-Based Climate Solutions: Expert Panel on Canada's Carbon Sink Potential*](#) (Council of Canadian Academies, 2022)

Each year, NRCan and ECCC determine priority improvements to implement in Canada's National GHG Inventory. Key criteria for prioritizing improvements include:

- the magnitude of the uncertainty;
- the availability of data to improve the estimates; and
- the current scientific understanding to support the improvement.

Canada's planned forest GHG improvements are tracked in an [Improvement Plan](#). This plan details the objectives of the planned improvements and when they are expected to be implemented. It also describes the research and development needed to implement the improvements.

Conclusion

Understanding the contribution of forests to the global carbon cycle is a complex but critically important task. Using the best available science and data, NRCan and ECCC are committed to continuously improving Canada's forest carbon estimates. Collaboration with external experts and stakeholders is key to identifying opportunities and informing the continuous improvement process. As new science and data on forests continue to surface, Canada's forest carbon estimates will continue to be improved.

References

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EXAMPLE FOREST GHG IMPROVEMENT PROJECT: FORESTS ONTARIO'S 50 MILLION TREE PROGRAM

Forests Ontario is a non-profit organization supporting the creation of new forests (afforestation) across the province.

Identification of new data: Forests Ontario collected data on its afforestation activities from 2007 to 2016.

Quality control: NRCan validated Forests Ontario's afforestation data using high resolution imagery.

Research: The results of NRCan's validation study were published in scientific literature and peer-reviewed (Magnus et al., 2021).

Development: NRCan developed methods to incorporate the new afforestation data into forest carbon modelling.

Improved estimates: NRCan and ECCC incorporated and described the improvement in Canada's 2021 National GHG Inventory Report.