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Human Activity and the Environment 2017

Human Activity and the Environment: Forests in Canada

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Contents

Human Activity and the Environment 2017: Forests in Canada

Highlights

Human Activity and the Environment 2017: Forests in Canada tells the story of Canada's forests, providing up-to-date statistics on forest area; forest products and ecosystem services; economic and social contributions of the forest sector; and forest management activities and environmental impacts.[1]

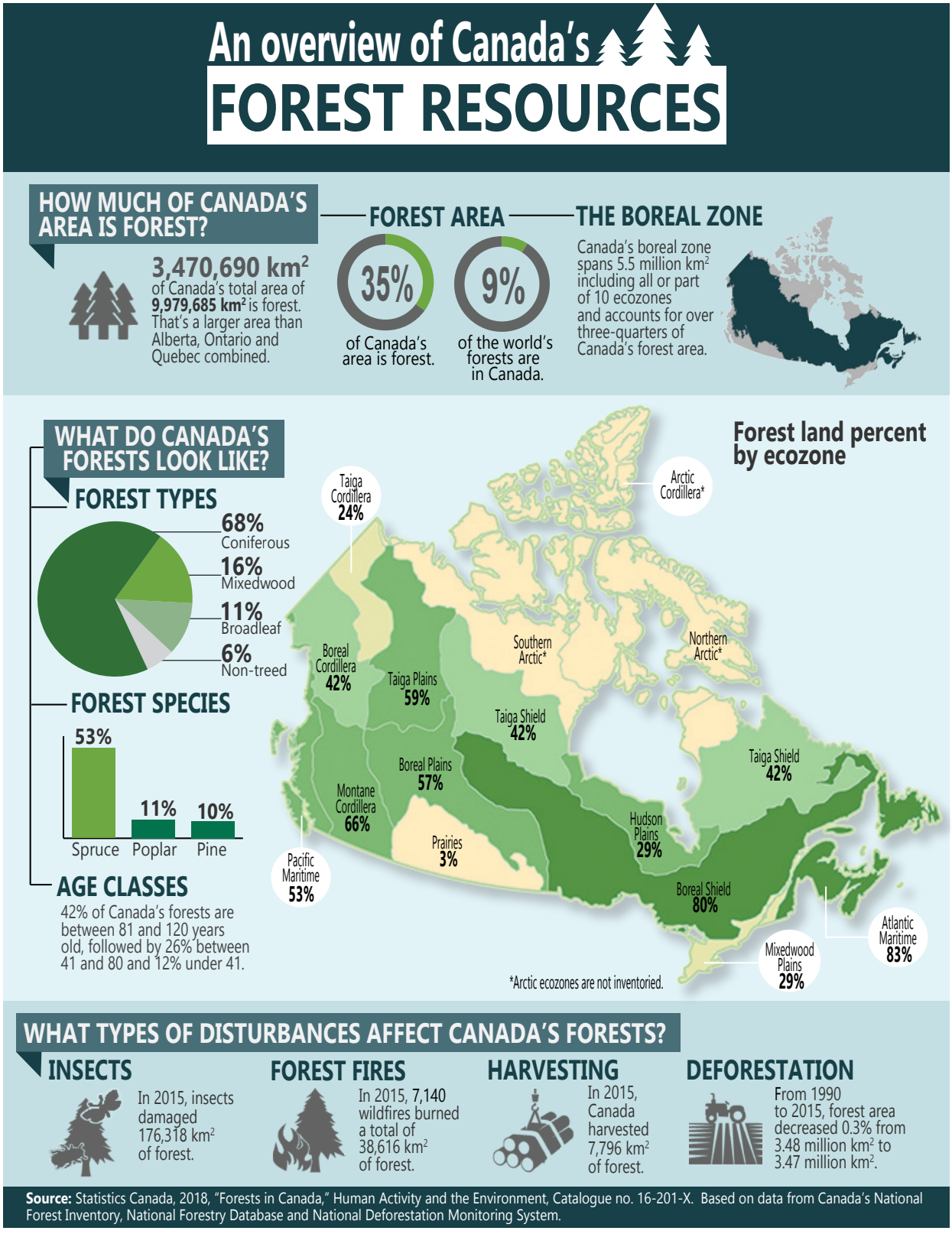
The following bullets present selected highlights from the report:

- Canada is rich in forest resources. In 2015, the country's 3.47 million km^2 of forest—located in the boreal and temperate zones—accounted for 9% of forests worldwide and 35% of the country's total area.
- The boreal zone covers over 5.5 million km^2 of Canada—from Newfoundland and Labrador to the Yukon—including all or substantial parts of ten ecozones. More than three-quarters of Canada's forest is located in the boreal zone. Canada has some of the largest areas in the world of remote and inaccessible forest landscapes.
- Coniferous forests account for 68% of Canada's forest area with spruce forests being the most common. Spruce forests are particularly characteristic of the boreal zone, accounting for large proportions of forest area in the Taiga Cordillera (89%), Hudson Plains (89%), Taiga Shield (86%) and Taiga Plains (85%).
- Insect outbreaks damaged an estimated 176,318 km^2 of forest in 2015. The largest proportions of damage were caused by the eastern spruce budworm (38%) and the forest tent caterpillar (29%).
- In 2015, 7,140 wildfires burned a total of 38,616 km^2 of forest land—49% were started by lightning strikes, 48% had a human source of ignition and the remainder had an unknown cause. Fires started by lightning were responsible for the majority of the burned area.
- In 2015, Canada harvested 7,796 km^2 of forest, which accounted for 0.2% of Canada's 3.47 million km^2 of forest area. Clearcutting was the most common method and was used to harvest 6,608 km^2 of forest—85% of the total harvested area in Canada.
- Canada's forest area decreased 0.3% from 3.483 million km^2 in 1990 to 3.471 million km^2 in 2015. Over this period, most forest converted to other land uses was used for agriculture (42%), mining, oil and gas (24%), built-up area (16%), hydro-electric infrastructure and reservoirs (13%) and forestry roads (6%).
- The value of Canada's accessible timber stocks—a component of natural resource wealth—was estimated at $215.4 billion in 2016.
- The total volume of roundwood harvested in Canada was 160.5 million m^3 in 2015, up 35% from the most recent low in 2009. By volume, British Columbia accounted for the greatest proportion at 42%, followed by Quebec (18%) and Alberta (17%).
- In 2014, gross domestic product (GDP) for the forest sector in Canada was $22.1 billion with wood product manufacturing responsible for 39% of this total, followed by paper manufacturing (36%), forestry and logging (17%) and support activities for forestry (8%). The forest sector's overall contribution to GDP has declined, from 1.7% in 2007 to 1.2% in 2014.
- As a proportion of total Canadian exports, forest products including logs and pulpwood, lumber and pulp and paper, have declined from 12% in 1997 to 6% in 2016. In 2016, exports were valued at $29.5 billion, with exports of lumber, sawmill and millwork products and pulp and paper accounting for the large majority of this total.

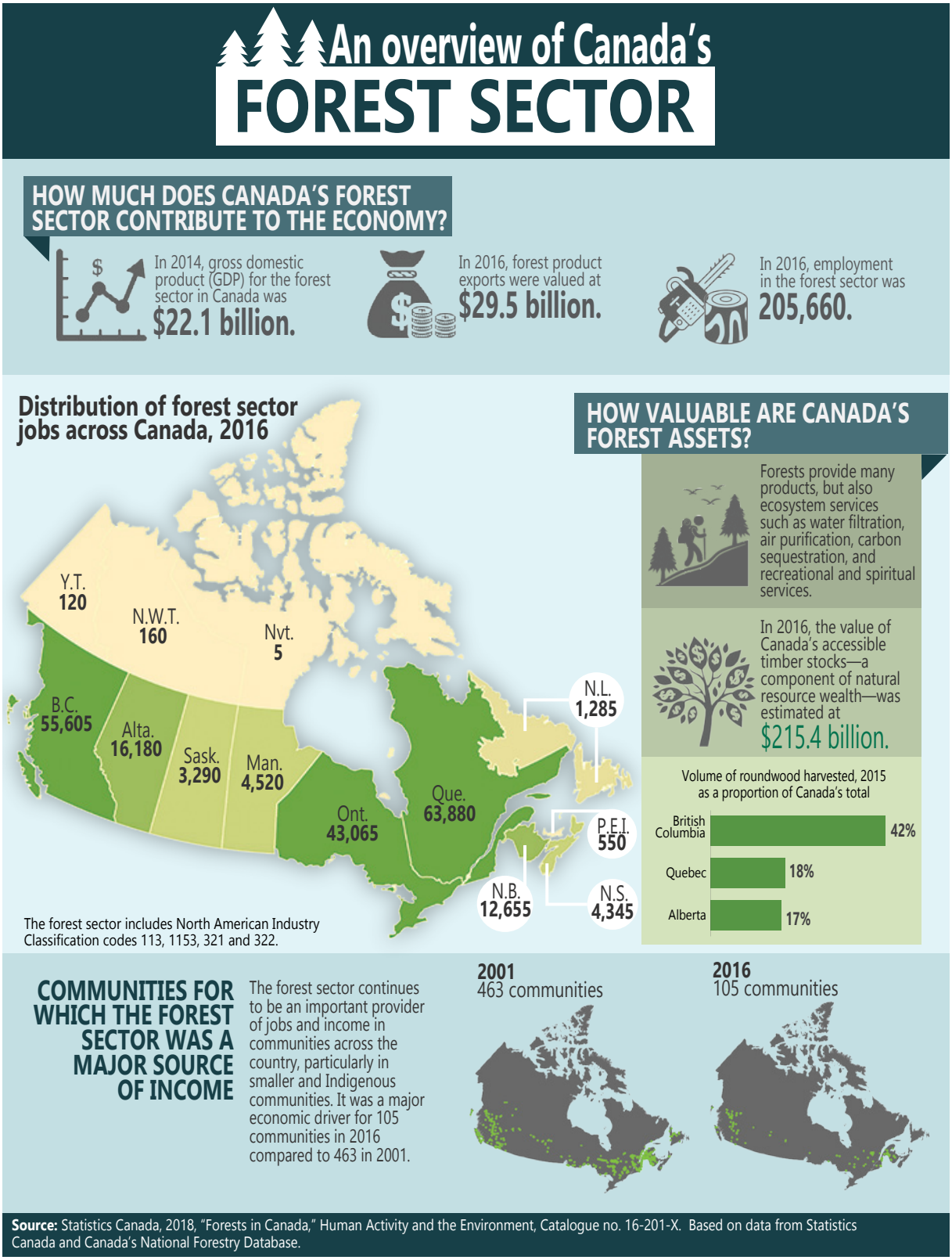
1 This report is based on data from the National Forest Inventory (NFI), the National Forestry Database (NFD) and Statistics Canada, and also includes a variety of information from other sources. For more information see Textbox 1.1 and complete citations in Section 2.

- While the number of forest sector jobs has declined 42% since 1997, the sector continues to be an important provider of jobs and income—providing Canadians with 205,660 jobs in 2016 that had a total compensation valued at $16.0 billion, 1.5% of all compensation in Canada.
- The forest sector was a major economic driver for 105 communities in 2016 compared to 463 in 2001. Increasingly, communities that receive a significant proportion of their income from the forest sector are smaller. The overall share of forest sector employment income generated by these forest sector-based communities decreased from 30% in 2000 to 11% in 2015.
- The forest sector was responsible for 4% of total Canadian water use in 2013 and greenhouse gas emissions associated with the sector totalled 39,931 kt in 2015, 5% of total industrial and household emissions. Environmental protection expenditures by the sector totaled $659.2 million in 2014.
- Linear features from roads, rail lines, electrical transmission lines and cutlines contribute to habitat fragmentation. While linear feature density is highest in more densely populated ecoregions, it is also elevated in other less densely populated areas including parts of the Boreal Plains and Taiga Plains ecozones, largely due to the influence of seismic lines for resource-based activities.
- Canada's forests are adapted to climate conditions associated with their specific geographic area, and as the climate changes, forests will change in response. From 1948 to 2016, the average annual temperature in Canada increased by 1.7 °C with all 11 of Canada's climate regions experiencing temperature increases during this time period.
- In 2006, 240,410 km^2 or 7% of Canada's total forest area was protected, for example, in conservation areas and large national, provincial and territorial parks. The proportion of protected area was highest for older forests—27% for stands aged 181 to 200 years, followed by 18% for stands aged 161 to 180 years and 16% for stands aged over 200 years.

