Natural Resources Canada
Ressources naturelles Canada

The State of Canada's Forests

ANNUAL REPORT 2022

Features:

Diversity: The key to resilience in forest ecosystems

Enhanced forest monitoring data to support sustainable forest management

Adapting to climate change: The story of invasive insects in Canada's forests

Joining forces internationally to better understand and fight forest fires

Wildland fire and forest carbon: Understanding impacts of climate change

Biodiversity, conservation, and Indigenous Peoples' well-being

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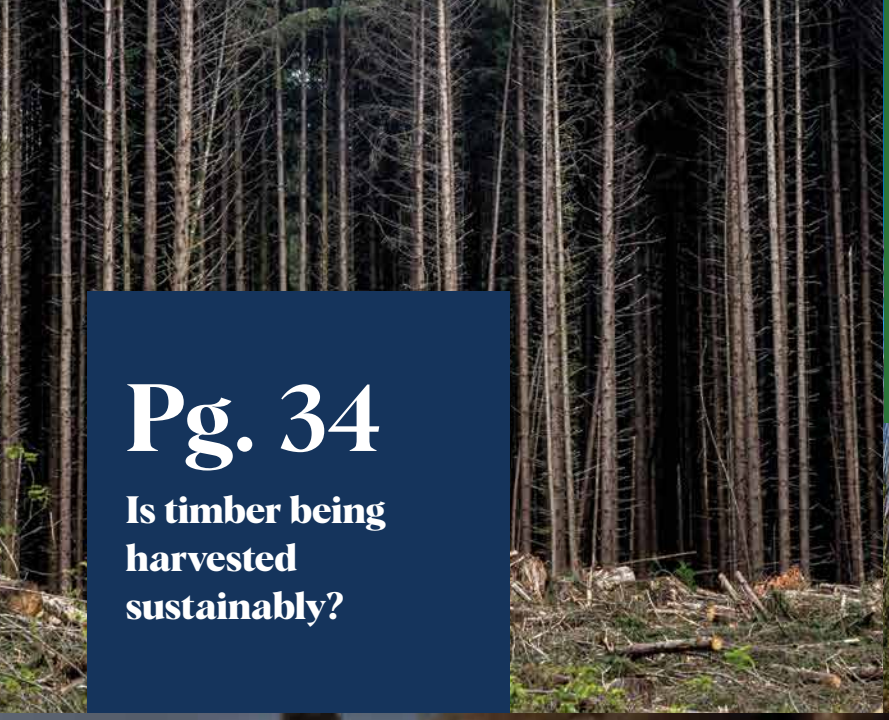

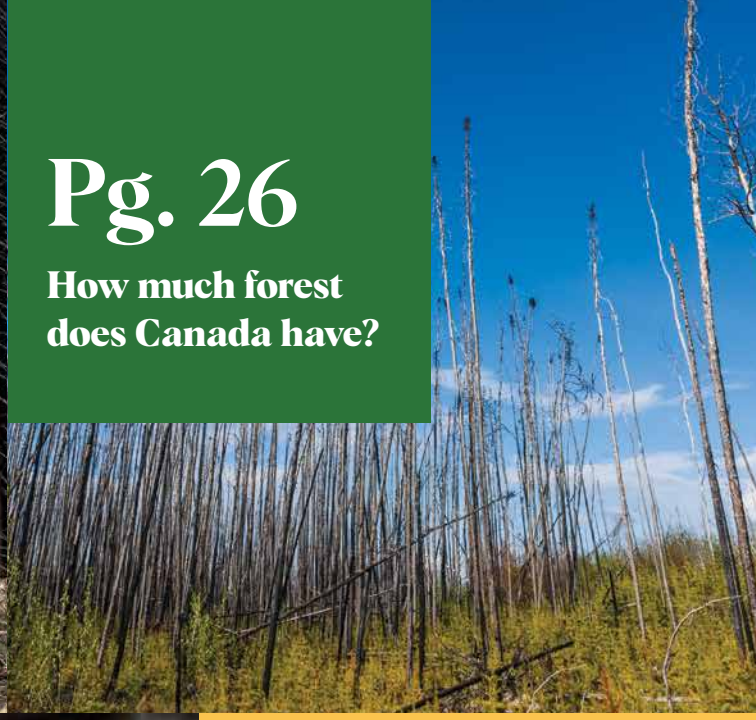

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Minister's Message

Canada faces twin crises in climate change and biodiversity loss. Canada's forests are an important part of the solution to both: they are storers of carbon and habitats for wildlife. Our forests are also an important part of the lives of Canadians. Forests themselves contribute to our health and well-being, while the forest industry provides good jobs across the country.

The theme of this year's report, *Diverse forests for a diverse Canada*, is highlighted in stories from across our heavily forested country. These stories show how we are helping our forests adapt to a changing climate, respond to new stressors and benefit from sustainable forest resource management through the use of reliable data.

With forests covering nearly 40% of Canada's land area, it is important that they be managed sustainably in order to preserve their many great environmental, social and cultural benefits for both present and future generations. Effective management also creates opportunities for innovative economic development.

Now, as the global economy recovers from the COVID-19 pandemic and market demands change, it is essential for the forest sector to continue to innovate, to find new ways to use wood fibre and to improve environmental performance.

The Government of Canada supports the drive toward sustainability through innovation. For instance, the Forest Innovation Program (FIP) and Investments in Forest Industry Transformation (IFIT) program support the transformation of the Canadian forest sector through research and development, the adoption of innovative technologies and the expansion of value-added forest products, while the Green Construction through Wood (GCWood) program encourages greater use of wood in construction projects.

And we continue to make real progress toward our goal of planting 2 billion trees over 10 years. The first year of the program was a success: our partners achieved 97% of our 30-million-tree planting target. These trees will clean the air we breathe and the water we drink and will help cool our urban centres. Nearly one in every five projects was Indigenous-led, and a high volume of applications for the second year shows continued growth and interest.

By rooting our actions and decisions in science-based sustainability indicators, we can better understand both short- and long-term trends to promote the sustainable management of our forests. By incorporating Indigenous and local perspectives and knowledge into forest management, restoration and conservation, we are strengthening the resiliency of our forests and communities.

Canada's forests have always defined our country. Through good management and innovation, we are preserving their role in our country's future.

The Honourable Jonathan Wilkinson
Minister of Natural Resources

The 2022 *State of Canada's Forests Report*: An overview

Canadians are deeply committed to sustainably managing their forests for the multiple important values they provide. Canada's rich forest ecosystems offer significant environmental, social and cultural benefits, as well as opportunities for responsible economic development. Sustainable forest management ensures that these benefits are maintained for both present and future generations.

Canada has been managing its forests according to the principles of sustainable forest management for many years. *The State of Canada's Forests: Annual Report* has been a trusted and authoritative source of comprehensive information on the social, economic and environmental state of Canada's forests and forest sector for 32 years.

Each year, *The State of Canada's Forests: Annual Report* delivers thematic content about Canada's forest sector through feature stories. To explore this year's theme of **Diverse forests for a diverse Canada**, this report includes stories on:

- how biodiversity promotes forest ecosystem resilience and how forest management can contribute to increasing this resilience in a context of climate change
- the new National Forest Inventory (NFI) remeasurements and how these more accurate and detailed forest data can help better guide sustainable forest management decisions
- the challenge presented by invasive insects in Canada's forests and climate change and possible solutions to prevent new invasions and make our forests more resilient to these stressors
- how international collaboration in firefighting and scientific wildfire research helps ecosystems and communities prepare and adapt in response to shifts in wildfire frequency, severity and size
- how the variety of methods used to report on wildland fires and carbon emissions help promote forest ecosystem resilience and climate adaptation
- how Indigenous-led conservation initiatives such as **Indigenous Protected and Conserved Areas** can help restore and preserve nature as well as Indigenous leadership, culture, and knowledge systems

These stories provide a snapshot of some of the current challenges and opportunities facing Canada's forests and forest sector and provide insight into where the future may lead.

Sustainability indicators are important tools for managing Canada's forests

Science-based measures called **sustainability indicators** are helpful tools for understanding the overall condition or state of Canada's forests. Indicators provide a way to consistently define, assess, monitor and report progress toward sustainable forest management. Reporting on sustainability indicators over time helps to ensure and promote the long-term sustainable management of our forests. They do so by:

- providing reliable data and essential information on the state of and trends in Canada's forests
- highlighting any needs for improvement in forest management policies and practices
- supplying reliable information for discussions and initiatives related to environmental performance and trade

The indicators included in *The State of Canada's Forests* annual reports are based on the most accurate and currently available data from Canada's most trusted sources, including Statistics Canada, the National Forestry Database, and the NFI, among others. These data and information are then analyzed by a collection of Canada's leading experts who produce the written text for each indicator in the report. As a whole, the indicators as well as the Statistical Profiles section at the end of the report provide government, industry, researchers and the general public with relevant context on the current day status, the historical trends as well as future forecasts on these varied indicator topics. Above all, the indicators in this report demonstrate Canada's ongoing commitment to sustainably managing its forests and forest sector.

Canada uses internationally agreed-upon indicators of sustainable forest management

Along with 11 other countries, Canada is a member of the Montréal Process, an international working group of northern and southern hemisphere nations committed to sustainable forest management. Since 1995, the Montréal Process member countries have used a common set of science-based criteria and indicators to measure progress toward the conservation and sustainable management of 90% of the world's boreal and temperate forests. The set of indicators reported here are inspired by, and seek to align with, this evolving and internationally relevant framework of criteria and indicators.

Sustainably managed forests contribute to global sustainable development goals

The United Nations identified 17 Sustainable Development Goals in the *2030 Agenda for Sustainable Development*, which was adopted by United Nations member states, including Canada, in September 2015. In addition to the 17 Sustainable Development Goals, the Agenda includes 169 associated targets aimed at improving global sustainable development across social, economic and environmental dimensions as well as peace, governance and justice. The sustainability indicators in *The State of Canada's Forests* reports support:

- The United Nations' Sustainable Development Goal 15 – Life on Land
- The United Nations' Global Forest Goals
    1. Reverse forest cover loss
    2. Improve the benefits and livelihoods derived from forests
    3. Protect forests and use sustainable forest products
    4. Mobilize resources

Reporting on the global Sustainable Development Goals is a step toward a shared understanding of the value of forests.

The State of Canada's Forests report is designed to be as informative and user-friendly as possible, and we welcome your feedback. Contact us at cfs-stateoftheforests-etatdesforets-scf@nrcan-rncan.gc.ca, and let us know what you think.

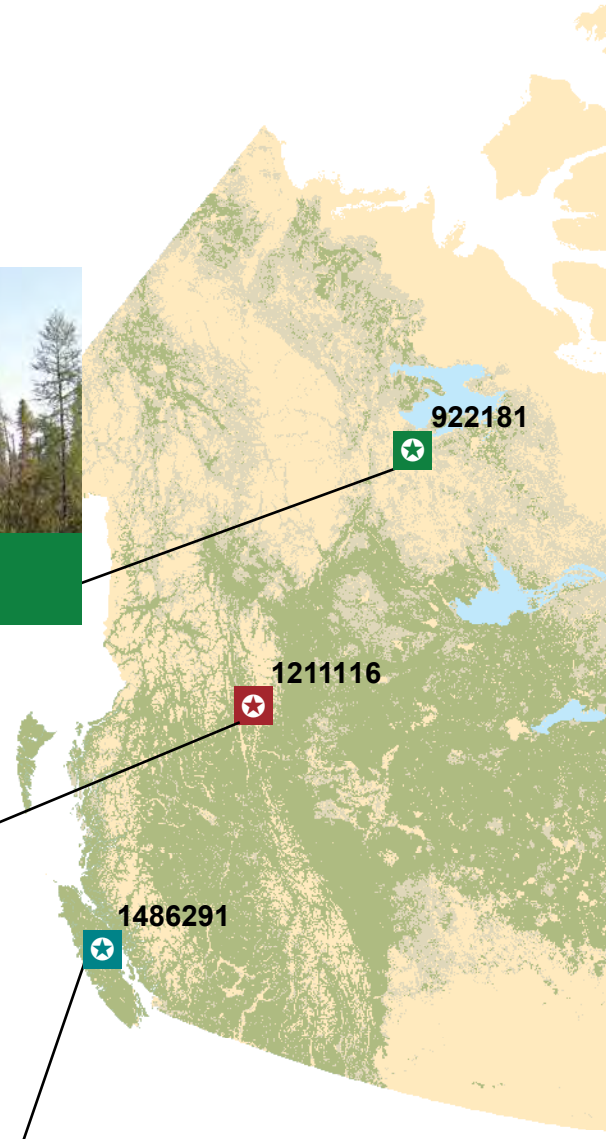
A sampling of old-growth forests in Canada

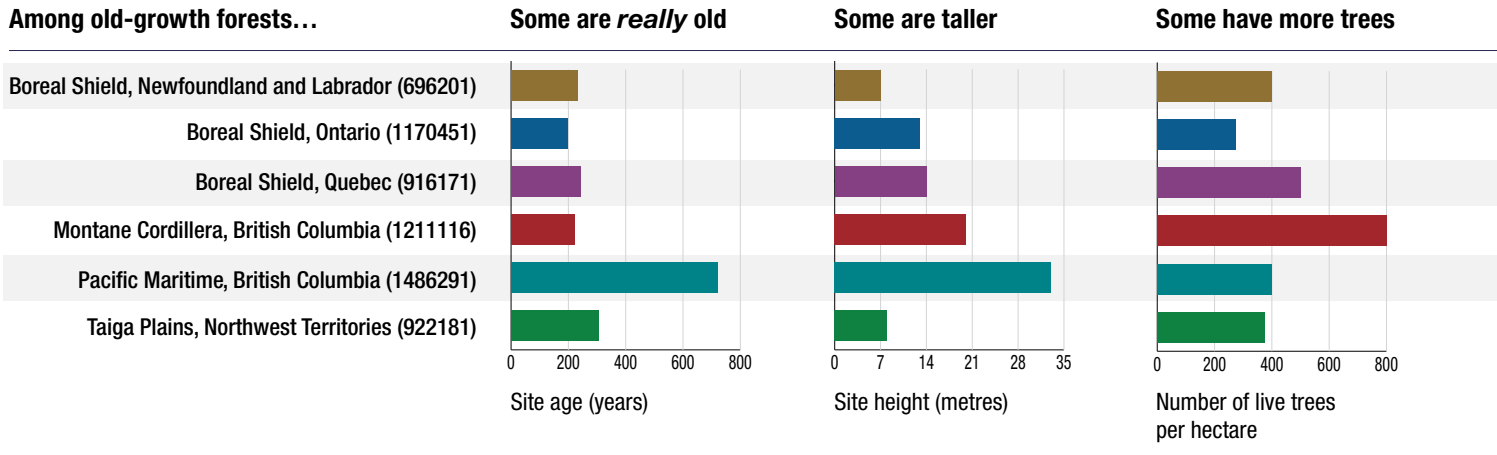
Old-growth forests are located throughout Canada's forest landscapes. Canada's National Forest Inventory (NFI) maintains a network of permanent forest monitoring plots at randomly selected points, and some of these happen to be in very old forest stands.

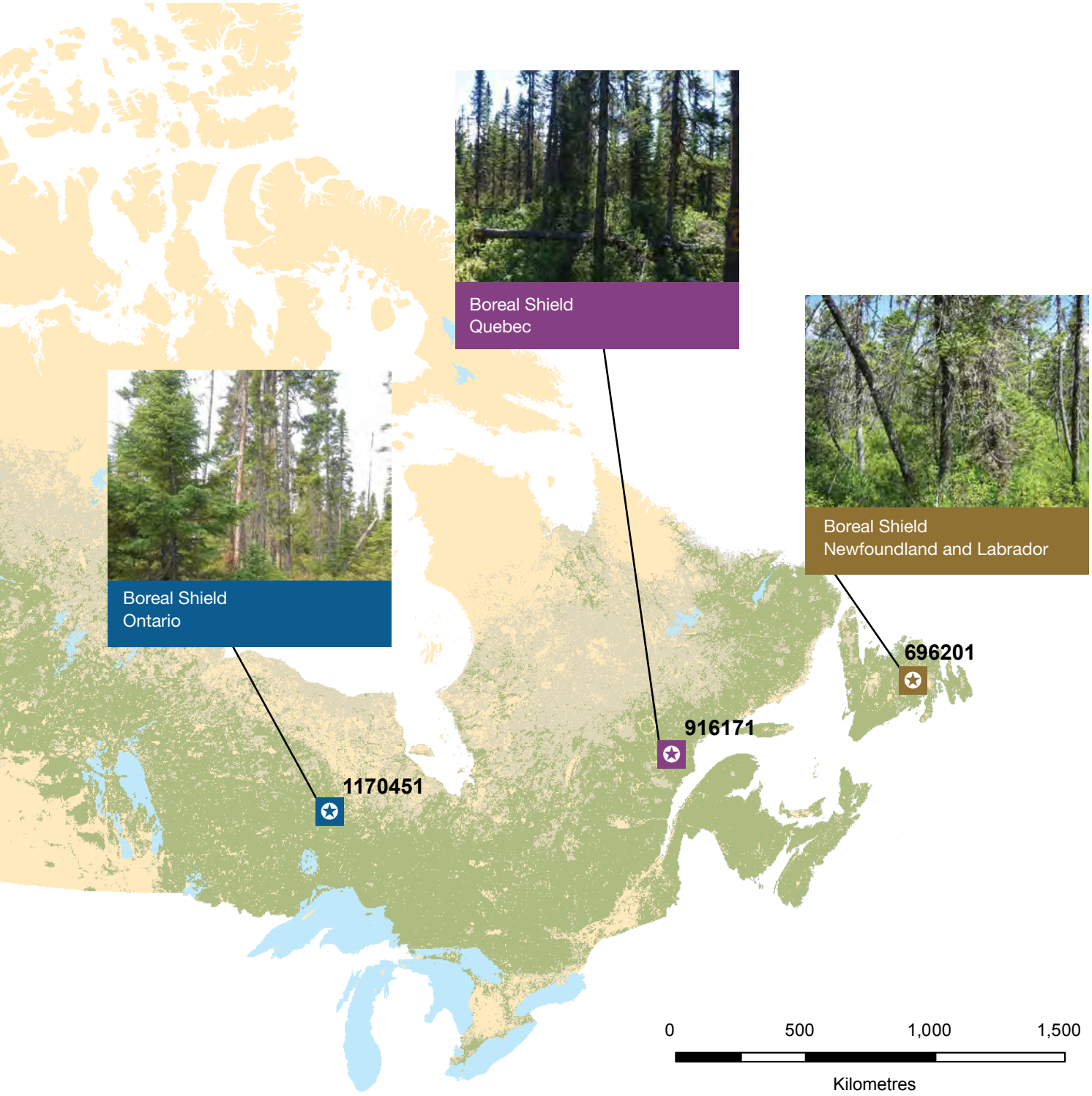
Taiga Plains
Northwest Territories

Montane Cordillera
British Columbia

Pacific Maritime
British Columbia



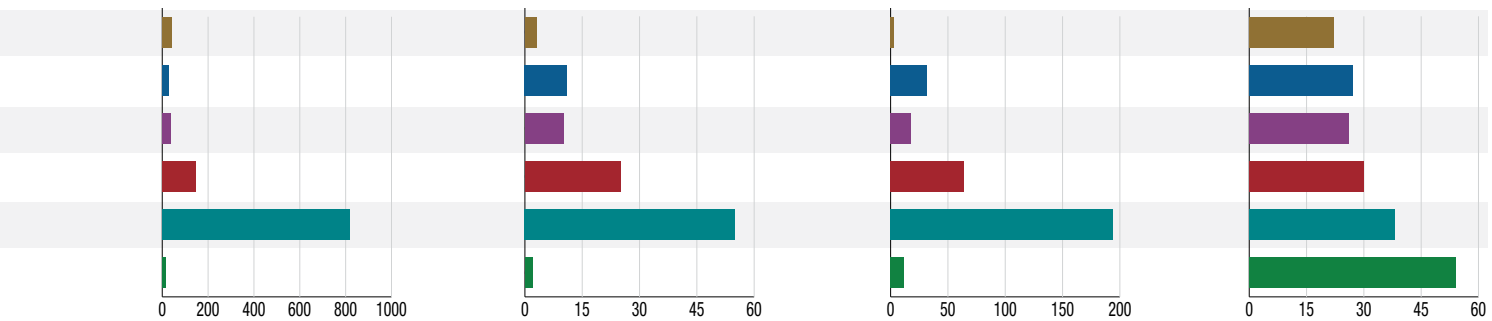




Some have *a lot* more biomass

Some have more deadwood

Some are home to more plant species



How old are Canada's forests?

Twelve thousand years ago, ice sheets covered most of what is now Canada. Canada's forests have undergone countless cycles of growth, disturbance and regrowth since then, dynamically adapting to changing conditions. Where natural disturbances occur frequently, such as in fire-prone landscapes, these cycles repeat more frequently and older stands are rare, even in the absence of human disturbance. In areas less exposed to large forest disturbances like on islands and along lakeshores, where water acts as a fuel break, forests may go centuries without being disturbed.

What is "old-growth"?

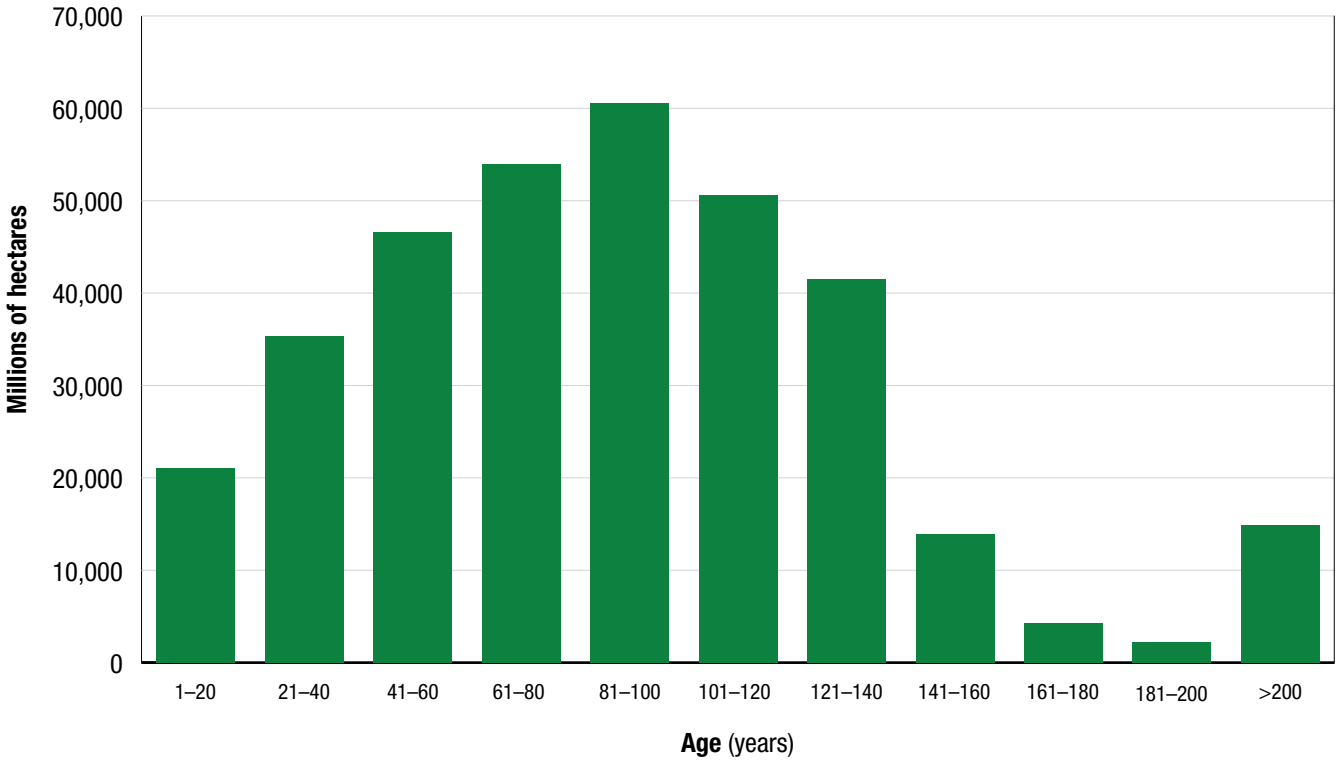
A forest can become old-growth if enough time passes and if major disturbances (e.g., wildfire or clear-cutting) do not cause the death of the trees within it. Old-growth forests are not stable or static. They continue to evolve through small-scale disturbances such as the death of individual trees.

Different forest types produce different kinds of old-growth. Old-growth forests in Newfoundland and Labrador look quite different from those in British Columbia. In general, old-growth forests are home to a range of trees including older – but not always bigger – trees, trees that are able to grow in the shade of other trees, standing deadwood (snags), and downed deadwood. Old-growth forests also have a unique and complex forest structure. For example, trees are of different heights, and the ground is dotted with pits and mounds because of uprooted trees. All these old-growth characteristics provide a diversity of habitat for many plants and animals.

Old-growth forests can store vast amounts of carbon in the wood and in the soil. However, because older trees don't grow as fast as they did when they were young, they have a limited ability to remove additional carbon from the atmosphere through photosynthesis. Some old forests can even release more carbon in the atmosphere from decaying plant material than they are able to uptake through vegetation growth, which makes them carbon sources.

Many of these characteristics are found in forests that have never been harvested and can persist for hundreds or even thousands of years if no major disturbance occurs. Some of these characteristics can also appear in previously harvested forests, but this recovery can take hundreds of years, depending on the forest type.

Forest area by stand age class



Canada's forests provide a diversity of benefits

Key facts and figures about Canada's forests and forest sector

Canada's forests provide a wealth of ecological resources

Canada has **9%** of the world's forests, with **362 million hectares (ha)**

Area of forest land by forest type

70% Coniferous

14% Mixedwood

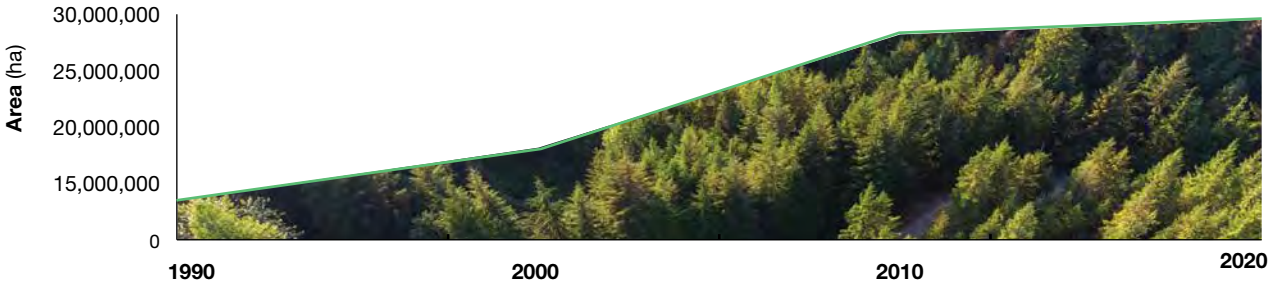
12% Broadleaf

5% Non-treed

Canada's over **280 million ha of boreal forest** (about the size of Argentina) provide **important breeding habitat** for 80% of North American waterfowl species, 63% of finch species, and 53% of warbler species.

Canada protects its forests and sustainably manages their resources

Area of protected forests in Canada, 1990–2020



About **90%** Canada's forests are **publicly owned** (federal, provincial, territorial, and municipal). (2021)

Canada has **158 million ha of forest certified to third-party standards** of sustainable forest management. This represents **35% of the world's certified forest area**. (2021)

Forests harvested on public lands must be regenerated.

Area affected by forest disturbances, and percentage of total forest area

17,768,618 ha
4.91%

Area affected by insects (2020)

710,333 ha
0.20%

Area harvested (2020)

4,307,520 ha
1.19%

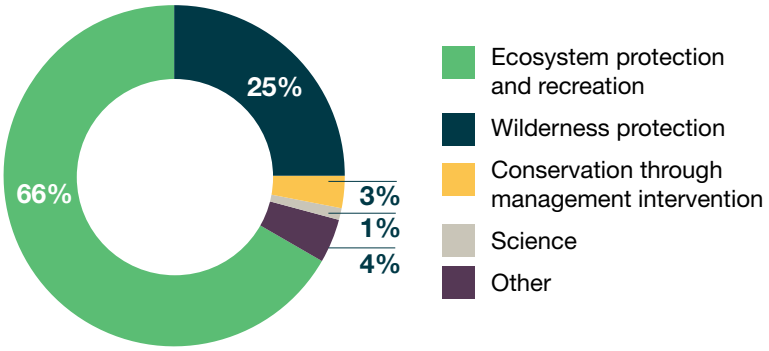
Area burned (2021)

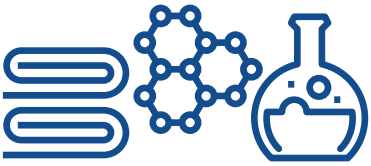
49,352 ha
0.01%

Area deforested (2020)

Canada's forests are managed for diverse objectives and products

Percentage of protected forest land by management objective (2021)





Canada's **138 native tree species** have at **least 40 known medical or pharmaceutical uses**, and are used **to produce common materials** such as rayon, cellophane, glue and turpentine (among others).

Canada's forests provide a diversity of social and economic values

In 2021, Canada's forest sector **directly employed 205,365 people**, a **10% increase** from 2020.

Average earnings across all forest sector activities were on average about **$54,500 for 2021**.

Canada's forest sector contributed **$34.8 billion to Canada's nominal GDP** in 2021, a **33% increase** from 2020.

Of all people employed in the forest sector (2016):

6% were Indigenous

12% were immigrants

17% were women

Canada's forests and forest sector play a key role in climate change adaptation and mitigation

In 2020, **600 million seedlings were planted** on 417,000 hectares of provincial forest lands in Canada.

In 2020, **Canada's managed forests** and the wood products harvested from them **removed about 5.3 Mt CO_2e** from the atmosphere.

Each **10% increase in urban tree cover** can contribute a **1°C cooling effect** to that area.

Building with wood stores tonnes of carbon! Construction grade lumber typically holds about **1 tonne of CO_2e for each m^3 of wood**, and an average Canadian single-family home stores almost **30 tonnes of CO_2e** within its wood-based construction materials.

Diversity: The key to resilience in forest ecosystems

What is biodiversity?

Biodiversity is the variability of life (plants, animals, bacteria, etc.) found in the world's ecosystems. Biodiversity includes genetic differences within species and variations in the ecosystems they inhabit.

Canada's forests are home to about 140 native tree species across the country, as well as a great variety of plants, insects, fungi, birds, mosses, lichens, and more. Of the 426 bird species that breed in Canada, about one-third depend on forests to survive. Forest characteristics such as age, composition and structure influence what species are able to thrive in Canada's forests, and these forest characteristics are primarily driven by forest disturbances. Disturbances can be of natural origin, such as forest fires ignited by lightning, ice storms, and native insect outbreaks and diseases (e.g., wood decay). They can also be human-induced, such as forest logging, land-use change and invasive pest outbreaks.

Biodiversity and resilient forests

Forest resilience to disturbances is closely related to biodiversity and its preservation. Generally, a forest with greater genetic, species, and habitat diversity is more resilient than one with less diversity.

Forest resilience, what is it exactly?

A forest is resilient if it is able to resist environmental change or regrow following a disturbance, while recovering the same composition and structure as before.

When a forest is able to regrow after a disturbance, it can continue to provide us with important ecological and cultural services, from carbon capture to engineered wood, while ensuring adequate wildlife habitats.

High genetic diversity within managed and unmanaged forests allows species to gradually adapt to changing environmental conditions, including climatic changes and outbreaks of forest insect pests and pathogens. For example, on the whole, Canada's boreal forests have relatively low tree species diversity, yet these species are highly adaptable because of their genetic diversity and large population size.

Species diversity increases forest resilience through the presence of species with special characteristics, called functional traits (characteristics that allow the organisms to survive and reproduce), which can help them return after a disturbance has occurred. A forest having all of its parts – including a range of habitats and young and old stands – can host more species, among which some will be able to re-establish after a disturbance, thanks to their special functional traits.

Assessing biodiversity to better protect it

Quantifying forest biodiversity is of paramount importance to understand the impacts of disturbances on forest ecosystems over time. However, given the high number of species and the vastness of the territory, assessing forest biodiversity can be challenging. Despite this challenge, there are still many ways to assess biodiversity, such as focusing on targeted species groups (e.g., species at risk), specialized species that need particular habitat conditions to survive and sensitive species that are known to respond negatively to disturbances or using forest habitat conditions as an indicator of species diversity. We need to assess biodiversity in managed forests to monitor the efficiency of our management strategies to maintain suitable habitat conditions for the targeted species. It is also important to monitor changes in biodiversity over time in unmanaged forests to be aware of the arrival of new species in Canada and of species that could decline because of human activities (e.g., pollution and habitat loss).

There are several ongoing projects that are working to improve our understanding of biodiversity in Canada's forests. Academic and government scientists are consistently collecting new forest biodiversity data and documenting the use of the forest environment as habitat. For example, the Boreal Avian Modelling Project (BAM) collects and collates avian (bird) data from across Canada and uses these data to create habitat maps that predict how the abundance of birds will change in response to habitat loss and changes in habitat connectivity and fragmentation, among other changes. The growth of Citizen Science initiatives for collecting data, such as eBird, the Breeding Bird Survey, and the Breeding Bird Atlas, provides opportunity for knowledgeable Canadians to contribute to scientific projects like BAM.

Partnerships between Indigenous monitoring programs, such as the Boreal Sentinel Project, and western scientific researchers are also growing more common and leading to a whole new perspective on forest biodiversity through

Collections: An essential anchor for research

The study of the biodiversity of Canada's forests is complex and requires a solid foundation. One of them is to build "collections" to which access is shared with the various research institutions. Researchers use items ranging from insect samples to fungi to plants and wood to document the past, present and future diversity of forest ecosystems.

The Canadian Forest Service manages 14 collections, with close to 1 million samples, across Canada.

"two-eyed seeing." The Boreal Sentinel Project is a partnership between Canadian Forest Service researchers at the Atlantic Forestry Centre, Miawpukek First Nation of Newfoundland and Labrador, and Parks Canada that aims to develop an early warning system for biodiversity loss using inventories of species in the field, an automated monitoring system with digital cameras, participatory science, and Indigenous science and knowledge. So far, the Forest Guardians of the Miawpukek Nation have taken an inventory of lichens in Gros Morne National Park and discovered several new species of lichens previously unknown to exist in this national park. A new phase of the project is expanding the area of interest to include Terra Nova National Park, an ecosystem corridor between the park and a new Forest Management Area managed by Miawpukek First Nation, and the Miawpukek First Nation's reserve.

Maintaining biodiversity and resilience in Canada's managed forests

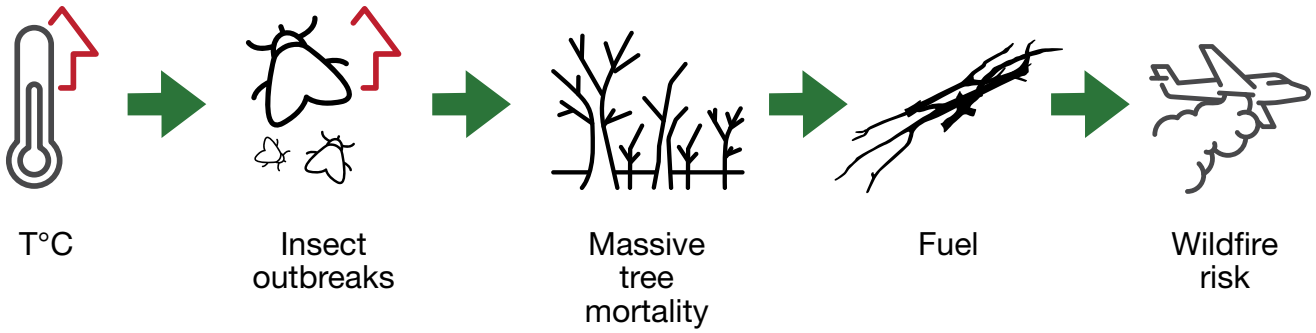
The best available scientific research and information are used to plan and implement sustainable forest management practices in Canada. The Montréal Process set out indicators for measuring sustainability of forest management practices. Criterion 1 of the Montréal Process is to conserve biological diversity. To meet this criterion, sustainable forest management must consider forest diversity at the genetic, species, and landscape scales. Numerous laws and regulations across Canada also require forest managers to conserve biodiversity, including species at risk.

The best-known strategy for managing and conserving biodiversity is to ensure that a range of forest ages, composition, and structure are spatially connected across landscapes. In addition to preserving critical habitat for species at risk, forest managers can maintain forest ecosystem resilience by using management practices inspired by natural disturbances such as fires and insect outbreaks. Initiatives such as the Ecosystem Management Emulating Natural Disturbance (EMEND) Project inform such management practices by testing the effects of residual forest structure on forest biodiversity, such as leaving live single trees and large patches of uncut forests within harvested areas.

Climate change: A game changer for the resiliency of Canada's forests

Canadian forests are well adapted to natural disturbances, but climate change is changing the frequency, severity and size of disturbances and facilitating the movement of forest pests. The increase in disturbances may transform forest composition. For example, the anticipated increase in fire frequency and severity may benefit some species that could take advantage of the new conditions (e.g., pines, white birch and red oaks), while other species could decline (e.g., sugar maple, American beech, and eastern hemlock). The rate of climate change in Canada also means that some tree species will not migrate quickly enough to maintain viable populations.

The speed and scale of climate change can make Canada's forests vulnerable



Climate-smart forestry for resilient future forests

Climate change is challenging the resiliency of Canada's forests, but research and innovation are leading to solutions. Advances in ecological modelling have provided greater insight in how species diversity and forest ecosystems may respond to a changing climate. For example, modellers are now able to utilize biodiversity data, such as those collected through BAM, citizen science, and Indigenous monitoring programs, with climate models to forecast how bird diversity will respond to climate-induced changes to forest habitats. Additionally, climate and habitat modelling can provide insight into areas that may change less over time (e.g., climate refugia), indicating priority areas for biodiversity conservation.

Genomics is also proving to be a powerful tool to understand the genetic and functional trait diversity of our forests and leading to innovative approaches to selecting seed sources for regenerating forests better suited to future climate conditions. For example, the recent FastPheno initiative aims to accurately assess the response of trees to environmental variations in near real-time through the use of next-generation drones at operational scale and will provide unprecedented capabilities for quantifying the adaptive characteristics of tree species. Also, the Traits of Plants in Canada (TOPIC) network is a group of university and government researchers studying the functional traits of plants and trees to develop a better understanding of species vulnerability and adaptability to climate change. By sharing information, these projects help answer important ecological questions and support policy decisions for enhancing the resilience of forests.

Finally, new experimental approaches to adaptive silviculture (the harvesting and regeneration of forests) are being tested through different projects. For example, Silva21 is a national research program aiming to provide data, tools and practical solutions to improve the resilience of our forests. The Canadian Forest Service's Petawawa Research Station also hosts Canada's first Adaptive Silviculture to Climate Change trial.

Maintaining and protecting the biodiversity of Canada's forests is a key priority of sustainable forest management, and, when managed well, working forests can be part of a resilient forest landscape. While climate change presents numerous challenges to forest resiliency and biodiversity, climate-smart sustainable forest management practices based on innovative research, scientific evidence, and traditional knowledge will ensure Canada's forests remain diverse and resilient while continuing to provide Canadians with a multitude of ecosystem services.

Enhanced forest monitoring data to support sustainable forest management

If you have ever caught a flight in Canada, gone for a drive through the countryside or walked through your local urban park, chances are you've noticed that there are a lot of trees in Canada. The numerous forest types and various stages of forest development represent a vast and diverse mosaic of ecosystems that people, animals and other plants rely on for their health and well-being. As the custodian of the third-largest forest area in the world, Canada has a responsibility to ensure it is sustainably managed. To do that, we need to understand the natural composition and dynamics of forest ecosystems, as well as their resilience, which means their ability to regrow and reorganize following different kinds of disturbances. How do we begin to understand forests as large and diverse as Canada's? We look at them from all angles, collecting and analyzing data on all forest ecosystem types over time.

What is a sustainably managed forest?

Managing Canada's forests responsibly and sustainably means recognizing the close interconnections between the environment, the economy and social well-being so that the needs and expectations of all forest users might be met today and in the future.

Sustainable forest management is a clear priority and central policy focus of Canada's governments. As the concept of sustainable forest management shifts and adjusts to address changing values, circumstances and needs, so too do the forest policies and other initiatives designed to achieve it.

The National Forest Inventory: A pan-Canadian approach to collecting forest data

For decades, Canada has collected forest information in partnership with the provinces and territories to better understand and manage forest resources. In 2000, the National Forest Inventory (NFI) was created and tasked with collecting standardized sample data for reporting on the state and changes in all Canada's forests. The NFI was designed to provide pan-Canadian science-based information about forests for strategic analysis and decision making. Today, the NFI continues to be a collaboration between federal, provincial and territorial governments and is complementary to the provincial forest inventory programs that operate to ensure a sustainable wood supply, among other values.

Remeasuring sites over time: The key to understanding our forests

During the 2000s, "baseline" measurements were collected from the ground, from aircraft and from space and allowed us to understand Canada's forests in a methodical and comprehensive way that had not been done before. In the 2010s, the same locations were remeasured using enhanced methods compatible with those of the previous measurement. Now, after over a decade of new data collection and analysis, these remeasurement data are available to researchers, policy-makers and the public to better guide sustainable forest management decisions and allow us to investigate questions of forest resilience, adaptation and conservation at broad scales.

New ground plot data, now being released annually via the NFI, will provide researchers and forest practitioners with the data needed to better understand forest resilience and conservation value at broad scales in Canada.

How do new NFI data help us start answering questions on progress toward sustainable forest management?

Determining forest conservation value or resilience to different stresses or disturbances can be challenging, and there is no one way to do it. But access to quality, unbiased data is vital. Before beginning to answer "Is a forest resilient to stress?" or "Where should we target forest conservation efforts to preserve biodiversity?" we first need to know the composition and structure of these forests and how they change over time. This is where the NFI data can be of use.

Returning and remeasuring the same forest sites, decade after decade, allows data users to track forest attributes and the natural processes in forests through time. For example, the NFI remeasurement data can allow us to track species distribution and changes in the amount of deadwood and old forest, which can provide valuable information on habitat suitability for specialized species such as those depending on deadwood and old-growth forests to survive. NFI remeasurement data also play a vital role in validating and improving Canadian forest ecosystem and carbon models. All these data inform us, directly or indirectly, about the capacity of our forests to sequester and store carbon and to conserve biodiversity in the long-term.

NFI data are also often collected before a disturbance or stressor occurs and then gathered again during or after a forest has been impacted by a disturbance such as a wildfire,

Examples of data measured over time with the National Forest Inventory

On the ground

Data collected: tree condition, shrubs, herbs and mosses

Improvements in methods:

- Tree condition is now recorded, allowing for assessment of damage and better estimates of tree biomass.
- Shrubs are now separately identified and measured, which can aid in assessing fuel conditions.
- Species identification of shrubs, herbs and mosses is now standardized to improve accuracy of species ranges and other ecological attributes.

From aircraft and from orbit

Data collected: species, disturbances, forest structure, development stage, density and height

Improvements in methods:

- New, highly detailed imagery enables more accurate estimates of forest attributes.
- Improved techniques are used to estimate forest biomass.

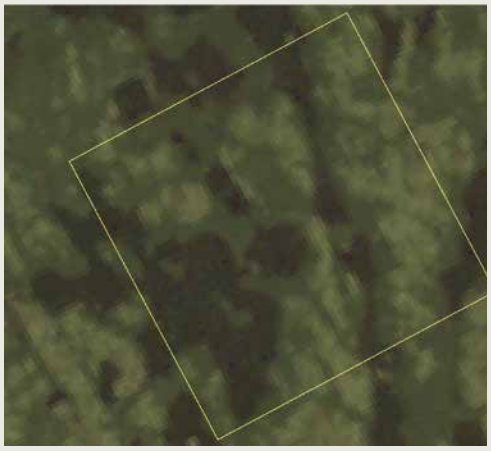
drought, harvest, insect outbreak or disease. Understanding those previous forest conditions and returning to collect new data once a forest begins to recover allows us to investigate how (or if) a forest is able to regrow and return to its previous state, in which case the forest would demonstrate resilience. This can be a slow process spanning decades. Changes in forest growth, species composition and soil nutrients are some of the forest attributes monitored by the NFI that can tell us about its resilience.

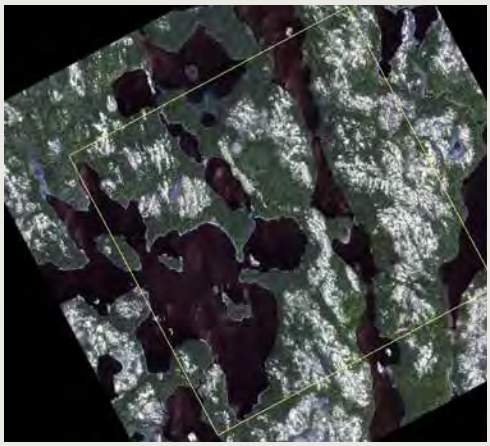
New tools, technologies and data to keep pace with ever-changing forests

Forests are constantly adapting to the conditions around them. But climate change has made basic assumptions on forest conditions in Canada more uncertain. Different forest types and tree species will adapt to the effects of climate change at different rates and in different ways. To keep pace, the science and criteria that guide how we sustainably manage our forests have continued to evolve. The NFI time series, constructed from repeated measurements over time, can act as a regularly updated library recording the adaptation needs and changing conditions in Canada's forests. These data can inform the evolving sustainable forest management practices needed for a rapidly changing climate.

Over 75% of Canada's forests lie in the boreal zone, covering almost 282 million hectares, or about the size of Argentina. If the Canadian boreal forest were its own country, it would be the eighth largest country in the world. Much of these forests are extremely remote and difficult to access and measure.

By employing new tools, technologies and data sources, the NFI works to continuously improve our ability to accurately estimate forest characteristics in Canada. One of the most profound changes in technology has been the improved quality of satellite imagery. Having new, high-quality satellite imagery better able to distinguish forest types from non-forest areas around them has allowed us to improve our understanding of these remote forest areas, as well as the pressures on these forests.





Accurately monitoring Canada's forests is more important than ever

Canada's forests have the potential to help mitigate climate change by absorbing carbon from the atmosphere, while producing sustainable wood products and conserving biodiversity for future generations. At the same time, these forests and the communities that rely on them will be adapting to some of the fastest rates of warming and change on the planet. Rigorous forest measurements and improvements in the accuracy of those measurements play a crucial role in understanding how forests respond to both human-induced and natural disturbances. Science-based evidence helps us better understand forest trends and how to address them through sustainable forest management in the face of a changing climate.

Adapting to climate change: The story of invasive insects in Canada's forests

Invasive species, a familiar story

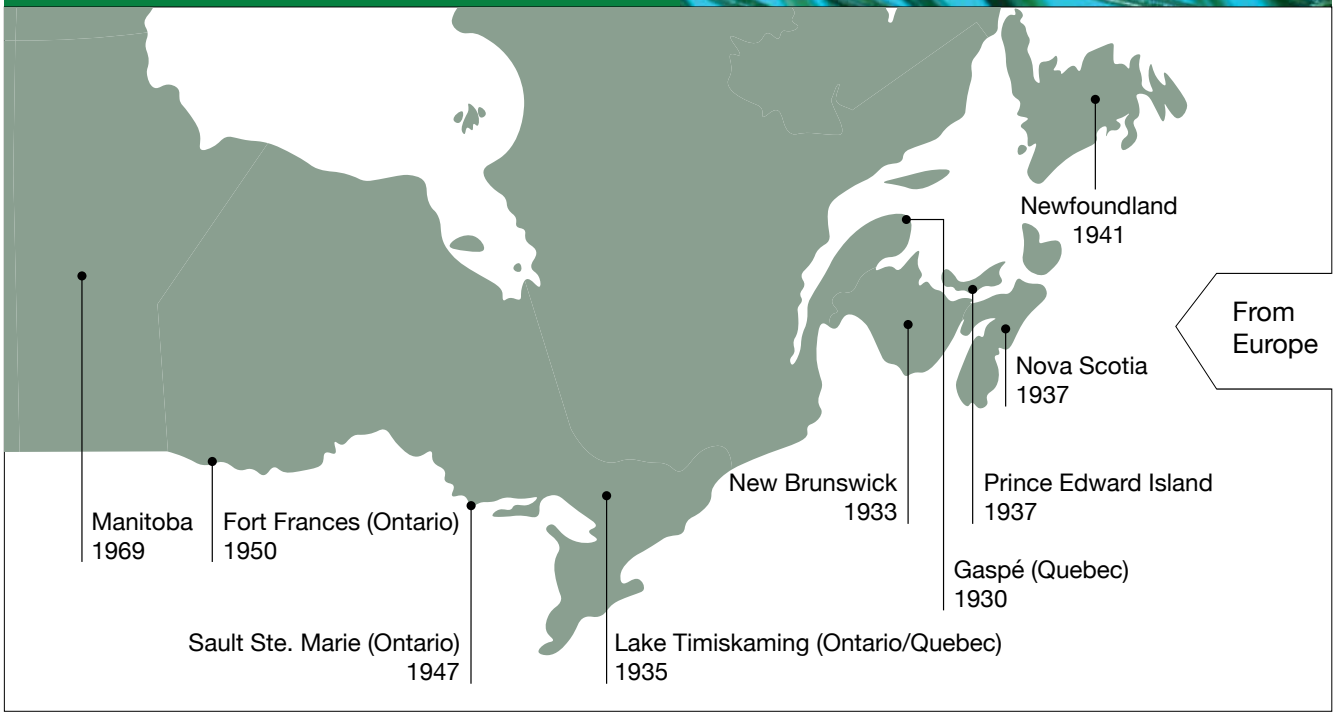
The story is by now a familiar one. Communities notice that trees are dying; experts are deployed to determine why; the answer is an insect and not an insect anyone has seen before. Then other experts are consulted, who determine that the species isn't native to Canada. The insect will go on to destroy millions of trees while scientists and forest managers are tasked with devising ways to respond to these impacts. This could be the story of the emerald ash borer, or the Asian longhorned beetle, or the spongy moth. But it's also the story of the European spruce sawfly and not one that is well-known.

What is an invasive species?

Alien species are those that have become established outside their historical, natural range. Often these species are introduced by people, or they spread on their own. Most alien species cause little harm, or may be beneficial. When they cause harm to our environment, the economy, or to society, they are called invasive alien species, often shortened to invasive species.

Portrait of an invader

Name: European spruce sawfly
Status: Invasive alien species
Feeds on: Black spruce, Norway spruce and white spruce



Response of Canada's authorities to the European spruce sawfly

Creation of the Forest Insect Survey. The introduction of this insect to Canada caused widespread concern that it would result in spruce trees no longer being a significant component of our forests, especially in Quebec and Ontario. This led to the creation of a national insect and disease survey to determine the extent and severity of major forest pests in Canada. These surveys are now done by the provincial forest health agencies. The information they report helps guide the response to invasive and native pests and document the spread and impact of invasive species.

Creation of elements of the Canadian Forest Service that persist to this day. The lab that is now known as the Atlantic Forestry Centre in Fredericton, New Brunswick, began as a small research station to respond to the European spruce sawfly and other forest pests. Today, there are six federal forestry research labs across Canada, all of which have a component related to forest pests.

Use of biocontrol to reduce impacts of an invasive species. Several parasitic insects and a viral disease from the sawfly's home range in Europe were introduced into Canada as biocontrol agents in the 1900s. The sawfly population in Canada now remains at low levels, causing little defoliation and minimal impacts on the forest. This work established Canada as a leader in forest biological control during the 50s, 60s and 70s and continues to inform how Canada responds to new invasive species such as the emerald ash borer and hemlock woolly adelgid.

Climate change is a major accomplice of invasive species

Climate change makes the challenge of responding to invasions more difficult. Canada knows it is at risk of invasions from places with a similar climate, yet climate change modifies the rules of the game. For example, climate change may make parts of Canada warmer and more suitable to species that were previously unable to establish here because of cooler temperatures. Several invasive insects, such as the spongy moth, are indeed controlled by diseases that can be less effective under warm and dry conditions. Warmer winters also mean a better survival of the eggs that start outbreaks each spring.

Many invasive species already do well in Canada because they lack some of the predators and diseases that control them in their native range. However, climate change stresses trees and forests, making them more susceptible to attack and less able to respond. Trees in urban areas are especially affected by drought, making them more susceptible to insects such as the emerald ash borer and birch leafminers. When trees and forests are stressed, they are also less able to defend themselves against diseases such as oak wilt and beech bark disease.

One predicted effect of climate change is changes in global circulation patterns, which can result in more unpredictable weather and extreme weather events. One such effect is the change in the location, frequency or intensity of polar vortex events, when cold arctic air descends into southern Canada. These events can cause significant mortality to overwintering insects such as emerald ash borer and the hemlock woolly adelgid. Climate change can thus make the impacts of these established invasive species more difficult to predict.

Portrait of an invader

Name: Southern pine beetle
Status: Native species expanding its range towards Canada
Feeds on: Pines

Canada has already experienced range expansion of mountain pine beetle across the Rockies and into the boreal forest. This was partly a result of successive mild winters that led to increased beetle populations in British Columbia that then breached the Rockies into northern Alberta. In the United States, climate warming has allowed a relative of the mountain pine beetle, the southern pine beetle, to expand its range into New Jersey and New York. This species could eventually threaten Canada's southern pine forests in Quebec and Ontario.

Portrait of an invader

Name: Spongy moth
Status: Invasive alien species
Feeds on: Hardwood species, including oaks and maples, but also on conifers

The spongy moth expanded its range into Canada in the 1960s from the United States, where it was introduced in 1869. Climate change will modify the way this species affects our forests. The fungus that helps control this insect will be less effective if the spring-summer weather is warm and dry. Warmer winter temperatures can lead to an increased survival rate of the eggs, but greater egg mortality could occur if snow depth is reduced (lack of insulation). Some of these effects can already be observed. For example, Ontario experienced its largest outbreak of spongy moth in 2021 when the insect defoliated an area the size of Lake Ontario.

As the forest changes, so will our way of managing invasive species

Adapting to invasive species will require us to understand which species may arrive, how the ability of trees to respond will be impacted, and how forest management can mitigate those impacts. The best way to save trees is to prevent invasives from arriving in the first place. Canada Border Services Agency (CBSA) and the Canadian Food Inspection Agency (CFIA) inspect imports to intercept invaders at the border. Should an alien species get through the border, the CFIA and provinces conduct annual surveys to detect, identify, and map the invaders. CFIA can also restrict people from moving infested material or the invasive species itself from infested areas. Once infested, trees can be cut and destroyed or treated with a pesticide to control the invasive species.

Diversifying the urban forest can help mitigate the impacts of climate change and invasive species by reducing the number of trees that are vulnerable to a particular invasive species. Following the devastation of the emerald ash borer, many communities in eastern Canada have replanted with more diverse urban forests and incorporated native species. This should help protect those forests from the impact of the next invasive species. The impacts of invasive species in natural and managed forests are more challenging to adapt to. Recent invasions by the hemlock woolly adelgid into Nova Scotia and Ontario have led to the examination of thinning (removing some trees so others can grow better) as one tactic to manage the pest in Canada.

Adapting to the dual impacts of climate change and invasive species will be challenging, and we can only guess at what some of those impacts may be. However, continued efforts to detect new invasive species and vigilance to prevent their introduction and movement will help protect Canada's forests, as will efforts to understand those impacts and develop new tactics to prevent them from occurring. We have been managing invasive species in our forests for almost 100 years; each new invasion teaches us something new and makes us better able to adapt in the future.

Joining forces internationally to better understand and fight forest fires

Wildland fire challenges in Canada and around the world

Wildland fires have the potential to be at once harmful and beneficial. They can cause forest degradation and may result in the loss of human lives, economic devastation, social disruption and environmental deterioration. Yet wildland fires are a natural part of the forest ecosystem and important in many parts of Canada for maintaining the health and diversity of the forest. As we understand more about wildland fires and improve our ability to predict and manage both their positive and negative effects, we will be better able to co-exist with this powerful force of nature. In some cases, fire can be prescribed as a valuable resource management tool for enhancing ecological conditions while limiting potential damage and costs. This makes wildland fire management a vital component of both sustainable forest management and emergency management in Canada.

Wildland fire activity is increasing around the world. Because of climate change, fire-prone conditions are predicted to increase over much of the globe, and as this happens, risks to lives, livelihoods, communities, nature and biodiversity will continue to increase. Canada is no exception and is already experiencing the effects of climate change (warmer temperatures, unpredictable precipitation, and drier forest conditions) that are resulting in longer fire seasons and, on average, a cost increase of about $150 million per decade since data collection started in 1970.

- British Columbia, the prairies and northwest Ontario experienced extended drought in 2021.
- In June 2021, when the temperature reached 49.6°C in the village of Lytton, British Columbia, many were shocked to hear of such record-breaking heat in Canada.

In this context, it is of utmost importance to better understand and manage wildland fires. To achieve this, Canada is working hard to enhance its own firefighting capacity. One way of doing so over the last decades is through the development of partnerships within the country and around the world. Together with our "friends," we can learn from each other and try to help people and ecosystems prepare and adapt in response to shifts in wildland fire frequency, severity, and size. Ultimately, this will result in a better management of forests and protection of surrounding communities.

Calling a friend in a time of need

When fire hazard is high and firefighting resources in Canada are inadequate for the anticipated fire load, Canada is able to efficiently "call a friend" when needed through formal international arrangements. For example, Canada and the United States have a long history of cooperation and robust reciprocity through the *Canada/United States Reciprocal Forest Fire Fighting Arrangement*, signed in 1982. Similarly, resource exchange and cooperation arrangements are also in place with countries such as Mexico, Australia, New Zealand, South Africa and Costa Rica. Within Canada, fire agencies share firefighting personnel and equipment, such as pumps, hoses and aircraft on a formal basis under the Canadian Interagency Mutual Aid Resources Sharing (MARS) Agreement.

How often do we "call a friend" for help?

Since 1982, there are only a few years when there *hasn't* been support one way or the other.

Noteworthy Canadian mobilizations to the United States:

- In 2000, over 1,300 Canadian personnel mobilized to the United States in what was a truly record-setting year.
- In 2020, 594 Canadian firefighters and specialist staff participated in deployments to the United States.

United States mobilizations to Canada:

- 2017 – 47 personnel
- 2018 – 12 personnel
- 2019 – 418 personnel

Valuable partnerships from around the world

During the 2018 fire season, Canada received more than 840 international personnel through these arrangements, totalling more than 19,800 person-days of work – representing 38% of the total person-days dedicated to wildland firefighting in Canada during the 2018 season.

Similarly, in 2021, 367 international personnel were deployed to various provinces in Canada to assist with wildland fire challenges – 203 personnel from Mexico; 55 from Australia; 109 from South Africa. Collectively, these international personnel totalled 17,778 person-days and accounted for 37% of the total person-days dedicated to wildland firefighting in Canada during the 2021 season.

Sharing knowledge and building partnerships around the world

The Canadian Forest Service (CFS) has a long history of active involvement in international fire initiatives beginning with research collaborations between scientists in Canada, the United States and Australia. These were scientists who anticipated the growing importance and threat of global wildland fire and started the involvement of CFS in international fire management and research committees.

Through these collaborations, and particularly after the 1960s, the CFS came to be recognized worldwide for its extensive field-centred experimental burning programme as exemplified by the International Crown Fire Modeling Experiment, which provided foundational knowledge to develop new fire danger and fire behaviour prediction systems.

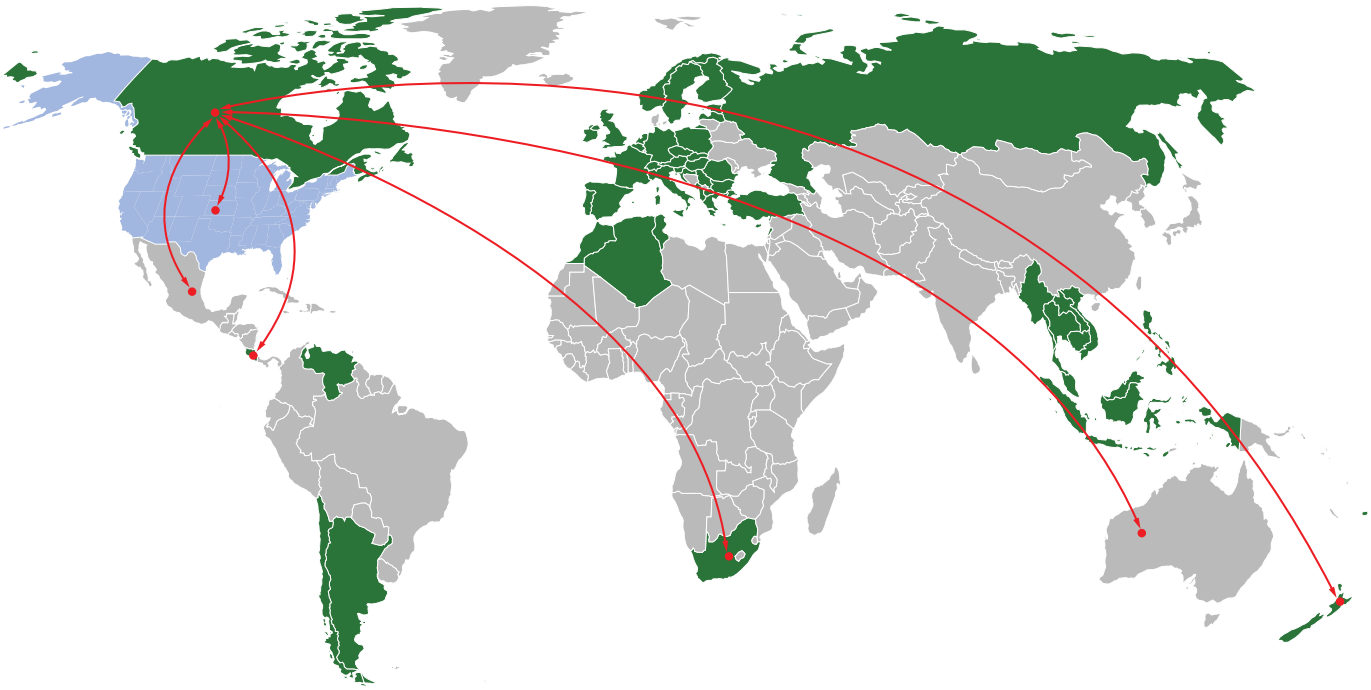
CFS is widely recognized for sharing fire science and technology (S&T), particularly with countries in the developing world, and for collaborating on multi-national research projects. The Canadian Interagency Forest Fire Centre, which represents all federal, provincial and territorial fire agencies, also engages internationally on wildland fire management issues.

Canadian science used around the world

The Canadian Forest Service developed the Canadian Forest Fire Weather Index (FWI) System, which is the most widely used fire danger rating system in the world. This advanced intelligence information allows time to implement fire prevention, detection, and pre-suppression action plans before disaster fires occur, including the coordination of resource-sharing and mobilization within and between countries.

International Crown Fire Modeling Experiment in the Northwest Territories

Countries around the world who help to better understand and manage wildland fires



Legend

- Countries with which Canada has an arrangement for exchanging resources

Countries using the Canadian Forest Fire Weather Index System

- Full application at national level
- Partial application at subnational level

Foundations for the future

As the challenge of managing fire in populated landscapes increases around the globe, there is increasing recognition that we need effective international cooperation to develop solutions that will allow us to better manage risks and increase resiliency.

> Fire does not respect national boundaries, and no single jurisdiction has the solution to effectively managing wildland fires.

With its long history of wildland fire research, development and applications, and technology transfer to the fire management community, many countries expect Canada to step up and play a leading role to enhance international cooperation on fire management and information sharing. Many would view this as a key step in the evolution of a new, better-informed, and interconnected global fire community. For Canada's part, strengthening our engagement in international fire-related research and management issues would also strengthen both our own prevention and response capacities to wildland fires, helping 1. to anticipate the coming challenges and enhance our ability to mitigate fire risks before they occur and 2. to improve our forest and landscape restoration practices and approaches following wildland fires.

Wildland fire and forest carbon: Understanding impacts of climate change

Wildland fires are a natural disturbance that contribute to regenerating and maintaining healthy, diverse forest ecosystems. However, Canada is experiencing longer wildland fire seasons and more frequent and extreme fire behaviour, placing growing risks on communities, critical infrastructure, economies, people's health and safety, and long-term forest health. Since the 1970s, the average area burned annually has doubled, and wildfire experts predict that number will double again by the end of the century. Modelling also suggests that overall fire occurrence will increase as much as 75% by 2100.

Several combining factors are driving changes in wildland fire risk and behaviour. These include historic fire suppression approaches (which interrupted the natural restorative function of wildfire); the exclusion of Indigenous cultural burning (for millennia Indigenous Peoples used fire for landscape management); the growth of the wildland urban interface (more people, activities and assets located in forested areas); and climate change (warmer temperatures, fluctuating precipitation levels, and drier forest conditions).

Current and anticipated growth in wildland fire activity, in combination with other natural disturbances in the forest (such as pest infestations), impact carbon emissions. This includes direct emissions of greenhouse gases (GHG) and particulates, delayed emissions as fire-killed trees decompose, and reductions in overall carbon uptake (because dead trees are no longer able to absorb carbon from the atmosphere). Since the mid-2000s, natural disturbance-related emissions have generally increased but the emissions vary greatly between years, based on annual area burned. In Canada, annual carbon emissions from wildland fires alone can equal the annual total carbon emissions from burning fossil fuels across the country.

Monitoring wildland fires

Wildfire occurrence is monitored across the country using a variety of methods including aerial surveys (small airplanes, watchtowers) and weather mapping. A great deal of work also takes place to project where wildland fires may occur. Researchers use statistical, simulation and climate models to assess the areas most likely to experience a fire or to predict how a fire may behave under certain conditions. The resulting data provide a better understanding of how wildfires ignite, spread and behave, and how these factors are changing over time and under climate change.

Remote sensing (satellites) is also used to track and report both wildland fire and carbon emissions. Satellite imagery is an important input in Canada's National Burned Area Composite (NABC), which is a geographic information system (GIS) that uses data to measure the area of forest burned nationally every year. This information helps estimate annual carbon emissions from wildland fire and contributes to assessments in the National Inventory Report to support Canada's international GHG reporting requirements.

> Canada's new WildFireSat Mission, a $230-million initiative announced in February 2022, will be the world's first fully dedicated wildfire monitoring satellite system. It will work to provide detailed near-immediate fire analysis directly to those fighting fires on the ground. The system will also allow Canada to better measure carbon emitted by wildland fires.

More fire on the landscape: How to adapt?

Climate change is transitioning Canada into a different relationship with wildland fire. What is now considered extreme seasonal fire activity will become increasingly common. To adapt to these changes, it is critical to understand how and why they are happening and what needs to be done to prevent the risk or severity of future fires. Data, science, and other ways of knowing will improve the ways Canada manages for wildland fire and help mitigate the release of CO_2 emissions from large fire events.

Long-term solutions include pro-active forest and fire management approaches such as reducing fuels available to burn (tree thinning, conducting planned burns, removing deadwood); planting fire-tolerant tree species; creating more fire breaks to reduce the area burned and fire severity; and expanding best practices, such as the FireSmart™ Canada program, to proactively mitigate risk to communities and forest-based infrastructure.

Biodiversity, conservation, and Indigenous Peoples' well-being

In Canada and around the world, protected areas and conservation actions have often been informed by non-Indigenous worldviews, viewing the natural environment as one with limited contact by humans. This approach contributed to impoverishing Indigenous Peoples, who also had to face complex socio-economic issues. Because Indigenous health, livelihoods, and well-being are intrinsically linked to the health of nature, transformative changes were needed to restore and protect nature in ways that would also strengthen the health and well-being of Indigenous Peoples.

Over the last two decades, there has been a wind of change with greater recognition and commitments to reconciliation and respect for Indigenous rights in Canada under the *United Nations Declaration on the Rights of Indigenous Peoples* (UNDRIP) and also following the establishment of the Truth and Reconciliation Commission (TRC). In response to Calls to Action, the UNDRIP became a law in 2021 and states that "Indigenous peoples have the right to the conservation and protection of the environment and the productive capacity of their lands or territories and resources" (article 29.1).

At the same time, efforts have been made to meet international conservation targets, such as those set out in the *Convention on Biological Diversity* (CBD). Canada is also committed to addressing climate change. It has been recognized that conserving, protecting and restoring nature are the best nature-based solutions to mitigate its impacts, and that collaboration with Indigenous Peoples is essential in this endeavour. As the Government of Canada aims to designate 25% of the land as protected space by 2025 and 30% by 2030, advancing Indigenous-led conservation and new ways to collaborate is critical to meet these ambitious targets.

Key facts about Canada's forests and Indigenous Peoples

In Canada, almost 5% of the population identify as an Aboriginal person, and almost 70% of them live in or near forested lands.

The culture and economy of more than 200 language groups are strongly interconnected with the land.

When local people are empowered to manage and restore forests, forests are more resilient with positive impacts on biodiversity and socio-economic benefits for the communities.

Resilient forests are able to withstand or recover quickly from disturbances or new conditions.

Indigenous Protected and Conserved Areas: A new path to promote Indigenous-led conservation and reconciliation in Canada

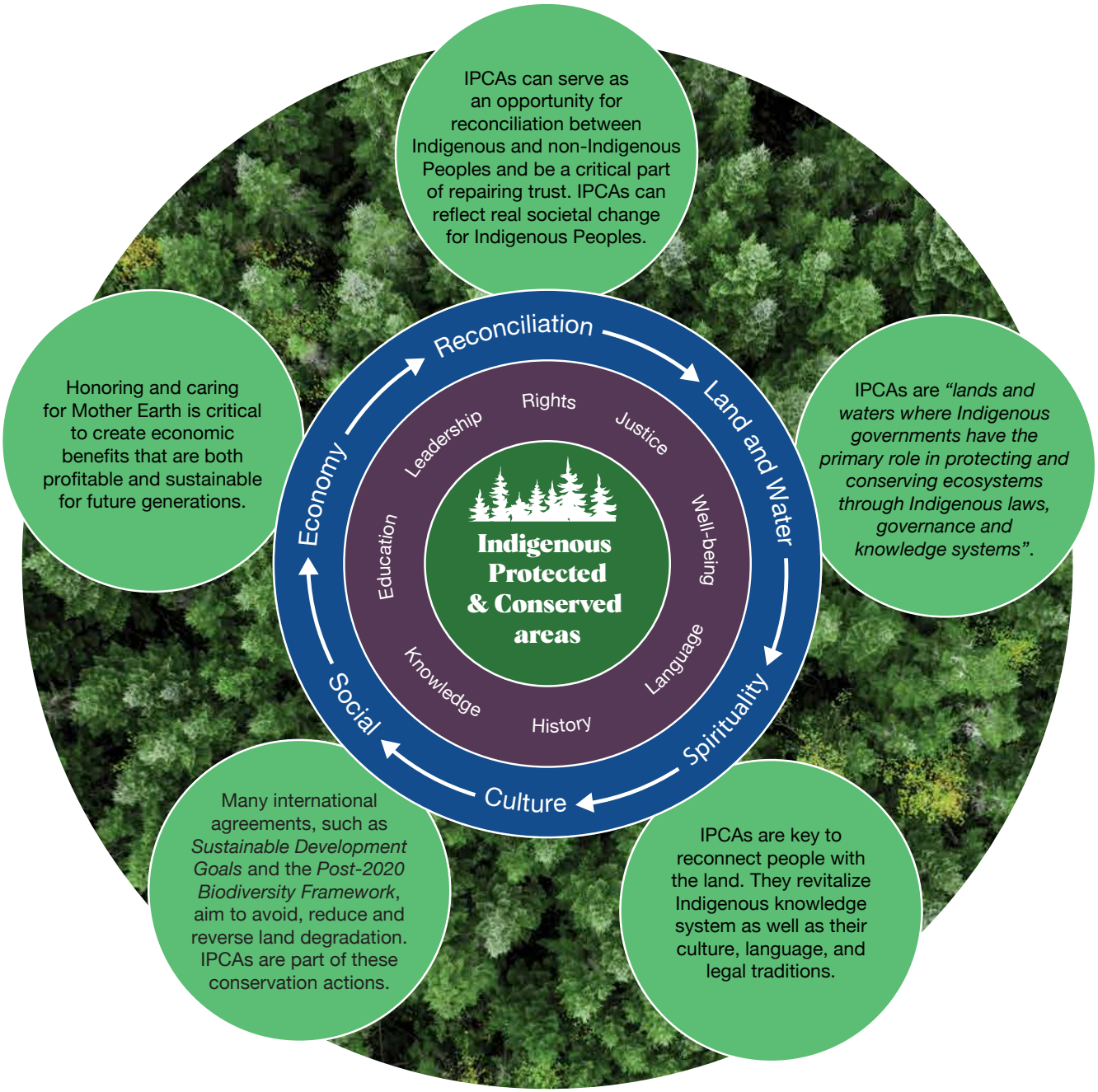
In 2017, Indigenous government representatives, Elders, and a range of land users added their voices to establish the Indigenous Circle of Experts with the aim to define new Indigenous-led conservation initiatives: the Indigenous Protected and Conserved Areas (IPCA). The goal was to promote and inspire Indigenous leadership to make conservation decisions for land and water, but also to recognize and address the consequences of colonization in terms of parks management and protected areas. Therefore, IPCAs aim to fill multiple gaps in addition to conservation goals such as the need to advance reconciliation actions and to create collaboration, respect and sharing across the Indigenous and western cultures. IPCAs will then contribute to advance conservation efforts from an Indigenous perspective and restore Indigenous knowledge systems that have historically been disregarded and sometimes criminalized.

Scaling up Indigenous-led conservation initiatives

Canada has one of the largest land masses and Indigenous populations in the world. IPCAs can thus contribute significantly to conserve both the environment and Indigenous Peoples' culture. To support these conservation efforts, the Government of Canada has put in place the **Indigenous Guardians Program** that provides funding for Indigenous Peoples to exercise greater leadership and stewardship in protecting and conserving their traditional lands. Since 2018, three terrestrial IPCAs, Saoyú-?ehdacho, Thaidene Nëné, and Ts'udé Niljné Tuyeta, have been formally established under the *Protected Areas Act*. They are all located in the Northwest Territories and have a total area of 24,715 km^2, or the size of Lake Winnipeg. In Budget 2021, the Government of Canada announced up to $100 million over five years (2021–2026) to support new and existing Indigenous Guardians initiatives and could position Canada as a leader in Indigenous-led conservation. To date, more than 50 Indigenous communities across the country have received funding to either establish IPCAs or undertake early planning and engagement work that could result in additional IPCAs.

Collaboration is key for protecting natural environments in Canada

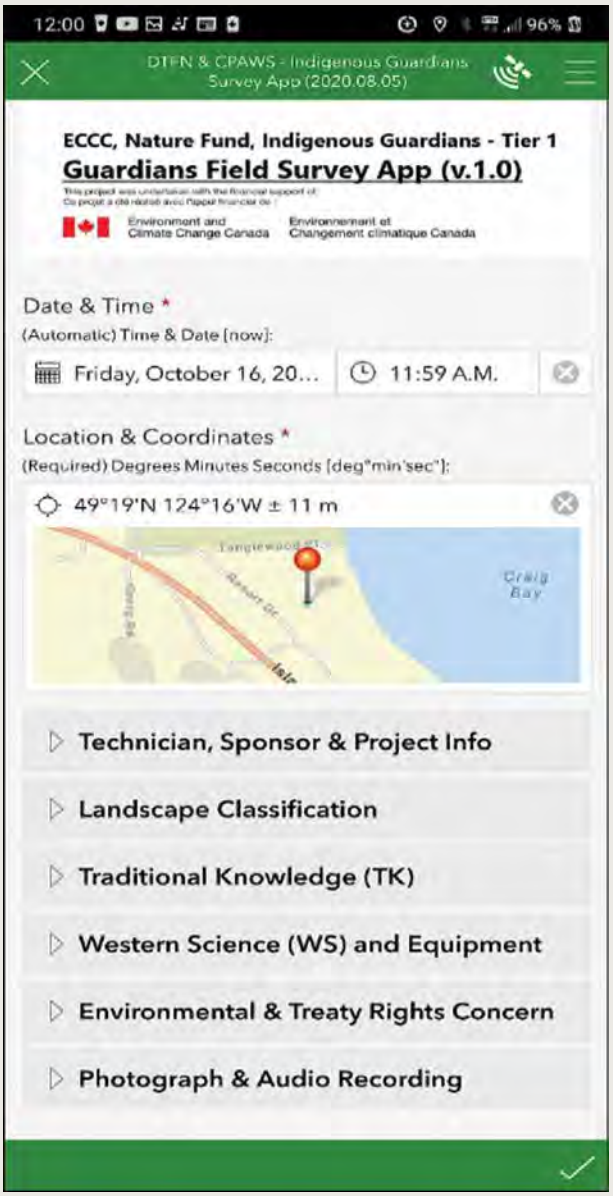
Because the IPCAs are in their infancy, there is a unique opportunity to combine community-based knowledge and expertise with western science to protect and restore resilient ecosystems. The Canadian Forest Service (CFS) along with Environment and Climate Change Canada (ECCC) and Parks Canada, is working with Indigenous



The objectives of an IPCA are multiple and aim to restore and preserve Indigenous leadership, their environment, culture and knowledge systems. (Image was modified from Mansuy et al., submitted).

leaders and scholars to support community and Indigenous-led conservation efforts to achieve these goals. Examples of engagement include collaboration with Dene Tha' First Nation, located on Treaty 8 in the Province of Alberta and the University of Alberta to ensure that conservation efforts are implemented following Indigenous values and way of life. The University of Alberta is also leading the Ărramăt project, involving more than 150 Indigenous organizations around the world and following the principles of reciprocity, recognition, and reconciliation.