Infograhic 1 An overview of Canada's forest resources



Infograhic 2 An overview of Canada's forest sector



Source: Statistics Canada, 2018, "Forests in Canada," Human Activity and the Environment, Catalogue no. 16-201-X. Based on data from Statistics Canada and Canada's National Forestry Database.

Section 1 Introduction

Canada's forests are diverse and dynamic ecosystems that provide many benefits to Canadians. Forests are also a renewable resource and are an important component of Canada's natural capital. In addition to providing timber and other forest products, forests provide habitat for wildlife, sequester carbon, filter air and water and offer recreational, spiritual and other benefits.

Although the forest sector experienced a significant decline in the late 2000s, with decreases in its overall contribution to gross domestic product, exports and employment, it continues to play an important role in the economy, particularly in many smaller and remote communities. Canada's forests are managed to sustain the multiple economic, social and environmental benefits they provide to society and to minimize the environmental impacts of forest operations.

Human Activity and the Environment 2017: Forests in Canada tells the story of Canada's forests, providing up-to-date statistics on forest area; forest products and ecosystem services; economic and social contributions of the forest sector; and forest management activities and environmental impacts.

The report is organized as follows:

Section 1 – Introduction

Section 2 – Forests and the forest sector in Canada

2.1 Forest resources provides the statistics on Canada's tree cover, as well as forest area, age structure, timber volume, natural disturbance and deforestation by ecozone.

2.2 Forest products and ecosystem services provides data on timber and non-timber forest products, biodiversity and selected ecosystem goods and services including carbon sequestration and recreation.

2.3 Forest sector provides data on gross domestic product, production, exports, employment, compensation and communities.

2.4 Forest management provides the latest statistics on harvested areas, regeneration, certification and protection of Canada's forests as well as information and data on selected environmental impacts associated with the forest sector.

2.5 Conclusion

Section 3 – Glossary

Acknowledgements

Textbox 1.1 What you need to know about this study

This report is based on data from the National Forestry Database (NFD), the National Forest Inventory (NFI) and Statistics Canada, and also includes a variety of information from other sources.

In Canada, the provinces and territories are responsible for developing forestry legislation and policy. Forestry operations must also meet federal legislation and international agreements. The Canadian Forest Service (CFS) of Natural Resources Canada (NRCan) is the main agency responsible for compiling national forestry statistics and monitoring and reporting on Canada's forests.

Forest management data (e.g., volume of wood harvested, area harvested and areas burned or damaged by insects) are collected by provincial and territorial governments and reported annually through the NFD (http://nfdp.ccfm.org), managed by NRCan.

The NFI is a statistical sampling program that collects data on Canada's forest area over time. It is carried out by the provinces, territories and NRCan (https://nfi.nfis.org). Monitoring is based on remote sensing—high resolution satellite imagery and aerial photographs. Photo plots are 2 km by 2 km and are located systematically on a 20 km by 20 km national sampling grid with reduced sampling in the north. In addition, field surveys are used for about 8% of the photo plots. The sampling points are stratified by ecozone.

The first cycle of the NFI was established from 2000 to 2006 and re-measurement occurs on a 10-year cycle with the current re-measurement cycle occurring from 2008 to 2017. Estimates of forest area change at the Canada-level are produced annually using data from Canada's National Deforestation Monitoring System, which was designed to meet information needs for reporting under the United Nations Framework Convention on Climate Change (UNFCCC).

Map data created by the CFS are used to visually represent treed area and species composition information. These data are statistically imputed from the NFI photo plots using the k nearest neighbour (kNN) mapping method and data from 26 geospatial layers including moderate resolution imaging spectroradiometer (MODIS) spectral data to produce maps with a 250 m x 250 m pixel spatial resolution.

Statistics Canada produces data on the value of timber assets, environmental protection expenditures, water use and greenhouse gas emissions, lumber and wood chip production, GDP, exports, employment and compensation, income and population.

Spatial data are used to illustrate the areas affected by wildfire, harvesting activities, changes in climate and linear features such as roads, rail lines, transmission lines and cutlines, as well as the population and population change in communities for which the forest sector is a major source of income.

Definitions: forest, other wooded land, tree cover, land cover and land use

Forest is defined by the Food and Agriculture Organization of the United Nations (FAO) as "land spanning more than 0.5 hectares with trees higher than 5 metres and a canopy cover of more than 10%, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use."[2] Forest may include treed areas and non-treed areas (e.g., areas that have recently been harvested and that are temporarily unstocked).

Non-forest land includes other wooded land, other land and other land with tree cover.

Note: The above definition of *forest* differs from that used by Canada for reporting under the UNFCCC, which uses a forest canopy cover of more than 25%.[3]

2 Food and Agriculture Organization of the United Nations (FAO), 2012, *FRA 2015—Terms and Definitions*, Forestry Department, Forest Resources Assessment Program, Working Paper 180, Rome, p. 3, http://www.fao.org/docrep/017/ap862e/ap862e00.pdf (accessed May 1, 2017).

3 Natural Resources Canada, 2017, "Inventory and Land-use change," *Carbon Accounting*, http://www.nrcan.gc.ca/forests/climate-change/carbon-accounting/13111 (accessed October 10, 2017).

Textbox 1.1 continued

Land cover refers to the observed physical and biological surface of the earth and includes biotic (living, such as vegetation) and abiotic (non-living, such as rocks) surfaces. For example, tree cover, grassland, shrubland, cropland, barren land, built-up, wetland and open water are some typical land cover classes. Land cover is usually determined using aerial or satellite imagery.

Tree cover and shrub cover refer to areas with trees and shrubs; however, these areas may or may not meet the FAO criteria for forests. They may include, for example, urban parks, woodlands on farms or treed areas around homes.

Land use describes the economic and social functions of land to meet human demands—how people are using land. For example, typical land use classes might include settlements, agricultural land, recreational areas or forest management areas. Land use can impact the natural environment and therefore may result in changes in land cover. Many land use classifications use land cover to describe natural and semi-natural vegetation, land use to describe agricultural and urban areas and a combination of the two to describe forests.[4]

The annual *Human Activity and the Environment* publications bring together data from many sources to present a statistical portrait of Canada's environment, with special emphasis on human activity and its relationship to natural elements—air, water, soil, plants and animals. Each issue provides accessible and relevant information on an environmental issue of concern to Canadians.

4 Gong, X., L.G. Marklund and S. Tsuji, 2009, "Land use classification," *14th Meeting of the London Group on Environmental Accounting*, Canberra, April 27-30, 2009, p. 2, https://unstats.un.org/unsd/envaccounting/londongroup/meeting14/LG14_10a.pdf (accessed May 15, 2017).

Section 2 – Forests and the forest sector in Canada

Forests cover approximately 30% of the earth's land area—the total area of the world's forests was 39.99 million km^2 in 2015, down 3% from 41.28 million km^2 in 1990.[5] However, most deforestation that has occurred in recent decades has occurred in tropical and sub-tropical forests. Canada's 3.47 million km^2 of forest—located in the boreal and temperate zones—accounted for 9% of the world's forests in 2015.[6] These forests provide many benefits to Canadians and to people around the world.

Of Canada's total forest area, 2.06 million km^2 are covered by a management plan that includes production, conservation or other uses.[7] The rest are located in more remote and northern areas and are often relatively undisturbed by human activity.[8] Logging is the largest direct human influence in the forest, but forest ecosystems are also affected by other activities including agriculture, mining, oil and gas extraction, as well as urban development.

Many other factors including fire, insect outbreaks and other natural disturbances, as well as climate change, play a role in shaping Canada's forest structure and composition. Humans are also affected by what is happening in Canada's forests—as can be seen from the recent wildfires that displaced thousands of people from their homes in Fort McMurray, Alberta in 2016 and the interior of British Columbia in 2017.

2.1 Forest resources

Canada's total area is 9,979,685 km^2.[9] The country has a wide variety of landscapes that can be divided into 15 ecozones—areas defined broadly by their climate, topography, soils and vegetation. Most of the land is vegetated—covered by trees, shrubs, grass and crops. The remaining area includes built-up as well as barrenland, water, snow and ice.

Areas with more tree cover occur along the west coast and southern interior of British Columbia and through the boreal zone (Map 2.1). Land cover in the Prairies is mostly cropland and grassland, while the Arctic is largely shrubland and barrenland.[10] Soil conditions and climate, including precipitation, temperatures, frost free periods and wind speed, have a large influence on the distribution of vegetation types and species across different areas of the country.

The boreal zone is an area of forests, woodlands, wetlands and lakes covering over 5.5 million km^2 of Canada from Newfoundland and Labrador to the Yukon,[11] as well as vast areas of Alaska, northern Europe and Asia. In Canada, the boreal zone covers all or substantial parts of ten ecozones. Tree cover extends across more than half of the zone[12]—this vegetation is shaped by cold climate conditions, regular fires, insect outbreaks and other natural disturbances.[13] As Canada's largest biome, it provides a host of benefits including food and renewable raw materials, wildlife habitat, climate regulation, carbon sequestration, nutrient cycling, air and water purification, erosion control and opportunities for recreational activities.[14]

5 Food and Agriculture Organization of the United Nations (FAO), 2016, *Global Forest Resources Assessment 2015: How are the world's forests changing?* Second edition, p. 16, http://www.fao.org/3/a-i4793e.pdf (accessed May 1, 2017).

6 Natural Resources Canada, Canadian Forest Service, 2016, The State of Canada's Forests: Annual Report 2016, Ottawa, Catalogue no. Fo1-6E-PDF, p. 18–19, http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/37265.pdf (accessed April 15, 2017). Note that Canada-level forest area for 2015 is estimated using forest inventory data (2006) and deforestation monitoring data.

7 Food and Agriculture Organization of the United Nations (FAO), 2015, *Global Forest Resources Assessment 2015: Desk Reference*, p. 212, http://www.fao.org/3/a-i4808e.pdf (accessed May 1, 2017).

8 Federal, Provincial and Territorial Governments of Canada, 2010, *Canadian Biodiversity: Ecosystem Status and Trends 2010*, Canadian Councils of Resource Ministers, Ottawa, ON, p. 16, http://www.biodivcanada.ca/default.asp?lang=En&n=83A35E06-1 (accessed May 10, 2017).

9 Canada's National Forest Inventory (NFI), 2013, Table 1.0 Area (1000ha) of land cover in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 07, 2017). Note that this total includes inland water.

10 The arctic ecozones (Arctic Cordillera, Northern Arctic, Southern Arctic) and small portions of the Taiga Plains and Hudson Plains ecozones located in Nunavut are largely devoid of tree cover and are not included in Canada's National Forest Inventory.

11 Brandt, J.P., 2009, "The extent of the North American boreal zone," *Environmental Reviews*, Vol. 17, no. 1, p. 101–161, http://cfs.nrcan.gc.ca/publications/?id=29569 (accessed June 15, 2017); Canada's National Forest Inventory (NFI), 2013, Table 1.2 Area (1000ha) of land cover by boreal zone in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 07, 2017).