Collaboration is key to bridging different knowledge systems and visions of the ecosystems and the ecological services they provide. Given the different values and uses of the territory, collaboration between multiple stakeholders and land users is also important to develop more holistic and interdisciplinary approaches. Holistic approaches view both biodiversity conservation and human well-being as interdependent and equal, and are therefore essential to achieving the multiple benefits of IPCAs (ecological, socio-economic and cultural). In the face of climate change and rapid land-use changes, working with Indigenous Peoples is fundamental in developing adaptive approaches that integrate the multiple ecosystem services and values into conservation management. As the need to protect biodiversity becomes increasingly urgent, so too does the need to promote Indigenous Peoples' role as stewards of the land, and to support various Indigenous-led conservation measures.



Elders discussing over maps.

A collared caribou from a camera trap set up on Dene Tha' First Nation land to monitor caribou population and movement.

Western science and traditional knowledge are combined in the Bistcho Lake IPCA project led by Dene Tha' First Nation in collaboration with the Canadian Parks and Wilderness Society (CPAWS). This collaboration resulted in the creation of the *Indigenous Guardians Survey App* that can localize and classify traditional knowledge into a geodatabase. This project was funded by the Guardian Program of ECCC and the CFS. (Image was modified from Mansuy et al., submitted. Photos are courtesy of Dene Tha' First Nation)

How much forest does Canada have?

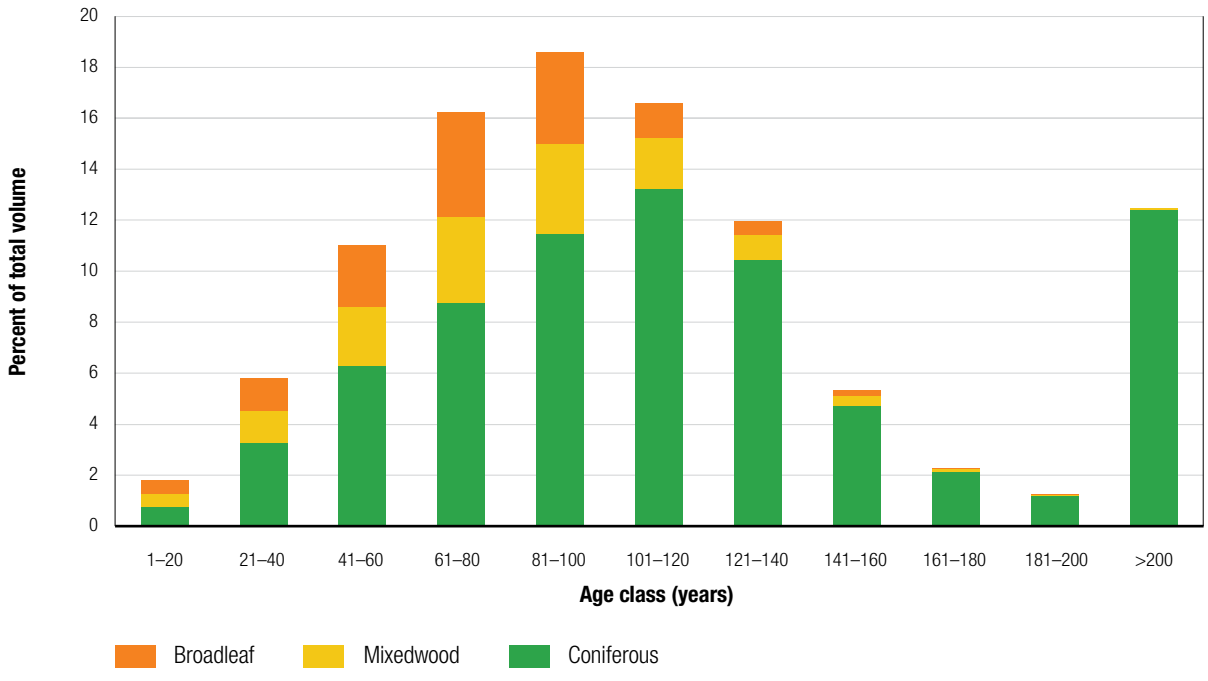
With almost 362 million hectares (ha), Canada ranks as the country with the third-largest forest area in the world. Much of this forest grows in the boreal zone. There, over 280 million hectares of forest are interspersed with lakes, wetlands and other ecosystem types. According to Canada's National Deforestation Monitoring System, the forest area of Canada is stable, with less than half of 1% deforested since 1990.

A diverse landscape

The forest area of Canada contains a mosaic of different forest ages and types. Some are dominated by young trees re-growing after wildfire or harvesting, which presently contain only small amounts of volume but are actively growing. Other forests can contain mainly old trees which are growing slowly or gradually being replaced by younger trees growing up through the forest canopy.

- 44% of forests in Canada, by area, are less than 60 years old but contain only 18% of total forest wood volume.
- Forests between the ages of 60 and 120 years hold 50% of all forest volume.
- Forests older than 120 years contain 32% of all wood volume in Canada – forests older than 200 years hold 12% of the wood volume.

Percentage of total forest volume by forest type and age class



What is a forest?

Canada uses the Food and Agriculture Organization of the United Nations definition of forest area:

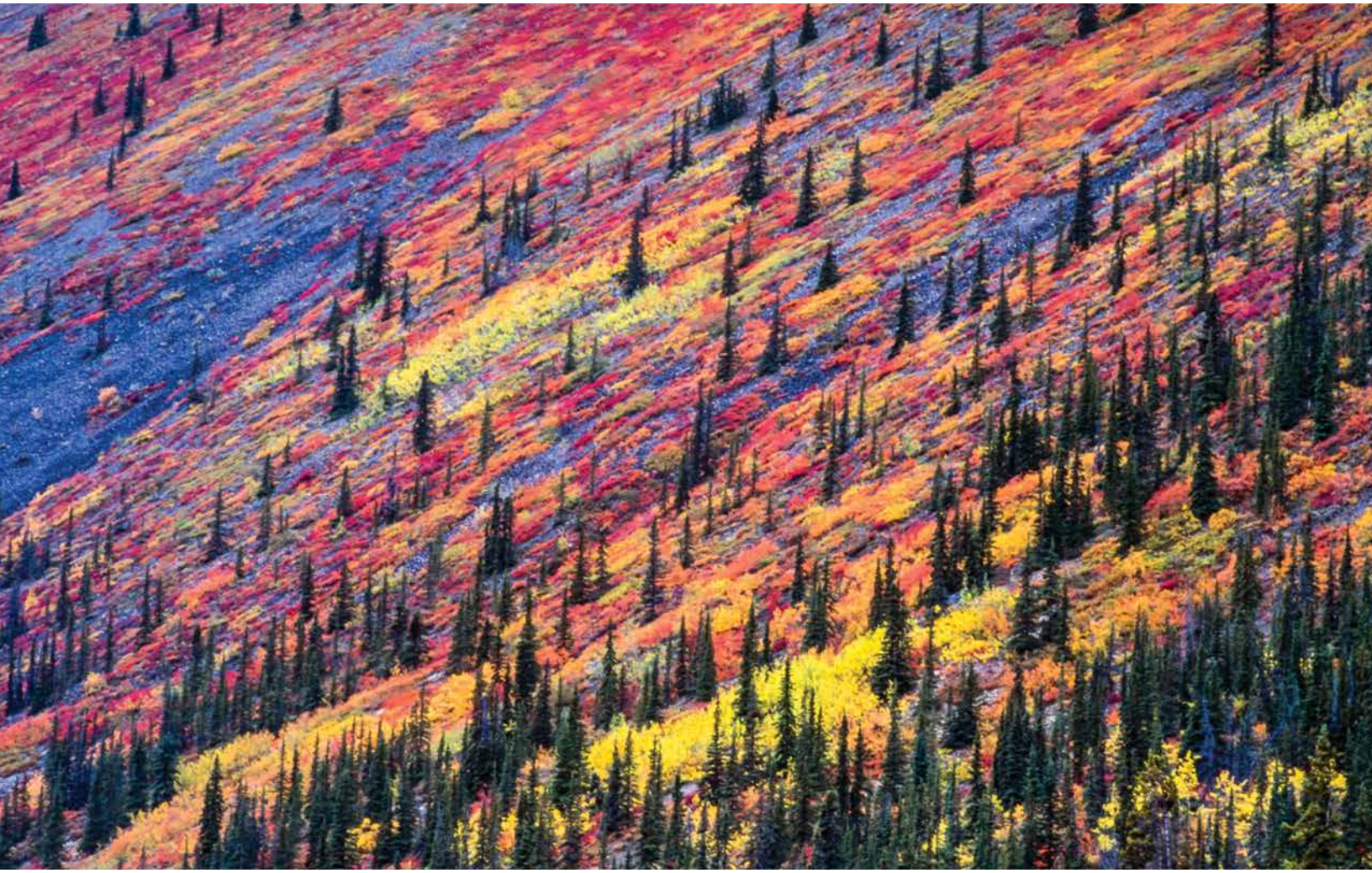
- land not predominantly under agricultural or urban land-use
- spanning an area greater than 0.5 ha
- with trees taller than 5 metres
- a tree canopy cover of more than 10%

OR

- land that has the capability to reach these criteria in the natural environment

Forest area is still considered to be forest after a temporary loss of tree cover, such as after wildfire or clearcut harvesting. Changes in forest area result from:

- afforestation – the deliberate establishment of forests on lands previously not forested
- deforestation – the permanent clearing of forests to make way for new, non-forest land uses, such as agriculture or urban expansion
- natural forest expansion or dieback



Source: Dyk, A., Leckie, D., et al. 2015; Food and Agriculture Organization of the United Nations; National Forest Inventory. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:
Forest area

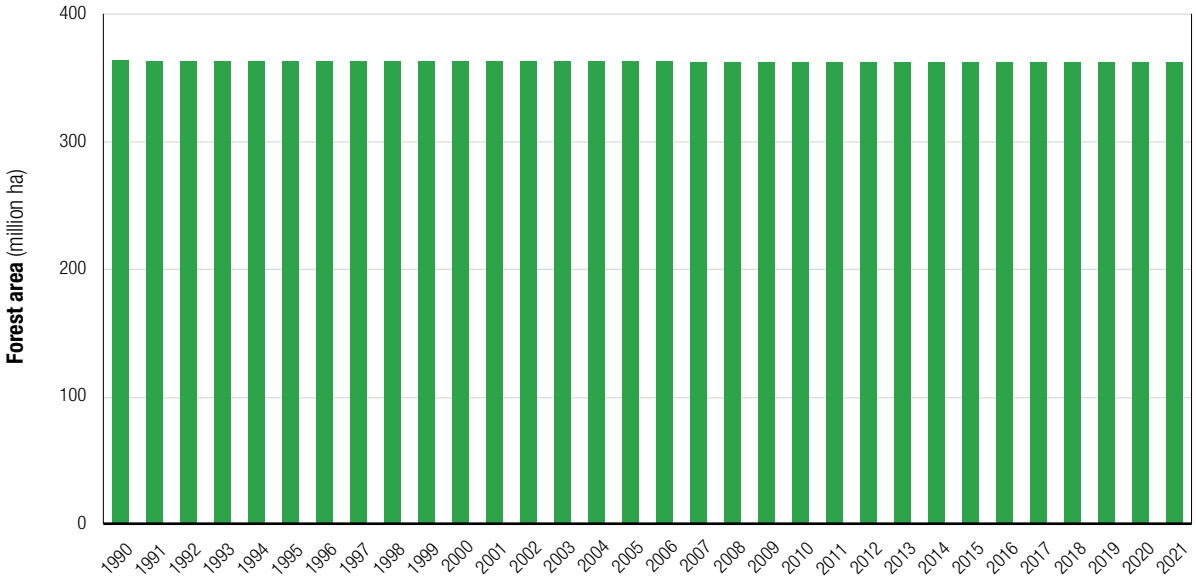
Canada is a boreal country. More than 75% of Canada's nearly 362 million hectare forest area is within the boreal zone. This zone also contains other ecosystem types and land covers, including peatlands, lakes, wetlands and tundra. Twenty-eight percent of the world's boreal zone falls in Canada, and two thirds of that is forest or woodland. The tree species most prevalent in the boreal zone are Spruce and Poplar as they are well-adapted to boreal conditions. These tree species dominate nearly two-thirds of all forest stands in Canada. Growing conditions and disturbances like wildfire can be harsh in the boreal, so while old and large trees do exist in the boreal forest, the biggest and oldest trees in Canada are found south of the boreal, in Canada's more temperate climates.

Since 1990, less than half of 1% of Canada's forest has been deforested – converted to a non-forest land-use. Relative to the size of Canada's existing forests, very little afforestation has been recorded. Some gradual changes in forest area, including those attributed to climate change, are more challenging to quantify but can include expansions in some areas and losses in others. The current estimate of forest area in Canada (362 million hectares) is an improved estimate relative to what has been reported previously, based on better data and more advanced assessment tools.

- Like most countries, Canada uses a consistent approach and definition, established by the United Nations Food and Agricultural Organization to estimate and track forest area through time.
- While forest area in Canada is relatively stable, the tree cover within is more dynamic due to forest fires, insect infestations, harvest activities and re-growth of forest cover.
- Canada's National Forest Inventory (NFI) continues to improve and refine estimates for critical sustainable forest management indicators, including forest area.

The NFI collects pan-Canadian forest data to assess and monitor the extent and state of Canada's forest land base and to determine how they are changing over time. The NFI is a partnership between federal, provincial and territorial governments that collects data to a uniform standard to ensure consistency through space and time.

Canada's estimated forest area, 1990–2021



Why is this indicator important?

- Forest area losses are a concern and closely monitored because forests provide habitat for biodiversity and many important ecosystem goods and services.
- An increase in forest area and sustainable forest management could support a green recovery and a transition to carbon-neutral economies.

What is the outlook?

- Natural increases and decreases in forest area tend to occur gradually where and when growing conditions or disturbance patterns allow. Changes to natural ecosystem processes induced by climate change may accelerate this historically slow process.
- Forest area is expected to remain generally stable. Rates of human-induced change are likely to remain low (See the indicator **Deforestation and afforestation** for more information).

Source: Dyk, A., Leckie, D., et al. 2015; Food and Agriculture Organization of the United Nations; National Forest Inventory. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:
Deforestation and afforestation

Canada's annual deforestation rate declined slightly over the last 30 years, with 49,000 ha of forest converted to other land uses in 2020 compared to 64,000 ha in 1990.

- Canada has 9% of the world's forest and 0.37% of the total global deforestation that has occurred since 1990.
- Agricultural expansion continues to be the main driver of deforestation in Canada.
- Forest flooded during the development of hydroelectric reservoirs produces large annual spikes in deforestation, as seen in 1993 and 2006.
- New forestry roads and landings that are not slated for prompt decommissioning contribute to deforestation, as shown in the following figure.
- The annual area of recorded afforestation has been very small relative to the total forest area of Canada – and much smaller than the annual area of deforestation.

Why is this indicator important?

- Forest loss affects biodiversity, soil, air and water quality, and the availability of wildlife habitat. Forests also store more carbon than other terrestrial ecosystems and can be managed to mitigate climate change, for example, by increasing the area of forest through afforestation or by avoiding deforestation.

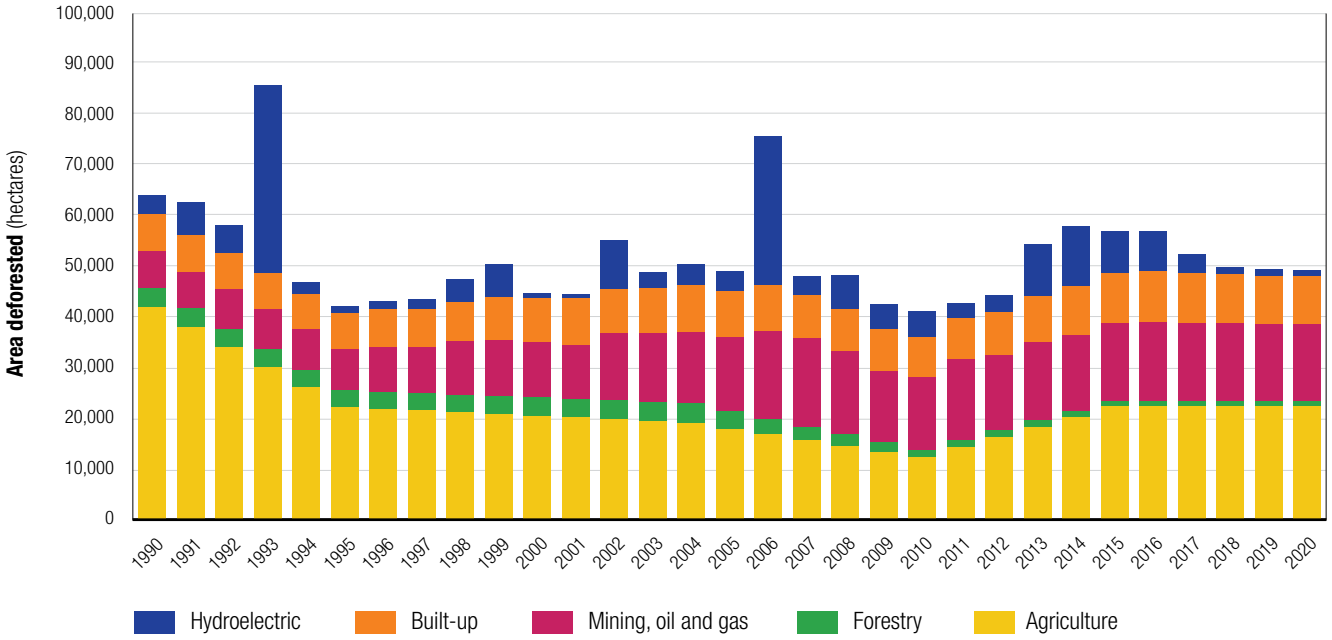
The National Deforestation Monitoring System (NDMS) tracks changes from forest land to other land uses across Canada. Deforestation does not include forest harvest when forest is being regrown on the site.

The NDMS can show trends by time, region and industry sector type.

What is the outlook?

- Canada's overall deforestation rate is expected to remain consistent at current levels.
- The industrial sectors contributing most to deforestation in Canada are agriculture, mining, oil and gas.
- Ongoing and planned initiatives for urban and rural tree planting are expected to increase the area afforested in coming years. The contribution of this activity to ecosystem services such as restoring habitat and carbon sequestration is increasingly recognized.
- The federal government's 2 Billion Trees program will increase the rate of additional tree planting, including afforestation, by up to 40% over 10 years from 2020 to 2030.

Estimated area (hectares) of annual deforestation in Canada, by industrial sector, 1990–2020



Source: Dyk, A., Leckie, D., et al. 2015; Natural Resources Canada; United Nations Framework Convention on Climate Change. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

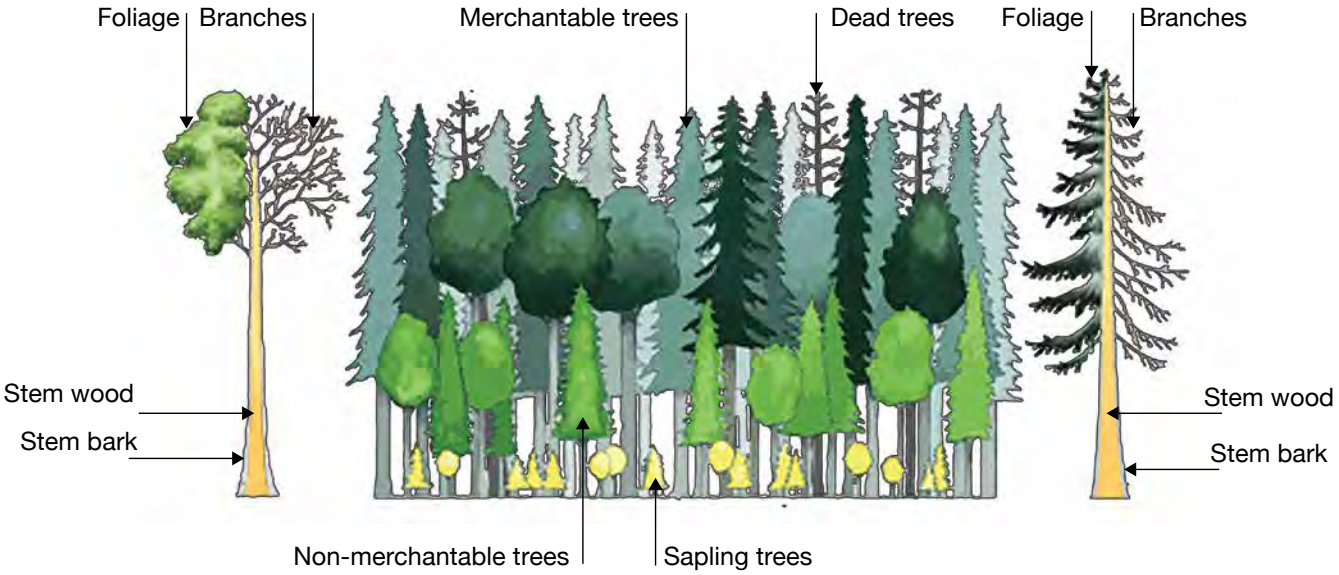
Indicator:
Wood volume

Canada's forests contain an estimated 50 billion cubic metres (m^3) of wood. Because of its importance in assessing available wood supply for the forest sector, managing carbon stocks in forests and determining the productivity of Canada's forest resources, wood volume is one of the most frequently studied, measured and analyzed forest attributes.

What is wood volume and why do we measure it?

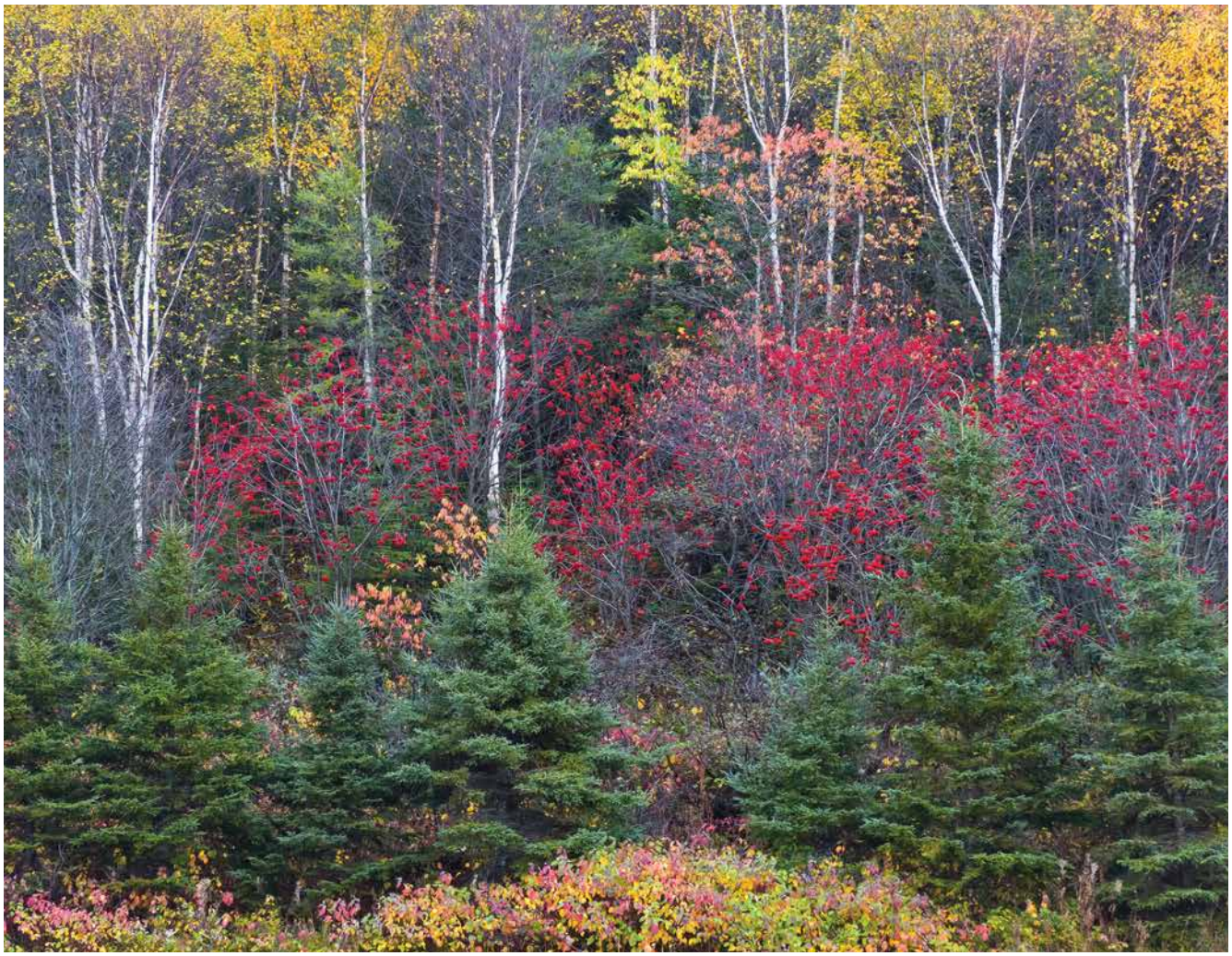
Wood volume is a common attribute of measurement in forestry. It is often summarized at the tree or stand level to understand how productive a forest is, what amount of wood could be harvested for the production of forest products, and when.

Traditionally, there has been a focus on the "merchantable" volume of the tree, meaning the part of the tree or stem that can be milled into conventional forest products. As society began to put greater emphasis on other forest values such as non-timber forest products (NTFP), biodiversity and carbon storage, understanding the total volume of a forest including small or dead components became more important. Also, what is considered "merchantable" varies across Canada and over time. Estimates of total volume presented here are strategically useful for determining changes and trends across Canada. Detailed local forest inventories are maintained by foresters for forest management planning.



Estimated wood volume (million cubic metres) in Canada

Year	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Wood volume	53,305	53,280	52,842	51,167	50,608	50,147	50,096	49,900	49,598	49,513	49,562



Why is this indicator important?

- Wood volume is used along with other information to determine forest productivity, calculate biomass and estimate carbon storage in Canada's forests.
- It is important to monitor general trends in wood volume in all forests for predicting fire behaviour and monitoring carbon storage.

What is the outlook?

- After notable drops in volume caused by the historic mountain pine beetle outbreak in British Columbia and despite significant wildfire activity in recent years, wood volume at the national level has stabilized.
- Other large-scale natural disturbances, such as insect or disease outbreaks and drought, can have negative impacts on wood volume and regrowth. While these disturbances occur regularly, normally at low severity levels, occasional large or high severity disturbances can have lasting impacts on national volume trends.
- Recent large forest disturbances, specifically wildfires, have led to some local wood volume reductions. Wood volume recovery can take decades to reach pre-disturbance levels.

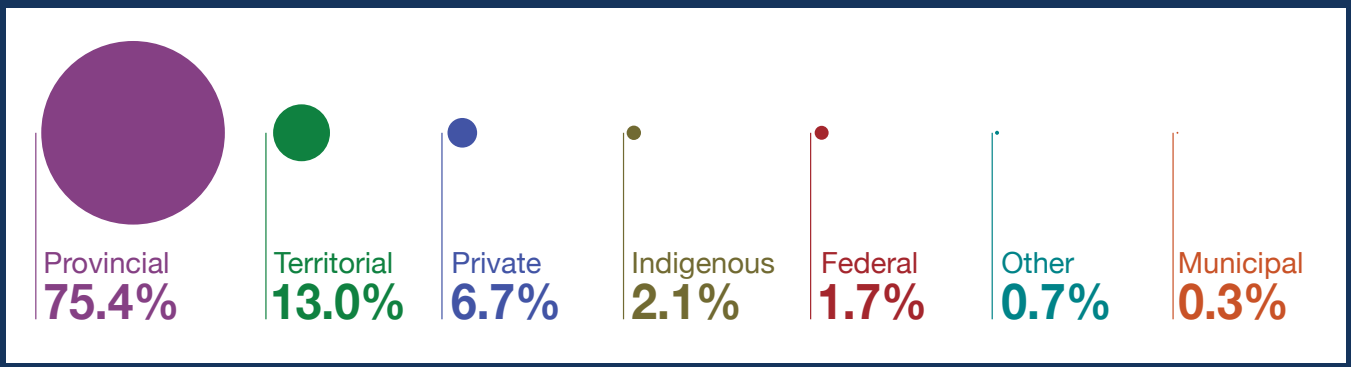
Source: Environment and Climate Change Canada; National Forest Inventory. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Is timber being harvested sustainably?

Sustainable forest management (SFM) aims to maintain and enhance the environmental, social and economic values of forests for the benefit of present and future generations. It involves conserving biodiversity and protecting forest health, while ensuring the procurement of wood-based products and ecosystem services. Canadian forests are managed under the paradigms and guiding principles of sustainable forest management (for more information, see report section *The 2022 State of Canada's Forests Report: An overview*). In 2020, about 716,000 ha of forests were harvested in Canada, which corresponds to 0.2% of the forested land.

Most Canadian forests are publicly owned

In Canada, about 90% of forests are owned by provincial or territorial governments. They manage forests through varied regulations and policies under the overarching principles of sustainable forest management. For example, sustainable management is the central purpose of the *Forests Act* and the *Biodiversity Act* of Nova Scotia, the *Sustainable Forest Development Act* of Quebec and the *Provincial Timber Management Goals, Objectives and Targets* of British Columbia.



Harvesting rates are based on forest growth

Forest management is a process that integrates principles from various sciences. It involves conducting resource inventories based on ground-based surveys, satellite remote sensing, airborne laser (LiDAR) or a combination of these, that inform forest stand composition, age and structure. This information, when combined with a new generation of growth and yield models, allows planners to calculate the volume of wood that can be harvested sustainably while maintaining key ecosystem functions.

Successful regeneration, either through natural or artificial means, is a keystone of sustainable forest management. About 603 million seedlings were planted in Canadian forests in 2020.

Forest management plans outline objectives and strategies

Forest management plans are prepared for specific forest lands and describe the actual and desired forest states and values. They propose strategies to reach these objectives, considering natural disturbance regimes and the challenges associated with climate change. Forest management plans are prepared by professionals working in governments, forest companies and other forestry stakeholders, in accordance with the laws, rules and policies in place. The process of creating forest management plans involves the consultation and participation of Indigenous Peoples and partners interested in forest management on public lands and often include efforts to integrate Indigenous ways of knowing and traditional knowledge in the decision-making process.

Regeneration after harvesting is a key element

Successful regeneration ensures that harvested stands return to a forested state so that they can maintain wood fibre supply, biodiversity, carbon sequestration and other ecosystem services. In all provinces and territories, tree regeneration is mandatory after harvesting activities. Regeneration success is appraised after a specified number of years using criteria describing species composition, density and stocking of free-to-grow stems. Most harvested stands are regenerated naturally after harvesting. However, natural regeneration success depends on many factors, including an abundant seed supply and an adequate substrate for germination. Artificial regeneration through planting usually results in productivity gains compared to natural regeneration because of tree breeding programs and a better use of the space by the growing trees. Plantation silviculture offers the opportunity to influence the composition of forests and adapt them to future conditions.

As also observed in many parts of the world, global climate change presents significant challenges to Canadian forestry. The changing climate affects regeneration success of major tree species and modifies forest ecosystems. Innovative silviculture for conventional products with the procurement of other forest resources, such as biomass for bioenergy, is being developed to support the decarbonization of the economy.

Source: National Forest Inventory. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:

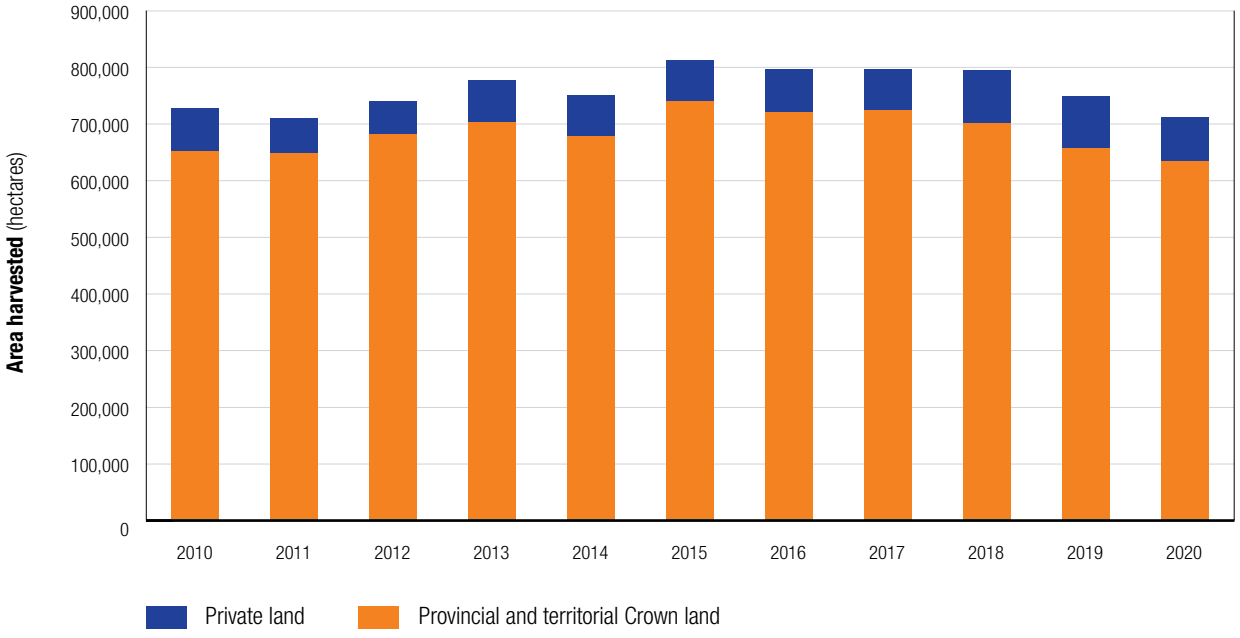
Forest area harvested

Monitoring the area of forest harvested each year is important for understanding the level of industrial activity in Canada's forests and for assessing long-term sustainability. In 2020, an estimated 710,000 ha of forest were harvested. This is a 5% decrease from 2019 levels, when 747,000 ha were harvested, and is below the average area harvested each year during the peak period of 1995 to 2005 (1 million ha).

The area of forest harvested each year is less than 0.5% of Canada's 362 million ha of forest land, significantly smaller than the areas affected by insects and burned by fires each year.

- The area of forest harvested decreased in all provinces and territories, except Yukon, as the COVID-19 pandemic affected forest workers' health, and forest companies suspended operations temporarily while occupational health and safety measures were put in place to slow the spread of COVID-19.
- The largest decline was in British Columbia, where the area of forest harvested decreased by 13,000 ha (8%). The reduction in harvesting activities caused by COVID-19, combined with the impact of the mountain pine beetle and severe forest fires, contributed to this decline.
- The largest decline in percentage terms was in Nova Scotia, where the area of forest harvested decreased by 25% (8,000 ha), was due largely to the impact of COVID-19 on forestry and mill workers.

Forest area harvested on private and Crown land in Canada, 2010–2020



Why is this indicator important?

- Commercial timber harvesting is one of several indicators of the level of industrial activity in the forest sector.
- Harvesting of provincial and territorial Crown forests, the source of most commercial timber, is regulated to provide a sustainable level of timber for industrial use.

What is the outlook?

- The area harvested each year will vary as forest managers adjust their management objectives in response to conservation objectives, natural disturbances such as pests and forest fires, changes in the demand for Canadian forest products, and the COVID-19 pandemic.
- Robust demand for Canadian forest products is expected to continue into 2022 and 2023 as the economy recovers from the COVID-19 pandemic. However, the recovery has been uneven across the sector, with lumber and panel industries recovering more rapidly than pulp and paper. While the demand for newsprint continues to decline, the demand for Canadian solid wood products is exceeding expectations in the new home construction market, which remains strong despite rising interest rates and inflation.

Source: National Forestry Database. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:

Forest regeneration

In 2020, 426,000 ha of provincial forest lands in Canada were regenerated. Of these, 417,000 ha were planted with 600 million seedlings and 9,200 ha were established by seeding.

- The 2020 area artificially regenerated increased by 4.2% and the number of seedlings planted increased by 7.3%, compared to the 10-year average.
- Both area planted and seedlings planted are at or near 10-year highs. These higher levels are mostly due to higher rates of planting in British Columbia in recent years. The area seeded in 2020 increased slightly but was still 35% lower than the 10-year average. The proportion of area regenerated by seeding has been declining in recent years indicating that it is a less favoured approach, or that there are fewer areas suitable for seeding that are being regenerated.

Successful regeneration is required following forest harvesting on public lands.

The forest type and silviculture system determine the regeneration method (natural or artificial).

Artificial regeneration – planting or seeding – has been applied to 53% of the area harvested in the past 20 years; natural regeneration occurs in the remaining area.

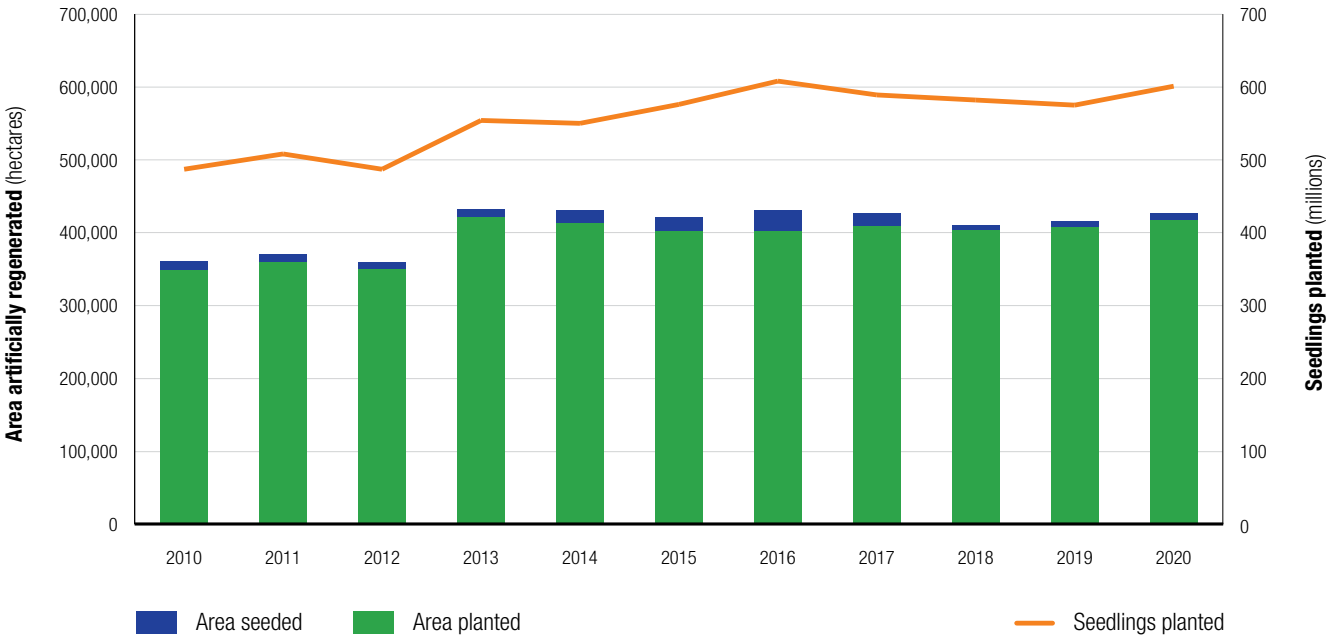
Why is this indicator important?

- Regeneration activities ensure that harvested, and also sometimes burned, areas regrow as forests and continue to produce timber and maintain ecosystem services, such as storing carbon, regulating water quality and providing habitat.
- Forest composition can be influenced by the regeneration method. Most artificial regeneration establishes coniferous trees, but may include planting multiple species to ensure diversity.

What is the outlook?

- Regeneration is required on all Crown lands in Canada, so virtually all harvested lands will continue to be regenerated.
- Regeneration rates are most strongly related to recent harvest levels. These levels are influenced by market conditions but are within the bounds of sustainable forest management.
- British Columbia is one of the largest Canadian forestry jurisdictions and accounts for nearly 50% of the national artificial regeneration activity. While British Columbia harvest rates are expected to decline through this decade, mostly because of the mountain pine beetle epidemic, accelerated planting efforts have been underway since 2018 to help recover from the mountain pine beetle mortality and record-breaking wildfire disturbances in 2017, 2018 and 2021.
- The 2 Billion Trees program specifically excludes support for regeneration post-harvest. It will, however, increase the area and number of seedlings planted in areas where there is no legal requirement to replant.

Area artificially regenerated and number of seedlings planted on provincial and territorial Crown lands in Canada, 2010–2020



Source: National Forestry Database. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:

Volume harvested relative to the sustainable wood supply

In 2020, Canada harvested 141.1 million m^3 of industrial roundwood, well below the estimated sustainable wood supply level of 215.3 million m^3.

- The volume harvested was an increase of 1.6 million m^3 from 2019 levels, when 139.5 million m^3 of industrial roundwood was harvested. At the same time, the estimated wood supply deemed to be sustainable declined by 360,000 m^3.
- Since the volume of industrial roundwood harvested increased and the sustainable wood supply declined compared to 2019, the gap between them narrowed.
- Canada continues to harvest at levels that are well below the level deemed to be sustainable.
- The increase in harvest is attributable to an increase in the volume of softwood timber harvested in Alberta.

Sustainable wood supply refers to the volume of timber that can be harvested annually from federal, provincial, territorial and private lands while meeting environmental, economic and social objectives as set out in provincial legislation that regulates harvest on Crown lands.

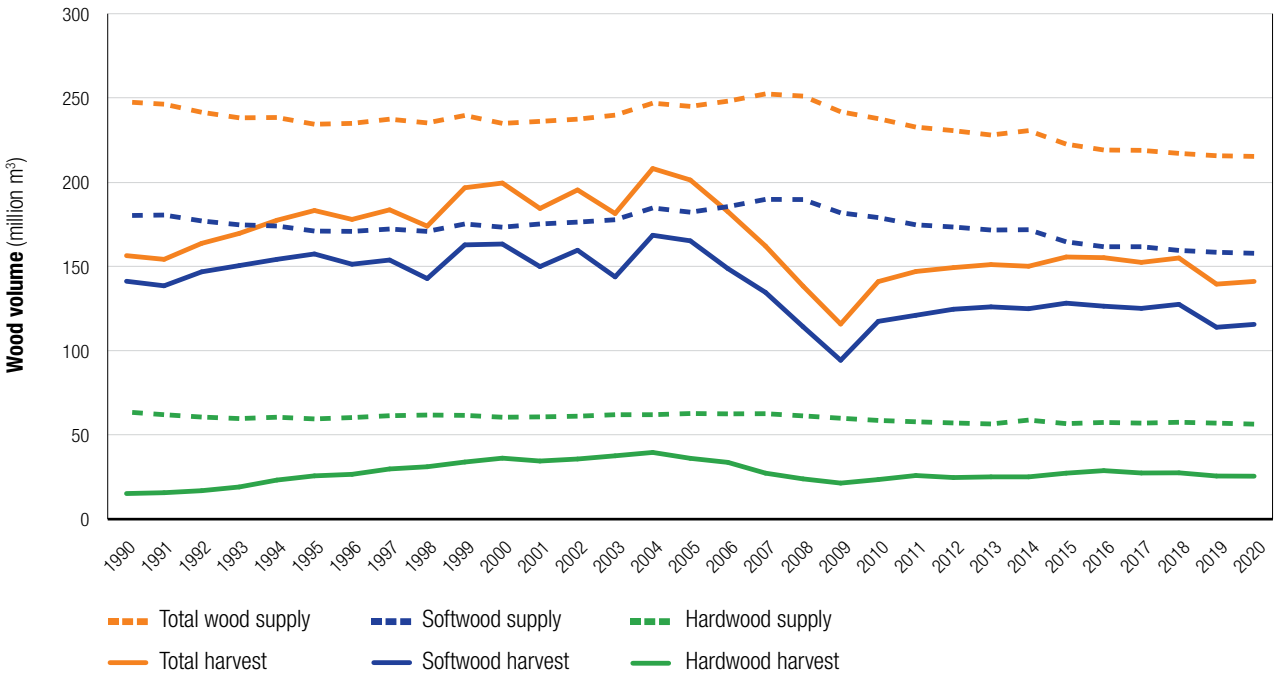
Why is this indicator important?

- Forest managers track the volume of industrial roundwood harvested each year to ensure it falls within sustainable levels, as set out in provincial legislation and policies that regulate the harvest on provincial lands.
- Harvests from provincial Crown lands are regulated by allowable annual cuts (AAC) set by provinces. Although there is no AAC calculated for Canada as a whole, it is possible to compare the combined provincial AACs with the combined harvest totals from the same provincial Crown land base.

What is the outlook?

- Harvest levels are expected to remain below the sustainable wood supply.
- The sustainable wood supply will continue to decline over the next several years as AACs in British Columbia are reduced in response to the impact of the mountain pine beetle and severe wildfires and measures are taken to protect wildland caribou habitat and old-growth forests.
- As the economy continues to recover from the COVID-19 pandemic, demand for Canadian wood products will remain strong, driven by the demand for new housing, which remains elevated from pre-pandemic levels despite rising interest rates and inflation, serving to narrow the gap between harvest and sustainable wood supply.

Annual harvest versus supply deemed sustainable for harvest, 1990–2020



Source: National Forestry Database. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

How does disturbance shape Canada's forests?

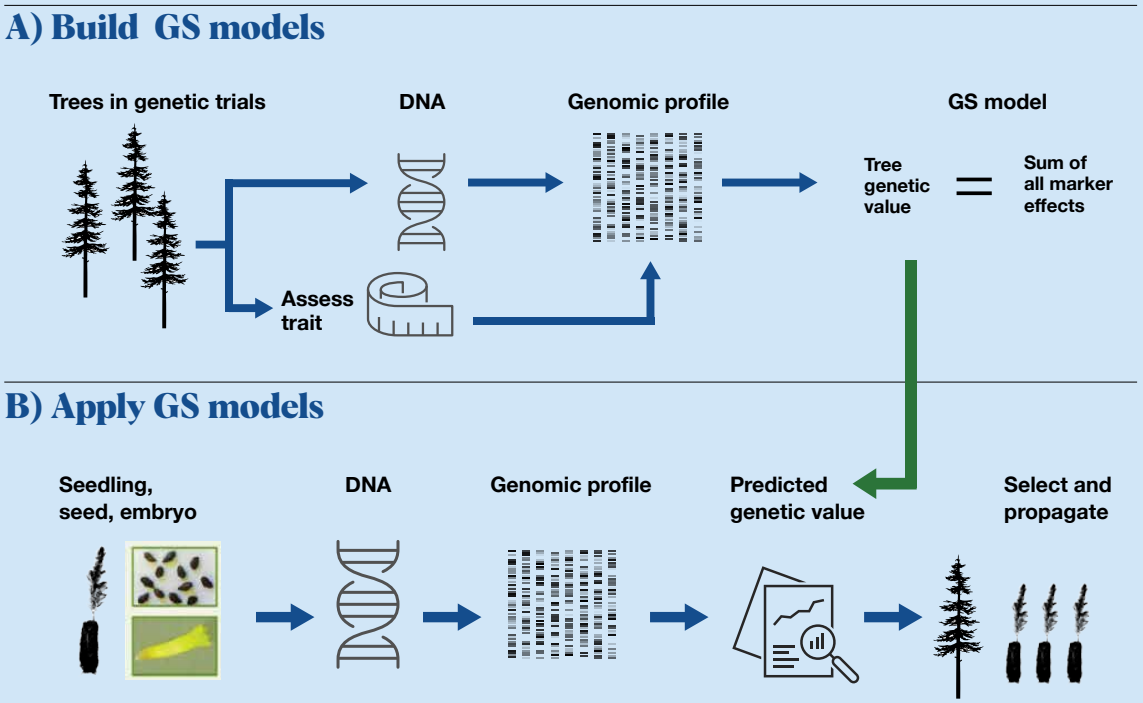
Forest environments are dynamic, changing continuously through the effects of climatic variation and ecological processes such as forest succession, species migration, and interspecific competition. Wildfires, drought, windthrow, parasitism and disease, and other disturbances, while often more sudden or dramatic, are among these natural features of forest environments. Disturbances are increasing in frequency and magnitude as a result of invasive species introductions and climate change.

Managing forests for optimal resilience to disturbances has relied on forest practices derived from information about whole organisms and whole ecosystems. New tools are now available to advance forest management, allowing us to look at their natural genetic variation at the organism level. This lens offers unique insights on forest ecology, plant physiology, and long-term population trends and complements existing ecological knowledge. The natural genetic variation, viewed as "forest genetic resources" (FGR), provides a basis from which current and future resilience of forests can be drawn. These tools can help to project and monitor disturbances, promote forest qualities that reduce the impact of disturbances, and speed up the recovery of forests following disturbances.

Tools for forest management

Linking genetic data at the organism level with forestry traits (e.g., growth, drought tolerance, and insect resistance) provides a way to identify genes related to those traits. Linking such data with forest habitat features (e.g., ambient temperature, forest stand productivity) can reveal aspects of the environment that prompt individual organisms' evolution, define their range boundaries, or influence where they grow. Thus, these tools inform key forest management decisions by estimating an individual tree's and a forest population's success in existing or new situations (e.g., new habitats, changing climatic regimes).

Genomic data is genetic information measured from across the genome of one or more individuals (e.g., trees, insects). It can range in resolution from thousands or millions of variable sites ("genetic markers") to complete genomic reads ("whole-genome sequences") for each individual sampled. Steadily falling sequencing costs and widely available computing resources have now brought genomic data within reach of any species for as little as a few thousand dollars. The image shows one kind of genomic tool that can be developed from this type of information, a "genomic selection" (GS) model. Applying the model involves (a) measuring and correlating natural genetic variation in trees with a desired tree trait, then (b) genetically profiling tree seedlings and planting those predicted to best express the desired trait. This tool can drastically speed up tree breeding. (Image from Lenz et al., 2020)



Tools for disturbance resilience and restoration

These new tools also offer direct approaches to manage forests for disturbance resilience, including:

- selecting and planting tree seeds (e.g., spruce and pine trees) that are best adapted to thrive in current or projected future climates (both to planting for regeneration after harvests as well as restoration after large-scale disturbances such as wildfires)
- favouring tree genetic sources that show natural resilience to fluctuations in abiotic (e.g., temperature, water) or biotic disturbances (e.g., invasive species)
- better understanding the potential impacts of exotic (e.g., spongy moth, sudden oak death) or native species (e.g., spruce budworm) of insects or diseases, to better predict their disturbance risk and to optimize insect control or stand management measures

Stewardship of genetic variability/forest genetic resources

There is now widespread recognition of the importance of forest biodiversity for strengthening resilience to environmental change, and more generally for optimizing biological, cultural, recreational and commercial forest values into the long-term. Disturbance events can diminish genetic variability or forest genetic resources (FGR) if they create imbalances in species composition or if they drive local or broader scale species extinctions. The new tools noted above help to reinforce Canadian forests against these threats. In addition, monitoring and management of FGR on a national and regional scale is now in practice to conserve and sustainably use FGR into the future. Conserving Canada's FGR is one of the primary objectives of the Natural Resources Canada-Canadian Forest Service's National Tree Seed Centre – the only seed bank in Canada with a national mandate for science, education, and long-term seed banking to conserve the genetic diversity of Canada's forests through a dynamic living library of tree and shrub seeds.

Source: Commission on Genetic Resources for Food and Agriculture & Food and Agriculture Organization of the United Nations; Lenz, P.R., Nadeau, S., et al. 2020; Natural Resources Canada. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

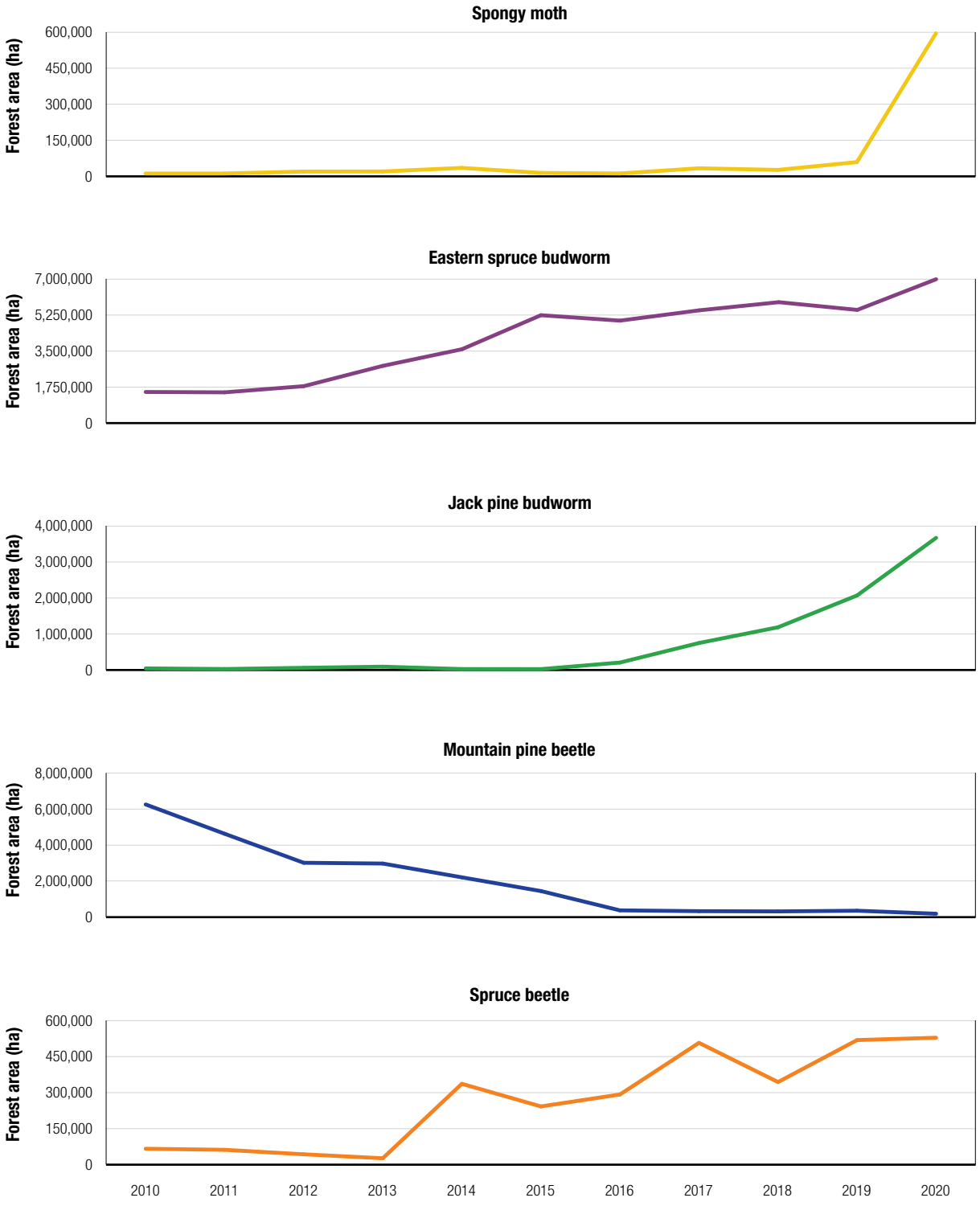
Indicator:
Forest insects

In 2020, 17.8 million ha were affected by insects, a 23% increase from 2019.

- The areas of moderate to severe defoliation by the spruce budworm and the jack pine budworm both increased. The most significant defoliation by these species occurred in the northern and Gaspé regions of Quebec and northeastern Ontario but outbreaks were observed in many regions across Canada.
- The area affected by the spruce beetle continued to increase in British Columbia. The area impacted by the mountain pine beetle decreased in British Columbia and Alberta.
- The spongy moth (*Lymantria dispar*, former common name: gypsy moth) outbreaks in southern Ontario and parts of southeastern Quebec reached record levels, defoliating over 580,000 ha in Ontario alone.
- The range of hemlock woolly adelgid, an invasive species relatively new to Canada, continued to increase in southern Nova Scotia and the Niagara region of Ontario. Its expansion threatens ecologically important forests in both regions.

Canada's forests are home to thousands of species of native and introduced insects. Only a small number of these species kill trees and damage forests and then only when those species experience outbreaks that span over vast areas. The rest of the time, these species contribute a vital role to the normal functioning of forest ecosystems as prey for other species or by recycling nutrients back into the forest.

Forest area (in hectares) containing defoliated or beetle-killed trees for five insects in Canada, 2010–2020



Why is this indicator important?

- Insects are a normal and natural part of all forest ecosystems. Some insect populations, however, experience occasional outbreaks that damage or kill trees and forests. These impacts can reduce Canada's timber supply and influence the functioning of forest ecosystems, which can in turn affect carbon stocks, increase fire risk and reduce the recreational and non-timber uses of forests.
- Invasive insects are an increasing threat to many forests in Canada. Outbreaks of invasive species can have the same impacts as outbreaks of native species, but can sometimes persist for longer or indefinitely. This occurs when these species are not subject to regulation in the ecosystem they have invaded. Understanding the impacts of these species on Canada's forests helps to assess the risk and prioritize the development of prevention, control, and mitigation tactics.

What is the outlook?

- Outbreaks of spruce budworm will continue to grow and impact forests from Ontario to Newfoundland and Labrador. Jack pine budworm outbreaks are expected to decrease. The impact of both species will affect forest composition, timber supply, and fire risk in the region for many years.
- Spruce beetle populations will continue to increase and mountain pine beetle populations will continue to decrease. The risk of mountain pine beetle spread through eastern Alberta will persist, however, if climate change and forest composition remain suitable for the beetle's spread eastward to central Canada. At present, although it has been found within 50 km of the border, this insect has not yet spread from northern Alberta into northern Saskatchewan.
- Spongy moth outbreaks will continue and likely expand in central Canada, impacting urban forests in the major centres in the region and in smaller and rural communities as well. These outbreaks should end in 2 to 3 years but may persist if climate conditions remain favourable for growth and expansion of the population. Increased abundance of spongy moth will also increase the likelihood of the species being introduced to other regions of Canada because of the potential for people to inadvertently move egg masses laid on goods and outdoor items, such as when relocating within Canada.

Source: National Forestry Database. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:
Forest diseases

Forest diseases are a natural component of healthy forest ecosystems, where they profoundly affect productivity, diversity, structure, succession, and nutrient and carbon cycling. Canadian forests increasingly face unprecedented health challenges resulting from a changing climate and invasive forest diseases.

- Climate change is increasing the severity of endemic forest diseases such as Swiss needle cast on Douglas-fir and Dothistroma needle blight on lodgepole and other pine species.
- Invasive species, such as oak wilt that is poised to enter Canada from the American border, continue to threaten the health of Canada's forests.
- The historic heat dome over western Canada during the summer of 2021 resulted in extreme drought stress to trees; the effect of this will likely be seen in the next few years.

Severe Swiss needle cast of Douglas-fir (Vancouver Island, July 2021).

Why is this indicator important?

- Climate change and increasing extreme weather events can weaken forest trees and make them more susceptible to both endemic and invasive diseases.
- Invasive forest diseases cause widespread damage and mortality to Canadian forests, threatening biodiversity, ecosystems, and forest-based industries.

The Disease Triangle

Forest diseases depend on three interacting factors: a susceptible host, a pathogen and a suitable environment. If one of these factors is missing, disease will not occur. A changing climate, introduced novel pathogens, or weakened host trees can exacerbate disease occurrence and severity.

What is the outlook?

- A changing climate poses significant uncertainty in predicting which diseases will emerge as serious threats to forest health. Pathogens that are inconsequential today may become serious pests in the future while serious pests today may become less prominent in the future.
- Future uncertainties demand proactive forest management strategies including assessment of assisted migration, breeding trees for disease resistance and tolerance to stresses including drought, and deploying genomics-based surveillance and diagnostics tools.

Source: Bérubé, J.A., Gagné, P.N., et al. 2018; Bilodeau, G.J., Tanguay, P., et al. 2022; Canadian Food Inspection Agency. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

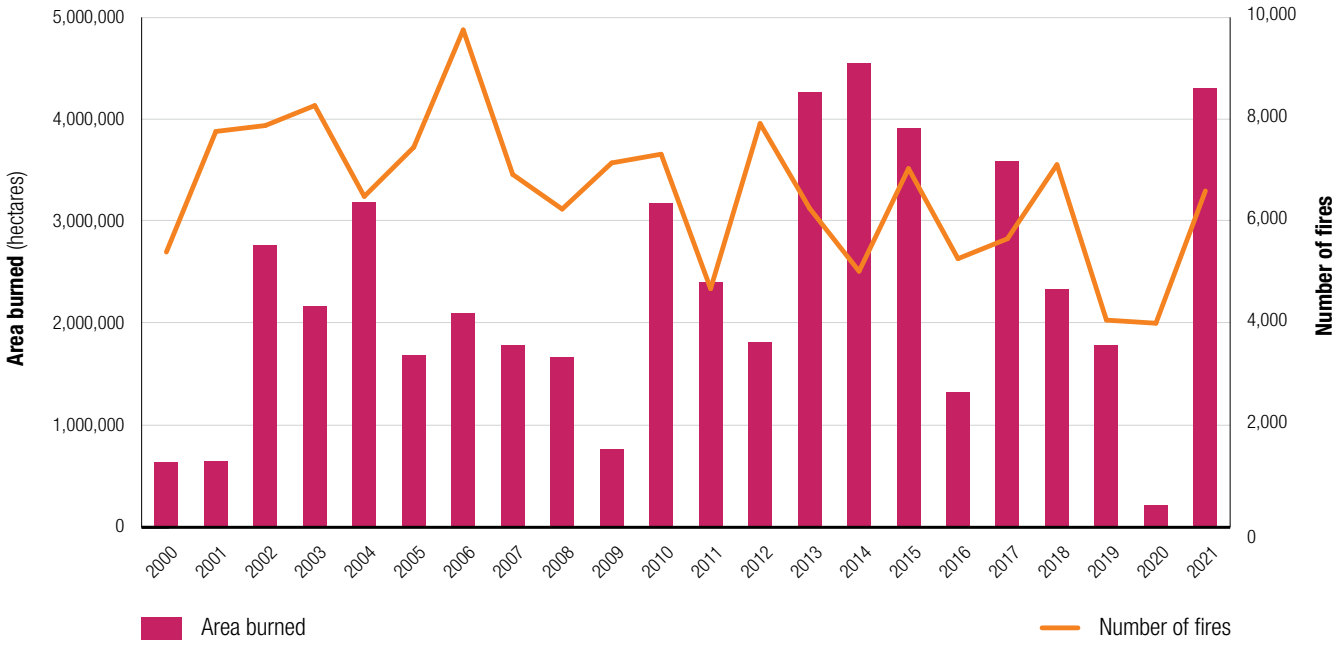
Indicator:
Forest fires

In 2021, Canada experienced about 6,500 forest fires that burned approximately 4.3 million hectares, well above the annual average area burned. Record temperatures and extreme fire weather contributed to a severe fire season for many parts of the country.

In 2021, evacuations disproportionately impacted Indigenous communities across the country. This is a continued trend in Canada with some communities being evacuated because of smoke and fire impacts on an annual basis or even being evacuated multiple times in the same fire season.

- British Columbia, Saskatchewan, Manitoba and Ontario were the hardest hit by wildfire, recording significantly above average area burned. Ontario experienced more hectares burned than in any other year. Manitoba and British Columbia both recorded the third-highest area.
- Over 200 evacuations occurred because of wildfire and smoke affecting nearly 52,000 citizens. Most evacuations occurred in British Columbia, and 35% of the total evacuations were in Indigenous communities.
- The wildfires resulted in over 300 homes being lost across several communities and the town of Lytton, British Columbia, being destroyed by fire.

Forest area burned and number of forest fires in Canada, 2000–2021



Why is this indicator important?

- Forest fires are a natural part of the forest ecosystem and are important for maintaining the health and diversity of the forest. However, they also result in costly economic and environmental losses and public health and safety concerns by directly threatening communities and infrastructure or reducing visibility and air quality through smoke.

What is the outlook?

- When and where forest fires occur varies from year to year, but studies of long-term trends show that fire seasons are starting earlier and lasting longer.
- The hotter and drier conditions from climate change will result in more frequent and more severe forest fires in Canada.
- The increased frequency and severity of fires affects the cost of fire management and results in greater impacts on people and communities, such as evacuations and losses of homes and businesses.
- In Canada, provincial and territorial fire management agencies, along with Natural Resources Canada, are working to meet these challenges through strategic investments in prevention and mitigation (e.g., FireSmart), increased firefighting resources and enhanced intelligence and decision support.

Source: Canadian Interagency Forest Fire Centre; Natural Resources Canada; National Forestry Database. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:

Forest carbon emissions and removals

In 2020, total net greenhouse gas (GHG) emissions – reported as carbon dioxide equivalent (CO_2e) – from Canada's managed forests (forest lands managed for timber production, conservation or fire suppression) and forest products were about 3.5 million tonnes (Mt).

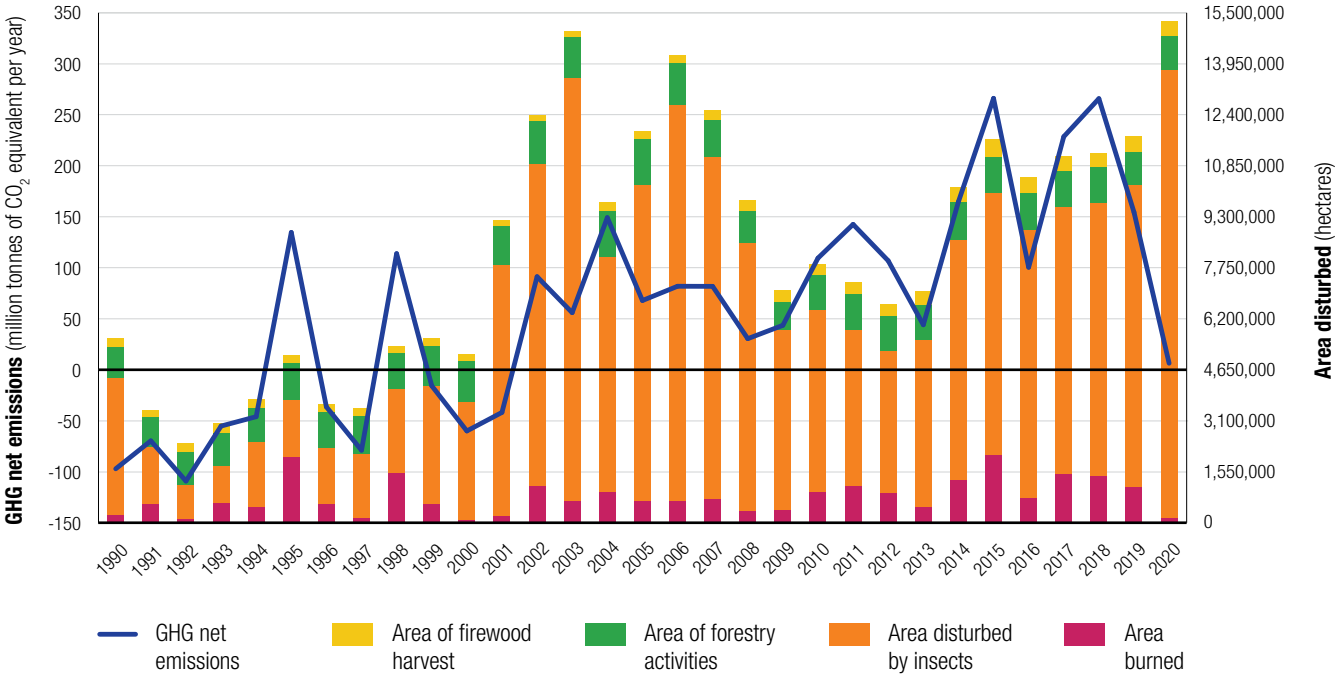
Total net emissions are calculated by adding emissions/removals caused by human activities in Canada's managed forests to emissions/removals caused by natural disturbances in Canada's managed forests.

Human activities in Canada's managed forests accounted for removals of about 5.3 Mt CO_2e from the atmosphere in 2020, while natural disturbances accounted for emissions of about 8.8 Mt CO_2e, resulting in net emissions of about 3.5 Mt CO_2e.

The area burned in managed forests of Canada in 2020 was only about 130,000 hectares (ha), about 10% of the area burned in 2019. In 2020, the area burned was generally low when compared to other years since 1990. This resulted in the natural partition of Canada's managed forests emitting about 8 Mt CO_2e.

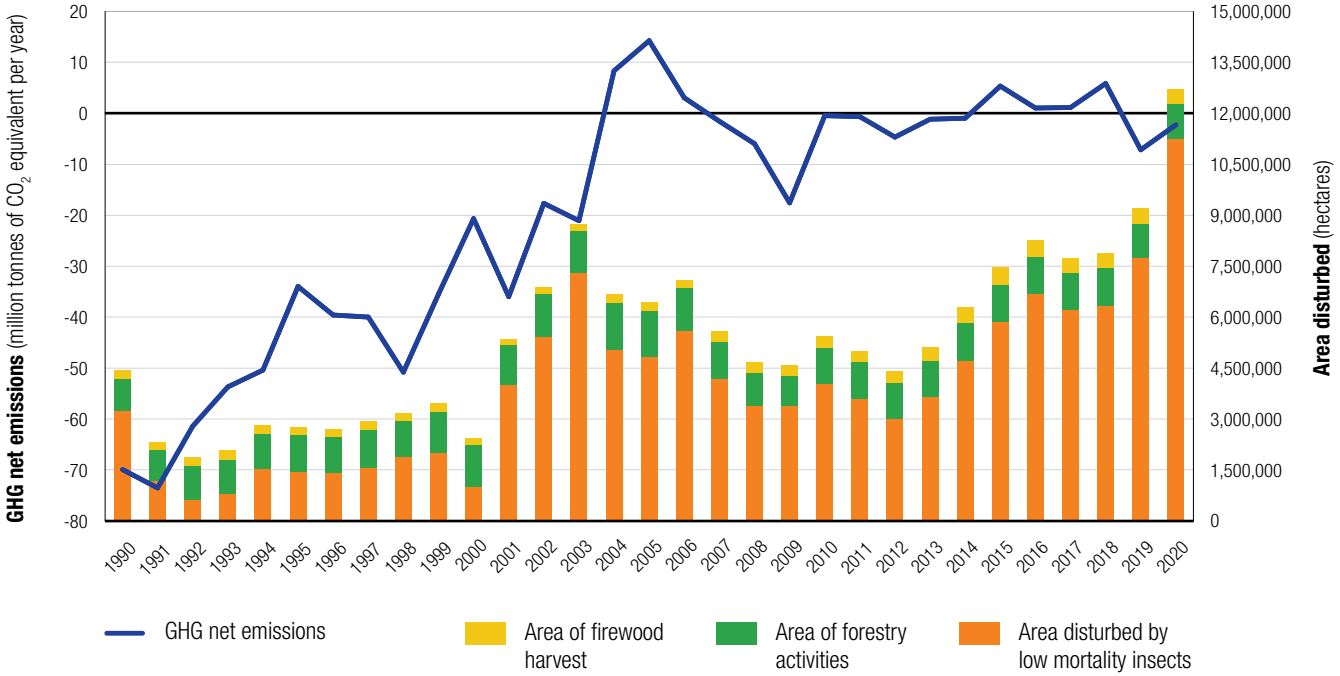
Canada's forests both absorb carbon and emit atmospheric carbon dioxide, methane, carbon monoxide and nitrous oxide. In any given year, depending on the area of natural disturbances such as forest fires, insect outbreaks and windthrows, Canada's forests will either be a source of GHGs or a sink of atmospheric carbon. Data from 2020 suggest that overall the forests were a minor source of GHGs of about 3.5 Mt CO_2e because of a relatively small amount of area burned.

Net carbon emissions in Canada's managed forests: All areas, 1990–2020



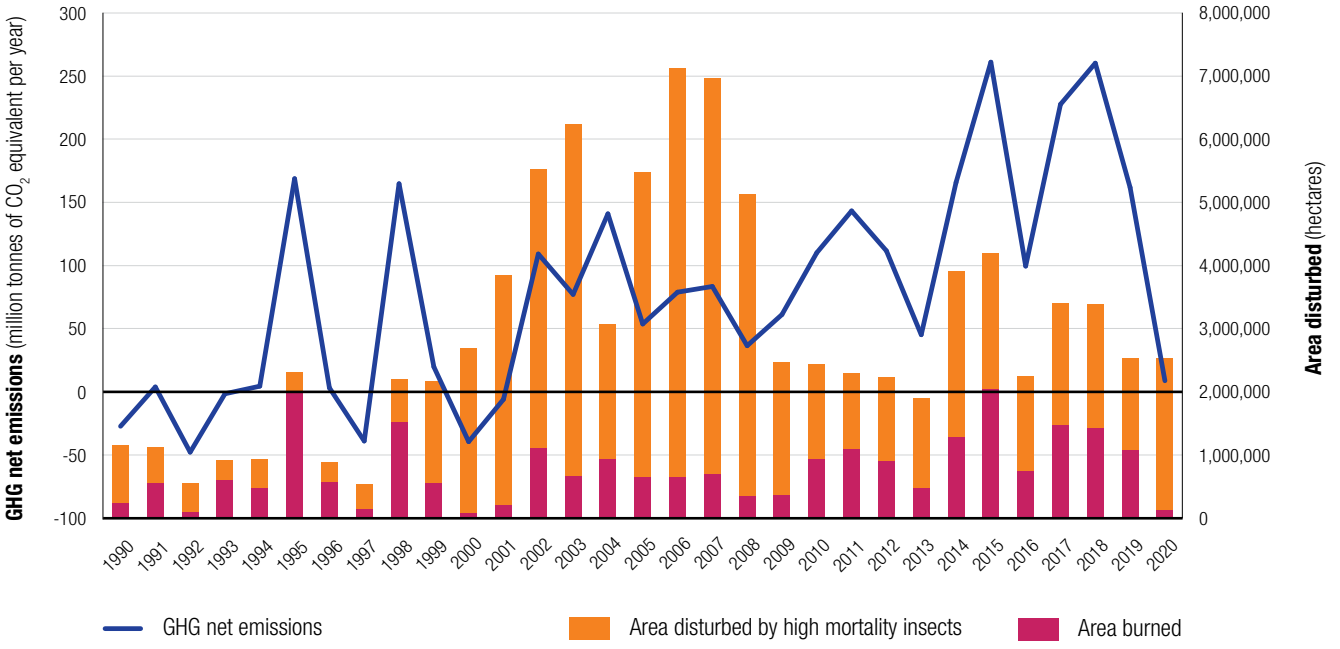
The total net emissions and removals from Canada's managed forests, taking into account both human activities and natural disturbances, were about 3.5 Mt CO_2e in 2020.

Net carbon emissions in Canada's managed forests: Areas subject to human activities, 1990–2020



Human activities in Canada's managed forests, such as harvesting, slash pile burning, regeneration, and firewood collection, as well as the use and disposal of harvested wood products, were a net sink of about 5.3 Mt CO_2e in 2020.

Net carbon emissions in Canada's managed forests: Areas subject to natural disturbances, 1990–2020



The relatively small area burned in Canada's managed forests resulted in net emissions of about 8.8 Mt CO_2e in 2020.

Why is this indicator important?