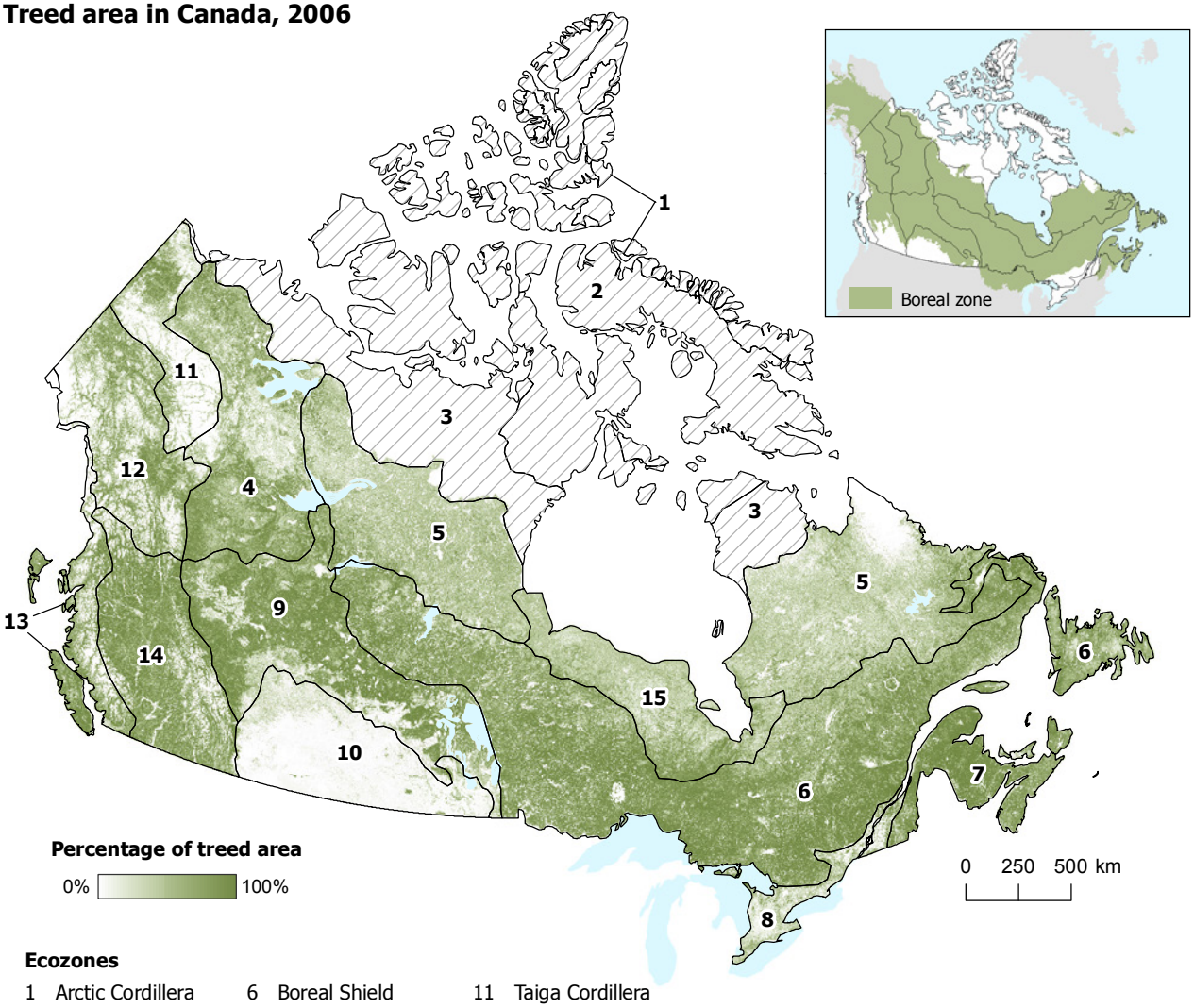
12 Canada's National Forest Inventory (NFI), 2013, Table 1.2 Area (1000ha) of land cover by boreal zone in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 07, 2017).

13 Thomas, S.C. and J. MacLellan, "Boreal and temperate forests," *Forests and Forest Plants*, Vol. 1, https://www.eolss.net/Sample-Chapters/C10/E5-03-01-03.pdf (accessed June 15, 2017).

14 Brandt, J.P., 2009, "The extent of the North American boreal zone," *Environmental Reviews*, Vol. 17, no. 1, p. 101, http://cfs.nrcan.gc.ca/publications/?id=29569 (accessed June 15, 2017).

Temperate zone forests are located across six ecozones south of the boreal zone and vary quite widely based on climate, moisture, soils, topography and vegetation. These forests include coastal rainforests in the Pacific Maritime ecozone; inland rainforests, montane and sub-alpine forests in the Montane Cordillera ecozone and mixedwood and deciduous forests of the Mixedwood Plains ecozone and the Atlantic Maritime ecozone.

Map 2.1
Treed area in Canada, 2006



Ecozones

1	Arctic Cordillera	6	Boreal Shield	11	Taiga Cordillera
2	Northern Arctic	7	Atlantic Maritime	12	Boreal Cordillera
3	Southern Arctic	8	Mixedwood Plains	13	Pacific Maritime
4	Taiga Plains	9	Boreal Plains	14	Montane Cordillera
5	Taiga Shield	10	Prairies	15	Hudson Plains

Boundaries

Ecozone boundary

Non-inventoried ecozones

Notes: This map provides a visual representation of the distribution of treed area across Canada. Data for treed area are available from the National Forest Inventory by ecozone. Treed area is different from forest area—the former includes areas with trees on non-forest land use areas (e.g., agricultural or urban lands) while forest area includes lands that are temporarily unstocked with trees (e.g., after disturbance or harvesting) and that are expected to regenerate. Non-inventoried land includes the Arctic ecozones (Arctic Cordillera, Northern Arctic, Southern Arctic) and small portions of the Taiga Plains and Hudson Plains ecozones located in Nunavut—areas that are largely devoid of tree cover.

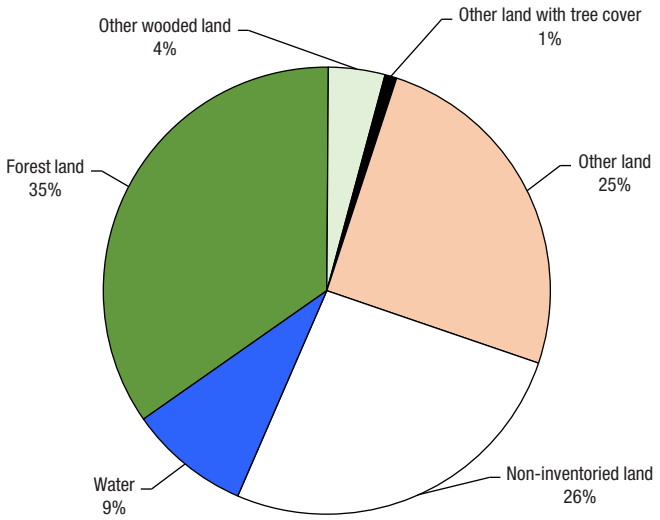
Sources: Statistics Canada, Environment, Energy and Transportation Statistics Division, 2018; Canada's National Forest Inventory (NFI), 2016, Grouped *k*NN Map layers, http://tree.pfc.forestry.ca (accessed April 7, 2017); NFI, 2013, Table 1.1 Area (1000 ha) of land cover by terrestrial ecozone in Canada, revised 2006 baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017); Brandt, J.P., 2009, "The extent of the North American boreal zone," *Environmental Reviews,* Vol 17, p. 101–161; Natural Resources Canada, 2016, *North American boreal zone map shapefiles,* www.nrcan.gc.ca/forests/boreal/14252 (accessed June 15, 2017).

Forest area and structure

Canada's forests—including areas recently burned or harvested but that are expected to revert back to treed land—account for 35% of the country's total area (Chart 2.1).[15] More than three-quarters of Canada's forest is located in the boreal zone.[16] The Boreal Shield ecozone has the largest forest area with 1,312,747 km^2, accounting for 80% of its total land area (Chart 2.2). Other boreal ecozones with significant areas of forest include the Taiga Shield with 462,929 km^2, accounting for 42% of its land area, and the Boreal Plains, with 384,547 km^2 of forest land, accounting for 57% of its land area.

The Atlantic Maritime ecozone has the highest proportion of forest area at 83%. Other ecozones with significant proportions of forest include the Taiga Plains (59%), Montane Cordillera (66%) and Pacific Maritime (53%). Forest area was lowest in the Prairies, the Mixedwood Plains, the Taiga Cordillera and Hudson Plains ecozones.

Chart 2.1
Forest and non-forest area, 2006

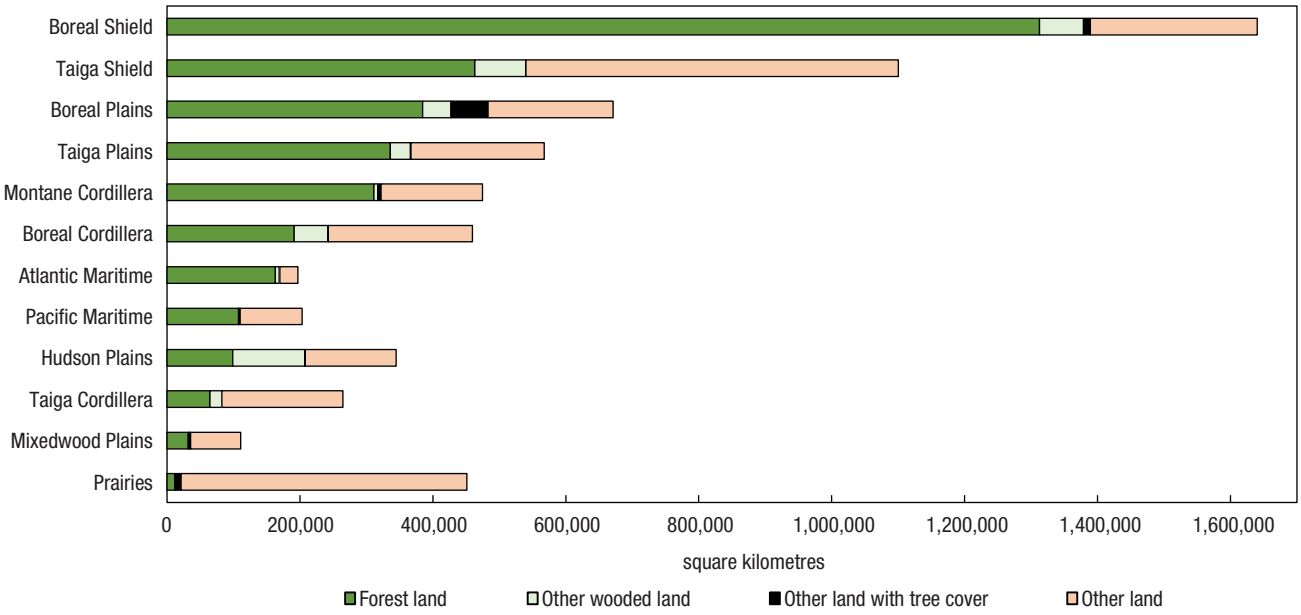


Notes: Forest land is defined as area with trees higher than 5 metres and a canopy cover of more than 10%, or trees able to reach these thresholds in situ. It includes areas that are temporarily unstocked with trees. Other wooded land has trees higher than 5 m and a canopy cover of 5% to 10%, or trees able to reach these thresholds, or with a combined cover of shrubs, bushes and trees above 10%. These two classes do not include land that is predominantly under agricultural or urban land use. Other land is not classified as forest or other wooded land and includes agricultural land, built-up and barrenland. Other land with tree cover has patches of tree cover over 0.5 ha with a canopy cover of more than 10% and trees able to reach a height of 5 metres at maturity. Non-inventoried land includes the Arctic ecozones (Arctic Cordillera, Northern Arctic, Southern Arctic) and small portions of the Taiga Plains and Hudson Plains ecozones located in Nunavut—areas that are largely devoid of tree cover.
Sources: Canada's National Forest Inventory, 2013, Table 4.0 Area (1000 ha) of forest and non-forest land in Canada and Table 1.0 Area (1000 ha) of land cover in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

15 Note that all forest area data provided in this section are for circa 2006. While deforestation monitoring data has been used to estimate forest change and provide annual forest area data at the Canada-level, the National Forestry Inventory (NFI) data are not updated at the ecozone level or for other forest characteristics. Forest area is different from treed area—the former does not include treed land predominantly under agricultural or urban land use, but does include areas that are temporarily unstocked with trees. Treed area accounts for 36% of the country's total area.