- Emissions of carbon as carbon dioxide (CO_2) and as methane (CH_4) to the atmosphere are important contributors to global warming.
- Canada's forest sector provides renewable resources to the Canadian economy, resulting in emissions and removals, while also providing employment, aesthetic values, clean water, wildlife habitat and many other ecosystem services.

What is the outlook?

- The impacts of climate change on Canada's future forest GHG balance are difficult to predict but will be characterized by large inter-annual variability. The area burned in Canada's managed forests in 2021 was the largest on record since 1990, one and a half times larger than the previous record year of 2015, and thus 2021 GHG emissions will be substantially higher than in any previous year since 1990. Regionally, impacts of climate change can be both positive (enhanced forest growth and therefore larger carbon sinks) and negative (higher mortality, more forest fires or insect outbreaks).
- Natural disturbances, mostly outside the control of humans, impact significantly the ability of Canada's managed forests to consistently absorb more CO_2 than they emit.
- Federal and provincial governments are investing in programs aimed at reducing fuel loads in Canada's forests and to improve firefighting capabilities.
- Changes in forest management and the use of harvested wood products can contribute to mitigating climate change.
- Increased use of long-lived wood products to store carbon in the built environment and use of wood products instead of emissions-intensive materials such as concrete, steel and fossil fuels provide climate change mitigation opportunities.
- The databases and models that are used to generate estimates of forest carbon emissions and removals are improved on an ongoing basis as new science and new measurements become available.

Source: Environment and Climate Change Canada. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

How do forests benefit Canadians?

Canada's forests play an essential role in the economy and the lives of Canadians, including in Indigenous and rural communities. Forests sustain life by providing essential habitat, food, renewable energy and materials. They also provide important environmental services and opportunities for spiritual and cultural enrichment.

Forest ecosystems are essential for life

Forests provide many important ecosystem services. They clean the air and water, regulate and cool climate, and mitigate floods and soil erosion. They also provide critical, biodiverse habitat for a wide range of plants and animals. These services provide significant benefits to Canadians, from improved health outcomes to the energy benefits that tree canopies provide through shade and wind protection.

Forests are a vital part of the Earth's carbon cycle – the constant movement of carbon from the land and water through the atmosphere and living organisms. Forests contribute to this cycle by storing and releasing carbon in a dynamic process of growth, decay, disturbance and renewal. This capacity to store carbon, including carbon emitted from human activity, is an essential part of the solution to climate change.

Forests are important to social and cultural identity

Forests are the place for many recreational activities such as hiking, mountain bike riding, camping and bird watching. They are also a source of spiritual, cultural and aesthetic value to all people in Canada, especially for First Nations, Métis and Inuit peoples. These activities and values continued to support the physical and mental well-being of Canadians during the COVID-19 pandemic and beyond.

Forests play a key role in meeting essential needs for Canadians

Forests are sustainably managed in Canada so that they can provide ecosystem services and social and cultural benefits, while also providing essential goods for Canadians such as toilet paper and sanitary products, packaging products, lumber, biofuels for power generation in remote communities, and many other goods and services. The extraction and manufacture of these products provides economic benefits, which are especially important in rural communities including many First Nations, Métis and Inuit communities. The forest sector supports about 300 forest-reliant communities and directly employs 205,365 Canadians, including approximately 12,000 First Nations, Métis and Inuit peoples.

Source: Statistics Canada. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:

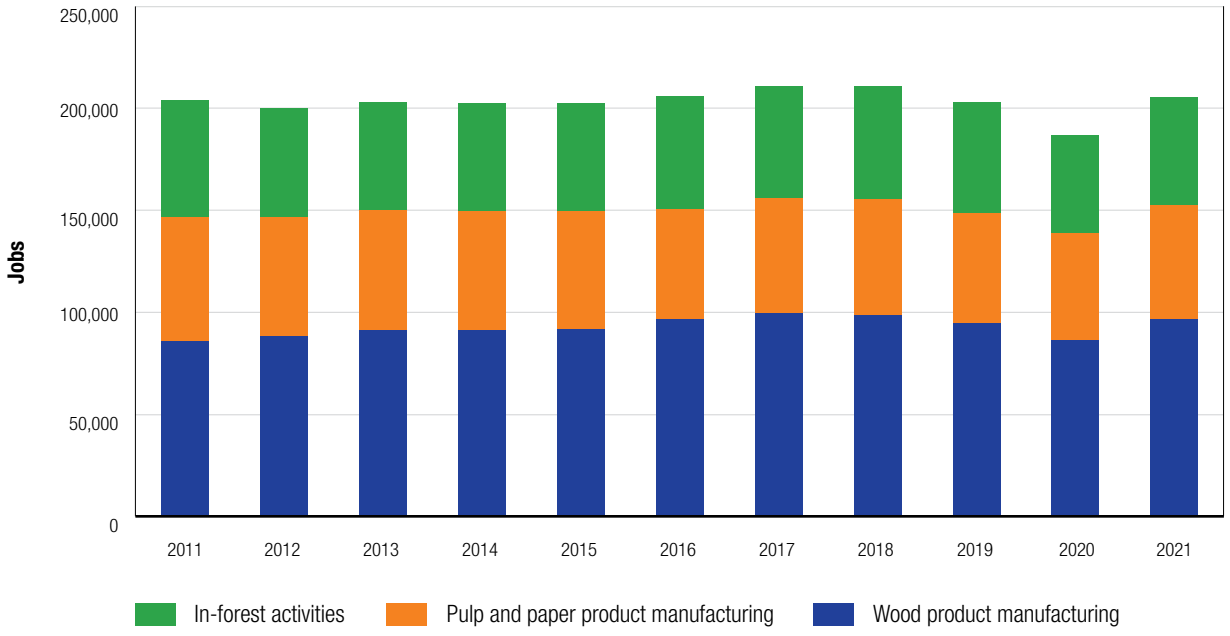
Forest sector employment

In 2021, Canada's forest sector employed 205,365 people, an increase of almost 10% from 2020. The increase is due to the economic recovery from the COVID-19 pandemic.

- Employment in the wood products manufacturing subsector recovered to pre-pandemic levels because of positive market conditions. Due to a slight downturn toward the end of 2021, employment in the wood product manufacturing sector declined slightly as mills curtailed operations, partially because of shipment delays that were exacerbated by wildfires and flooding in British Columbia.
- In recent years, employment in the pulp and paper manufacturing subsector declined as consumers continued to switch to digital media and reduce their demand for newsprint and printing and writing paper. In 2021, employment returned to its pre-pandemic level.
- Employment increased in 2021 for in-forest activities such as nursery operations, tree planting, and timber cruising and logging, but remains slightly below pre-pandemic levels.

2021 was an unusual year in forest sector employment. Despite an annual increase in employment, the number of unfilled jobs reached record highs. Employment was interrupted by the COVID-19 pandemic, wildfires, flooding, and the resulting supply chain disruptions. These interruptions happened at the same time as elevated hiring in response to positive market conditions.

Forest sector direct employment, 2011–2021



Why is this indicator important?

- The Canadian forest sector is an important employer nationwide and contributes to the economic and social welfare of Canadians. Forest sector employment is particularly important in many rural and Indigenous communities, where forest-related work is often the main source of income.

What is the outlook?

- After ramping up operations to meet surging demand in 2020 and 2021, the forest sector is now returning to its long-term trend for employment. Long-term challenges related to fibre supply and transportation issues, as well as emerging issues such as inflation, may affect employment in the forest sector.
- Despite these challenges, the sector's transformation to increase efficiencies in the use of timber and energy, reduce negative environmental impacts, and shift production toward higher-value and specialty products, will create new job opportunities across the country.

Source: Statistics Canada. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:

Forest sector average earnings

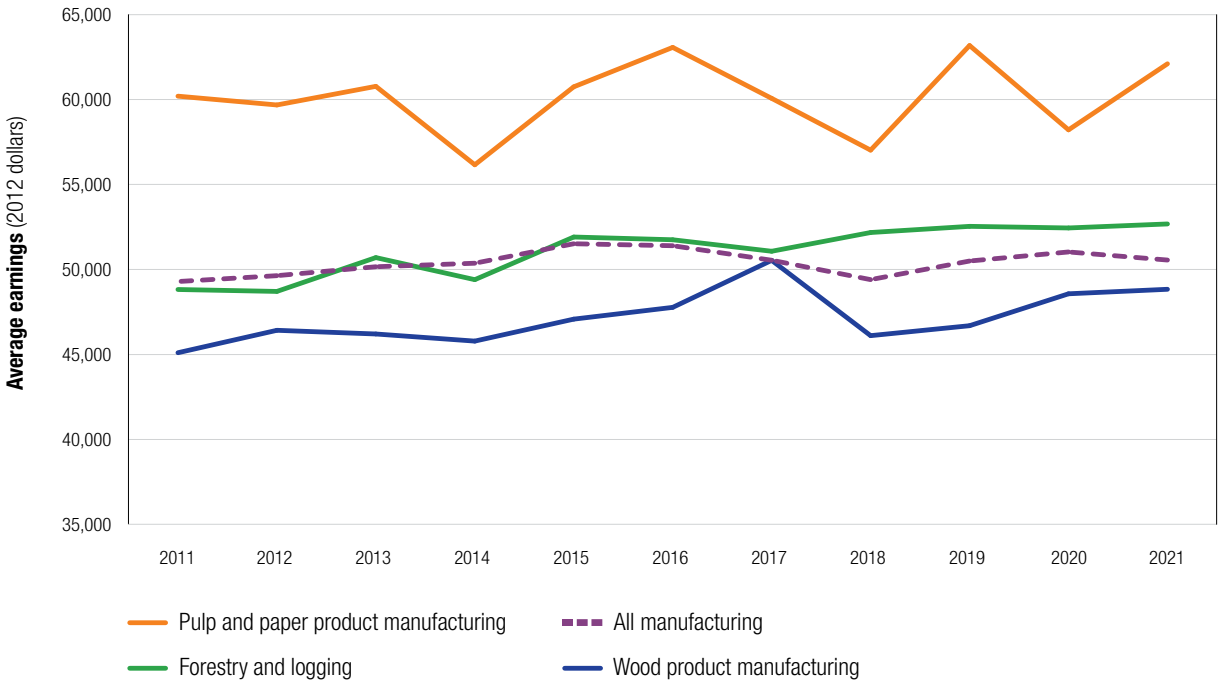
Average 2021 earnings across the forest sector increased by 2.8% from 2020 levels. They were 0.6% above the 10-year peak achieved in 2016 – averaging approximately $54,500 annually. While average earnings tend to be volatile year-over-year, they have followed a relatively stable upward trend since 2011.

- In 2021, average earnings in the pulp and paper product manufacturing subsector bounced back from last year's decline, with an increase of 6.7% compared to 2020. While demand for newsprint has been declining, demand for tissue and packaging was strong in 2021. Labour-intensive production facilities, facing COVID-19-related staff shortages and disruptions, had to significantly increase wages to attract and retain staff so they could ramp up operations.

Average earnings refer to the average net annual income per person directly employed in the forest sector, not including overtime pay. These earnings are defined by real wages, i.e., the average earnings adjusted to exclude the effect of inflation.

- Earnings from wood product manufacturing and from forestry and logging activity were slightly up (by, respectively, 0.5% and 0.4%) from 2020. Despite record lumber prices, wage increases were moderated by market volatility, high production costs and logistics issues. Performance in forestry and logging activity has been limited by fibre availability as well as by supply chain constraints in the second half of 2021.
- Overall, average earnings in the forest sector outperformed average earnings for all manufacturing, with the latter falling by 0.9% between 2020 and 2021.

Average earnings in the forest sector compared with all manufacturing sectors, 2011–2021



Why is this indicator important?

- Trends in forest sector average earnings indicate the importance of the sector to the economy and to the social well-being of Canadians, especially when compared with other industries.
- Real wage growth (that is not the result of inflation) shows the change in actual purchasing power of forest sector employees.

What is the outlook?

- In the short term, the forest industry will continue to compete with other resource sectors to attract workers, thus leading to higher wages. Increases could be moderated by rising production costs that are caused by higher energy prices, inflation and logistic issues. Overall earnings will depend on post-pandemic economic recovery and the impact of new COVID-19 variants on labour.
- Looking to the long-term, average forest sector earnings are anticipated to increase because of productivity improvements, as well as the ongoing transition toward the bioeconomy and other high-value forest products. This is likely to support growth in specialized technical positions with enhanced skills and education, thus requiring high rates of pay.

Source: Statistics Canada. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:
Forest communities

Forests provide important environmental, economic and cultural benefits for communities across Canada, including in both urban and rural areas.

- More than 23 million people, or about two-thirds of Canada's total population, live in or near forests.
- In roughly 300 Canadian communities, the forest sector is a major source of employment and income.
  - These forest-reliant communities are home to about 2% of Canada's population, or 700,000 people.
- According to the most recently available census (2016), over 1.1 million First Nations, Inuit and Métis people live in or near forests, and represent nearly 12,000 forest sector employees.

Communities are municipalities or an equivalent area where local people live and work. There are about 5,100 communities in Canada.

Local employment in the forest sector develops community self-reliance, economic resilience, and opportunities for a diversified economy.

Why is this indicator important?

- Communities that are near forests play an important role in Canada's forest sector both as a source of labour and stewards of forested landscapes. Forest-reliant communities are instrumental to the delivery of local mitigation and adaptation initiatives involving forests.
- Forests are also of vital cultural significance to many First Nations, Inuit and Métis communities, and are central to their health and well-being.

A significant share of economic activity in the Canadian forest sector takes place near forest resources and in rural areas. Forests will continue to provide essential economic, cultural, and health benefits for the 23 million people who live in forested areas.

What is the outlook?

- Despite various recent challenges related to the COVID-19 pandemic, opportunities in the bioeconomy and a strong market for forest products are expected to elevate demand. Forest communities benefit from demand for Canadian forest products.
- Labour supply continues to be a challenge for forest-reliant communities, as the number of unfilled forest sector jobs reached record highs in 2021. Ongoing efforts to recruit, train, and retain workers in these communities will be essential to ensure continued benefits from living near forests and from participating in the forest sector.
- Canada's forest-reliant communities continue to be affected by climate change and natural disturbances, including increasingly frequent and severe wildfire activity and pest infestations that impact forest health.

Source: Statistics Canada. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

How does the forest sector contribute to Canada's economy?

The forest sector is a key to Canada's economy and a source of well-being and prosperity for communities and workers from coast to coast. The forest sector:

Accounts for about

205,365

direct jobs across Canada (2021), including an estimated 12,000 Indigenous Peoples (2016)

Generates more than

$2.3 billion

in revenue for provincial and territorial governments (2020)

Exports about

$44.9 billion

of forest products, or about 7.3% of Canada's total exports (2021)

Accounts for

$34.8 billion

of Canada's **nominal gross domestic product** (GDP) (2021)

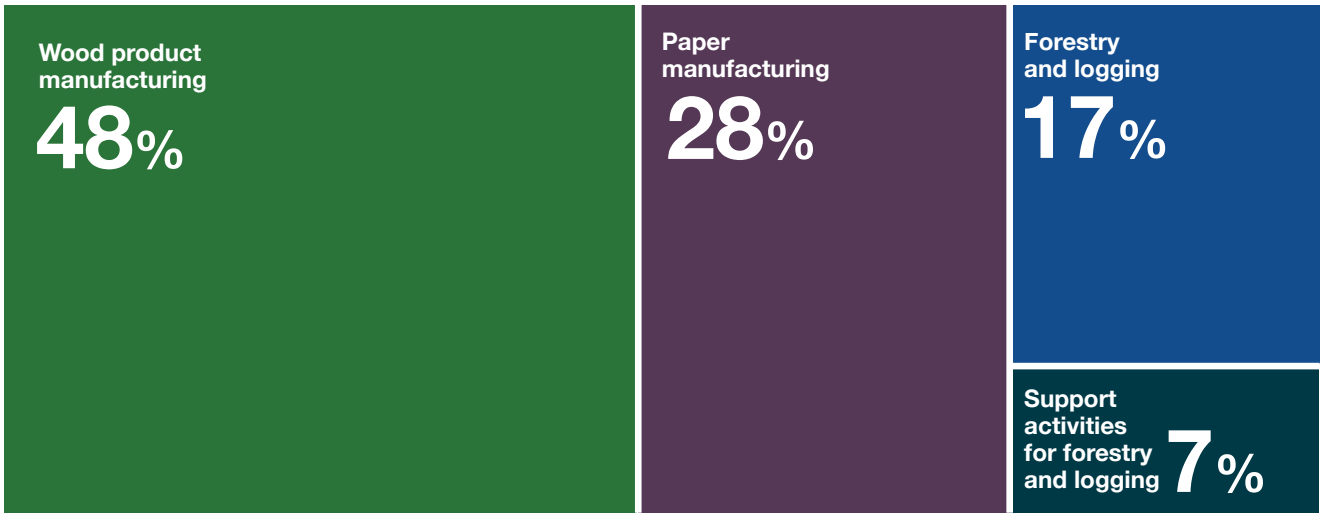
Innovation in Canada's forest sector

New and innovative forest products are an increasingly important part of Canada's economy. These include innovative building materials such as cross-laminated timber and other innovative wood products, biofuels that can substitute for fossil fuels, biodegradable replacements for single-use plastics, and various personal care products. Through programs such as Investments in Forest Industry Transformation, the Government of Canada supports the forest sector transition toward new markets, ensuring that Canada is in a position to meet increasing global demand for innovative forest products.

Forest sector employment

The forest sector serves as an important source of economic opportunity for people and communities. The forest sector is particularly important in many rural, remote, and Indigenous communities where the forest sector is often a primary source of jobs and income. Most of the forest sector jobs in Canada are located in Quebec (30%), British Columbia (27%), and Ontario (22%). Atlantic Canada (8%), Saskatchewan (2%), Manitoba (2%) and the Territories (0.1%) account for the remaining forest sector jobs. Although forest sector employment fluctuates from year to year, it consistently accounts for about 1.1% of the total labour force (across all industries).

Who works where in the forest sector?



A competitive source of forest products for the global market

Despite ongoing disruptions to global supply chains related to the COVID-19 pandemic, globalization continues to increase the trade market possibilities for Canada's forest sector. In recent decades, Canada's forest sector has proven to be a key source of forest products for markets around the world. Canada is a leading exporter of products such as softwood lumber, newsprint, structural panels, and packaging products. About 80% of Canada's forest product exports are destined for the United States (2021). In the aftermath of the global financial crisis of 2008, the United States share of Canada's exports fell to a 20-year low of about 60% and has risen steadily since that time. Despite Canada's strong trade relationship with the United States, Canada continues to focus on market diversification and seizing new opportunities in emerging markets, particularly in Asia and Europe.

Source: Statistics Canada. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:

Forest sector gross domestic product

In 2021, the forest sector contributed $34.8 billion (1.5%) to Canada's nominal GDP, which represents a 33% growth in forest sector GDP compared to 2020. Real GDP in the forest sector also increased by 5.3%.

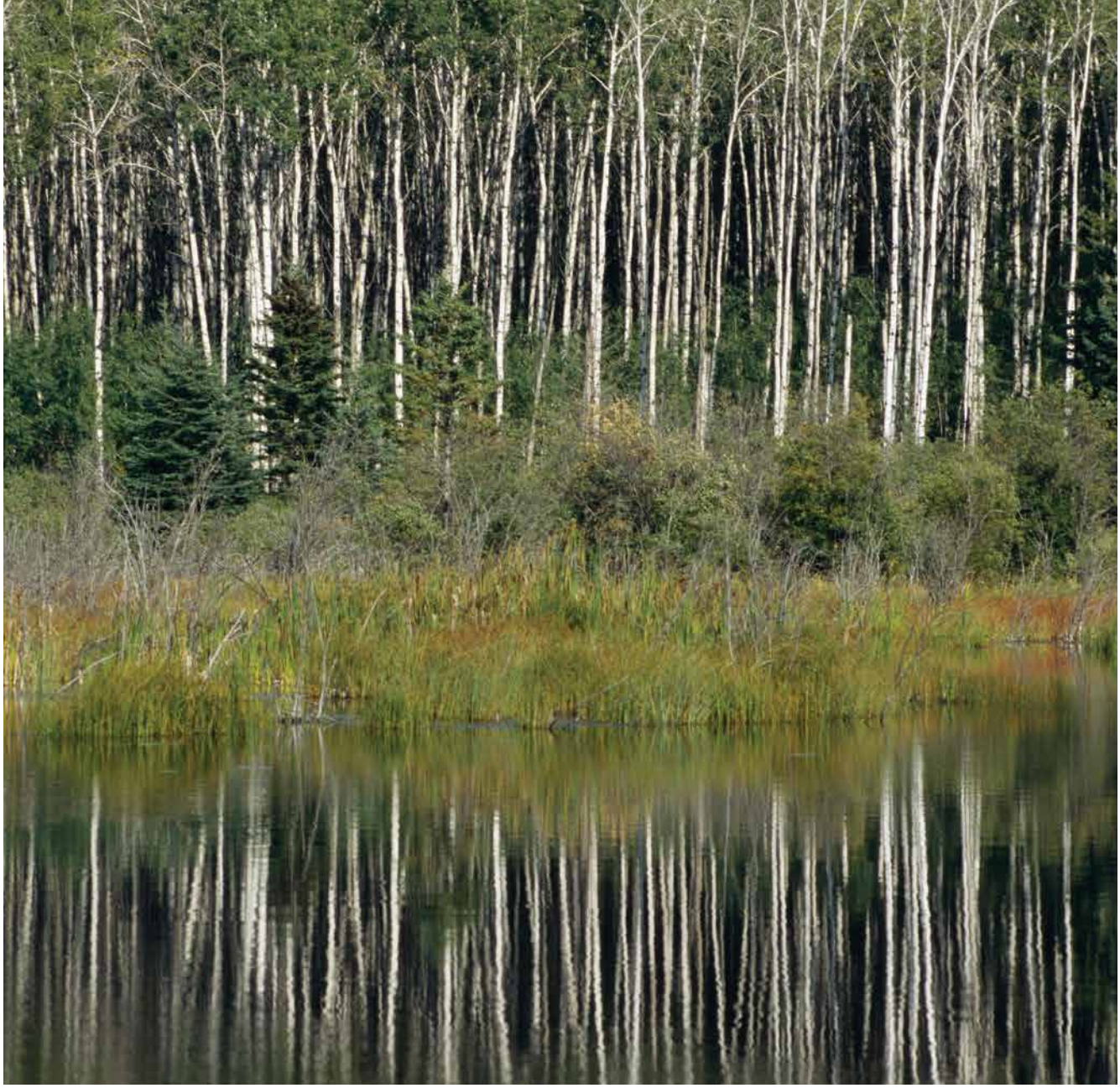
For comparison, nominal GDP for the total economy increased by 19.5% during that period, and by 5% in real terms.

- The difference in growth between nominal and real GDP is due to elevated prices for most forest products, especially lumber and panels. While some forest sector operations slowed down because of supply chain issues, most gains were the result of economic recovery from the COVID-19 pandemic and the resulting improvements in demand.
- In the wood product manufacturing subsector, real GDP increased by 10%. This increase reflects high demand from industries such as the home building and renovation market.

Gross domestic product (GDP) represents the total value of all final goods and services that are produced each year. It is a measure of the size of a country's economy. In 2020, the World Bank ranked Canada as the ninth largest economy in the world.

- The pulp and paper manufacturing subsector had minimal year-over-year growth in real GDP (0.2%) in 2021. Steady demand for certain products such as packaging and tissues and towels offset the decline in demand for other products such as newsprint.
- The contribution of the forestry and logging subsector to Canada's real GDP increased by 3% in 2021. This increase was due to the removal of some COVID-19 restrictions after they disrupted many forestry and logging operations in 2020.

Canadian forest sector's GDP, 2011–2021



Why is this indicator important?

- Contribution to nominal GDP is one of the primary indicators used to gauge the size and health of Canada's forest sector compared with the size and health of other economic sectors in a year.
- Real GDP provides an indicator for analysts to gauge the health of Canada's forest sector economy relative to the entire national economy. It measures the year-over-year change in the size of the forest sector economy, after taking inflation into account.

What is the outlook?

- Overall, Canada's forest sector is expected to grow again in 2022 as economic recovery from the COVID-19 pandemic continues. Growth will be driven by strong demand, particularly from the United States, and elevated prices for products such as lumber.
- Demand for traditional paper products such as newsprint and printing and writing paper are likely to decline in 2022, returning to their long-run, downward trend. Demand for other products such as packaging is expected to remain relatively stable, adding growth to the forest sector.

Source: Statistics Canada. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:

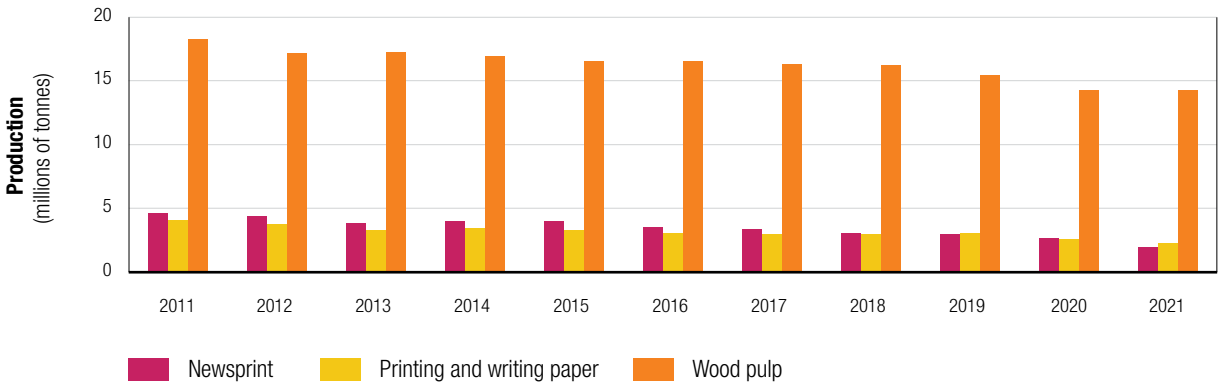
Production of forest products

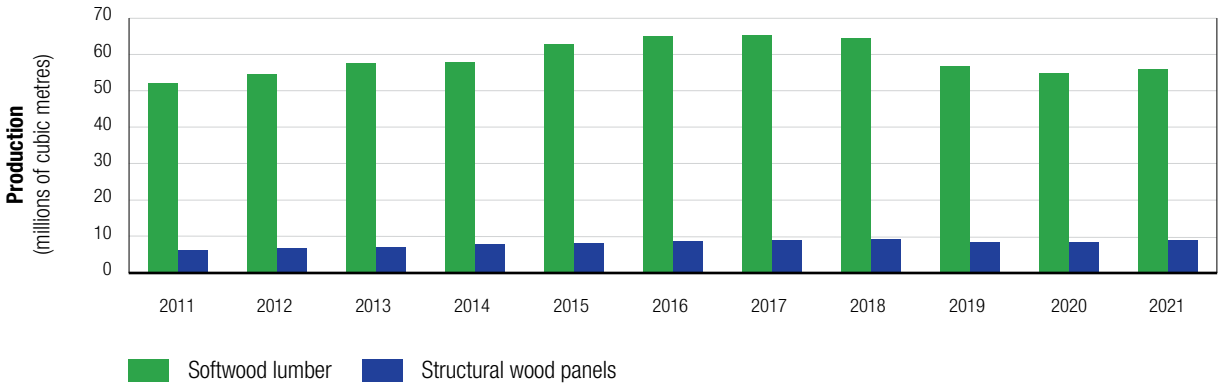
Production of solid wood products increased between 2020 and 2021. Softwood lumber production increased by 2.3%, and production of structural panels increased by 7.7%. In the pulp and paper subsector, printing and writing paper production increased by 7.4% in 2021, while wood pulp and newsprint production decreased by 0.2% and 3.5%, respectively.

Canada is the world's largest producer of newsprint, the largest producer of northern bleached softwood kraft pulp, and the second-largest producer of softwood lumber.

- The strong demand for solid wood products in 2021 was due to elevated home construction and residential renovation activity in both Canada and the United States, prompting mills to increase production where possible.
- In 2021, production of printing and writing paper recovered slightly from a significant decline in 2020. However, production remained below pre-pandemic levels as pulp and paper manufacturing has lagged in recovery from the COVID-19 pandemic.
- Transportation supply chain challenges had a negative impact on forest sector production and was worsened by various floods, landslides, wildfires, and weather events across the country.

Production of Canadian forest products, 2011–2021





Why is this indicator important?

- Canada is one of the top global manufacturers of forest products.
- Production is one of the first indicators to be affected by economic and market challenges.

What is the outlook?

- Demand for solid wood products is expected to remain strong in 2022. Further production increases are constrained by logistics issues and fibre supply challenges, particularly in British Columbia.
- The pandemic accelerated the structural decline in demand for newsprint and printing and writing paper, because it advanced digitization and resulted in a decline in demand for print advertising.
- Production of both newsprint and printing and writing paper are expected to remain on a downward trend as demand for those products continues to decline, but there are opportunities to diversify toward bioeconomy products.

Source: APA – the Engineered Wood Association; Pulp and Paper Products Council; Statistics Canada. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:

Exports of forest products

In 2021, Canada's total forest product exports increased 35% from 2020, to $44.9 billion. As the global economy began to recover from the impact of the COVID-19 pandemic, there was a surge in both demand and prices for certain forest products.

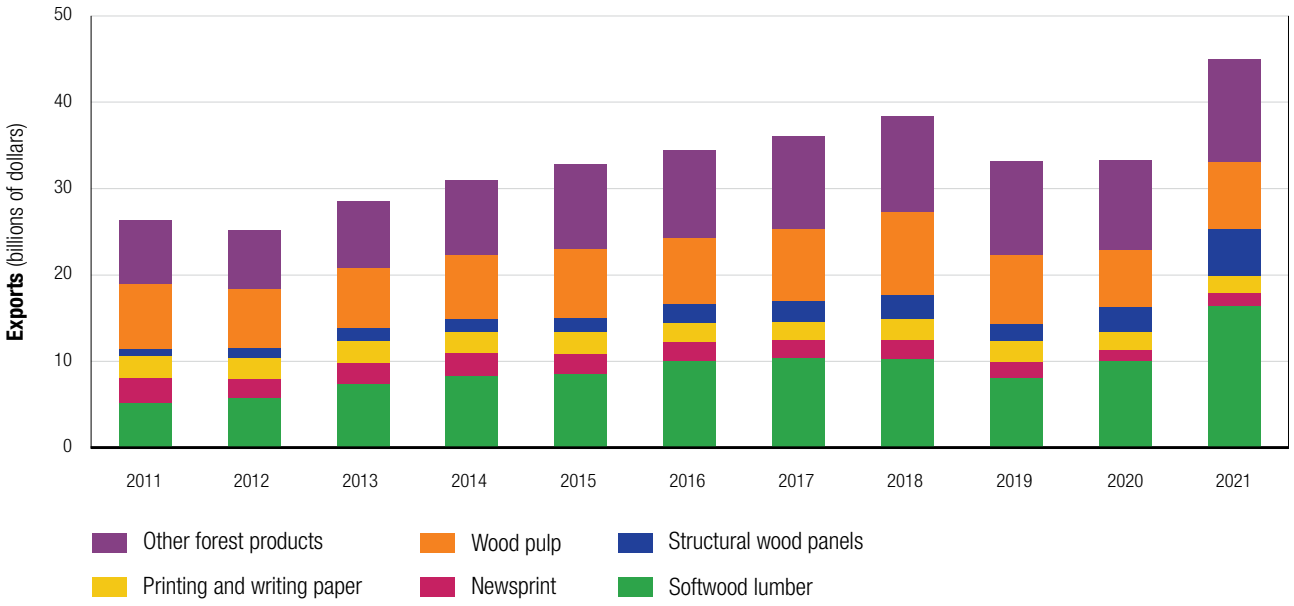
- Canadian exports of softwood lumber increased to $16.4 billion in 2021, a 63% increase relative to 2020. Canadian exports of structural panels increased by 91% to $5.5 billion. This increase in wood product exports is primarily due to strong demand from United States housing construction, demand for renovation and re-modelling, and high prices following relatively low exports in 2020 due to the pandemic.

Canada is the third-largest forest product exporter in the world (by value), behind the United States and Germany.

Canada is the world's leading exporter of softwood lumber, exporting $16.4 billion in 2021.

- Wood pulp exports increased by 15% in 2021, and the value of newsprint increased by 5%. Newsprint recovered slightly after a sharp fall in demand in 2020, mostly because of a relative increase in demand for advertising material. Exports of printing and writing paper declined by 0.4% from 2020.

Exports of Canadian forest products, 2011–2021



Why is this indicator important?

- As one of the world's largest forest product exporters, Canada is a key supplier to markets around the world.
- Canada has an abundant and renewable supply of wood sourced from sustainably managed forests. By exporting forest products, Canada's forest sector meets the needs of global consumers, including helping achieve climate change mitigation goals, while providing a substantial contribution to Canada's economy and balance of trade.

What is the outlook?

- Forest product exports that are used for building and renovating homes, such as structural wood panels and softwood lumber, will likely continue to benefit from persistent demand from the residential construction sector in the United States.
- While some pulp and paper products may benefit from an increase in demand relative to the shock of the pandemic in 2020 and 2021, products such as newsprint and printing and writing paper will continue their long-term, downward trend.

Source: Statistics Canada. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

How is the forest sector changing?

Canada's forest sector continues to adapt to changes in the global market for forest products. The COVID-19 pandemic exacerbated existing challenges for some industries such as newsprint manufacturing. For other industries such as engineered wood products, personal hygiene paper products, and bioeconomy products, the pandemic created new opportunities. A skilled and resilient forest sector labour force ensures that the sector can adapt to these changing markets, while also ensuring that the forest sector contributes to Canada's transition to a low-carbon economy.

Changing markets for Canada's forest products

In recent years, Canada's forest sector faced a significant decline in global demand in traditional paper markets as digital media options replaced many paper products. The COVID-19 pandemic accelerated this trend, as consumers rapidly switched from printed material to digital sources in light of health and safety restrictions and work-from-home policies.

The forest sector produces innovative products, materials and services that are in high demand. For example, the COVID-19 pandemic raised consumer demand for certain packaging products and personal care products, including hygienic tissue produced by Canada's forest sector. Canada continues to meet high demand for lumber, engineered wood products and other building materials. Canada's forest sector is pursuing increased development of biochemicals that can be used to produce bio-based pharmaceuticals, biodegradable plastics and industrial chemicals.

These examples show how identifying new ways to use wood fibre and to maximize the value derived from wood is essential for Canada's forest sector as it adapts to evolving market conditions. Adaptation is key for ensuring strong industry performance and an ongoing contribution to Canada's low-carbon economy.

Improving environmental performance

While developing innovative products in order to adapt to market conditions, the forest sector continues to improve environmental performance and has a leading role in Canada's low-carbon economy.

Canada's forest sector invests in technology that reduces its environmental impact. The sector has significantly reduced its carbon emissions and energy use. Between 2005 and 2019, the forest sector reduced energy use by 28% and total fossil GHG emissions (direct emissions plus indirect emissions from purchased electricity) by 46%. This is partly due to the forest sector's capacity to generate its own electricity, largely from bioenergy, which has reduced the sector's use and reliance on fossil fuels. Bioenergy generates power internally from "waste" products such as pulping liquor and wood residues.

The Government of Canada supports the forest sector in its continued improvements in environmental performance. For example, Investments in Forest Industry Transformation supports the forest sector by advancing technology adoption that improves environmental performance, and the Green Construction through Wood (GCWood) program encourages greater use of wood in construction projects.

Source: Natural Resources Canada. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:

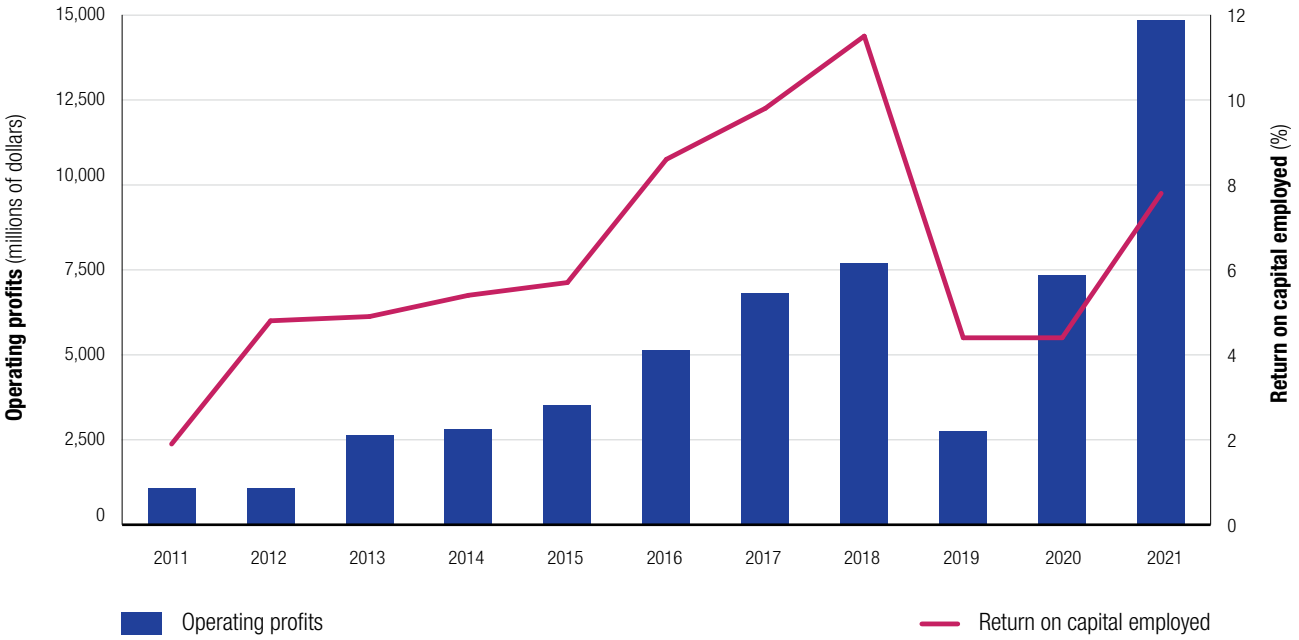
Forest sector financial performance

Financial performance in the forest sector improved significantly in 2021 from a strong performance in 2020. In 2021, operating profits more than doubled from the two-decade high reached in 2020. The return on capital employed increased from 4.4% to 7.8%, suggesting that the sector generated high economic value from capital resources.

- Commodity prices improved during the COVID-19 pandemic, helping the forest sector's financial performance in 2020 after operating profits fell to a seven-year low in 2019.
- The upward trend continued in 2021, as the price for most forest products increased above historical averages, and some products reached record high prices. High prices and strong demand resulted in strong profits.

Both operating profits and the return on capital employed indicate the economic competitiveness of the forest sector. Operating profit measures the difference between operating revenues and operating expenses. Return on capital employed measures the efficiency of capital in the sector.

Financial performance by Canada's forest sector, 2011–2021



Why is this indicator important?

- Strong financial performance is essential for the continued economic competitiveness of Canada's forest sector.
- Both operating profits and return on capital employed indicate whether Canada's forest sector can attract investment and continue to generate economic benefits for Canadians.

What is the outlook?

- Canada's continued economic recovery from the COVID-19 pandemic will help to support financial performance in the forest sector.
- Strong demand for wood products and certain pulp and paper products is expected to continue into 2022, which is expected to support prices and strong financial performance. However, fibre supply challenges, supply chain issues, and rising costs could negatively impact the sector's financial performance.

Source: Statistics Canada. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:

Forest sector secondary manufacturing

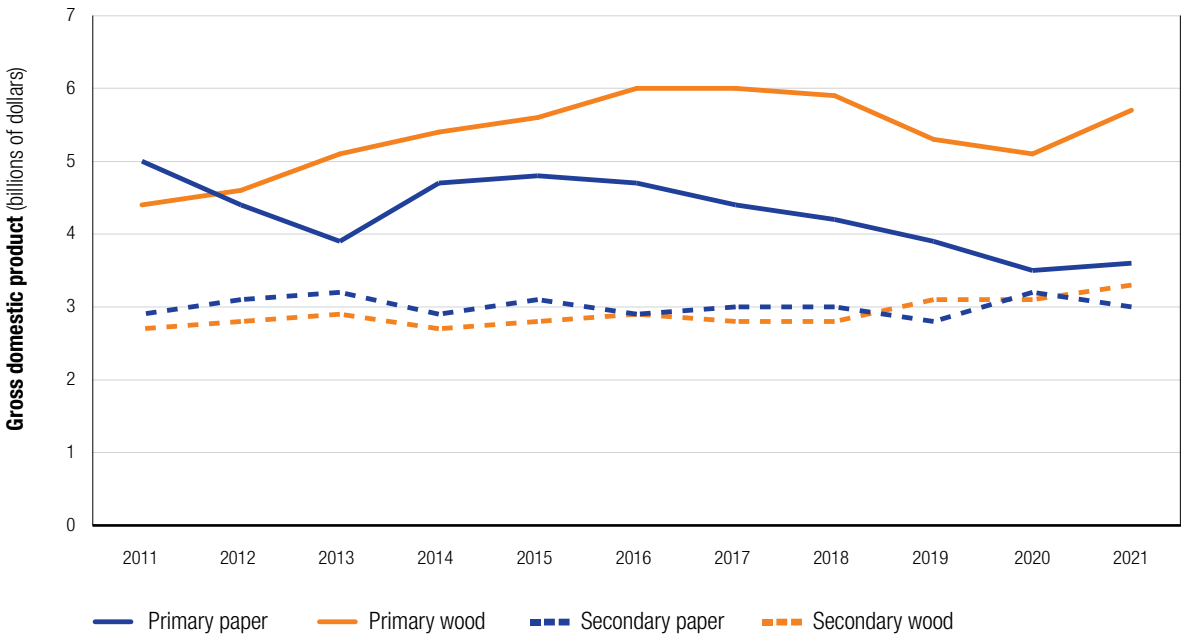
The secondary wood and paper product manufacturing industries in Canada generated $6.3 billion in real gross domestic product (GDP), an increase of 1.2% over 2020. Since 2011, real GDP from forest sector secondary manufacturing has grown 12%.

- Secondary wood manufacturing real GDP increased 5.8% over 2020 levels, while secondary paper manufacturing real GDP decreased 3.4% below 2020 levels.
- Secondary wood manufacturing was supported by very strong domestic and export sales. The moderate decrease in secondary paper manufacturing real GDP was largely due to rebalancing in demand following sharp increases in the need for hygiene products and packaging products in 2020, as well as the growth of competing imports.

Secondary wood and paper product manufacturers transform lumber and bulk paper into hundreds of intermediate and final products, from window frames and sheds to packaging and grocery bags.

The growth rate of the GDP provides an indication of how well the industry is doing. It measures the value added by the industry in terms of wages, salaries and operating surplus, plus taxes less subsidies.

Gross domestic product from primary and secondary wood and paper product subsectors, 2011–2021



Why is this indicator important?

- Secondary manufacturing of forest products generates additional employment and revenue, which in turn increases the forest sector's overall contribution to the Canadian economy.
- Secondary manufacturing helps balance changes in world markets because it is largely focused on domestic markets, which tend to be more stable than the international market on which the primary products are geared.

What is the outlook?

- Despite Canadian and global economies grappling with supply chain disruptions and inflation, demand for secondary wood and paper products is expected to remain stable.
- Housing construction trends in North America during 2022 will be important for the outlook of the secondary wood product manufacturing industries, while trends in on-line shopping, health and sanitation, and remote work will affect the secondary paper product industries.

Source: Statistics Canada. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Indicator:

Forest sector carbon emissions

Total greenhouse gas (GHG) emissions from fossil fuel use in the Canadian forest industry have been stable over the last decade following a pronounced decline between 2005 and 2010. Energy use has followed a similar trend. GHG emissions are expressed as carbon dioxide equivalents (CO_2e) to facilitate comparison of different gases based on their relative global warming potentials.

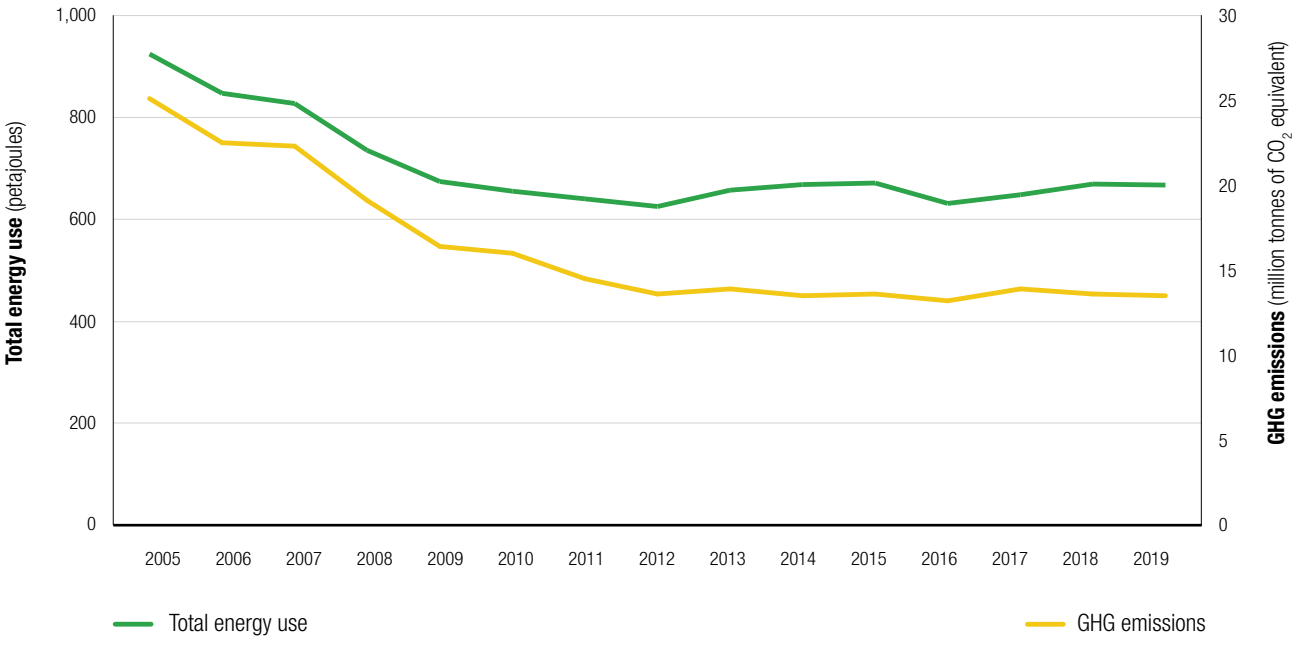
- Bioenergy use in Canada's forest sector has remained relatively stable over the past decade, representing almost 55% of the sector's total energy use annually.
- The forest industry's ability to generate its own electricity, largely from biomass, has reduced its reliance on fossil fuels. Between 2005 and 2019, the forest industry reduced total energy use by 28% and reduced total fossil GHG emissions (direct emissions plus indirect emissions from purchased electricity) by 46%.
- Wood pellet production in Canada grew from 0.4 million tonnes in 2005 to 3.2 million tonnes in 2019, of which 2.6 million tonnes were exported. Wood pellets are mostly made from sawmill residues and increasingly from damaged logs and harvest residues taken from forests that cannot be used by sawmills or pulp and paper mills. The same types of residues are also used to provide heat to an increasing number of Canadians, with 516 community systems using biomass in operation in 2019 across the country, compared to 61 in 2011.

The trends in forest sector energy use and emissions are strongly affected by:

- **structural decline in the newsprint and publishing industries**
- **related closures of pulp and paper mills**
- **investments in improving environmental performance and energy efficiency**

Wood pellet facilities have helped fill the role in the supply chain vacated by newsprint facilities by using residues from sawmills.

Fossil fuel greenhouse gas (GHG) emissions and total energy use in Canada's forest sector, 2005–2019



Why is this indicator important?

- The forest sector has transitioned to a greater use of biomass for its own energy needs while continuing to responsibly advance as a supplier of sustainable forest biomass for energy generation in other sectors. Consequently, the need to track energy use and emissions for the sector grows more important.
- Climate change mitigation benefits come from using forest biomass that is sourced sustainably for bioenergy. The preferred sources are harvest residues as well as pulping liquor and other residues from wood product manufacturing facilities. This is because they have lower GHG emissions compared to fossil fuels and have limited uses.
- Unlike most other renewable energy sources, bioenergy creates direct GHG emissions. However, these emissions are part of the natural carbon cycle, in which carbon removals from forest regrowth occur in parallel with the emissions from biomass combustion, unlike GHG emissions from the combustion of fossil fuels.

What is the outlook?

- The 2030 Emissions Reduction Plan describes the existing and new measures that will ensure Canada reaches its emissions reduction target of 40 to 45% below 2005 levels by 2030. The Plan recognizes the potential of nature-based solutions and negative emissions technologies that permanently store and remove CO_2 from the atmosphere. The Government of Canada will continue to explore the potential of such technologies in the forest sector, particularly in facilities where biomass is used as an energy source.

Source: Natural Resources Canada. See *Sources and information* for more detail, and visit us online at cfs.nrcan.gc.ca/stateoftheforests.

Statistical profiles

Canada

Population (January 2022)	**38,436,447**
Arboreal emblem	**Maple**

Forest inventory

Forest area by classification (hectares)	
Forest land	361,732,641
Other wooded land	36,249,346
Other land with tree cover	12,662,714
Forest area change (hectares, 2020)	
Afforestation	Not available
Deforestation (total; by sectors below)	49,352
Agriculture	22,378
Mining, oil and gas	15,144
Built-up	9,637
Hydroelectric	1,101
Forestry	1,092
Forest type (forest land only)	
Coniferous	67.8%
Mixedwood	15.8%
Broadleaf	10.5%
Temporarily non-treed	5.9%
Forest ownership	
Provincial	75.4%
Territorial	13.0%
Private	6.7%
Indigenous	2.1%
Federal	1.7%
Municipal	0.3%
Other	0.7%
Growing stock (million cubic metres, 2020)	
Total volume	49,900

Disturbance

Insects (hectares, 2020)	
Area defoliated by insects and containing beetle-killed trees	17,768,618
Fire (2021)	
Area burned (hectares)	4,307,520
Number of fires	6,596

Forest management

Harvesting (2020)	
Area harvested (hectares)	710,333
Volume harvested (cubic metres)	143,061,196
Regeneration (hectares, 2020)	
Area planted	422,363
Area seeded	9,210
Third-party certification (hectares, 2021)	
Area certified	158,391,456
Protected forest (IUCN categories)	
Ia Strict Nature Reserve	0.1%
Ib Wilderness area	2.4%
II Ecosystem conservation and protection	6.3%
III Conservation of natural features	0.0%
IV Conservation through active management	0.3%
V Landscape conservation and recreation	0.0%

Greenhouse gas inventory

For forest lands affected by land-use change (2020)	
Removals from the atmosphere due to afforestation (CO_2e/yr, megatonnes)	0.2
Total emissions due to deforestation (CO_2e/yr, megatonnes)	11.5
For managed forests (2020)	
Area of managed forests (hectares)	225,516,062
Total net emissions or removals to the atmosphere, all causes (CO_2e/yr, megatonnes)	3.5
Net emissions or removals due to natural disturbances (CO_2e/yr, megatonnes)	8.8
Net emissions or removals due to human forest management activities and from harvested wood products (CO_2e/yr, megatonnes)	-5.3
Transfers from the managed forest sector to the forest products sector due to harvesting (CO_2e/yr, megatonnes)	-142

Domestic economic impact	
Canadian housing starts (2021)	271,198
Contribution to nominal GDP * (current dollars, 2021)	
Forestry and logging	5,270,035,084
Pulp and paper product manufacturing	9,719,878,832
Wood product manufacturing	19,820,127,123
Total contribution to nominal GDP	34,810,041,039
Contribution to real GDP * (constant 2012 dollars, 2021)	
Forestry and logging	3,844,000,000
Pulp and paper product manufacturing	6,685,000,000
Wood product manufacturing	9,020,000,000
Total contribution to real GDP	19,549,000,000
Revenue from goods manufactured (dollars, 2020)	
Logging	9,591,110,000
Pulp and paper product manufacturing	27,303,223,000
Wood product manufacturing	36,050,943,000
Total revenue from goods manufactured	72,945,276,000
Forest sector employment	
Employment (number, 2021)	
Survey of Employment, Payrolls and Hours	177,693
Canadian System of National Accounts	205,365
Natural Resources Satellite Account	210,706
Direct and indirect employment	345,825
Wages and salaries (dollars, 2020)	
Logging	1,664,414,000
Pulp and paper manufacturing	3,593,874,000
Wood product manufacturing	5,297,817,000
Total wages and salaries	10,556,105,000
Trade	
Balance of trade (total exports, dollars, 2021)	31,957,683,387
Value of exports (dollars, 2021)	
Primary wood products	1,327,619,745
Pulp and paper products	16,702,542,987
Wood-fabricated materials	26,866,265,998
Total value of exports	44,896,428,730
Value of imports (dollars, 2021)	
Primary wood products	537,895,074
Pulp and paper products	8,116,421,363
Wood-fabricated materials	4,284,428,906
Total value of imports	12,938,745,343

Domestic production and investment	
Production (2021)	
Hardwood lumber (cubic metres)	873,500
Softwood lumber (cubic metres)	55,950,700
Newsprint (tonnes)	1,888,000
Printing and writing paper (tonnes)	2,418,000
Wood pulp (tonnes)	14,266,000
Structural panels (plywood and oriented strandboard, cubic metres)	8,938,385
Capital expenditures (dollars, 2021)	
Forestry and logging	544,700,000
Pulp and paper product manufacturing	1,011,100,000
Wood product manufacturing	1,104,000,000
Total capital expenditures	2,659,800,000
Repair expenditures (dollars, 2020)	
Forestry and logging	517,400,000
Pulp and paper product manufacturing	1,124,700,000
Wood product manufacturing	1,151,700,000
Total repair expenditures	2,793,800,000
Domestic consumption	
Consumption (2021)	
Hardwood lumber (cubic metres)	1,038,494
Softwood lumber (cubic metres)	19,963,049
Newsprint (tonnes)	-90,833
Printing and writing paper (tonnes)	937,245
Wood pulp (tonnes)	6,643,821
Structural panels (plywood and oriented strandboard, cubic metres)	4,111,910

See the *Sources and information* section for background information and sources for the statistics presented in these tables.

* See the *Sources and information* section for information on GDP from Statistics Canada's Natural Resources Satellite Account.

British Columbia

Population (January 2022)	**5,249,635**
Arboreal emblem	**Western redcedar**
Disturbance	
Insects (hectares, 2020)	
Area defoliated by insects and containing beetle-killed trees	5,083,672
Fire (2021)	
Area burned (hectares)	869,255
Number of fires	1,635
Forest management	
Harvesting (2020)	
Area harvested (hectares)	136,386
Volume harvested (cubic metres)	54,542,442
Regeneration (hectares, 2020)	
Area planted	203,980
Area seeded	1,761
Third-party certification (hectares, 2021)	
Area certified	40,599,622
Domestic economic impact	
Housing starts (2021)	47,607
Revenue from goods manufactured (dollars, 2020)	
Logging	4,299,380,000
Pulp and paper product manufacturing	4,152,719,000
Wood product manufacturing	11,287,029,000
Total revenue from goods manufactured	19,739,128,000
Forest sector employment	
Employment (number, 2021)	
Canadian System of National Accounts	55,715
Survey of Employment, Payrolls and Hours	47,640
Wages and salaries (dollars, 2020)	
Logging	733,153,000
Pulp and paper product manufacturing	551,945,000
Wood product manufacturing	1,511,963,000
Total wages and salaries	2,797,061,000
Trade	
Balance of trade (total exports, dollars, 2021)	13,647,886,409
Value of domestic exports (dollars, 2021)	
Primary wood products	999,315,529
Pulp and paper products	3,956,201,370
Wood-fabricated materials	11,158,910,813
Total value of domestic exports	16,114,427,712
Value of imports (dollars, 2021)	
Primary wood products	105,708,336
Pulp and paper products	1,031,769,790
Wood-fabricated materials	1,329,063,177
Total value of imports	2,466,541,303

Alberta

Population (January 2022)	**4,464,170**
Arboreal emblem	**Lodgepole pine**
Disturbance	
Insects (hectares, 2020)	
Area defoliated by insects and containing beetle-killed trees	1,173,924
Fire (2021)	
Area burned (hectares)	54,088
Number of fires	1,342
Forest management	
Harvesting (2020)	
Area harvested (hectares)	99,712
Volume harvested (cubic metres)	29,653,479
Regeneration (hectares, 2020)	
Area planted	79,776
Area seeded	2,939
Third-party certification (hectares, 2021)	
Area certified	20,549,817
Domestic economic impact	
Housing starts (2021)	31,935
Revenue from goods manufactured (dollars, 2020)	
Logging	1,206,152,000
Pulp and paper product manufacturing	2,115,846,000
Wood product manufacturing	5,165,065,000
Total revenue from goods manufactured	8,487,063,000
Forest sector employment	
Employment (number, 2021)	
Canadian System of National Accounts	17,090
Survey of Employment, Payrolls and Hours	15,759
Wages and salaries (dollars, 2020)	
Logging	217,004,000
Pulp and paper product manufacturing	Not available
Wood product manufacturing	714,856,000
Total wages and salaries	931,860,000
Trade	
Balance of trade (total exports, dollars, 2021)	5,587,805,898
Value of domestic exports (dollars, 2021)	
Primary wood products	24,356,719
Pulp and paper products	1,795,550,916
Wood-fabricated materials	4,106,178,598
Total value of domestic exports	5,926,086,233
Value of imports (dollars, 2021)	
Primary wood products	6,267,892
Pulp and paper products	177,719,973
Wood-fabricated materials	154,292,470
Total value of imports	338,280,335

Saskatchewan

Population (January 2022)	**1,180,867**
Arboreal emblem	**White birch**
Disturbance	
Insects (hectares, 2020)	
Area defoliated by insects and containing beetle-killed trees	38,507
Fire (2021)	
Area burned (hectares)	956,084
Number of fires	635
Forest management	
Harvesting (2020)	
Area harvested (hectares)	22,968
Volume harvested (cubic metres)	4,058,297
Regeneration (hectares, 2020)	
Area planted	5,522
Area seeded	0
Third-party certification (hectares, 2021)	
Area certified	6,672,844
Domestic economic impact	
Housing starts (2021)	4,172
Revenue from goods manufactured (dollars, 2020)	
Logging	142,649,000
Pulp and paper product manufacturing	Not available
Wood product manufacturing	888,690,000
Total revenue from goods manufactured	1,031,339,000
Forest sector employment	
Employment (number, 2021)	
Canadian System of National Accounts	3,465
Survey of Employment, Payrolls and Hours	1,444
Wages and salaries (dollars, 2020)	
Logging	19,170,000
Pulp and paper product manufacturing	Not available
Wood product manufacturing	92,630,000
Total wages and salaries	111,800,000
Trade	
Balance of trade (total exports, dollars, 2021)	982,065,579
Value of domestic exports (dollars, 2021)	
Primary wood products	3,774,540
Pulp and paper products	221,536,595
Wood-fabricated materials	870,912,428
Total value of domestic exports	1,096,223,563
Value of imports (dollars, 2021)	
Primary wood products	9,575,661
Pulp and paper products	68,351,617
Wood-fabricated materials	36,230,706
Total value of imports	114,157,984

Manitoba

Population (January 2022)	**1,386,333**
Arboreal emblem	**White spruce**
Disturbance	
Insects (hectares, 2020)	
Area defoliated by insects and containing beetle-killed trees	2,688,047
Fire (2021)	
Area burned (hectares)	1,266,777
Number of fires	460
Forest management	
Harvesting (2020)	
Area harvested (hectares)	8,946
Volume harvested (cubic metres)	1,252,415
Regeneration (hectares, 2020)	
Area planted	3,412
Area seeded	0
Third-party certification (hectares, 2021)	
Area certified	11,373,530
Domestic economic impact	
Housing starts (2021)	8,023
Revenue from goods manufactured (dollars, 2020)	
Logging	43,247,000
Pulp and paper product manufacturing	Not available
Wood product manufacturing	551,430,000
Total revenue from goods manufactured	594,677,000
Forest sector employment	
Employment (number, 2021)	
Canadian System of National Accounts	4,840
Survey of Employment, Payrolls and Hours	3,511
Wages and salaries (dollars, 2020)	
Logging	11,227,000
Pulp and paper product manufacturing	86,295,000
Wood product manufacturing	115,759,000
Total wages and salaries	213,281,000
Trade	
Balance of trade (total exports, dollars, 2021)	42,269,258
Value of domestic exports (dollars, 2021)	
Primary wood products	1,614,628
Pulp and paper products	352,519,093
Wood-fabricated materials	323,036,499
Total value of domestic exports	677,170,220
Value of imports (dollars, 2021)	
Primary wood products	10,418,345
Pulp and paper products	476,629,456
Wood-fabricated materials	147,853,161
Total value of imports	634,900,962

Ontario

Population (January 2022)	**14,915,270**
Arboreal emblem	**Eastern white pine**
Disturbance	
Insects (hectares, 2020)	
Area defoliated by insects and containing beetle-killed trees	2,114,198
Fire (2021)	
Area burned (hectares)	793,326
Number of fires	1,198
Forest management	
Harvesting (2020)	
Area harvested (hectares)	125,456
Volume harvested (cubic metres)	14,025,132
Regeneration (hectares, 2020)	
Area planted	43,219
Area seeded	4,510
Third-party certification (hectares, 2021)	
Area certified	29,149,719
Domestic economic impact	
Housing starts (2021)	99,566
Revenue from goods manufactured (dollars, 2020)	
Logging	1,046,645,000
Pulp and paper product manufacturing	8,821,907,000
Wood product manufacturing	5,915,020,000
Total revenue from goods manufactured	15,783,572,000
Forest sector employment	
Employment (number, 2021)	
Canadian System of National Accounts	44,465
Survey of Employment, Payrolls and Hours	36,579
Wages and salaries (dollars, 2020)	
Logging	188,020,000
Pulp and paper product manufacturing	1,268,745,000
Wood product manufacturing	1,019,094,000
Total wages and salaries	2,475,859,000
Trade	
Balance of trade (total exports, dollars, 2021)	-763,885,383
Value of domestic exports (dollars, 2021)	
Primary wood products	53,091,970
Pulp and paper products	2,773,543,171
Wood-fabricated materials	3,153,822,222
Total value of domestic exports	5,980,457,363
Value of imports (dollars, 2021)	
Primary wood products	80,770,883
Pulp and paper products	4,805,145,715
Wood-fabricated materials	1,858,426,148
Total value of imports	6,744,342,746

Quebec

Population (January 2022)	**8,631,147**
Arboreal emblem	**Yellow birch**
Disturbance	
Insects (hectares, 2020)	
Area defoliated by insects and containing beetle-killed trees	6,246,502
Fire (2021)	
Area burned (hectares)	49,728
Number of fires	625
Forest management	
Harvesting (2020)	
Area harvested (hectares)	198,990
Volume harvested (cubic metres)	25,925,399.02
Regeneration (hectares, 2020)	
Area planted	64,868
Area seeded	0
Third-party certification (hectares, 2021)	
Area certified	43,174,309
Domestic economic impact	
Housing starts (2021)	67,810
Revenue from goods manufactured (dollars, 2020)	
Logging	2,072,306,000
Pulp and paper product manufacturing	8,686,475,000
Wood product manufacturing	9,831,899,000
Total revenue from goods manufactured	20,590,680,000
Forest sector employment	
Employment (number, 2021)	
Canadian System of National Accounts	62,395
Survey of Employment, Payrolls and Hours	56,756
Wages and salaries (dollars, 2020)	
Logging	353,290,000
Pulp and paper product manufacturing	1,100,908,000
Wood product manufacturing	1,485,700,000
Total wages and salaries	2,939,898,000
Trade	
Balance of trade (total exports, dollars, 2021)	9,570,743,501
Value of domestic exports (dollars, 2021)	
Primary wood products	140,545,483
Pulp and paper products	5,947,897,113
Wood-fabricated materials	5,753,927,472
Total value of domestic exports	11,842,370,068
Value of imports (dollars, 2021)	
Primary wood products	272,812,107
Pulp and paper products	1,331,491,054
Wood-fabricated materials	667,323,406
Total value of imports	2,271,626,567

New Brunswick

Population (January 2022)	**794,300**
Arboreal emblem	**Balsam fir**
Disturbance	
Insects (hectares, 2020)	
Area defoliated by insects and containing beetle-killed trees	0
Fire (2021)	
Area burned (hectares)	427
Number of fires	180
Forest management	
Harvesting (2020)	
Area harvested (hectares)	79,047
Volume harvested (cubic metres)	9,341,187
Regeneration (hectares, 2020)	
Area planted	12,384
Area seeded	0
Third-party certification (hectares, 2021)	
Area certified	4,245,580
Domestic economic impact	
Housing starts (2021)	3,829
Revenue from goods manufactured (dollars, 2020)	
Logging	646,290,000
Pulp and paper product manufacturing	2,089,704,000
Wood product manufacturing	1,821,978,000
Total revenue from goods manufactured	4,557,972,000
Forest sector employment	
Employment (number, 2021)	
Canadian System of National Accounts	11,705
Survey of Employment, Payrolls and Hours	10,478
Wages and salaries (dollars, 2020)	
Logging	106,265,000
Pulp and paper product manufacturing	Not available
Wood product manufacturing	Not available
Total wages and salaries	106,265,000
Trade	
Balance of trade (total exports, dollars, 2021)	2,135,527,521
Value of domestic exports (dollars, 2021)	
Primary wood products	63,054,709
Pulp and paper products	1,188,649,518
Wood-fabricated materials	1,179,330,568
Total value of domestic exports	2,431,034,795
Value of imports (dollars, 2021)	
Primary wood products	52,309,618
Pulp and paper products	181,046,806
Wood-fabricated materials	62,150,850
Total value of imports	295,507,274

Nova Scotia

Population (January 2022)	**998,832**
Arboreal emblem	**Red spruce**
Disturbance	
Insects (hectares, 2020)	
Area defoliated by insects and containing beetle-killed trees	18,757
Fire (2021)	
Area burned (hectares)	197
Number of fires	113
Forest management	
Harvesting (2020)	
Area harvested (hectares)	25,331
Volume harvested (cubic metres)	2,502,463
Regeneration (hectares, 2020)	
Area planted	5,386
Area seeded	0
Third-party certification (hectares, 2021)	
Area certified	1,267,392
Domestic economic impact	
Housing starts (2021)	5,975
Revenue from goods manufactured (dollars, 2020)	
Logging	96,153,000
Pulp and paper product manufacturing	Not available
Wood product manufacturing	Not available
Total revenue from goods manufactured	96,153,000
Forest sector employment	
Employment (number, 2021)	
Canadian System of National Accounts	3,805
Survey of Employment, Payrolls and Hours	2,172
Wages and salaries (dollars, 2020)	
Logging	24,841,000
Pulp and paper product manufacturing	Not available
Wood product manufacturing	Not available
Total wages and salaries	24,841,000
Trade	
Balance of trade (total exports, dollars, 2021)	544,810,798
Value of domestic exports (dollars, 2021)	
Primary wood products	40,988,415
Pulp and paper products	297,718,659
Wood-fabricated materials	275,212,904
Total value of domestic exports	613,919,978
Value of imports (dollars, 2021)	
Primary wood products	32,232
Pulp and paper products	40,021,501
Wood-fabricated materials	29,055,447
Total value of imports	69,109,180

Prince Edward Island

Population (January 2022)	**165,936**
Arboreal emblem	**Red oak**
Disturbance	
Insects (hectares, 2020)	
Area defoliated by insects and containing beetle-killed trees	0
Fire (2021)	
Area burned (hectares)	0.1
Number of fires	1
Forest management	
Harvesting (2020)	
Area harvested (hectares)	2,652
Volume harvested (cubic metres)	410,636
Regeneration (hectares, 2020)	
Area planted	369
Area seeded	0
Third-party certification (hectares, 2021)	
Area certified	0
Domestic economic impact	
Housing starts (2021)	1,260
Revenue from goods manufactured (dollars, 2020)	
Logging	10,770,000
Pulp and paper product manufacturing	Not available
Wood product manufacturing	Not available
Total revenue from goods manufactured	10,770,000
Forest sector employment	
Employment (number, 2021)	
Canadian System of National Accounts	620
Survey of Employment, Payrolls and Hours	Not available
Wages and salaries (dollars, 2020)	
Logging	1,787,000
Pulp and paper product manufacturing	Not available
Wood product manufacturing	Not available
Total wages and salaries	1,787,000
Trade	
Balance of trade (total exports, dollars, 2021)	24,588,690
Value of domestic exports (dollars, 2021)	
Primary wood products	64
Pulp and paper products	24,464,146
Wood-fabricated materials	164,986
Total value of domestic exports	24,629,196
Value of imports (dollars, 2021)	
Primary wood products	Not available
Pulp and paper products	40,497
Wood-fabricated materials	9
Total value of imports	40,506

Newfoundland and Labrador

Population (January 2022)	**521,758**
Arboreal emblem	**Black spruce**
Disturbance	
Insects (hectares, 2020)	
Area defoliated by insects and containing beetle-killed trees	3,533
Fire (2021)	
Area burned (hectares)	324
Number of fires	82
Forest management	
Harvesting (2020)	
Area harvested (hectares)	7,509
Volume harvested (cubic metres)	1,299,627
Regeneration (hectares, 2020)	
Area planted	3,433
Area seeded	0
Third-party certification (hectares, 2021)	
Area certified	1,358,643
Domestic economic impact	
Housing starts (2021)	1,021
Revenue from goods manufactured (dollars, 2020)	
Logging	26,836,000
Pulp and paper product manufacturing	Not available
Wood product manufacturing	Not available
Total revenue from goods manufactured	26,836,000
Forest sector employment	
Employment (number, 2021)	
Canadian System of National Accounts	960
Survey of Employment, Payrolls and Hours	36
Wages and salaries (dollars, 2020)	
Logging	9,521,000
Pulp and paper product manufacturing	Not available
Wood product manufacturing	Not available
Total wages and salaries	9,521,000
Trade	
Balance of trade (total exports, dollars, 2021)	185,422,250
Value of domestic exports (dollars, 2021)	
Primary wood products	877,688
Pulp and paper products	144,457,757
Wood-fabricated materials	44,325,289
Total value of domestic exports	189,660,734
Value of imports (dollars, 2021)	
Primary wood products	Not available
Pulp and paper products	4,204,957
Wood-fabricated materials	33,530
Total value of imports	4,238,484

Yukon

Population (January 2022)	**43,095**
Arboreal emblem	**Subalpine fir**
Disturbance	
Insects (hectares, 2020)	
Area defoliated by insects and containing beetle-killed trees	788
Fire (2021)	
Area burned (hectares)	118,126
Number of fires	112
Forest management	
Harvesting (2020)	
Area harvested (hectares)	3,002
Volume harvested (cubic metres)	13,450
Regeneration (hectares, 2020)	
Area planted	14
Area seeded	0
Third-party certification (hectares, 2021)	
Area certified	0
Trade	
Balance of trade (total exports, dollars, 2021)	Not available
Value of domestic exports (dollars, 2021)	
Primary wood products	0
Pulp and paper products	0
Wood-fabricated materials	Not available
Total value of domestic exports	Not available
Value of imports (dollars, 2021)	
Primary wood products	0
Pulp and paper products	0
Wood-fabricated materials	444,219
Total value of imports	444,219

Northwest Territories

Population (January 2022)	**45,515**
Arboreal emblem	**Tamarack**
Disturbance	
Insects (hectares, 2020)	
Area defoliated by insects and containing beetle-killed trees	400,690
Fire (2021)	
Area burned (hectares)	156,630
Number of fires	140
Forest management	
Harvesting (2020)	
Area harvested (hectares)	334
Volume harvested (cubic metres)	36,669
Regeneration (hectares, 2020)	
Area planted	Not available
Area seeded	Not available
Third-party certification (hectares, 2021)	
Area certified	0
Trade	
Balance of trade (total exports, dollars, 2021)	4,647
Value of domestic exports (dollars, 2021)	
Primary wood products	0
Pulp and paper products	4,649
Wood-fabricated materials	0
Total value of domestic exports	4,649
Value of imports (dollars, 2021)	
Primary wood products	0
Pulp and paper products	0
Wood-fabricated materials	2
Total value of imports	2

Nunavut

Population (January 2022)	**39,589**
Trade	
Balance of trade (total exports, dollars, 2021)	Not available
Value of domestic exports (dollars, 2021)	
Primary wood products	0
Pulp and paper products	0
Wood-fabricated materials	0
Total value of domestic exports	0
Value of imports (dollars, 2021)	
Primary wood products	0
Pulp and paper products	0
Wood-fabricated materials	0
Total value of imports	0

Sources and information

The data in this report are derived from a number of sources, which are identified here by their relevant section. Where necessary, data have been edited for accuracy and consistency. All data are subject to revision.

In most cases, the data represent the year before the reporting period. However, when they are gathered from several sources, it takes longer to analyze and produce them. In these cases, the numbers reflect results from two or three years before the reporting period.

While most figures are calculated for the calendar year, some are based on the federal government's fiscal year (April 1 to March 31). Numbers are rounded off. In the case of employment data, they are rounded to the nearest hundred. All dollar figures, unless specified otherwise, are in Canadian dollars.

It may not be possible to directly compare the data from the various sections, as they come from several sources that may compile their statistics differently from each other.

Dates on which data were accessed online are now included for the Food and Agriculture Organization of the United Nations, the National Forest Inventory, the National Forestry Database, the Canadian Interagency Forest Fire Centre, and Statistics Canada.

The 2022 State of Canada's Forests Annual Report: An overview

Food and Agriculture Organization of the United Nations. 2020. *Global Forest Resources Assessment 2020: Main Report.* Rome, Italy. https://doi.org/10.4060/ca9825en

Additional information can be found at:

- Montréal Process Working Group. https://montreal-process.org/
- United Nations. 2019. *Global forest goals and targets.* https://www.un.org/esa/forests/wp-content/uploads/2019/04/Global-Forest-Goals-booklet-Apr-2019.pdf

Map: A sampling of old-growth forests in Canada

Featured National Forest Inventory (NFI) ground plots

Data from the most recent field measurements for each featured plot were downloaded from the NFI database. Featured plots were selected to show old-growth forest conditions that can be found across Canada. NFI ground plot data are available upon request from https://nfi.nfis.org/en/.

Old-growth forest characteristics

Plot number, ecozone, site age, site height, number of live trees per hectare, live tree biomass, standing deadwood mass, downed deadwood (woody debris) mass, and number of plant species are reported for each featured plot to give an indication of what these forests are like.

Old-growth forest site			Old-growth forest characteristic						
Plot ID	Province / Territory	Ecozone	Site age (years)	Site height (metres)	Number of live trees per hectare	Live tree biomass (tonnes/ hectare)	Standing deadwood mass (tonnes/ hectare)	Downed deadwood mass (tonnes/ hectare)	Number of plant species
1486291	British Columbia	Pacific Maritime	722	33	400	820	55	194	38
1211116	British Columbia	Montane Cordillera	221	20	800	145	25	64	30
922181	Northwest Territories	Taiga Plains	304	8	375	17	2	12	54
916171	Quebec	Boreal Shield	242	14	500	38	10	18	26
696201	Newfoundland and Labrador	Boreal Shield	233	7	400	40	3	3	22
1170451	Ontario	Boreal Shield	197	13	275	28	11	32	27

Number of plant species: This information is gathered through the NFI ecological plots and includes bryoids, herbs, shrubs and trees.

Site age definition: "The average total age of the dominant and co-dominant trees of the main species forming the stand (site trees), expressed in years." – NFI ground plot data dictionary, page 53. Definitions of dominant and co-dominant crown classes can be found in the NFI ground plot sampling guidelines document, page 122.

Site height definition: "The average height of dominant and co-dominant trees of the main species forming the stand (site trees), expressed in m." – NFI ground plot data dictionary, page 53.

Canada's National Forest Inventory. Ground plot. Documentation. https://nfi.nfis.org/en/ground_plot

National Forest Inventory. 2021. *Canada's National Forest Inventory – national standards for ground plots data dictionary, version 5.2.2*. 181 pages. http://nfi.nfis.org

Natural Resources Canada. 2008. *Canada's National Forest Inventory ground sampling guidelines: specifications for ongoing measurement.* Canadian Forest Service, Pacific Forestry Centre, Victoria, BC. 271 pages. https://cfs.nrcan.gc.ca/publications?id=29402

Forest area by age class graph

NFI first remeasurement data reports (2007–2017). Table 5.0, Area of forest land by forest type and age class in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/CA/html/CA_T5_FORAGE20_AREA_en.html (accessed May 9, 2022).