16 Canada's National Forest Inventory (NFI), 2013, Table 4.2 Area (1000 ha) of forest and non-forest land by boreal zone in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

Chart 2.2
Forest and non-forest land by ecozone, 2006



Notes: Forest land is defined as area with trees higher than 5 metres and a canopy cover of more than 10%, or trees able to reach these thresholds in situ. It includes areas that are temporarily unstocked with trees. Other wooded land has trees higher than 5 m and a canopy cover of 5% to 10%, or trees able to reach these thresholds, or with a combined cover of shrubs, bushes and trees above 10%. These two classes do not include land that is predominantly under agricultural or urban land use. Other land is not classified as forest or other wooded land and includes agricultural land, built-up and barrenland. Other land with tree cover has patches of tree cover over 0.5 ha with a canopy cover of more than 10% and trees able to reach a height of 5 metres at maturity. Excludes non-inventoried land in the Arctic ecozones (Arctic Cordillera, Northern Arctic, Southern Arctic) and small areas of the Taiga Plains and Hudson Plains ecozones located in Nunavut—areas that are largely devoid of tree cover. The total land area excludes inland water.
Source: Canada's National Forest Inventory, 2013, Table 4.1 Area (1000 ha) of forest and non-forest land by terrestrial ecozone in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

Forest type and species

Canadian forests can be divided broadly based on whether they are composed mostly of coniferous, broadleaf or a mix of coniferous and broadleaf tree species, termed mixedwood. Coniferous forests—including forests dominated by spruce, pine, fir, hemlock, Douglas-fir and cedar—account for 68% of forest area (Chart 2.3). Broadleaf forests dominated by trees such as poplar, birch, maple make up 11% proportion of Canada's forests. Mixedwood forests account for 16% of forest area.

Coniferous species are dominant across ecozones in western Canada and across much of the boreal zone (Map 2.2). The largest expanse of coniferous forest is found in the Boreal Shield with 788,790 km^2, 60% of the ecozone's forest area (Chart 2.4). The Taiga Shield ranks second with 384,541 km^2 (83%) and the Montane Cordillera ranks third with 276,268 km^2 (89%).

Broadleaf and mixedwood forests are more common throughout the Prairies, Mixedwood Plains and the Atlantic Maritime, but also account for significant proportions of the Boreal Plains, Hudson Plains, and Boreal Shield ecozones. The largest areas of mixedwood and broadleaf forest are found in the Boreal Shield with 436,923 km^2 and the Boreal Plains with 151,164 km^2.

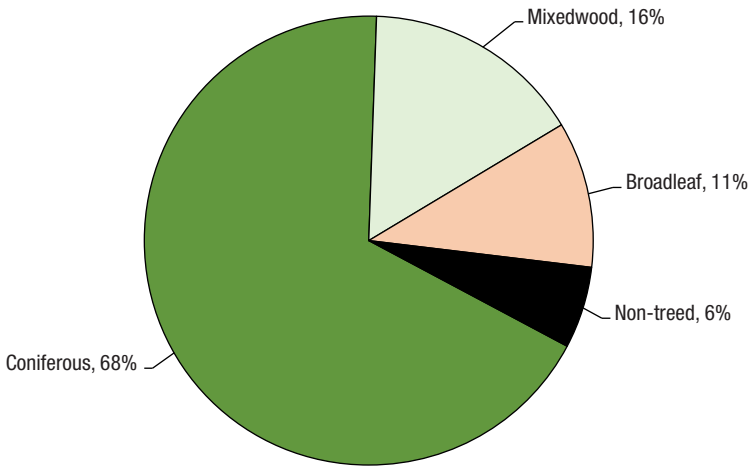
Spruce forests are the most common—they account for 53% of Canada's forest area.[17] Poplar is the second most common species group, representing 11% of Canada's forest, followed by pine at 10%.

17 Canada's National Forest Inventory (NFI), 2013, Table 14.0 Area (1000 ha) of land by species group and age class in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

Spruce trees are particularly characteristic of the boreal zone, with spruce–lichen forests providing important habitat for caribou and other species.[18] Spruce forests account for large proportions of forest area in the Taiga Cordillera (89%), Hudson Plains (89%), Taiga Shield (86%) and Taiga Plains (85%).[19] Poplar too are common in the boreal zone, particularly in the Boreal Plains and Boreal Shield ecozones, where they represent 32% and 12% respectively of forest area. The largest areas of pine forests occur in the Boreal Shield, Montane Cordillera and Boreal Plains ecozones.

Different species are seen to the south. In the Montane Cordillera ecozone, pines are the most common, accounting for 34% of the forest area, followed by spruce (21%), fir (19%) and Douglas-fir (12%). Hemlock forests account for 42% of the Pacific Maritime ecozone, followed by cedar (18%), fir (12%) and Douglas-fir (12%). Maple forests account for 19% of the forest in the Atlantic Maritime and 39% of the Mixedwood Plains ecozones.

Chart 2.3
Forest type, 2006

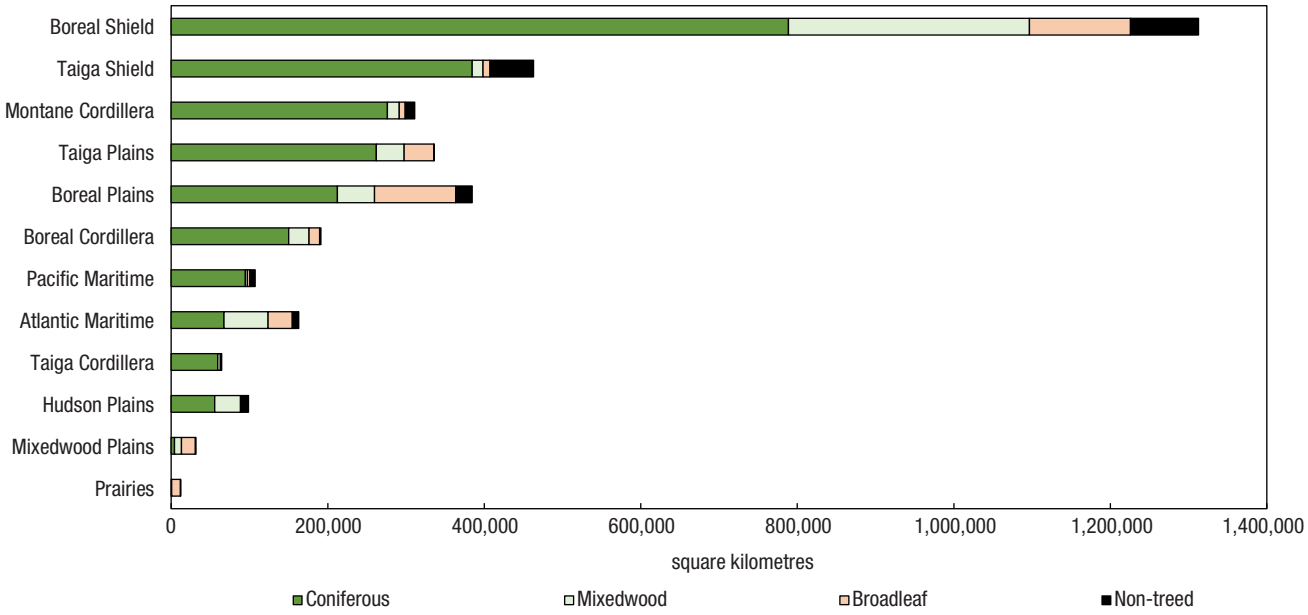


Note: The category 'non-treed' includes areas that meet the criteria to be classified as forests, but that are temporarily unstocked with trees.
Source: Canada's National Forest Inventory, 2013, Table 5.0 Area (1000 ha) of forest land by forest type and age class in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

18 Federal, Provincial and Territorial Governments of Canada, 2010, *Canadian Biodiversity: Ecosystem Status and Trends 2010*, Canadian Councils of Resource Ministers, Ottawa, ON, p.17, http://www.biodivcanada.ca/default.asp?lang=En&n=83A35E06-1 (accessed May 10, 2017).

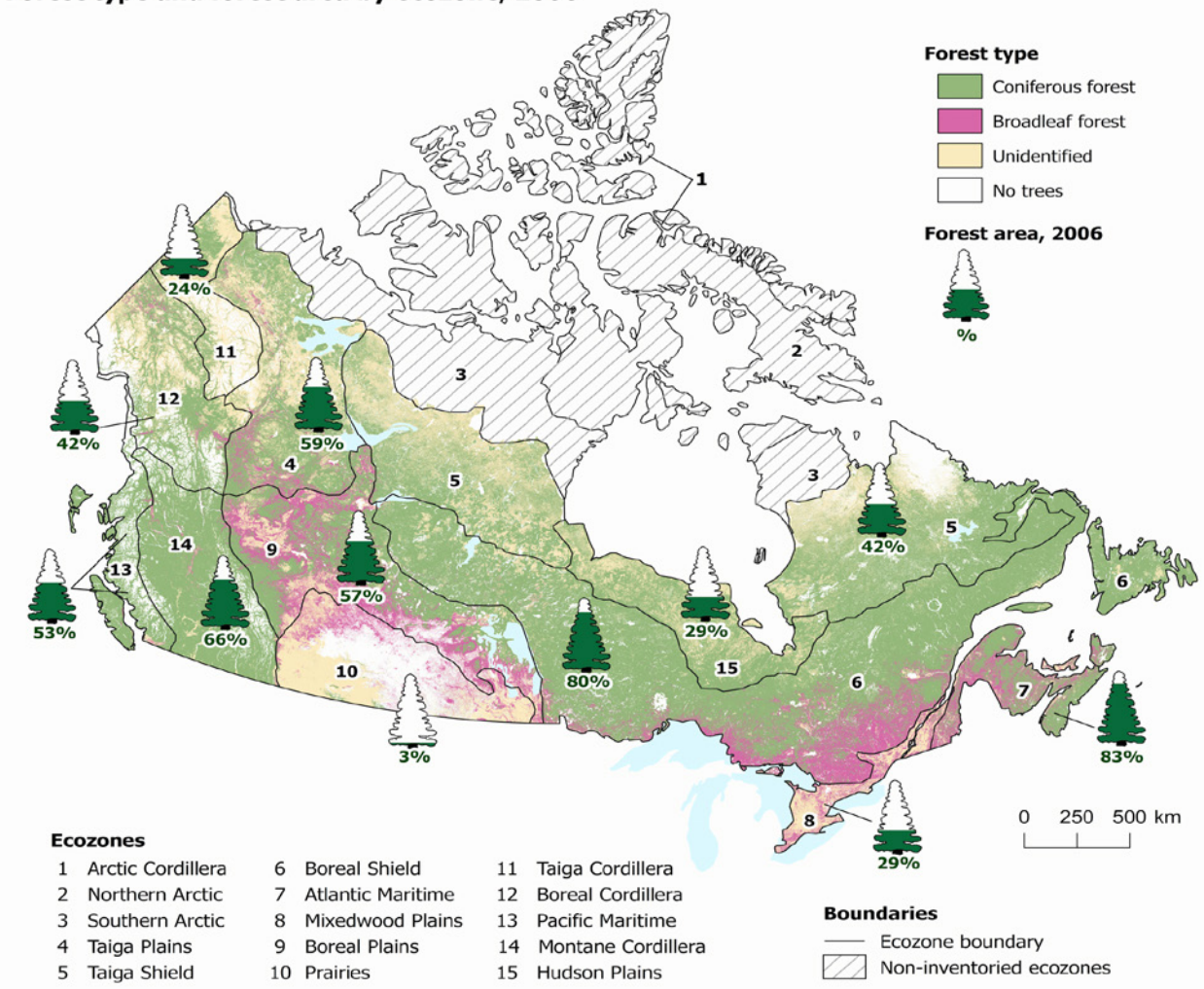
19 Canada's National Forest Inventory (NFI), 2013, Table 14.1 Area (1000 ha) of land by species group and age class and terrestrial ecozone in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

Chart 2.4
Forest type by ecozone, 2006



Note: The category 'non-treed' includes areas that meet the criteria to be classified as forests, but that are temporarily unstocked with trees.
Sources: Canada's National Forest Inventory, 2013, Table 5.1 Area (1000 ha) of forest land by forest type and age class and terrestrial ecozone in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

Map 2.2
Forest type and forest area by ecozone, 2006



Notes: This map provides a visual representation of the proportion of each ecozone that is classified as forest area, as well as the distribution of forest types across Canada. Non-inventoried land includes the Arctic ecozones (Arctic Cordillera, Northern Arctic, Southern Arctic) and small portions of the Taiga Plains and Hudson Plains ecozones located in Nunavut—areas that are largely devoid of tree cover. Areas where the dominant tree species was unidentified by the mapping technique generally have little tree cover.

Sources: Statistics Canada, Environment, Energy and Transportation Statistics Division, 2018; Canada's National Forest Inventory (NFI), 2016, Grouped kNN Map layers, http://tree.pfc.forestry.ca (accessed April 7, 2017); NFI, 2013, Table 4.1 Area (1000 ha) of forest and non-forest land by terrestrial ecozone in Canada, revised 2006 baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

Age class

Forests contain stands of trees of different ages. Stands are generally classified into different age classes based on the dominant age of trees. Forests in many areas of Canada have gotten younger over time because of harvesting,[20] while some have gotten older due to fire suppression.[21] Natural disturbance such as fires, insects, and windthrow create a mosaic of stands of different ages in forests. Major stand-replacing fires allow for the establishment of young forests and ecosystem-based forest management systems seek to emulate natural disturbances and the landscape patterns of young and old stands that they create.[22]

As forests age, trees grow bigger and biomass increases, but forests also develop greater structural complexity and biodiversity.[23] For example, there may be more coarse woody debris, snags and fallen trees, while tree size, plant and animal species may be more diverse.[24] From the perspective of timber production, however, older forests are less productive than young forests since growth rates slow as trees age and timber volumes decline as trees decay.[25]

The prevalence of older forests depends on the type of forest, since the biological life span of trees varies by species, but also on the area, climate and fire regime. Most forest area—42%—is classed from 81 to 120 years old, followed by 26% from 41 to 80 years and 12% under age 41 (Table 2.1). Forest areas that are classed older than 120 years make up 14% of Canada's forests. Broadleaf and mixedwood forests tend to be younger—and the oldest forests are almost entirely coniferous.[26]

Most of Canada's oldest forests are located in wetter areas of the west where the climate limits the frequency and severity of fires. In the boreal zone, the prevalence of older forests depends on the climate and fire regime in different areas. Fir, hemlock, spruce and cedar forests in the Montane Cordillera, Pacific Maritime and Boreal Cordillera ecozones account for 95% of Canada's oldest forests.[27] In coastal rainforests, some hemlock, western red cedar and yellow-cedar trees can reach over 1,500 years old.[28]

20 Federal, Provincial and Territorial Governments of Canada, 2010, *Canadian Biodiversity: Ecosystem Status and Trends 2010*, Canadian Councils of Resource Ministers, Ottawa, ON, p.17, http://www.biodivcanada.ca/default.asp?lang=En&n=83A35E06-1 (accessed May 10, 2017); Shorohova, E., et al., 2011, "Variability and dynamics of old-growth forests in the circumboreal zone: implications for conservation, restoration and management," *Silva Fennica*, Vol. 45, no. 4, p. 785, http://www.metla.fi/silvafennica/full/sf45/sf455785.pdf (accessed June 21, 2017).

21 BC Market Outreach Network and Ministry of Sustainable Resource Management, 2003, *British Columbia's Forests: A Geographical Snapshot*, p.14, https://www.for.gov.bc.ca/hfd/pubs/Docs/Mr/Mr112/ (accessed May 15, 2017); Shorohova, E. et al., 2011, "Variability and dynamics of old-growth forests in the circumboreal zone: implications for conservation, restoration and management," *Silva Fennica*, Vol. 45, no. 4, p. 785, http://www.metla.fi/silvafennica/full/sf45/sf455785.pdf (accessed June 21, 2017).

22 Gauthier, S. et al., 2009, *Ecosystem Management in the Boreal Forest*, N. Lecompte (ed.), Les Presses de l'Université du Québec, Québec, http://chaireafd.uqat.ca/publication/articlePDF/RecettesDeDameNature_En.pdf (accessed October 16, 2017).

23 British Columbia, Ministry of Forests Research Program, 1998, "Seral stages across forested landscapes: relationships to biodiversity," *Extension Note*, p. 1–8, https://www.for.gov.bc.ca/hfd/pubs/Docs/EN/EN18.pdf (accessed June 23, 2017); Federal, Provincial and Territorial Governments of Canada, 2010, *Canadian Biodiversity: Ecosystem Status and Trends 2010*, Canadian Councils of Resource Ministers, Ottawa, ON, p.17, http://www.biodivcanada.ca/default.asp?lang=En&n=83A35E06-1 (accessed May 10, 2017.

24 BC Market Outreach Network and Ministry of Sustainable Resource Management, 2003, *British Columbia's Forests: A Geographical Snapshot*, p.14, https://www.for.gov.bc.ca/hfd/pubs/Docs/Mr/Mr112/ (accessed May 15, 2017).

25 Royal Commission on Forest Resources, 1975, *Regulation of the Rate of Timber Harvesting in British Columbia*, https://www.for.gov.bc.ca/hfd/library/documents/regulrate.pdf (accessed June 26, 2017).

26 Canada's National Forest Inventory (NFI), 2013, Table 5.1 Area (1000 ha) of forest land by forest type, age class in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

27 Canada's National Forest Inventory (NFI), 2013, Table 14.1 Area (1000 ha) of forest land by forest type, age class and terrestrial ecozone in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

28 BC Market Outreach Network and Ministry of Sustainable Resource Management, 2003, *British Columbia's Forests: A Geographical Snapshot*, p.14, https://www.for.gov.bc.ca/hfd/pubs/Docs/Mr/Mr112/ (accessed May 15, 2017).

Table 2.1
Forest area by age class and ecozone, 2006

	1 to 40	41 to 80	81 to 120	121 to 160	161 to 200	201 and over	Other[1]	Total
	square kilometres							
Canada	**428,634**	**913,416**	**1,453,208**	**266,121**	**62,551**	**149,874**	**201,953**	**3,475,757**
Boreal Shield	244,448	421,405	501,168	55,880	4,349	101	85,395	1,312,747
Taiga Shield	1,330	46,831	277,538	81,636	0	0	55,594	462,929
Boreal Plains	48,482	178,361	108,717	22,339	5,018	664	20,967	384,546
Taiga Plains	3,593	53,778	264,247	12,014	1,197	516	667	336,012
Montane Cordillera	20,895	41,708	73,041	64,887	36,253	62,208	12,292	311,285
Boreal Cordillera	21,120	45,843	62,951	22,210	11,577	26,061	1,403	191,165
Atlantic Maritime	60,672	76,970	16,679	382	17	2	8,235	162,957
Pacific Maritime	9,258	13,171	8,485	4,904	4,121	60,323	7,179	107,441
Hudson Plains	1,062	2,395	85,401	646	0	0	9,074	98,577
Taiga Cordillera	6,581	8,540	48,193	1,097	18	0	0	64,429
Mixedwood Plains	11,157	17,186	2,380	125	0	0	845	31,692
Prairies	37	7,228	4,411	1	0	0	302	11,978

1. Missing or unknown age class

Source: Canada's National Forest Inventory, 2013, Table 5.1 Area (1000 ha) of forest land by forest type, age class in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

Timber volume

The amount or volume of wood present in a forest provides important information to inform decisions on forest management and harvesting.[29] The total standing timber volume in Canada is 47.3 billion m^3, with one-third of this total occurring in the Boreal Shield, followed by 17% in the Montane Cordillera (Table 2.2).

Timber volume depends in large part on growth rates, which vary according to the tree species, age and health and on-site conditions including climate and access to light and nutrients.[30] The fastest growing trees, as well as some of the oldest trees, are found on the west coast. The Pacific Maritime ecozone has the highest timber volume per unit area in the country—432 m^3/ha—more than three times the national average of 136 m^3/ha (Chart 2.5).

Coniferous forests account for 72% of timber volume, followed by mixedwood forests at 16% and broadleaf forests at 12%.[31] Spruce, pine and fir—the main species used to produce softwood lumber, make up almost two-thirds of Canada's total timber volume (Table 2.2).

29 Natural Resources Canada, Canadian Forest Service, 2016, *The State of Canada's Forests: Annual Report 2016*, Ottawa, Catalogue no. Fo1-6E-PDF, p. 21, http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/37265.pdf (accessed April 15, 2017).

30 Natural Resources Canada, Canadian Forest Service, 2016, *The State of Canada's Forests: Annual Report 2016*, Ottawa, Catalogue no. Fo1-6E-PDF, p. 21, http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/37265.pdf (accessed April 15, 2017).

31 Canada's National Forest Inventory (NFI), 2013, Chart 15.0 Total tree volume (million m^3) on forest land by forest type and age class in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

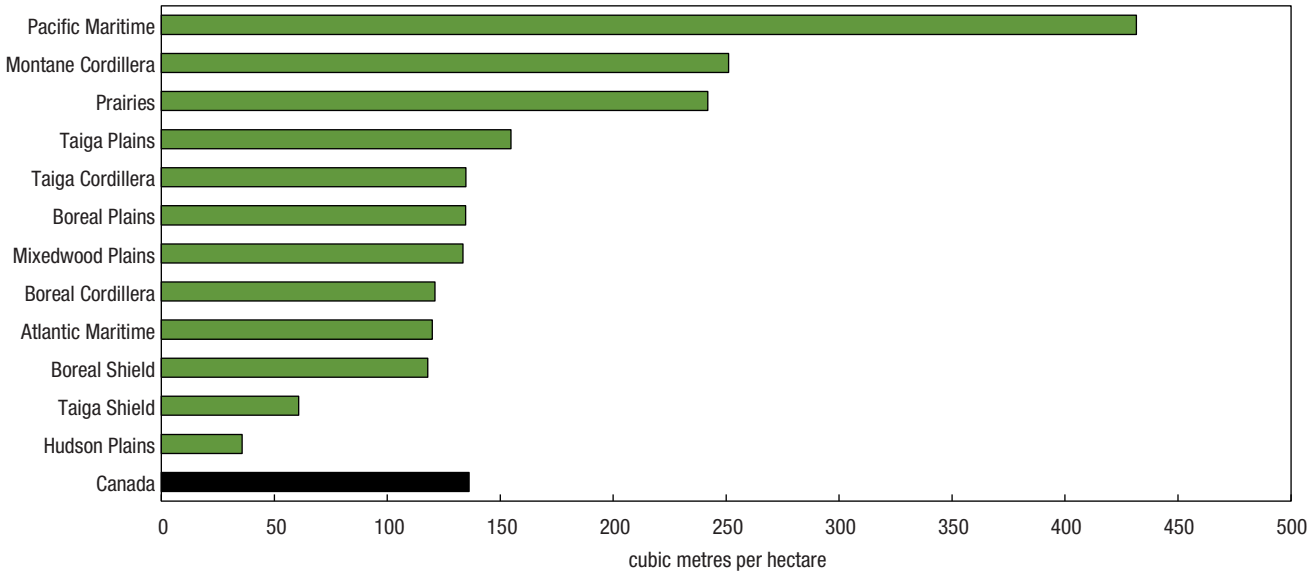
Table 2.2
Standing timber volume by species group and ecozone, 2006

	Spruce	Poplar	Pine	Fir	Hemlock	Douglas-fir	Birch	Maple	Others[1]	Total
	million cubic metres									
Canada	**22,383**	**6,176**	**5,611**	**3,499**	**2,741**	**1,653**	**1,575**	**1,403**	**2,279**	**47,320**
Boreal Shield	7,955	2,364	1,658	691	37	0	1,291	799	675	15,470
Montane Cordillera	1,970	216	2,486	1,359	413	1,016	34	0	322	7,815
Taiga Plains	4,306	775	77	0	0	0	38	0	5	5,201
Boreal Plains	2,226	2,112	711	19	0	0	34	1	77	5,180
Pacific Maritime	137	39	60	545	2,279	636	7	12	922	4,636
Taiga Shield	2,749	42	3	13	0	0	3	0	5	2,815
Boreal Cordillera	1,338	134	536	293	0	0	14	0	0	2,315
Atlantic Maritime	516	158	43	532	7	0	126	398	174	1,953
Taiga Cordillera	824	0	2	24	0	0	19	0	0	869
Mixedwood Plains	7	57	28	24	6	0	9	192	100	423
Hudson Plains	342	5	5	0	0	0	0	0	1	353
Prairies	12	276	1	0	0	0	0	0	0	290

1. Includes cedar and other conifers, larch, other hardwoods, unspecified conifers, unspecified hardwoods and unclassified trees.