Forest area by age class includes all forests in Canada. Table 5.0 also reports forest area with age class "other", which includes missing or unknown age. These areas are most commonly uneven aged stands (no single age) or temporarily non-stocked forest areas (no trees or very early regeneration) and are not shown in the figure.

Reference map

Beaudoin, A., Bernier, P.Y., et al. 2014. Mapping attributes of Canada's forests at moderate resolution through kNN and MODIS imagery. *Canadian Journal of Forest Research* 44(5): 521–532. https://doi.org/10.1139/cjfr-2013-0401

Maps of Canada's forest attributes for 2001 and 2011. https://open.canada.ca/data/en/dataset/ec9e2659-1c29-4ddb-87a2-6aced147a990
On this map, Forest has a crown closure >=25% and Open Forest has a crown closure between 10 to 25%.

Infographic: Canada's forests provide a diversity of benefits

Canada's forests provide a wealth of ecological resources

Boreal Songbird Initiative. *Fast Facts: Fascinating facts about boreal birds and the boreal forest.* https://www.borealbirds.org/fast-facts-boreal-forest (accessed April 4, 2022).

Food and Agricultural Organization of the United Nations. 2020. *The state of the world's forests 2020: Forests, biodiversity and people.* Rome, Italy. http://www.fao.org/documents/card/en/c/ca8642en

Food and Agriculture Organization of the United Nations. 2020. *Global Forest Resources Assessment 2020: Country Report: Canada*. Rome, Italy. http://www.fao.org/3/ca9983en/ca9983en.pdf

National Forest Inventory. Standard reports, Table 4.2, Area (1000 ha) of forest and non-forest land by boreal zone in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/BORE/html/BORE_T4_FOR_AREA_en.html (accessed April 4, 2022).

National Forest Inventory. Standard reports, Table 5.0, Area (1000 ha) of forest land by forest type and age class in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/CA/html/CA_T5_FORAGE20_AREA_en.html (accessed April 4, 2022).

Canada protects its forests and sustainably manages their resources

Certification Canada. Canadian statistics. http://certificationcanada.org/en/statistics/canadian-statistics (accessed May 25, 2022).

- If a forest area has been certified to more than one of the three sustainable forest management standards (Canadian Standards Association, Sustainable Forestry Initiative, and Forest Stewardship Council), the area is counted only once. Therefore, the total certification for sustainable forest management standards may be less than the sum of the individual totals for these standards. The independently certified forest area is calculated using Forest Management Units, which include streams, lakes, rivers and roads.

Food and Agriculture Organization of the United Nations. 2020. *Global Forest Resources Assessment 2020: Country Report: Canada.* Rome, Italy. http://www.fao.org/3/ca9983en/ca9983en.pdf

- Geographic boundaries of legally established protected areas are from the Conservation Areas Reporting and Tracking System (CARTS), published and maintained by the Canadian Council on Ecological Areas (CCEA) (http://www.ccea.org).
- Data on forest area are from Canada's National Forest Inventory baseline survey, completed during 2000–2006.
- Global Forest Resources Assessment (FRA) definition used for "Forest area within legally established protected areas" includes IUCN Categories I – IV and excludes IUCN Categories V – VI.
- NFI forest area data were overlaid with the geographic boundaries of legally established protected areas, from CARTS, and classified according to IUCN code. NFI statistical estimation procedures were used to estimate the area of forest in legally established protected areas by summing across IUCN codes, consistent with the FRA 2020 definition of legally protected. Estimates were calculated for 1990, 2000, 2010 and 2016 in this manner, using protected areas established as of 1990, 2000, 2010 and 2016, respectively. For simplicity, the estimate for 2016 is also reported in 2015. Values for 2017–2020 have been carried over from 2016. No forecasting was done for this section. No adjustments were made to account for changes in forest area. It is assumed that negligible land-use change occurred in legally established protected areas.

National Forest Inventory. Standard reports, Table 12.0, Area (1000 ha) of forest land by ownership in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/CA/html/CA_T12_FOROWN_AREA_en.html (accessed May 5, 2022).

Sources for Deforestation, Forest insects, Forest fires and Forest area harvested are found in their respective indicator source sections.

Canada's forests are managed for diverse objectives and products

Hinterland's Who's Who. *Biodiversity.* https://www.hww.ca/en/issues-and-topics/biodiversity.html (accessed April 18, 2022).

National Forest Inventory. Standard reports, Table 22.0, Area (1000 ha) of forest land by IUCN category and ownership in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/CA/html/CA_T22_PSOWN_AREA_en.html (accessed April 4, 2022).

- IUCN: International Union for Conservation of Nature (http://www.iucn.org). Data obtained from the Canadian Protected and Conserved Areas Database (CPCAD) (https://www.canada.ca/en/environment-climate-change/services/national-wildlife-areas/protected-conserved-areas-database.html).
- "Other" includes the following IUCN categories: Protected with missing or unknown category, Protected area managed mainly for landscape/seascape protection and recreation, Protected area managed mainly for conservation of specific natural features, and Sustainable use of natural resources.

Canada's forests provide a diversity of social and economic values

Statistics Canada. *2016 Census of Population.* https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/index-eng.cfm

Sources for Forest sector employment, Forest sector average earnings and Forest sector gross domestic product are found in their respective indicator source sections.

Canada's forests and forest sector play a key role in climate change adaptation and mitigation

Alliance for Community Trees. 2011. *Benefits of trees and urban forests: A research list.* http://www.actrees.org/files/Research/benefits_of_trees.pdf

Natural Resources Canada. 2021. *The state of mass timber in Canada 2021.* https://www.nrcan.gc.ca/our-natural-resources/forests/industry-and-trade/forest-products-applications/mass-timber-construction-canada/23428

Sources for Forest regeneration and Forest carbon emissions and removals are found in their respective indicator source sections.

Article: Diversity: The key to resilience in forest ecosystems

Arsenault, A., Jedorre, G., et al. 2020. *Boreal sentinels: Forest biodiversity early warning system/So nipukt kelo't keliket nipuket mimajuaqn.* Presented at the 2020 Canadian Botanical Association meeting. https://abc-cba2020.uqat.ca/index.php

Aubin, I., Cardou, F., et al. 2020. Managing data locally to answer questions globally: The role of collaborative science in ecology. *Journal of Vegetation Science* 31: 509–517. https://doi.org/10.1111/jvs.12864

Birds of Canada: http://www.birdcanada.com/birds-of-canada/

Canadian Forest Service collections: https://apps-scf-cfs.rncan.gc.ca/collections/en/index

Canadian Trait Network. http://cfs.cloud.nrcan.gc.ca/ctn/

FastPheno project

- The FastPheno project is co-directed by Ingo Ensminger, from the University of Toronto, Nathalie Isabel and Julie Godbout, from the Ministère des Forêts, de la Faune et des Parcs du Québec (MFFPQ), and Ilga Porth, from the Université Laval. This project will be conducted in collaboration with Jean-François Côté and Patrick Lenz, from the Canadian Wood Fibre Centre, and other MFFPQ representatives.

Gauthier, S., Bernier, P., et al. 2014. Climate change vulnerability and adaptation in the managed Canadian boreal forest. *Environmental Reviews* 22: 1–30. https://doi.org/10.1139/er-2013-0064

Genome Canada. https://genomecanada.ca/project/fast-track-diagnosis-of-stress-disease-phenology-and-growth-drone-based-high-throughput-field-phenotyping-for-genome-assisted-tree-breeding-and-selection-fastpheno/

Jeddore, G., Arsenault, A., with the assistance of the Miawpukek Forest Guardians: Joe, A., Jeddore, G., et al. *Gros Morne lichen/Training Report.* Unpublished report, 34 pages.

Lichen Grazing Project 2021. iNaturalist project. https://sites.google.com/view/foraynl-2021-fungi-series/participate/lichen-grazing

North American Bird Conservation Initiative Canada. 2019. *The State of Canada's Birds, 2019.* Environment and Climate Change Canada, Ottawa, ON. 12 pages. www.stateofcanadasbirds.org

Stralberg, D., Matsuoka, S.M., et al. 2015. Projecting boreal bird responses to climate change: The signal exceeds the noise. *Ecological Applications* 25: 52–69. https://doi.org/10.1890/13-2289.1

The TOPIC network: Traits of Plants in Canada database (TOPIC) and the Canadian Repository of Invertebrate Traits and Trait-like Ecological Records (CRITTER): https://www.nrcan.gc.ca/science-and-data/research-centres-and-labs/forestry-research-centres/great-lakes-forestry-centre/the-topic-network-traits-plants-canada-database-topic-and-the-canadian-repository-inv/20303

Article: Enhanced forest monitoring data to support sustainable forest management

Barker, J., Bonnor, M., et al. 1996. A new national inventory for Canada: The need is now. *Forestry Chronicle* 72(3): 276–279. https://pubs.cif-ifc.org/doi/abs/10.5558/tfc72276-3

Canadian Council of Forest Ministers. 2017. Sustainable forest management policies in Canada. Fact Sheet. 2 pages. https://www.ccfm.org/wp-content/uploads/2020/08/Sustainable_Management_Policies_EN.pdf

Canadian Council of Forest Ministers. *Environmental leadership.* https://www.ccfm.org/healthy-forests/environmental-leadership/ (accessed May 27, 2022).

Food and Agriculture Organization of the United Nations. 2020. *Global forest resources assessment 2020: Key Findings.* https://www.fao.org/documents/card/en/c/ca8753en (accessed May 20 2022).

Gilani, H.R., and Innes, J.L. 2020. The state of Canada's forests: A global comparison of the performance on Montréal Process criteria and indicators. *Forest Policy and Economics* 118: 102234. https://doi.org/10.1016/j.forpol.2020.102234

Hararuk, O., Shaw, C., et al. 2017. Constraining the organic matter decay parameters in the CBM-CFS3 using Canadian National Forest Inventory Data and a Bayesian inversion technique. *Ecological Modelling* 364(2017): 1–12. https://doi.org/10.1016/j.ecolmodel.2017.09.008

Landsat-5 image (Aug. 6, 2009) courtesy of the U.S. Geological Survey.

National Forest Inventory. Standard reports, Table 4.2, Area (1000 ha) of forest and non-forest land by boreal zone in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/BORE/html/BORE_T1_LC_AREA_en.html (accessed May 9, 2022).

News release: Thaidene Nene established as Canada's newest national park reserve. August 21, 2019 https://www.canada.ca/en/parks-canada/news/2019/08/thaidene-nene-established-as-canadas-newest-national-park-reserve.html

Pleiades satellite image (June 27, 2015) supplied by Effigis Geo-Solutions.

Shaw, C.H., Hilger, A.B., et al. 2013. Evaluation of simulated estimates of forest ecosystem carbon stocks using ground plot data from Canada's National Forest Inventory. *Ecological Modelling* 272: 323–347. https://cfs.nrcan.gc.ca/publications/download-pdf/35389

Article: Adapting to climate change: The story of invasive insects in Canada's forests

Allen, E.A., and Humble, L.M. 2002. Nonindigenous species introductions: A threat to Canada's forests and forest economy. *Canadian Journal of Plant Pathology* 24: 103–110. https://doi.org/10.1080/07060660309506983

Allen, E., Noseworthy, M., et al. 2017. Phytosanitary measures to reduce the movement of forest pests with the international trade of wood products. *Biological Invasions* 19: 3365–3376. https://doi.org/10.1007/s10530-017-1515-0

An Invasive Alien Species Strategy for Canada. https://www.canada.ca/en/environment-climate-change/services/biodiversity/invasive-alien-species-strategy.html

Dodds, K.J., Aoki, C.F., et al. 2018. Expansion of southern pine beetle into northeastern forests: Management and impact of a primary bark beetle in a new region. *Journal of Forestry* 116(2): 178–191. https://doi.org/10.1093/jofore/fvx009

Emilson, C., Bullas-Appleton, E., et al. 2018. *Hemlock woolly adelgid management plan for Canada.* Natural Resources Canada, Canadian Forest Service. Information Report GLC-X-21. 26 pages. https://cfs.nrcan.gc.ca/publications?id=39158

Lymantria dispar dispar moth: https://www.ontario.ca/page/lymantria-dispar-dispar-ldd-moth

McGugan, B.M., and Coppel, H.C. 1962. *A review of the biological control attempts against insects and weeds in Canada.* Part II – Biological Control of Forest Insects, 1910–1958. CAB Farnham Royal, England.

Quiring, D., Quiring, V., et al. 2016. Historical trends in Canadian forest entomology. *Canadian Entomologist* 148(S1): S19–S32. https://doi.org/10.4039/tce.2015.21

Southern pine beetle: https://www.invasivespeciescentre.ca/invasive-species/meet-the-species/invasive-insects/southern-pine-beetle/

What's in my firewood and why should it matter: https://www.science.gc.ca/eic/site/063.nsf/eng/97858.html

Article: Joining forces internationally to better understand and fight forest fires

de Groot, W.J., Wotton, B.M., et al. 2015. Chapter 11 – Wildland fire danger rating and early warning systems. In J.F. Shroder and D. Paton (eds.) *Wildfire hazards, risks and disasters.* Elsevier.

Flannigan, M.D., Cantin, A.S., et al. 2013. Global wildland fire severity in the 21st century. *Forest Ecology and Management* 294: 54–61. https://doi.org/10.1016/j.foreco.2012.10.022

Taylor, S.W., and Alexander, M.E. 2006. Science, technology, and human factors in fire danger rating: The Canadian experience. *International Journal of Wildland Fire* 15: 121–135. https://doi.org/10.1071/WF05021

Article: Wildland fire and forest carbon: Understanding impacts of climate change

Boulanger, Y., Gauthier, S., et al. 2014. A refinement of models projecting future Canadian fire regimes using homogeneous fire regime zones. *Canadian Journal of Forest Research* 44: 365–376. https://cdnsciencepub.com/doi/10.1139/cjfr-2013-0372

Wotton, B.M., Nock, C.A., et al. 2010. Forest fire occurrence and climate change in Canada. *International Journal of Wildland Fire* 19: 253–271. https://www.publish.csiro.au/wf/WF09002

Article: Biodiversity, conservation, and Indigenous Peoples' well-being

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Ărramăt project: https://arramatproject.org/story-map/

Colchester, M. 2004. Conservation policy and Indigenous peoples. *Environmental Science & Policy* 7(3): 145–153. https://doi.org/10.1016/j.envsci.2004.02.004

Conservation through reconciliation partnership. Indigenous Protected and Conserved Areas. https://conservation-reconciliation.ca/about-ipcas (accessed July 5, 2022).

Dawson, N.M., Coolsaet, B., et al. 2021. The role of Indigenous peoples and local communities in effective and equitable conservation. *Ecology and Society* 26(3): 19. https://doi.org/10.5751/ES-12625-260319

Dene Tha' First Nation. 2021. *Reconnection, resiliency, and refuge. The case for an Indigenous Protected and Conserved Area at Bistcho Lake.* A draft report prepared by the Dene Tha' First Nation for use in public discussions. Property of the Dene Tha' First Nation. https://bistcholake.ca/the-case-for-an-ipca-at-bistcho-lake/

EduCanada. *About Canada.* https://www.educanada.ca/study-plan-etudes/before-avant/about-canada-a-propos.aspx?lang=eng (accessed June 27, 2022).

Food and Agriculture Organization (FAO) of the United Nations. 2022. *The state of the world's forests 2022. Forest pathways for green recovery and building inclusive, resilient and sustainable economies.* Rome, Italy. https://doi.org/10.4060/cb9360en

Government of Canada. 2021. *Indigenous Guardians pilot.* https://www.canada.ca/en/environment-climate-change/services/environmental-funding/indigenous-guardians.html

Government of Canada. *First Nations.* https://www.rcaanc-cirnac.gc.ca/eng/1100100013791/1535470872302 (accessed June 27, 2022).

Government of Canada. Justice and Laws. *United Nations Declaration on the Rights of Indigenous Peoples Act.* https://laws-lois.justice.gc.ca/eng/acts/u-2.2/FullText.html (accessed July 5, 2022)

Government of the Northwest Territories. 2022. *State of the conservation network report.* https://www.enr.gov.nt.ca/en/services/conservation-network-planning/state-conservation-network-report

Hodgson, D., McDonald, J.L., et al. 2015. What do you mean, 'resilient'? *Trends in Ecology & Evolution* 30(9), 503–506. https://doi.org/10.1016/j.tree.2015.06.010

Indigenous Circle of Experts (ICE). 2018. *We rise together: Achieving pathway to Canada Target 1 through the creation of Indigenous Protected and Conserved Areas in the spirit and practice of reconciliation.* The Indigenous Circle of Experts. Report and recommendations, 112 pages. https://static1.squarespace.com/static/57e007452e69cf9a7af0a033/t/5ab94aca6d2a7338ecb1d05e/1522092766605/PA234-ICE_Report_2018_Mar_22_web.pdf

Mansuy, N., Staley, D., et al. Submitted. *Indigenous Protected and Conserved Areas (IPCAs): Canada's new path forward for biological and cultural conservation and Indigenous well-being.* Facets.

SUSTAINABILITY INDICATORS

How much forest does Canada have?

Dyk, A., Leckie, D., et al. 2015. Canada's National Deforestation Monitoring System: System description. Victoria, BC: Natural Resources Canada–Canadian Forest Service, Pacific Forestry Centre. https://cfs.nrcan.gc.ca/publications?id=36042

- National deforestation estimates are calculated on a periodic basis using the method described in the *National Deforestation Monitoring System* description report. Figure data provided by the *National Deforestation Monitoring System*, special tabulation, April 27, 2021.

Food and Agriculture Organization of the United Nations. 2020. *Global Forest Resources Assessment 2020: Country Report: Canada.* Rome, Italy. http://www.fao.org/3/ca9983en/ca9983en.pdf

- Describes the methodology used to adjust the National Forest Inventory baseline estimate of forest area.

Food and Agriculture Organization of the United Nations. 2020. *Global Forest Resources Assessment 2020: Main Report.* Rome, Italy. https://doi.org/10.4060/ca9825en

- This dataset was used to calculate Canada's forest area as a proportion of the world's forest area.

Food and Agriculture Organization of the United Nations. 2020. *Global Forest Resources Assessment 2020: Terms and Definitions.* Rome, Italy. http://www.fao.org/3/I8661EN/i8661en.pdf

- This document describes the definitions of forest, afforestation and other terms. Note that Canada uses this definition of forest for most but not all purposes. For example, the national greenhouse gas inventory and forest carbon accounting use a slightly different definition.

National Forest Inventory. 2021. Canada's National Forest Inventory Business Process. Version 8.0. National Forest Inventory (NFI) Project Office. March 31, 2021. https://nfi.nfis.org/resources/general/NFI-Business-Process-Version-8.0.pdf

- Description of the procedure and means by which the NFI collects, validates, stores, uses and disseminates national forest inventory data.

National Forest Inventory. Standard reports, Table 4.0, Area (1000 ha) of forest and non-forest land in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/CA/html/CA_T4_FOR_AREA_en.html (accessed May 9, 2022).

- Remeasurement (2017) estimate of Canada's forest area.

National Forest Inventory. Standard reports, Table 4.1, Area (1000 ha) of forest and non-forest land by terrestrial ecozone in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/NFI/html/NFI_T4_FOR_AREA_en.html (accessed May 9, 2022).

- Remeasurement (2017) estimate of Canada's forest area by terrestrial ecozone.

Forest area

Dyk, A., Leckie, D., et al. 2015. *Canada's national deforestation monitoring system: System description.* Victoria, BC: Natural Resources Canada–Canadian Forest Service, Pacific Forestry Centre. http://cfs.nrcan.gc.ca/publications?id=36042

- This document describes Canada's deforestation monitoring system. Note that the system was initially set up for greenhouse gas inventory and forest carbon accounting purposes, so it uses the greenhouse gas inventory and carbon accounting definition of forest.

Food and Agriculture Organization of the United Nations. 2020. *Global Forest Resources Assessment 2020: Country Report: Canada.* Rome, Italy. http://www.fao.org/3/ca9983en/ca9983en.pdf

- Describes the methodology used to adjust the National Forest Inventory baseline estimate of forest area.

Food and Agriculture Organization of the United Nations. 2020. *Global Forest Resources Assessment 2020: Terms and Definitions.* Rome, Italy. http://www.fao.org/3/I8661EN/i8661en.pdf

- This document provides definitions of forest, afforestation, and other key terms. Note that Canada uses this definition of forest for most, but not all, purposes. Note that this report uses National Forest Inventory Baseline data. National greenhouse gas inventory and forest carbon accounting uses a slightly different definition of forest and deforestation.

National Forest Inventory. (2021) *Canada's National Forest Inventory Business Process. Version 8.0.* National Forest Inventory (NFI) Project Office. March 31, 2021. https://nfi.nfis.org/resources/general/NFI-Business-Process-Version-8.0.pdf

- Description of the procedure and means by which the NFI collects, validates, stores, uses and disseminates national forest inventory data.

National Forest Inventory. Standard reports, Table 4.0, Area (1000 ha) of forest and non-forest land in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/CA/html/CA_T4_FOR_AREA_en.html (accessed May 9, 2022).

- First remeasurement (2017) estimate of Canada's forest area.

National Forest Inventory. Standard reports, Table 4.2, Area (1000 ha) of forest and non-forest land by boreal zone in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/BORE/html/BORE_T1_LC_AREA_en.html (accessed May 9, 2022).

- First remeasurement (2017) estimate of Canada's forest area in the boreal zone.

National Forest Inventory. Standard reports, Table 1.2, Area (1000 ha) of land cover by boreal zone in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/BORE/html/BORE_T1_LC_AREA_en.html (accessed May 9, 2022).

- First remeasurement (2017) estimate of Canada's land cover in the boreal zone.

Two Billion Trees Initiative. https://www.canada.ca/en/campaign/2-billion-trees.html

- Two Billion Tree Commitment

Publications referenced when considering the potential effects of climate change on forest area:

- Johnston, M., Campagna, M., et al. 2009. *Vulnerability of Canada's tree species to climate change and management options for adaptation: An overview for policy makers and practitioners.* Ottawa, ON.: Canadian Council of Forest Ministers. http://cfs.nrcan.gc.ca/publications?id=30276
- Natural Resources Canada–Canadian Forest Service. *Changing climate, changing forest zones.* https://www.nrcan.gc.ca/climate-change/impacts-adaptations/climate-change-impacts-forests/impacts/changing-climate-changing-forest-zones/13093 (accessed March 26, 2020)
- Price, D.T., Alfaro, R.I., et al. 2013. Anticipating the consequences of climate change for Canada's boreal forest ecosystems. *Environmental Reviews* 21, 322–365. http://cfs.nrcan.gc.ca/publications?id=35306

Deforestation and afforestation

Dyk, A., Leckie, D., et al. 2015. *Canada's national deforestation monitoring system: System description.* Victoria, BC: Natural Resources Canada–Canadian Forest Service, Pacific Forestry Centre. https://cfs.nrcan.gc.ca/publications?id=36042

- National deforestation estimates are calculated on a periodic basis using the method described in Canada's National Deforestation Monitoring System: System description. Figure data provided by Canada's National Deforestation Monitoring System, special tabulation, May 11, 2022.

Environment and Climate Change Canada. 2022. *National inventory report 1990–2020: Greenhouse gas sources and sinks in Canada.* https://unfccc.int/documents/461919 (accessed May 11, 2022).

- Environment and Climate Change *Canada's National inventory report 1990–2020: Greenhouse gas sources and sinks in Canada* is based on data and analysis from Natural Resources Canada–Canadian Forest Service's National Forest Carbon Monitoring, Accounting and Reporting System.

Natural Resources Canada. *2 Billion Trees Commitment.* https://www.canada.ca/en/campaign/2-billion-trees.html

United Nations Framework Convention on Climate Change. *Report on the conference of the parties on its seventh session, held at Marrakesh from 29 October to 10 November 2001; Addendum, part two: Action taken by the conference of the parties.* FCCC/CP/2001/13/Add.1. Bonn, Germany. https://unfccc.int/resource/docs/cop7/13a01.pdf

- Natural Resources Canada–Canadian Forest Service's National Deforestation Monitoring System and National Forest Carbon Monitoring, Accounting and Reporting System both define "forest" as a minimum land area of 1 ha with tree crown cover of more than 25%, and with trees having the potential to reach a minimum height of 5 m at maturity in situ. This definition harmonizes with the definitions found in the Marrakesh Accords of the United Nations Framework Convention on Climate Change but is different from the Food and Agriculture Organization of the United Nations' definition used elsewhere in this report.
- Deforestation is the conversion of forest to non-forest land uses. Consistent with international definitions, deforestation does not include harvest followed by forest regrowth.
- Data have been updated with new mapping including Northwest Territories Taiga Plains and hydroelectric reservoirs.
- Deforestation by the forestry sector includes the creation of new permanent forestry access roads and landings.
- Deforestation by the hydroelectric sector includes new hydro lines and reservoir flooding.
- Deforestation by the built-up sector includes industrial, institutional or commercial developments as well as municipal urban development, recreation (ski hills and golf courses) and transportation.
- Deforestation by the mining, oil and gas sector includes mine development for minerals and peat as well as oil and gas developments.
- Afforestation is the conversion of non-forest land to forest through the planting or seeding of trees.

Wood volume

Environment and Climate Change Canada. 2022. *National inventory report 1990–2020: Greenhouse gas sources and sinks in Canada.* https://unfccc.int/documents/461919

- Environment and Climate Change Canada's *National inventory report 1990–2020: Greenhouse gas sources and sinks in Canada* is based on data and analysis from Natural Resources Canada–Canadian Forest Service's National Forest Carbon Monitoring, Accounting and Reporting System.

Girardin, M.P., Bouriaud, O., et al. 2016. No growth stimulation of Canada's boreal forest under half-century of combined warming and CO_2 fertilization. *Proceedings of the National Academy of Sciences of the United States of America* 113(52), E8406–E8414. https://doi.org/10.1073/pnas.1610156113

Keith, H., Mackey, B.G., et al. 2009. Re-evaluation of forest biomass carbon stocks and lessons from the world's most carbon-dense forests. *Proceedings of the National Academy of Sciences of the United States of America* 106(28), 11635–11640. https://doi.org/10.1073/pnas.0901970106

Kurz, W., Dymond, C., et al. 2009. CBM-CFS3: A model of carbon dynamics in forestry and land-use change implementing IPCC standards. *Ecological Modelling* 220, 480–504. https://cfs.nrcan.gc.ca/publications?id=29137

National Forest Inventory. 2021. *Canada's National Forest Inventory Business Process. Version 8.0.* National Forest Inventory (NFI) Project Office. March 31, 2021. https://nfi.nfis.org/resources/general/NFI-Business-Process-Version-8.0.pdf

- Description of the procedure and means by which the NFI collects, validates, stores, uses and disseminates national forest inventory data.

National Forest Inventory. Standard reports, Table 15.0, Total tree volume (million m^3) on forest land by forest type and age class in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/CA/html/CA_T15_FORAGE20_VOL_en.html (accessed May 9, 2022).

- First remeasurement (2017) estimate of Canada's wood volume.

Methodology used to adjust National Forest Inventory point estimates of wood volume to annual values:

- Canada's National Forest Inventory completed the data processing, quality control, compilation and estimation for its first remeasurement cycle (2008 to 2017). Canada is therefore in a position to report national wood volume estimates using higher quality and more recent data than in previous reports. The wood volume estimate based on these data is reported for 2017 and using this more accurate and updated value, wood volume for previous years have been adjusted according to the methods described below.
- Forecasting and backcasting from 2017 was done using above-ground biomass carbon stock estimates from Canada's National Forest Carbon Monitoring Accounting and Reporting System (NFCMARS), NIR 2022 version. Changes in wood volume should be closely related to changes in above-ground forest biomass and above-ground forest biomass carbon. Wood volume in 2017 was used to calculate wood volume in all other reporting years using the change in above-ground biomass carbon stock relative to 2017, as follows:
  - Wood volume in [year] = (wood volume in 2017) x (above-ground biomass in [year] / above-ground biomass in 2017)
  - Wood volume data are typically used to derive above-ground biomass and carbon data, but the opposite was done here in order to utilize NFCMARS annual time series data from 1990 to 2020.
  - In NFCMARS, the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) uses merchantable wood volume growth increment data and converts these to biomass and then carbon. However, this all happens internally in the model, and CBM-CFS3 outputs are all in units of carbon (CBM-CFS3: a model of carbon-dynamics in forestry and land-use change implementing IPCC standards. 2009. Kurz, W., et al.).
  - Note that NFCMARS does not provide data for all of Canada's forests. It is assumed here that the above-ground biomass carbon stock trend in Canada's managed forests is a good predictor of wood volume trend for Canada's entire forest (managed and unmanaged).

Is timber being harvested sustainably?

Boucher, D., Gauthier, S., et al. 2020. How climate change might affect tree regeneration following fire at northern latitudes: a review. *New Forests* 51, 543–571. https://doi.org/10.1007/s11056-019-09745-6

Cyr, D., Splawinski, T.B., et al. 2022. Mitigating post-fire regeneration failure in boreal landscapes with reforestation and variable retention harvesting: At what cost? *Canadian Journal of Forest Research* 52(4), 568–581. https://doi.org/10.1139/cjfr-2021-0180

Gouge, D., Thiffault, E., et al. 2021. Biomass procurement in boreal forests affected by spruce budworm: effects on regeneration, costs, and carbon balance. *Canadian Journal of Forest Research* 51(12), 1939–1952. https://doi.org/10.1139/cjfr-2021-0060

LégisQuébec. *Sustainable Forest Development Act.* https://www.legisquebec.gouv.qc.ca/en/tdm/cs/A-18.1

Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Province of British Columbia. *Provincial Timber Management Goals, Objectives and Targets.* https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/silviculture/timbergoalsobjectives2017apr05_revised.pdf

National Forest Inventory. Standard reports, Table 12.0, Area (1000 ha) of forest land by ownership in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/CA/html/CA_T12_FOROWN_AREA_en.html (accessed May 5, 2022).

Nova Scotia Legislature. *An Act Respecting Forests.* https://nslegislature.ca/sites/default/files/legc/statutes/forests.htm

Nova Scotia Legislature. *Biodiversity Act.* https://nslegislature.ca/sites/default/files/legc/statutes/biodiversity.pdf

Thiffault, N., Coll, L., et al. 2015. Natural regeneration after harvesting. In K.S.-H. Peh, R.T. Corlett and Y. Bergeron (eds.), *Routledge Handbook of Forest Ecology*, 371–384. Oxford, United Kingdom: Routledge.

Thiffault, N., Lenz, P.R., et al. In press. Plantation forestry, tree breeding, and novel tools to support the sustainable management of boreal forests. In M. Montoro Girona, H. Morin, et al. (eds.), *Boreal forests in the face of climate change: Sustainable management.* Cham, Switzerland: Springer-Nature.

Forest area harvested

National Forestry Database. Harvest, Table 5.2. Area harvested by ownership, management and harvesting method. http://nfdp.ccfm.org/en/data/harvest.php (accessed June 21, 2022).

- Data include provincial and territorial Crown and private forest land subject to even-aged management (clearcutting), uneven-aged management (selection cutting), and commercial thinning harvest methods.
- The graph does not display federal lands because their small area cannot be represented at the given scale.

Forest regeneration

Government of British Columbia. *Trends in timber harvest in B.C.* http://www.env.gov.bc.ca/soe/indicators/land/timber-harvest.html (accessed April 5, 2021).

Government of British Columbia. *A billion trees planted will benefit B.C. for generations.* https://news.gov.bc.ca/releases/2021FLNRO0091-002141 (accessed May 12, 2022).

National Forestry Database. Regeneration, Table 6.3, Area of direct seeding by ownership and application method. http://nfdp.ccfm.org/en/data/regeneration.php (accessed June 21, 2022).

National Forestry Database. Regeneration, Table 6.4, Number of seedlings planted by ownership and species group. http://nfdp.ccfm.org/en/data/regeneration.php (accessed June 21, 2022).

National Forestry Database. Regeneration, Table 6.5, Area planted by ownership and species group. http://nfdp.ccfm.org/en/data/regeneration.php (accessed June 21, 2022).

- Data are for forests on provincial and territorial Crown lands across Canada. Federally and privately owned lands are excluded.
- Natural regeneration is often the most efficient approach for regenerating harvested areas. One scenario is when there is abundant existing understorey regeneration and a plentiful seed supply (e.g., lowland black spruce and tolerant hardwoods, respectively). Another scenario is when tree species that can resprout from established root systems are present and desired (e.g., trembling aspen). The area of forest naturally regenerated is not reported by jurisdiction, so it is estimated as the difference between total area harvested and the area artificially regenerated.
- Artificial regeneration is suitable for sites where there is insufficient desired natural regeneration and where the objective is to achieve species composition targets required for sustainable forest management objectives.

Volume harvested relative to the sustainable wood supply

National Forestry Database. Wood supply, Table 2, Wood supply estimates by ownership and species group. http://nfdp.ccfm.org/en/data/woodsupply.php (accessed June 21, 2022).

- Wood supply includes allowable annual cuts for provincial and territorial Crown lands and potential harvests for federal and private lands.
- The discrepancy between the "total industrial roundwood" supply volumes and the sum of the "total industrial softwoods" and "total industrial hardwoods" supply volumes is due to a very small amount of harvest categorized as "unspecified." This supply represents some of the federal wood supply that has not been differentiated between "softwood" and "hardwood."

National Forestry Database. Harvest, Table 5.1, Net merchantable volume of roundwood harvested by ownership, category and species group. http://nfdp.ccfm.org/en/data/harvest.php (accessed June 21, 2022).

- Harvests include total industrial roundwood and exclude fuelwood and firewood.
- The discrepancy between the harvested volumes of "total industrial roundwood" and the sum of the "total industrial softwoods" and "total industrial hardwoods" is due to a very small amount of harvest categorized as "unspecified." Typically, this harvest occurs in mixedwood forests where neither softwood nor hardwood categories strictly apply, and it accounts for less than 1% of the harvested volume of total industrial roundwood. More information on these data can be found at the National Forestry Database.

How does disturbance shape Canada's forests?

Commission on Genetic Resources for Food and Agriculture & Food and Agriculture Organization of the United Nations. 2014. *Global plan of action for the conservation, sustainable use and development of forest genetic resources.* Rome, Italy. https://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/469497/

Lenz, P.R., Nadeau, S., et al. 2020. Multi-trait genomic selection for weevil resistance, growth, and wood quality in Norway spruce. *Evolutionary Applications* 13, 76–94. https://doi.org/10.1111/eva.12823

Natural Resources Canada. 2022. *National Tree Seed Centre.* https://www.nrcan.gc.ca/science-and-data/research-centres-and-labs/forestry-research-centres/atlantic-forestry-centre/national-tree-seed-centre/13449

Wang, T., O'Neill, G.A., et al. 2010. Integrating environmental and genetic effects to predict responses of tree populations to climate. *Ecological Applications* 20, 153–63. https://esajournals.onlinelibrary.wiley.com/doi/full/10.1890/08-2257.1

Forest insects

Bellemin-Noël, B., Bourassa, S., et al. 2021. Improved performance of the eastern spruce budworm on black spruce as warming temperatures disrupt phenological defences. *Global Change Biology* 27(14), 3358–3366. https://doi.org/10.1111/gcb.15643

Bleiker, K., and Brooks, J. 2021. *Spruce Beetle – A synthesis of biology, ecology, and management in Canada.* 2021. Natural Resources Canada–Canadian Forest Service. https://cfs.nrcan.gc.ca/publications?id=40527

Fewster, V., Fidgen, J.G., et al. 2021. *Hemlock Woolly Adelgid.* Sault Ste. Marie, ON: Natural Resources Canada–Canadian Forest Service, Great Lakes Forestry Centre. *Frontline Express* 89. https://cfs.nrcan.gc.ca/publications?id=40396

Martel, V., Morin, O., et al. 2021. Elm zigzag sawfly, *Aproceros leucopoda* (Hymenoptera: Argidae), recorded for the first time in North America through community science. *Canadian Entomologist* 154(1), E1. https://doi.org/10.4039/tce.2021.44

Sambaraju, K.R., and Goodsman, D.W. 2021. Mountain pine beetle: An example of a climate-driven eruptive insect impacting conifer forest ecosystems. 2021.; *CABI Reviews* 16(18), 1–18. http://dx.doi.org/10.1079/PAVSNNR202116018

National Forestry Database. Forest insects, Table 4, Area of moderate to severe defoliation (including beetle-killed trees) by insects. http://nfdp.ccfm.org/en/data/insects.php (accessed June 21, 2022).

- Forest area disturbed by defoliators (e.g., budworms, spongy moth) includes only areas with tree mortality or moderate to severe defoliation. Defoliation does not always result in mortality. Several factors, including defoliation severity, duration, and frequency, or presence of other stressors (e.g., drought), can affect the level of mortality.
- Forest area disturbed by bark beetles (e.g., mountain pine beetle, spruce beetle) is derived from aerial surveys that map trees that are dead or dying from successful beetle attack.
- Summing the areas affected by more than one insect to create a grand total can result in an overestimate if more than one insect species occurs in the same stand in the same year. For example, in a mixedwood forest, spruce budworm may defoliate balsam fir in the same stand where forest tent caterpillar is defoliating the aspen trees.

Note: "Spongy moth" was adopted by the Entomological Society of Canada and the Entomological Society of America in March 2022 as the new official common name for *Lymantria dispar*. The species was formerly known as gypsy moth, and as "LDD moth" in some reports. https://esc-sec.ca/2022/03/02/new-common-name-for-lymantria-dispar/

Forest diseases

Bérubé, J.A., Gagné, P.N., et al. 2018. Detection of *Diplodia corticola* spores in Ontario and Québec based on High Throughput Sequencing (HTS) methods. *Canadian Journal of Plant Pathology* 40(3), 378–386.

Bilodeau, G.J., Tanguay, P., et al. 2022. Detection of oak wilt eDNA in insect traps in eastern Canada using metagenomics and qPCR. (Abstr.) *Phytopathology* 111:S2.1. https://doi.org/10.1094/PHYTO-111-10-S2.1

Canadian Food Inspection Agency. *Science bulletin: Early warning research verifies the oak wilt threat is real.* https://inspection.canada.ca/plant-health/plant-pests-invasive-species/plant-diseases/oak-wilt/science-bulletin/eng/1597413492554/1597413493195 (accessed May 12, 2022).

Capron, A., Feau, N., et al. 2021. Signatures of post-glacial genetic isolation and human-driven migration in the Dothistroma needle blight pathogen in western Canada. *Phytopathology* 111(1), 116–127.