Source: Canada's National Forest Inventory, 2013, Table 16.1 Total tree volume (million m³) by species group, age class and terrestrial ecozone in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

Chart 2.5
Standing timber volume by ecozone, 2006



Source: Canada's National Forest Inventory, 2013, Table 15.1 Total tree volume (million m³) on forest land by forest type, age class, and terrestrial ecozone in Canada and Table 5.1 Area (1000 ha) of forest land by forest type, age class and terrestrial ecozone in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org (accessed April 7, 2017).

Forest change

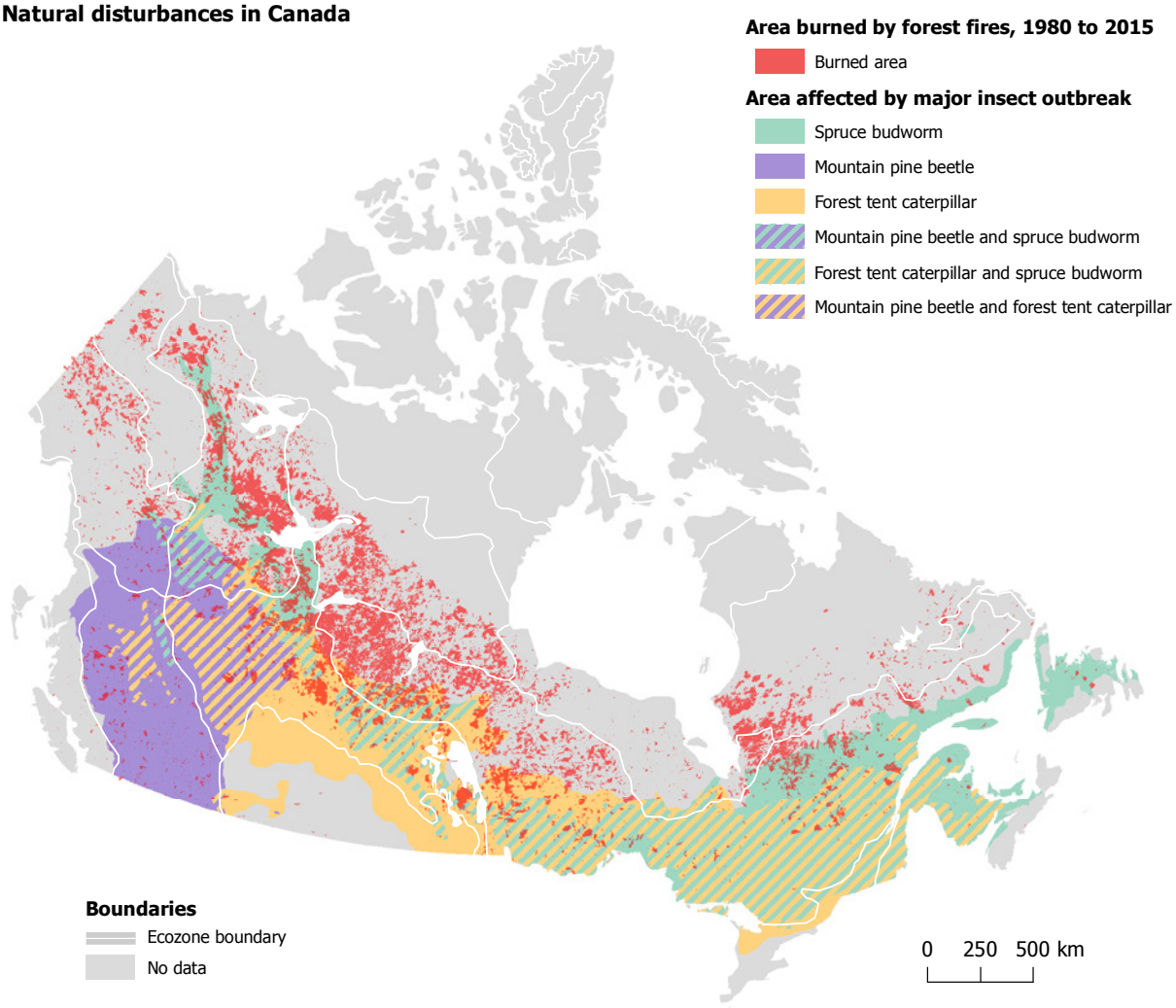
Change is constant in forest ecosystems. These changes can include changes in forest area, age class, structure, species diversity and composition. Forests are affected by natural disturbances such as insect infestations, diseases, fires, flooding and wind, as well as by timber harvesting, forest management practices and land use decisions. In addition, climate change influences the frequency and severity of natural disturbances and over time is expected to result in changes in tree growth and species range (see Textbox 2.1 for more information).[32]

Natural disturbance

Natural disturbance is a normal part of forest ecosystems shaping succession and regeneration of forests. The total area affected in a given year by natural disturbance, including insect outbreaks and fires, can be significant, although large annual fluctuations occur and the impacts of disturbance range from small reductions in growth to mortality of all trees. The area affected by natural disturbance normally greatly exceeds the area affected by logging and areas converted to other land uses (Map 2.3).

32 Natural Resources Canada, 2017, *Impacts*, http://www.nrcan.gc.ca/forests/climate-change/impacts/13095 (accessed September 18, 2017); Settele, J. et al., 2014, "Terrestrial and inland water systems," *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*, C.B. Field et al. (eds.), Cambridge University Press, p. 271–359, http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap4_FINAL.pdf (accessed June 29, 2017).

Map 2.3
Natural disturbances in Canada



Notes: Areas affected by major insect outbreaks represent the geographical range of insects. Burned areas regenerate over time and therefore will be in varying stages of succession.

Sources: Natural Resources Canada, 2015, "Where do forest fires and insect outbreaks affect Canada's forests," *The State of Canada's Forests,* 2015, http://cfs.nrcan.gc.ca/publications?id=36108 (accessed July 2, 2017); Natural Resources Canada, 2017, *Canadian Wildland Fire Information System,* http://cwfis.cfs.nrcan.gc.ca/datamart (accessed August 16, 2017); Statistics Canada, Environment, Energy and Transportation Statistics Division, 2018.

Insects

Insect outbreaks—including defoliator and bark beetle outbreaks—are a natural part of forest ecosystems. Major outbreaks occur periodically, increasing tree mortality and having significant economic impacts. Defoliating caterpillars eat tree needles, leaves and buds, resulting in reduced growth, tree deformity and in severe cases, tree mortality. Bark beetles bore through tree bark, laying eggs and spreading damaging fungi. Insect outbreaks may be short-lived or may last for many years depending on the species, natural predators, climate conditions, availability of host trees and other factors.

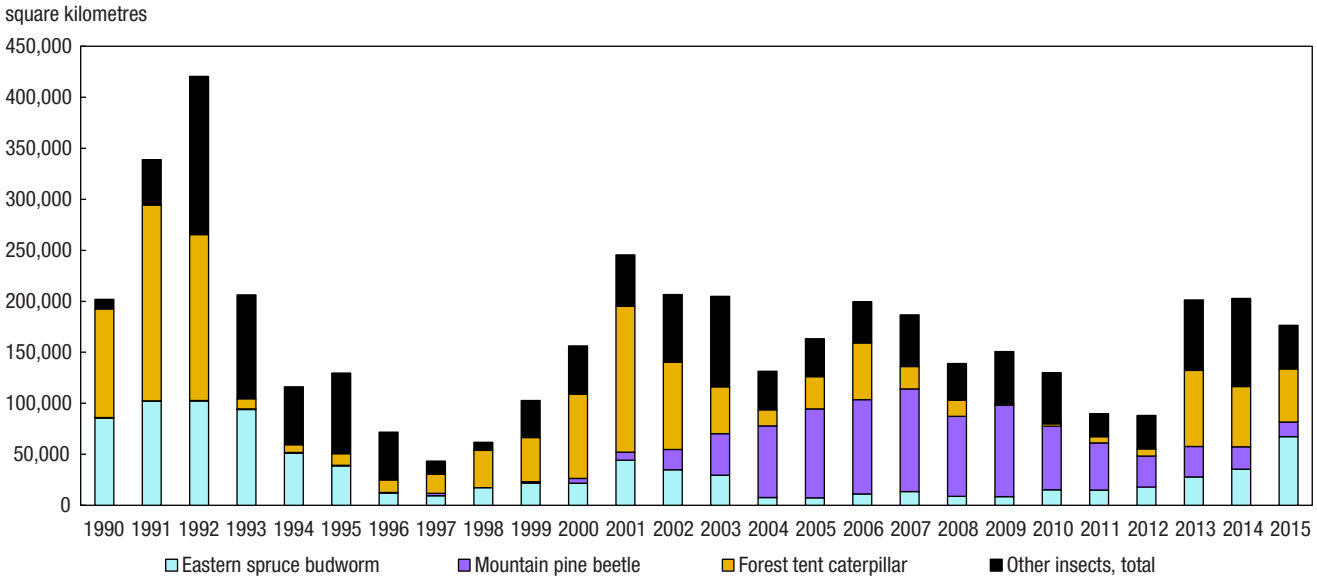
Insects damaged an estimated 176,318 km^2 of forest in 2015, down 13% from 203,075 km^2 in 2014, but up 100% from the recent low of 87,961 km^2 in 2012 (Chart 2.6). Major pests that periodically cause damage across large areas include the eastern spruce budworm, forest tent caterpillar and mountain pine beetle, while other insects that have caused significant damage include the hemlock looper and large aspen tortrix, among others. Locally important outbreaks of many other species have been recorded.

In 2015, the largest proportions of insect damage were caused by the eastern spruce budworm (38%) and the forest tent caterpillar (29%). Eastern spruce budworm affected areas increased 90% from 35,336 km^2 in 2014 to 67,260 km^2 in 2015. In comparison, the last major outbreak of spruce budworm occurred in the 1970s, affected 518,674 km^2 in 1975.[33] The current eastern spruce budworm outbreak is occurring mainly in Quebec. The infestation in this province has increased rapidly from 397 km^2 in 2006 to 63,151 km^2 in 2015.

Forest tent caterpillar caused moderate to severe damage to 51,991 km^2 of forest in 2015, with 38% of the affected area occurring in Alberta. The Alberta outbreak is in decline—affected areas dropped to 19,615 km^2 in 2015, from a peak of 64,730 km^2 in 2013. However, affected areas grew or remained elevated in Ontario, Manitoba and British Columbia.

After causing significant economic damage in British Columbia, mountain pine beetle affected areas dropped to 3,264 km^2 in 2015 from a high of 100,519 km^2 in 2007. According to the Province of British Columbia, an estimated 54% of the merchantable pine volume in the province was killed.[34] However, some insect-damaged areas were harvested to control the infestation and salvage dead trees.

Chart 2.6
Area with moderate to severe insect damage by insect type, 1990 to 2015



Notes: The area damaged by insects is a sum of reported moderate to severe defoliation or damage by insect type and province and may include duplication since forest areas may be damaged by more than one type of insect. Other insects includes jack pine budworm, hemlock looper, gypsy moth, blackheaded budworm, balsam fir sawfly, swaine jack pine sawfly, bruce spanworm, western spruce budworm, large aspen tortrix, two-year-cycle spruce budworm, spruce beetle, aspen twoleaf tier and others. Sums may include missing data where provincial-level species data for specific years was unavailable.
Source: National Forestry Database, 2017, Table 4.1 Area within which moderate to severe defoliation occurs including area of beetle-killed trees by insects and province/territory, http://nfdp.ccfm.org/insects/national_e.php (accessed July 24, 2017).

33 National Forestry Database, 2017, Table 4.1 Area within which moderate to severe defoliation occurs including areas of beetle-killed trees by insects and province/territory, http://nfdp.ccfm.org/insects/national_e.php (accessed May 15, 2017).

34 Province of British Columbia, n.d., *Mountain Pine Beetle Projections*, https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/forest-pests/bark-beetles/mountain-pine-beetle/mpb-projections (accessed June 9, 2017).

Wildfire

Fires too have an important influence on the health, structure and diversity of forest ecosystems. Many tree species in Canada's forests are adapted to fire. For example, jack pine and lodgepole pine need fire or heat to release their seeds from cones; Douglas-fir, ponderosa pine and western larch have a thick bark to protect themselves from surface fires; and species such as aspen and birch need full sunlight to grow and are among the first species to colonize burned sites.[35] Fire has a particularly important influence on the boreal forest, but is less common in the coastal forests of British Columbia as a result of wetter conditions.

From 1970 to 2015, on average over 8,100 fires burned close to 22,000 km^2 per year, though the number and size of fires varies greatly (Chart 2.7). The ignition and spread of fires depends on a number of factors including topography, weather (temperature, precipitation, humidity and wind speed) and fuel available for combustion.

In 2015, 7,140 wildfires burned a total of 38,616 km^2 of forest land. Overall, 53% of these fires occurred in Alberta and British Columbia. However, these two provinces accounted for only 19% of the total area burned—45% of the burned area occurred in Saskatchewan, followed by 17% in the Northwest Territories. Over the longer term 1970 to 2015 period, the largest burned areas occurred in the Northwest Territories, with 29% of the total forest land burned.[36]

In 2015, 49% of fires started as a result of lightning strikes, 48% had human sources of ignition and the remainder had an unknown ignition source.[37] Fires started by lightning were responsible for 79% of the burned area[38]—these fires are less likely to be suppressed, particularly if they occur in distant and uninhabited areas. Though they made up only 7% of the number of fires, fires greater than 10 km^2 in size made up about 97% of the total area burned in 2015.[39]

Because of the ecological benefits of fire and limits on the availability of resources to fight fires, not all fires are suppressed. At the same time, fires can be a threat to human safety, property, recreational areas, infrastructure, timber and wildlife. For example, the Fort McMurray wildfire in 2016 displaced almost 72,000 residents, destroyed 8% of homes and insured losses are estimated to have cost $3.7 billion.[40]

35 BC Market Outreach Network and Ministry of Sustainable Resource Management, 2003, *British Columbia's Forests: A Geographical Snapshot*, p.18, https://www.for.gov.bc.ca/hfd/pubs/Docs/Mr/Mr112/ (accessed May 15, 2017); Natural Resources Canada, *Fire Ecology*, http://www.nrcan.gc.ca/forests/fire-insects-disturbances/fire/13149 (accessed May 15, 2017).

36 National Forestry Database, 2017, Create Your Own Report, http://nfdp.ccfm.org/dynamic_report/dynamic_report_ui_e.php (accessed August 9, 2017).

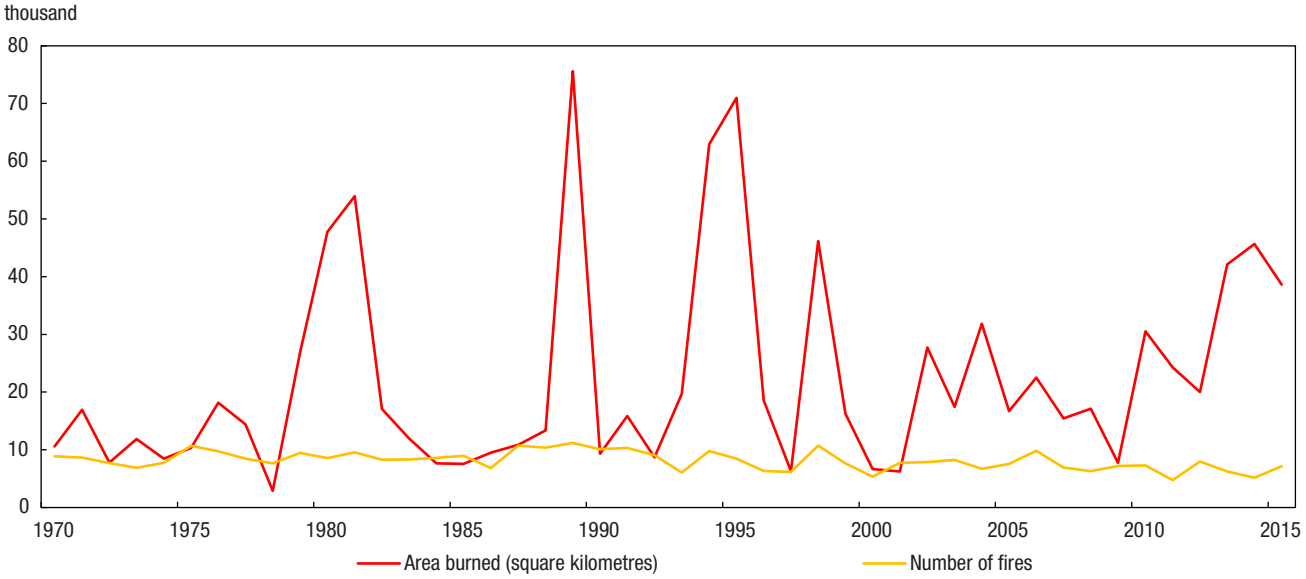
37 National Forestry Database, 2017, Table 3.2 Number of forest fires in the intensive and limited protection zones by response category, cause class, and province/territory/agency, http://nfdp.ccfm.org/fires/national_e.php (accessed August 9, 2017).

38 National Forestry Database, 2017, Table 3.3 Area burned in the intensive and limited protection zones by response category, cause class and province/territory/agency, http://nfdp.ccfm.org/fires/national_e.php (accessed August 9, 2017).

39 National Forestry Database, 2017, Table 3.6 Area burned in the intensive and limited protection zones by response category, fire size class and province/territory/agency, http://nfdp.ccfm.org/fires/national_e.php (accessed August 9, 2017). Note that these totals include 245 fires with an unspecified size class that accounted for 17% of the total area burned.

40 Statistics Canada, 2017, "Fort McMurray 2016 wildfire – Economic impact," *Statistics Canada – Infographics*, Catalogue no. 11-627-M, http://www.statcan.gc.ca/pub/11-627-m/11-627-m2017007-eng.htm (accessed August 9, 2017).

Chart 2.7
Total number and area burned by forest fires, 1970 to 2015



Source: National Forestry Database (NFD), 2017, Forest Fires: Area Burned, 1970-2015, http://nfdp.ccfm.org/data/graphs/graph_31_b_e.php (accessed July 18, 2017); NFD, 2017, Fo Fires: Number of Fires, 1970-2015, http://nfdp.ccfm.org/data/graphs/graph_31_a_e.php (accessed July 18, 2017).

Deforestation

Human activities can also drive changes in Canada's forest area, though the effects of these activities vary spatially and temporally.[41] Forests can be converted to other land uses—for example, agricultural or built-up areas—but overall Canada's forest area is stable.

From 1990 to 2015, forest area in Canada decreased 0.3% from 3.483 million km^2 to 3.471 million km^2.[42] In comparison, global forest area decreased 3.1% from 41.283 million km^2 to 39.991 million km^2 over the same period.[43] This deforestation—or conversion of forest area to other land uses—does not include temporary loss of forest cover due to timber harvesting or natural disturbances since they are not considered land use changes.

The annual rate of deforestation in Canada declined from 1990 to 2015, although there were spikes in 1993 and 2006 to create reservoirs for hydro-electric production (Chart 2.8). Over this period, most forest converted to other land uses was used for agriculture (42%), mining, oil and gas (24%), built-up area (16%), hydro-electric infrastructure and reservoirs (13%) and forestry roads (6%) (Map 2.4).

41 Brandt, J.P. et al., 2013, "An introduction to Canada's boreal zone: ecosystem processes, health, sustainability, and environmental issues," *Environmental Reviews*, Vol. 21, no. 4, p. 207–226, https://doi.org/10.1139/er-2013-0040 (accessed October 10, 2017); Wulder, M.A. et al., 2008, "Monitoring Canada's forests. Part 1: Completion of the EOSD land cover project," *Canadian Journal of Remote Sensing*, Vol. 34, no. 36, p. 549–562, http://cfs.nrcan.gc.ca/publications?id=29339 (accessed October 10, 2017).

42 Natural Resources Canada, Canadian Forest Service, 2016, *The State of Canada's Forests: Annual Report 2016*, Ottawa, Catalogue no. Fo1-6E-PDF, p. 19, http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/37265.pdf (accessed April 15, 2017). Note that forest area change from 1990 to 2015 is estimated using the baseline 2006 data from the NRCan's National Forest Inventory (NFI) and known afforestation and deforestation data, as described in Canada's report to the United Nations Food and Agriculture Organization (FAO) for the *Global Forest Resources Assessment 2015*, http://www.fao.org/3/a-az181e.pdf. The definition of forest area used by the deforestation monitoring program for reporting under the United Nations Framework Convention on Climate Change differs from the definition used by the FAO.

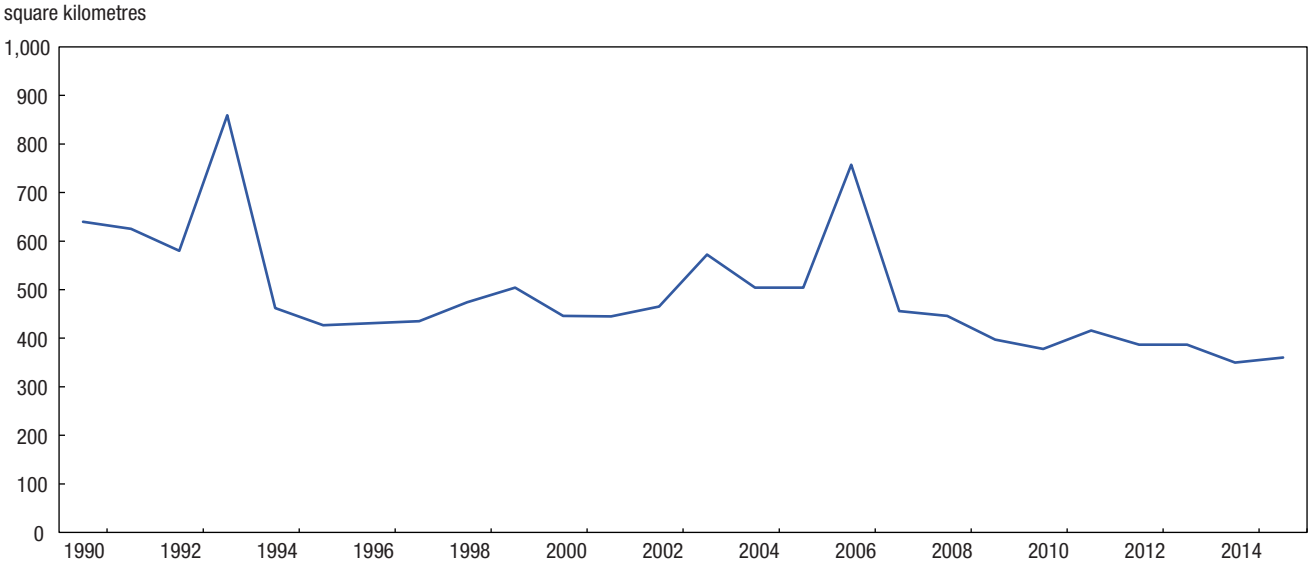
43 Food and Agriculture Organization of the United Nations (FAO), 2016, *Global Forest Resources Assessment 2015: How are the world's forests changing?* Second edition, p. 16, http://www.fao.org/3/a-i4793e.pdf (accessed May 1, 2017).