Gray, L.K., Russell, J.H., et al. 2013. Predicting the risk of cedar leaf blight (*Didymascella thujina*) in British Columbia under future climate change. *Agricultural and Forest Meteorology* 180, 152–163.

Hennon, P.E., Frankel, S.J., et al. 2020. A framework to evaluate climate effects on forest tree diseases. *Forest Pathology* 50(6), e12649. https://doi.org/10.1111/efp.12649

Hennon, P.E., Frankel, S.J., et al. 2021. Applications of a conceptual framework to assess climate controls of forest tree diseases. *Forest Pathology* 51(6), e12719. https://doi.org/10.1111/efp.12719

Montwé, D., Elder, B., et al. 2020. Swiss needle cast tolerance in British Columbia's coastal Douglas-fir breeding population. *Forestry: An International Journal of Forest Research* 94(2), 193–203.

Ostry, M., and Laflamme, G. 2009. Fungi and diseases – natural components of healthy forests. *Botany* 87(1), 22–25.

Westfall, J., and Duthie-Holt, M. 2022. *2021 summary of forest health conditions in British Columbia.* https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/aerial-overview-surveys/summary-reports

Woods, A.J., Heppner, D., et al. 2010. Forest health and climate change: a British Columbia perspective. *Forestry Chronicle* 86(4): 412–422.

Photo credit:

- Swiss needle cast (*Nothophaeocryptopus gaeumannii*) photo by Joey B. Tanney.

Forest fires

CBC News, 2021. Most homes in Lytton, BC., destroyed by catastrophic wildfire, minister says. https://www.cbc.ca/news/canada/british-columbia/bc-wildfires-lytton-july-1-2021-1.6087311 (accessed May 2, 2022).

Canadian Interagency Forest Fire Centre. *Canada Report 2021.* https://ciffc.ca/sites/default/files/2022-02/Canada_Report_2021_Final.pdf (accessed May 2, 2022).

Natural Resources Canada. 2022. Canadian Wildland Fire Evacuations Database (accessed May 9, 2022).

National Forestry Database. Forest fires, Table 3.1.1, Number of fires by cause class. http://nfdp.ccfm.org/en/data/fires.php (accessed June 21, 2022).

National Forestry Database. Table 3.2.1, Area burned by cause class. http://nfdp.ccfm.org/en/data/fires.php (accessed June 21, 2022).

- The National Forestry Database sources the latest year's fire data from the Canadian Interagency Forest Fire Centre, and all years prior from the Canadian Wildland Fire Information System.

Forest carbon emissions and removals

Environment and Climate Change Canada. 2022. *National inventory report 1990–2020: Greenhouse gas sources and sinks in Canada.* https://unfccc.int/documents/461919 (accessed May 18, 2022).

- This indicator is estimated annually using Natural Resources Canada–Canadian Forest Service's National Forest Carbon Monitoring, Accounting and Reporting System. The system integrates information about forest inventories, forest growth, natural disturbances, forest management activities and land-use change to evaluate carbon stocks, stock changes and emissions of non-CO_2 greenhouse gases (carbon monoxide, methane and nitrous oxide) in Canada's managed forests. The system estimates changes in biomass, woody debris, litter and soil carbon pools. The system also estimates transfers to the forest product sector and the fate of harvested wood products manufactured from wood harvested in Canada since 1900, including carbon storage and emissions resulting from these products regardless of where in the world these emissions occur.
- "Managed land" includes all lands managed for production of any wood products or wood-based bioenergy, for protection from natural disturbances, or for the conservation of ecological values. Within those managed lands, "forest" includes all areas of 1 hectare or more having the potential to develop forest cover, with a minimum crown closure of 25% and a minimum tree height of 5 metres at maturity in situ.
- Managed forest land is further divided into an anthropogenic partition (those lands predominantly influenced by human activities) and a natural partition (those lands predominantly influenced by large-scale natural disturbances). When stands are affected by stand-replacing wildfires, the emissions and subsequent removals during post-fire regrowth are reported in the "natural partition." When regrowing stands reach commercial maturity, the emissions and removals are reported in the "anthropogenic partition." Stands affected by partial disturbances that cause more than 20% mortality are reported in the natural partition until the biomass reaches pre-disturbance levels.
- The first figure includes the entire managed forest, while the second figure includes only the anthropogenic partition (areas impacted by management and by insect disturbances causing 20% or less tree mortality), and the third figure includes only the natural partition (areas impacted by stand-replacing wildfires or insect disturbances causing greater than 20% tree mortality. The sum of figures 2 and 3 is reported in figure 1.
- Harvested wood product emissions are estimated using the "simple decay" approach of the Intergovernmental Panel on Climate Change (IPCC) and include annual emissions from all wood harvested in Canada and removed from the forest to produce products or energy since 1900, regardless of its current location. Transfers of wood and paper products to landfills are assumed to instantly oxidize as CO_2.
- Starting in 2015, international greenhouse gas (GHG) reporting guidelines changed with respect to harvested wood products. Accordingly, Canada reports the net GHG balance of forested ecosystems and the net GHG balance from harvested wood products. In previous years, all wood removed from the forest was assumed to instantly release all carbon to the atmosphere, despite the long-term storage of carbon in houses and other long-lived wood products. Reporting the fate of carbon in harvested wood products encourages both the sustainable management of forests and the management of harvested wood products aimed at extending carbon storage.
- For forest lands affected by land-use change, the deforestation and afforestation figures reflect annual rates. Figures for CO_2 equivalent (CO_2e) emissions and removals reflect the current year plus the emissions in the reporting year from lands that were converted from or to forest in the previous 20 years. Thus, the figures for CO_2e emissions include residual emissions from areas deforested over the past 20 years, and the figures for CO_2e removals in the reporting year include removals by all areas afforested over the past 20 years.
- Emissions bear a positive sign. Removals bear a negative sign in accordance with international reporting standards.

Additional information can be found at:

- Kurz, W., Shaw, C., et al. 2013. Carbon in Canada's boreal forest: A synthesis. *Environmental Reviews* 21, 260–292. https://cdnsciencepub.com/doi/full/10.1139/er-2013-0041
- Kurz, W., Hayne, S., et al. 2018. Quantifying the impacts of human activities on reported greenhouse gas emissions and removals in Canada's managed forest: Conceptual framework and implementation. *Canadian Journal of Forest Research* 48(10), 1227–1240. https://cdnsciencepub.com/doi/full/10.1139/cjfr-2018-0176
- Lemprière, T., Kurz, W., et al. 2013. Canadian boreal forests and climate change mitigation. *Environmental Reviews* 21, 293–321. https://cdnsciencepub.com/doi/10.1139/er-2013-0039
- Metsaranta, J., Shaw, C., et al. 2017. Uncertainty of inventory-based estimates of the carbon dynamics of Canada's managed forest (1990–2014). *Canadian Journal of Forest Research* 47, 1082–1094. https://cdnsciencepub.com/doi/full/10.1139/cjfr-2017-0088
- Natural Resources Canada–Canadian Forest Service. *Carbon budget model.* https://www.nrcan.gc.ca/climate-change/impacts-adaptations/climate-change-impacts-forests/carbon-accounting/carbon-budget-model/13107 (accessed May 18, 2022).
- Natural Resources Canada–Canadian Forest Service. *Inventory and land-use change.* https://www.nrcan.gc.ca/climate-change/impacts-adaptations/climate-change-impacts-forests/carbon-accounting/inventory-and-land-use-change/13111 (accessed May 18, 2022).
- Ogle, S., Domke, G., et al. 2018. Delineating managed land for reporting national greenhouse gas emissions and removals to the United Nations Framework Convention on Climate Change. *Carbon Balance Management* 13(9). https://cbmjournal.biomedcentral.com/articles/10.1186/s13021-018-0095-3
- Stinson, G., Kurz, W., et al. 2011. An inventory-based analysis of Canada's managed forest carbon dynamics, 1990 to 2008. *Global Change Biology* 17, 2227–2244. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3597256/

How do forests benefit Canadians?

Forest-reliant communities

Statistics Canada. *2016 Census of Population* (special extraction). https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/index-eng.cfm

- Natural Resources Canada-Canadian Forest Service calculations for forest-reliant communities are based on Statistics Canada's *2016 Census of Population*.
- The *Forest communities* indicator is based on Statistics Canada's census subdivisions. A subdivision is "the general term for municipalities (as determined by provincial/territorial legislation) or areas treated as municipal equivalents for statistical purposes (e.g., Indian reserves, Indian settlements and unorganized territories)." Since there is no standardized definition of community across provinces and territories, using census subdivisions allows for a consistent approach in reporting over time. In 2016, Canada was divided into 5,162 census subdivisions.
- The methodology used to identify communities that rely on economic activity from the forest sector is based on the sector dependence index (SDI), a well-established approach to assess the relative importance of a given sector to local economies. In addition to considering the share of total income generated from the forest sector, CFS used the SDI to establish if the forest sector provides a high number of jobs relative to the average Canadian community. The calculations also establish if there are many other sectors that are also a source of jobs for local residents.

Total employment in the forest sector

Statistics Canada. Table 36-10-0489-01 (formerly CANSIM 383-0031): Labour statistics consistent with the System of National Accounts (SNA), by job category and industry. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610048901 (accessed May 20, 2022).

Indigenous employment in the forest sector

Statistics Canada. *2016 Census of Population* (special extraction) https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/index-eng.cfm

- Indigenous employment refers to the number of people employed, not the number of people in the labour force, which includes those unemployed.
- Indigenous refers to people who are First Nations (North American Indian), Métis or Inuk (Inuit) and/or those who are Registered or Treaty Indians (i.e., registered under the *Indian Act* of Canada), and/or those who have membership in a First Nation or Indian Band.

Forest sector employment

Total employment

Statistics Canada. *2016 Census of Population*, customized tables. https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/index-eng.cfm (accessed March 17, 2020).

Statistics Canada. Table 36-10-0489-01 (formerly CANSIM 383-0031): Labour statistics consistent with the System of National Accounts (SNA), by job category and industry. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610048901 (accessed May 20, 2022).

- Data include NAICS 113, 1153, 321, and 322.
- Employment includes jobs held by people employed directly in the following industries: forestry and logging, support activities for forestry, pulp and paper product manufacturing, and wood product manufacturing.
- Natural Resources Canada–Canadian Forest Service prefers to use employment data from Statistics Canada's System of National Accounts (SNA) because these data are linked to the underlying framework used to compile the Canadian System of National Accounts.

Indigenous employment in the forest sector

Statistics Canada. *2016 Census of Population* (special extraction, April 20, 2018).

- Natural Resources Canada–Canadian Forest Service calculations for Indigenous employment are based on Statistics Canada's *2016 Census of Population*.
- These values refer to the number of people employed, not in the labour force, which includes those unemployed.
- Indigenous refers to people who are First Nations (North American Indian), Métis or Inuk (Inuit). Indigenous also refers to people who are Registered or Treaty Indians (i.e., registered under the *Indian Act*) and/or those who have membership in a First Nation or Indian band.

Statistics Canada. Table 14-10-0326-01 (formerly CANSIM 285-0002): Job vacancies, payroll employees, job vacancy rate, and average offered hourly wage by industry sector, quarterly, unadjusted for seasonality. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410032601 (accessed May 20, 2022).

Forest sector average earnings

Statistics Canada. Table 14-10-0204-01 (formerly CANSIM 281-0027): Average weekly earnings by industry, annual. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410020401 (accessed March 29, 2022).

Statistics Canada. Table 18-10-0005-01 (formerly CANSIM 326-0021): Consumer Price Index, annual average, not seasonally adjusted. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810000501 (accessed March 3, 2022).

Statistics Canada. Table 14-10-0202-01 (formerly CANSIM 281-0024): Employment by industry, annual. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410020201 (accessed March 29, 2022).

- The data exclude overtime.
- Starting in 2020, the average earnings were calculated using the Consumer Price Index re-based to 2012 values. This method matches the one used for the previous reports in which all data prior to 2019 were updated as well according to current method.
- Issues of *The State of Canada's Forests: Annual Report* prior to 2018 calculated real average earnings using GDP at market prices as the measure of inflation. More recent issues of *The State of Canada's Forests: Annual Report* use the Consumer Price Index (including volatile commodities) because it is a better indicator of the spending power of Canadians.

Additional information can be found at:

- Random Lengths. Various weekly reports on North American forest products markets, including the one dated May 13, 2022 (Compensation survey).
- Packaging Europe. April 27, 2022. War in Ukraine could add to negative earnings outlook for paper and forest products industry, according to Moody's. https://packagingeurope.com/news/war-in-ukraine-could-add-to-negative-earnings-outlook-for-paper-and-forest-products-industry-according-to-moodys/8150.article
- Packaging Europe. March 17, 2022. Moody's: Rising energy prices and falling profit margins could accelerate paper mills' transition to packaging grades https://packagingeurope.com/news/moodys-rising-energy-prices-and-falling-profit-margins-could-accelerate-paper-mills-transition-to-packaging-grades/8001.article
- Forest2Market. January 8, 2022. 18 Predictions for the Global Forest, Pulp & Paper, and Chemicals Industries in 2022 https://www.forest2market.com/blog/predictions-for-the-global-forest-industry-in-2022 (accessed May 11, 2021).
- Fastmarket. December 8, 2021. How labor shortages could prolong forest products supply chain woes. https://www.fastmarkets.com/insights/supply-chain-challenges-continue-to-plague-forest-products-market (Accessed May 19, 2022)
- Natural Resources Canada–Canadian Forest Service. *Industry – Overview*. https://www.nrcan.gc.ca/our-natural-resources/forests-forestry/forest-industry-trade/overview-canadas-forest-industry/13311

Forest communities

Statistics Canada. *2016 Census of Population.* https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/index-eng.cfm

- Natural Resources Canada–Canadian Forest Service. Calculations based on Statistics Canada's *2016 Census of Population*.
- The *Forest communities* indicator is based on Statistics Canada's census subdivisions. A subdivision is "the general term for municipalities (as determined by provincial/territorial legislation) or areas treated as municipal equivalents for statistical purposes (e.g., Indian reserves, Indian settlements and unorganized territories)." Since there is no standardized definition of community across provinces and territories, using census subdivisions allows for a consistent approach in reporting over time. In 2016, Canada was divided into 5,161 census subdivisions.
- In 2019, the Canadian Forest Service (CFS) adopted a new method for identifying communities that rely on economic activity from natural resource sectors. The method is based on the sector dependence index (SDI), a well-established approach to assess the relative importance of a given sector to local economies. In addition to considering the share of total income generated from the forest sector, CFS used the SDI to establish if the forest sector provides a high number of jobs relative to the average Canadian community. The calculations also established if there are many other sectors that are also a source of jobs for local residents.
- In 2018, *The State of Canada's Forests: Annual Report* noted that the forest sector was a major source of income for 105 census subdivisions in Canada. In 2019, following the new method, it reported that 300 Canadian communities rely on the forest sector for a significant share of economic activity.
- Employment data from Statistics Canada's *2016 Census of Population* refers to the number of people employed, not in the labour force (which includes those people unemployed).

Statistics Canada. Table 14-10-0326-01 (formerly CANSIM 285-0002): Job vacancies, payroll employees, job vacancy rate, and average offered hourly wage by industry sector, quarterly, unadjusted for seasonality. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410032601 (accessed May 20, 2022).

How does the forest sector contribute to Canada's economy?

Statistics Canada. *2016 Census of Population.* https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/index-eng.cfm

Statistics Canada. Table 36-10-0489-01 Labour statistics consistent with the System of National Accounts (SNA), by job category and industry. https://doi.org/10.25318/3610048901-eng (accessed May 24, 2022).

Statistics Canada. Trade Data Online. HS Codes 44, 47, 48, 9419. https://www.ic.gc.ca/eic/site/tdo-dcd.nsf/eng/home (accessed May 11, 2022).

Forest sector gross domestic product

The World Bank. *Databank: World Development Indicators.* https://databank.worldbank.org/reports.aspx?source=world-development-indicators (accessed May 13 2021).

Nominal GDP

Statistics Canada. Table 36-10-0401-01 (formerly CANSIM 379-0029): Gross domestic product (GDP) at basic prices by industry (x 1,000,000). https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610040101 (accessed March 1, 2022).

- For nominal GDP up to (and including) 2017.

Statistics Canada. Table 36-10-0434-04: Gross domestic product (GDP) at basic prices, by industry, monthly (x 1,000,000). https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610043404 (accessed March 1, 2022).

Statistics Canada. Table 18-10-0267-01: Industrial product price index, by industry, monthly. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810026701 (accessed March 1, 2022).

Statistics Canada. Table 18-10-0268-01: Raw materials price index, monthly. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810026801 (accessed March 1, 2022).

Statistics Canada. Table 18-10-0265-01: Industrial product price index, by major product group, monthly. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810026501 (accessed March 1, 2022).

- Natural Resources Canada–Canadian Forest Service's calculations of nominal GDP for 2018 to the latest year are based on Statistics Canada's tables 36-10-0434-04, 18-10-0267-01, 18-10-0268-01 and 18-10-0265-01: GDP in 2012 constant prices and estimated industry price deflators indexed to 2012.

Real GDP

Statistics Canada. Table 36-10-0434-04: Gross domestic product (GDP) at basic prices, by industry, monthly (x 1,000,000). https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610043404 (accessed March 25, 2022).

- Real GDP in 2012 constant prices.
- Nominal and real GDP vary in that real values are adjusted for inflation whereas nominal values are not. Therefore, real GDP is used to account for differences between time periods (e.g., comparing previous two years' GDP).
- Data from Statistics Canada's Natural Resources Satellite Account (NRSA) are a key source of information on the economic contribution of the forest sector in Canada. The NRSA, the result of collaboration between Natural Resources Canada and Statistics Canada, is able to capture economic activity in forest industry segments that have traditionally been difficult to measure, such as wood furniture manufacturing. According to data from the NRSA, the forest sector directly accounted for $39.2 billion to Canada's nominal GDP (1.7% of total GDP) in 2021.

Production of forest products

APA – The Engineered Wood Association. Quarterly production reports.

- For production data of structural panels (plywood and oriented strand board).

Pulp and Paper Products Council.

- For production data of newsprint, printing and writing paper, and wood pulp.

Statistics Canada. Table 16-10-0045-01: Lumber, production, shipments and stocks, monthly (x 1,000). https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1610004501 (accessed April 8, 2021).

Statistics Canada. Table 16-10-0017-01: Lumber production, shipments, and stocks by species, monthly (x 1,000). https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1610001701 (accessed March 3, 2022).

- For production data of lumber, which includes total softwood production for Canada
- In January 2019, Statistics Canada noted that they made changes to the sampling and estimation methods for the monthly Sawmills survey, which is the source of the softwood lumber production data for this indicator. As a result of these changes, Statistics Canada replaced Table 16-10-0017-01 with Table 16-10-0045-01 as of January 2019. See https://www150.statcan.gc.ca/n1/daily-quotidien/200302/dq200302a-eng.htm for more information.
- Lumber production data for years 2010 to 2013 (inclusive) comes from the older Table 16-10-0045-01.
- Lumber production data for years 2014 to 2021 (inclusive) comes from the newer Table 06-10-0017-01.
- Because of changes in sampling and estimation methods in the Sawmills survey, readers should exercise caution in comparing data from different sources directly.

Exports of forest products

Statistics Canada. Merchandise trade data (special extraction, March 8, 2022).

- Each product in this dataset represents the total for a custom grouping of HS codes.

How is the forest sector changing?

Natural Resources Canada. Comprehensive Energy Use Database. https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive_tables/list.cfm (accessed May 31, 2022).

- NRCan's Comprehensive Energy Use Database is compiled using the following sources:
  - Environment and Climate Change Canada. 2021. *National inventory report 2000–2019: Greenhouse gas sources and sinks in Canada.*
  - Natural Resources Canada. 2021. Industrial End-Use Model.
  - Statistics Canada. 2021. *Report on Energy Supply and Demand in Canada 2000–2019.*
  - The Canadian Energy and Emissions Data Centre (CEEDC), Simon Fraser University. 2021.

Forest sector financial performance

Statistics Canada. Quarterly balance sheet and income statement, by North American Industry Classification System (NAICS) (special extraction, March 10, 2020).

- For data before and including 2019, as Statistics Canada discontinued the use and update of this source (to be replaced with Table 33-10-0225-01).

Statistics Canada. Table 33-10-0225-01: Quarterly balance sheet, income statement and selected financial ratios, by non-financial industries, non-seasonally adjusted (x 1,000,000) https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3310022501 (accessed March 3, 2022).

- For data including and beyond 2020.

Forest sector secondary manufacturing

Statistics Canada. Table 36-10-0434-04: Gross domestic product (GDP) at basic prices, by industry, monthly, industry detail. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610043404 (accessed March 1, 2022).

Statistics Canada. Table: 12-10-0136-01: Canadian international merchandise trade by industry for all countries. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1210013601 (accessed April 6, 2022).

Statistics Canada. Table 16-10-0047-01 (formerly CANSIM 304-0014): Manufacturers' sales, inventories, orders and inventory to sales ratios, by industry (dollars unless otherwise noted) https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1610004701 (accessed March 3, 2022).

Notes:

- Real GDP is in 2012 constant prices.
- Statistics Canada defines value added as a measure of net output, meaning gross output minus the purchased inputs that have been embodied in the value of the product.
- Domestic consumption is calculated as domestic sales minus exports plus imports.

Additional information on the regional secondary wood manufacturing industries can be found within these six publications:

- Bogdanski, B.E.C., Sun, L., et al. 2020. *Secondary manufacturing of solid wood products in Ontario 2017: Structure and economic contribution (Information report BC-X-451).* Retrieved from https://cfs.nrcan.gc.ca/publications/centre/pfc?sort=date&format=citation

- Bogdanski, B.E.C., Wong, L., et al. 2020. *Secondary manufacturing of solid wood products in Quebec 2017: Structure and economic contribution (Information report BC-X-453).* Retrieved from https://cfs.nrcan.gc.ca/publications/centre/pfc?sort=date&format=citation
- Sun, L., and Bogdanski, B.E.C. 2019. *Secondary manufacturing of solid wood product in Alberta 2017: Structure and economic contribution (Information report BC-X-448).* Retrieved from https://cfs.nrcan.gc.ca/publications/centre/pfc?sort=date&format=citation
- Sun, L., Bogdanski, B.E.C., et al. 2019. *Secondary manufacturing of solid wood products in Saskatchewan and Manitoba 2017: Structure and economic contribution (Information report BC-X-449).* Retrieved from https://cfs.nrcan.gc.ca/publications/centre/pfc?sort=date&format=citation
- Wong, L., Stennes, B., et al. 2019. *Secondary manufacturing of solid wood products in British Columbia 2016: Structure, economic contribution and changes since 1990 (Information report BC-X-447).* Retrieved from https://cfs.nrcan.gc.ca/publications/centre/pfc?sort=date&format=citation
- Wong, L., and Bogdanski, B.E.C. 2019. *Secondary manufacturing of solid wood products in New Brunswick and Nova Scotia 2017: Structure and economic contribution (Information report BC-X-452).* Retrieved from https://cfs.nrcan.gc.ca/publications/centre/pfc?sort=date&format=citation

Forest sector carbon emissions

Natural Resources Canada. Comprehensive Energy Use Database. https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive_tables/list.cfm (accessed May 31, 2022).

- National Resources Canada's Comprehensive Energy Use Database is compiled using the following sources:
  - Environment and Climate Change Canada. 2021. *National inventory report 2000–2019: Greenhouse gas sources and sinks in Canada.*
  - Natural Resources Canada. 2021. Industrial End-Use Model.
  - Statistics Canada. 2021. *Report on Energy Supply and Demand in Canada 2000–2019.*
  - The Canadian Energy and Emissions Data Centre (CEEDC), Simon Fraser University. 2021.

Notes:

- The Office of Energy Efficiency at Natural Resources Canada has changed the base year related to its National Energy Use Database (NEUD) from 1990 to 2000, beginning with the release of 2018 data. This change in methodology has resulted in minor changes in the energy use and GHG emissions data back to 2000. This rebasing is to ensure that NEUD reflects developments in trends and structures of Canada's energy end use and efficiency across sectors. It also synchronizes Canada's energy use data reporting with changes recently made by the International Energy Agency. While new estimates are no longer made available for years prior to 2000, data with the new base year are expected to better service the development, implementation and monitoring of government policies, programs and projects; evidence-based decision making; industrial and market analysis and projection; and energy use literacy, education and stakeholder engagement.

Statistical Profiles

Population

Statistics Canada. Table 17-10-0009-01 (formerly CANSIM 051-0005): Population estimates, quarterly. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710000901 (accessed March 3, 2022).

Forest inventory

Forest area by classification

Food and Agricultural Organization of the United Nations. 2020. *Global Forest Resources Assessment 2020: Country Report: Canada.* Rome, Italy. http://www.fao.org/3/ca9983en/ca9983en.pdf

National Forest Inventory. Standard reports, Table 4.0, Area (1000 ha) of forest and non-forest land in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/CA/html/CA_T4_FOR_AREA_en.html (accessed May 9, 2022).

- First remeasurement (2017) estimate of Canada's forest area
- The National Forest Inventory uses the following definitions from the Food and Agriculture Organization of the United Nations (FAO):
  - "Forest land" – land spanning more than 0.5 hectares where the tree canopy covers more than 10% of the total land area and the trees can grow to a height of more than 5 metres. It does not include land that is predominantly urban or used for agricultural purposes.
  - "Other land with tree cover" – areas of land where tree canopies cover more than 10% of the total area and the trees, when mature, can grow to a height of at least 5 metres. Includes treed areas on farms, in parks and gardens, and around buildings. Also includes tree plantations established mainly for purposes other than wood production, such as fruit orchards.
  - "Other wooded land" – areas of land where: 1) tree canopies cover 5% to 10% of the total area and the trees, when mature, can grow to a height above 5 metres; or 2) shrubs, bushes and trees together cover more than 10% of the area. These areas include treed wetlands (swamps) and land with slow-growing and scattered trees. They do not include land that is predominantly agricultural or urban.

Forest area change

Environment and Climate Change Canada. 2022. *National inventory report 1990–2020: Greenhouse gas sources and sinks in Canada.* https://unfccc.int/documents/461919 (accessed May 11, 2022).

- Environment and Climate Change Canada's *National inventory report 1990–2020: Greenhouse gas sources and sinks in Canada* uses Natural Resources Canada–Canadian Forest Service's National Forest Carbon Monitoring, Accounting and Report System.

Forest type

National Forest Inventory. Standard reports, Table 5.0, Area (1000 ha) of forest land by forest type and age class in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/CA/html/CA_T5_FORAGE20_AREA_en.html (accessed May 9, 2022).

Forest ownership

National Forest Inventory. Standard reports, Table 12.0, Area (1000 ha) of forest land by ownership in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/CA/html/CA_T12_FOROWN_AREA_en.html (accessed May 9, 2022).

Growing stock

National Forest Inventory. Standard reports, Table 15.0, Total tree volume (million m^3) on forest land by forest type and age class in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/CA/html/CA_T15_FORAGE20_VOL_en.html (accessed June 29, 2022).

National Forest Inventory. Standard reports, Table 16.0. Total tree volume (million m^3) by species group and age class in Canada. https://nfi.nfis.org/resources/general/summaries/t1/en/CA/html/CA_T16_LSAGE20_VOL_en.html (accessed June 29, 2022).

Disturbance

Insects

National Forestry Database. Forest insects, Table 4, Area of moderate to severe defoliation (including beetle-killed trees) by insects. http://nfdp.ccfm.org/en/data/insects.php (accessed June 21, 2022).

- Forest area disturbed by defoliators (e.g., budworms, *Lymantria dispar*) includes only areas with tree mortality or moderate to severe defoliation. Defoliation does not always result in mortality. Several factors, including defoliation severity, duration, and frequency, or presence of other stressors (e.g., drought), can affect the level of mortality.
- Forest area disturbed by bark beetles (e.g., mountain pine beetle, spruce beetle) is derived from aerial surveys that map trees that are dead or dying from successful beetle attack.
- Summing the areas affected by more than one insect to create a grand total can result in an overestimate if more than one insect species occurs in the same stand in the same year. For example, in a mixedwood forest, spruce budworm may defoliate balsam fir in the same stand where forest tent caterpillar is defoliating the aspen trees.

Fires

National Forestry Database. Forest fires, Table 3.1.1, Number of fires by cause class. http://nfdp.ccfm.org/en/data/fires.php (accessed June 21, 2022).

National Forestry Database. Forest fires, Table 3.2.1, Area burned by cause class. http://nfdp.ccfm.org/en/data/fires.php (accessed June 21, 2022).

- The National Forestry Database sources the latest year's fire data from the Canadian Interagency Forest Fire Centre and all years prior from the Canadian Wildland Fire Information System.

Forest management

Harvesting

National Forestry Database. Harvest, Table 5.1, Net merchantable volume of roundwood harvested by ownership, category and species group. http://nfdp.ccfm.org/en/data/harvest.php (accessed June 21, 2022).

National Forestry Database. Harvest, Table 5.2, Area harvested by ownership, management and harvesting method. http://nfdp.ccfm.org/en/data/harvest.php (accessed June 21, 2022).

- The national and provincial/territorial profile figures for harvesting volumes include data for industrial roundwood, fuelwood and firewood from provincial and territorial Crown land and from private land.
- Area harvested data include federal, provincial, territorial and private forest lands.

Regeneration

National Forestry Database. Regeneration, Table 6.3, Area of direct seeding by ownership and application method. http://nfdp.ccfm.org/en/data/regeneration.php (accessed June 21, 2022).

National Forestry Database. Regeneration, Table 6.5, Area planted by ownership and species group. http://nfdp.ccfm.org/en/data/regeneration.php (accessed June 21, 2022).

Third-party certification

Certification Canada. Canadian Statistics. http://certificationcanada.org/en/statistics/canadian-statistics/ (accessed May 25, 2022).

- If a forest area has been certified to more than one of the three sustainable forest management standards (Canadian Standards Association, Sustainable Forestry Initiative, and Forest Stewardship Council), the area is counted only once. Therefore, the total certification for sustainable forest management standards may be less than the sum of the individual totals for these standards. The independently certified forest area is calculated using Forest Management Units, which include streams, lakes, rivers and roads.

Protected forest

IUCN: International Union for Conservation of Nature (http://www.iucn.org).

- Data obtained from the Canadian Protected and Conserved Areas Database (CPCAD) (https://www.canada.ca/en/environment-climate-change/services/national-wildlife-areas/protected-conserved-areas-database.html).

Greenhouse gas inventory

Environment and Climate Change Canada. 2022. *National inventory report 1990–2020: Greenhouse gas sources and sinks in Canada.* https://unfccc.int/documents/461919 (accessed May 11, 2022).

- Environment and Climate Change Canada's *National inventory report 1990–2020: Greenhouse gas sources and sinks in Canada* is based on data and analysis from Natural Resources Canada–Canadian Forest Service's National Forest Carbon Monitoring, Accounting and Reporting System.
- For forest lands affected by land-use change, the deforestation and afforestation figures reflect annual rates. Figures for CO_2 equivalent (CO_2e) emissions and removals reflect the current year plus the previous 20 years. Thus, the figures for CO_2e emissions include residual emissions from areas deforested over the past 20 years, and the figures for CO_2e removals include ongoing removals by all areas afforested over the past 20 years.
- See the sources and information for the sustainability indicator **Forest carbon emissions and removals** for more detail.

Domestic economic impact

Canadian housing starts

Statistics Canada. Table 34-10-0126-01 (formerly CANSIM 0277-0009): Canada Mortgage and Housing Corporation, housing starts, under construction and completions, all areas, annual. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3410012601 (accessed March 3, 2022).

Contribution nominal GDP

Statistics Canada. Table 36-10-0434-04: Gross domestic product (GDP) at basic prices, by industry, monthly (x 1,000,000). https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610043404 (accessed March 1, 2022).

Statistics Canada. Table 18-10-0267-01: Industrial product price index, by industry, monthly. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810026701 (accessed March 1, 2022).

Statistics Canada. Table 18-10-0268-01: Raw materials price index, monthly. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810026801 (accessed March 1, 2022).

Statistics Canada. Table 18-10-0265-01: Industrial product price index, by major product group, monthly. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810026501 (accessed March 1, 2022).

- Natural Resources Canada–Canadian Forest Service's calculations for the latest year's nominal GDP are based on Statistics Canada's tables 36-10-0434-04, 18-10-0267-01, 18-10-0268-01 and 18-10-0265-01: GDP in 2012 constant prices and on estimated industry price deflators indexed to 2012.
- Data from Statistics Canada's Natural Resources Satellite Account (NRSA) are a key source of information on the economic contribution of the forest sector in Canada. The NRSA, the result of collaboration between Natural Resources Canada and Statistics Canada, is able to capture economic activity in forest industry segments that have traditionally been difficult to measure, such as wood furniture manufacturing. According to data from the NRSA, the forest sector directly accounted for $39.2 billion to Canada's nominal GDP (1.7% of total GDP) in 2021.

Contribution to real GDP

Statistics Canada. Table 36-10-0434-04: Gross domestic product (GDP) at basic prices, by industry, monthly (x 1,000,000). https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610043404 (accessed March 1, 2022).

- Real GDP in 2012 constant prices
- Nominal and real GDP vary in that real values are adjusted for inflation whereas nominal values are not. Therefore, real GDP is used to account for differences between time periods (e.g., comparing 2020 and 2021 GDP).

Revenue from goods manufactured

Statistics Canada. Table 16-10-0117-01 (formerly CANSIM 301-0008): Principal statistics for manufacturing industries, by North American Industry Classification System (NAICS) (x 1,000). https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1610011701 (accessed March 3, 2022).

Statistics Canada. Table 16-10-0114-01 (formerly CANSIM 301-0009): Logging industries, principal statistics by North American Industry Classification System (NAICS) (x 1,000). https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1610011401 (accessed May 25, 2022).

- Revenue from goods manufactured includes revenue from the sale of goods manufactured using materials owned by the establishment, as well as from repair work, manufacturing service charges and work contracted to others.

Forest sector employment

Employment

Statistics Canada. Table 14-10-0202-01 (formerly CANSIM 281-0024): Employment by industry, annual. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410020201 (accessed March 29, 2022).

Statistics Canada. Table 36-10-0489-01 (formerly CANSIM 383-0031): Labour statistics consistent with the System of National Accounts (SNA), by job category and industry. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610048901 (accessed May 20, 2022).

Statistics Canada. Table 38-10-0285-01 (formerly CANSIM 388-0010): Natural resources satellite account, indicators (x 1,000,000). https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810028501 (accessed June 29, 2022).

- Employment includes jobs held by people employed directly in the following subsectors: forestry and logging, support activities for forestry, pulp and paper product manufacturing, and wood product manufacturing.
- Natural Resources Canada prefers to use employment data from Statistics Canada's System of National Accounts (SNA) because these data are linked to the underlying framework used to compile the Canadian System of Natural Economic Accounts (e.g., GDP, national wealth).

- Employment data can also be sourced from Statistics Canada's Survey of Employment, Payrolls and Hours (SEPH) and the Natural Resources Satellite Account (NRSA).
  - SEPH data focus on industry and can be used for comparing direct company employment in forestry with that in other sectors.
  - Data from Statistics Canada's NRSA are a key source of information on the economic contribution of the forest sector in Canada. The NRSA is able to capture economic activity in forest industry segments that have traditionally been difficult to measure, such as wood furniture manufacturing.
- Natural Resources Canada–Canadian Forest Service calculated indirect employment using Statistics Canada's National Symmetric Input-Output Tables (15-207-XCB) and National Multipliers (15F0046XDB).
  - The calculations for indirect employment were changed in 2019 to better account for employment in the forest sector. Retroactive changes to previous years' data have not been applied at this time.

Wages and salaries

Statistics Canada. Table 16-10-0117-01 (formerly CANSIM 301-0008): Principal statistics for manufacturing industries, by North American Industry Classification System (NAICS) (x 1,000). https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1610011701 (accessed March 3, 2022).

Statistics Canada. Table 16-10-0114-01 (formerly CANSIM 301-0009): Logging industries, principal statistics by North American Industry Classification System (NAICS) (x 1,000). https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1610011401 (accessed May 25, 2022).

- Wages and salaries are the earnings, in cash or in kind, of Canadian residents for work performed before deduction of income taxes and contributions to pension funds, employment insurance and other social insurance schemes.

Trade

Statistics Canada. Merchandise trade data (special extraction, March 8, 2022).

- Balance of trade is the difference between the value of the goods and services that a country exports domestically and the value of the goods and services that it imports. If a country's exports exceed its imports, it has a trade surplus. If its imports exceed exports, the country has a trade deficit.

Domestic production and investment

Production of forest products

APA – The Engineered Wood Association. Quarterly production reports.

- For production data of structural panels (plywood and oriented strand board).

Pulp and Paper Products Council.

- For production data of newsprint, printing and writing paper, and wood pulp.

Statistics Canada. Table 16-10-0017-01: Lumber production, shipments, and stocks by species, monthly (x 1,000). https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1610001701 (accessed March 3, 2022).

- For production data of lumber, which include total softwood production for Canada.
- In January 2019, Statistics Canada noted that they made changes to the sampling and estimation methods for the monthly Sawmills survey, which is the source of the softwood lumber production data for this indicator. As a result of these changes, Statistics Canada replaced Table 16-10-0017-01 with Table 16-10-0045-01 as of January 2019. See https://www150.statcan.gc.ca/n1/daily-quotidien/200302/dq200302a-eng.htm for more information.
- Because of changes in sampling and estimation methods in the Sawmills survey, readers should exercise caution in comparing data from different sources directly.

Capital expenditures and repair expenditures

Statistics Canada. Table 34-10-0035-01 (formerly CANSIM 029-0045): Capital and repair expenditures, non-residential tangible assets, by industry and geography (x 1,000,000) https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3410003501 (accessed March 3, 2022).

- Capital expenditures include the costs of procuring, constructing and installing or leasing new durable plants, machinery and equipment, whether for the replacement of or addition to existing assets. Also included are all capitalized costs, such as costs for feasibility studies and architectural, legal, installation and engineering fees; the value of capital assets put in place by firms, either by contract or with the firm's own labour force; and capitalized interest charges on loans for capital projects.
- Repair expenditures include costs to repair and maintain structures, machinery and equipment.

Domestic consumption

Consumption figures for a range of products, calculated by Natural Resources Canada–Canadian Forest Service

- This information is available only at the national level.
- Domestic consumption of wood pulp (tonnes) contains Natural Resources Canada–Canadian Forest Service estimates of import volumes that may be subject to revision.

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