The Boreal Plains ecozone experienced the largest conversion of forest area from 1990 to 2015 at 5,849 km^2—46% of the total deforestation that occurred over this period. The main contributors to deforestation in the Boreal Plains were the agricultural (52%) and mining, oil and gas (37%) sectors.[44] Deforestation was second highest in the Boreal Shield ecozone at 2,307 km^2—18% of the national total. Hydro-electric infrastructure and reservoirs were the largest contributor to the conversion of forest area, followed by agriculture, forestry roads and built-up.

In the Pacific Maritime ecozone on Canada's west coast, 346 km^2 of forest were converted to other uses from 1990 to 2015. Overall, 59% of land was converted to built-up area, which includes areas used for transportation, recreation and residential, industrial, commercial and institutional development. The Montane Cordillera, which covers much of the interior of British Columbia and parts of Alberta, saw 871 km^2 of forest area converted from 1990 to 2015, with most converted to cropland (29%), built-up areas (24%), forest roads (21%) and mining area (18%).

The agricultural sector was also an important driver of forest change in the Prairies, Mixedwood Plains and Atlantic Maritimes ecozones. Forest area decreased 799 km^2 in the Prairies from 1990 to 2015, with 92% of this forest area lost to cropland. The Mixedwood Plains ecozone in Southern Ontario and Quebec saw an 838 km^2 decrease in forest area over the same period due mainly to conversion to cropland (51%) and built-up area (39%). Forest area decreased by 912 km^2 in the Atlantic Maritime ecozone due to conversion to cropland (37%) and built-up area (40%).

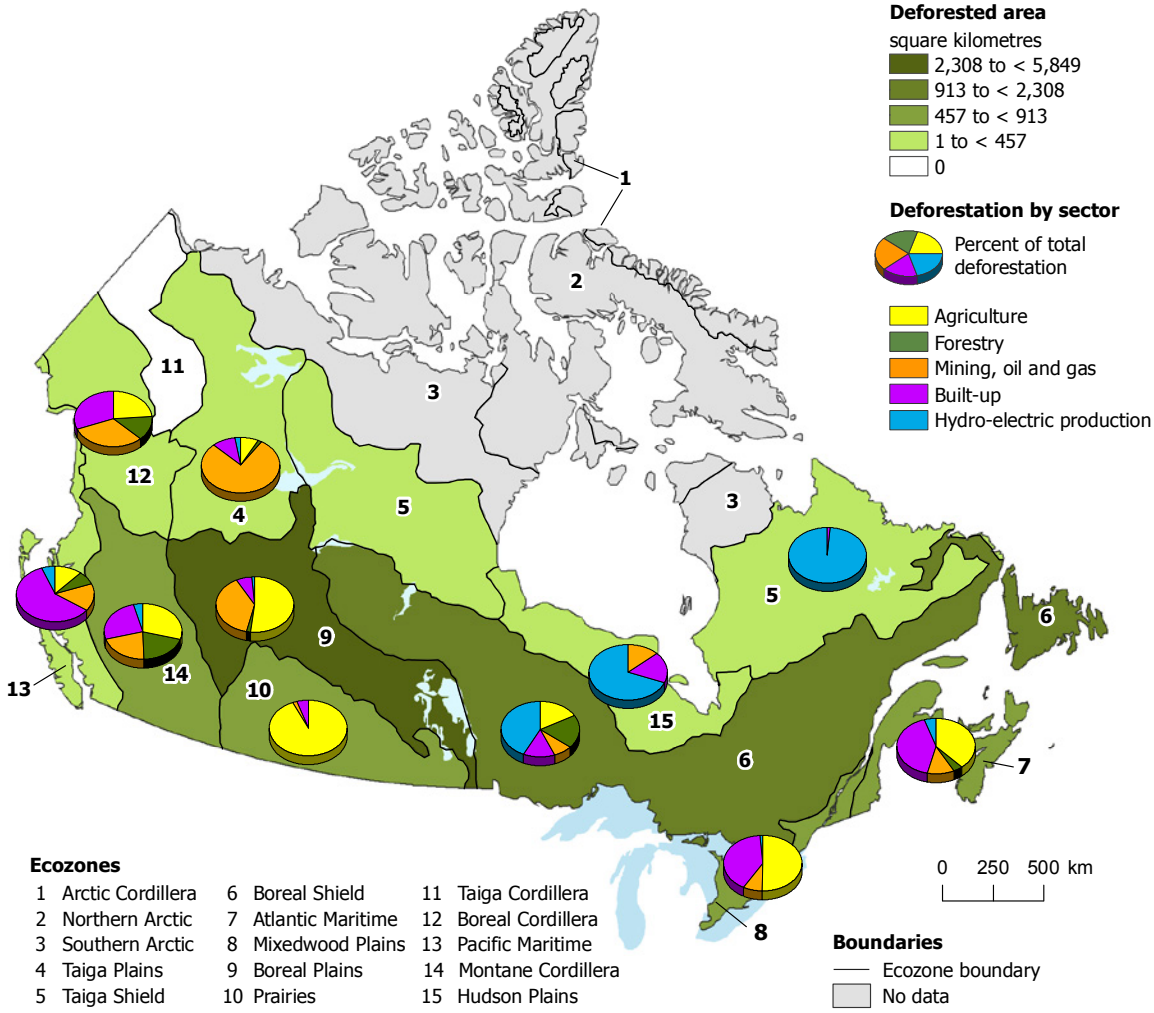
Chart 2.8
Deforestation area, 1990 to 2015



Note: Estimates of deforestation are produced by Canada's National Deforestation Monitoring System, which was designed to meet information needs for reporting under the United Nations Framework Convention on Climate Change (UNFCCC).
Source: Natural Resources Canada, Canadian Forest Service, National Deforestation Monitoring System, special tabulation May 12, 2017.

44 Natural Resources Canada, Canadian Forest Service, special tabulation from Canada's National Deforestation Monitoring System, May 12, 2017.

Map 2.4
Deforestation by ecozone and by sector, 1990 to 2015



Ecozones

1	Arctic Cordillera	6	Boreal Shield	11	Taiga Cordillera
2	Northern Arctic	7	Atlantic Maritime	12	Boreal Cordillera
3	Southern Arctic	8	Mixedwood Plains	13	Pacific Maritime
4	Taiga Plains	9	Boreal Plains	14	Montane Cordillera
5	Taiga Shield	10	Prairies	15	Hudson Plains

Notes: Deforestation from forestry results from the creation of permanent forest roads. Built-up includes industrial, commercial, institutional and residential development as well as recreational area and transportation. Hydro-electric production includes infrastructure and reservoirs. Deforestation from peat mines has been excluded. Estimates of deforestation are produced by Canada's National Deforestation Monitoring System, which was designed to meet the information needs for reporting under the United Nations Framework Convention on Climate Change (UNFCCC).

Sources: Natural Resources Canada, Canadian Forest Service, National Deforestation Monitoring System, special tabulation, May 12, 2017; Statistics Canada, Environment, Energy and Transportation Statistics Division, 2018.

Textbox 2.1 Climate change and Canada's forests

Rising global temperatures and atmospheric carbon dioxide concentrations as well as changing precipitation patterns have implications for forests.[45] Canada's forests are adapted to climate conditions associated with their specific geographic area, and as the climate changes, forests will change in response. Climate-induced changes in forests can include shifting species composition and range, extent, age class distribution, forest structure, rate of growth, growing stock, regeneration success, health and soil quality.[46] In turn, forests have an impact on climate change—particularly in their capacity to absorb and release vast amounts of carbon dioxide. Forests in Canada and around the world play an important climate-moderating role, absorbing a significant proportion of anthropogenic greenhouse gas emissions.[47]

Climate change has already impacted Canada's forests in numerous ways.[48] For example, an increase in the length of the growing season has been observed across Canada since 1950.[49] Climate conditions that support forests are shifting to higher latitude and higher elevation areas.[50] Increased drought severity and frequency in western Canada can impact trees directly and increase their vulnerability to disease and insect infestations.[51] Insect outbreaks beyond certain thresholds can damage forest health and decrease forest value, and recent insect outbreaks, such as Mountain pine beetle, have occurred further north than previously observed.[52] Wildland fires, affected greatly by climate variability, have increased in some boreal forests and are expected to increase in frequency in the decades to come.[53]

Human activity has the potential to reduce or increase the rate of forest carbon uptake and storage. Forest management practices can be used to increase carbon sequestration in the forests and in wood products, but deforestation can result in carbon emissions.[54]

Long-term climate trends

From 1948 to 2016, the average annual temperature in Canada increased by 1.7 °C.[55] All 11 of Canada's climate regions experienced temperature increases over this time period (Map 2.5). Northern climate regions generally experienced greater warming and increases were largest during winter months.

45 Settele, J. et al., 2014, "Terrestrial and inland water systems," *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*, C.B. Field et al. (eds.), Cambridge University Press, p. 271–359, Cambridge University Press, http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap4_FINAL.pdf (accessed June 29, 2017).

46 Settele, J. et al., 2014, "Terrestrial and inland water systems," *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*, C.B. Field et al. (eds.), Cambridge University Press, p. 271–359, http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap4_FINAL.pdf (accessed June 29, 2017).

47 Kurz, W.A. et al., 2013, "Carbon in Canada's boreal forest—A synthesis," *Environmental Reviews*, Vol. 21. no. 4, p. 260–292, https://doi.org/10.1139/er-2013-0041 (accessed September 25, 2017).

48 Natural Resources Canada, 2016, *Forest Change Indicators*, http://www.nrcan.gc.ca/forests/climate-change/forest-change/17768 (accessed June 27, 2017).

49 Natural Resources Canada, 2016, "Growing season," *Forest Change Indicators*, http://www.nrcan.gc.ca/forests/climate-change/forest-change/18470 (accessed June 27, 2017).

50 Natural Resources Canada (NRCan), 2017, "Distribution of tree species," *Forest Change Indicators*, http://www.nrcan.gc.ca/forests/climate-change/forest-change/17778 (accessed June 27, 2017); NRCan, 2016, "Assisted migration," *Adaptation*, http://www.nrcan.gc.ca/forests/climate-change/adaptation/13121 (accessed June 27, 2017); Gonzalez, P. et al., 2010, "Global patterns in the vulnerability of ecosystems to vegetation shifts due to climate change," *Global Ecology and Biogeography*, Vol. 19, no. 6, p. 755–768, http://www.patrickgonzalez.net/images/Gonzalez_et_al_2010_GEB.pdf (accessed September 25, 2017).

51 Natural Resources Canada, 2017, "Drought," *Forest Change Indicators*, http://www.nrcan.gc.ca/forests/climate-change/forest-change/17772 (accessed September 25, 2017).

52 Natural Resources Canada, 2016, "Mountain pine beetle," *Top Forest Insects and Diseases in Canada*, http://www.nrcan.gc.ca/forests/fire-insects-disturbances/top-insects/13381 (accessed June 27, 2017).

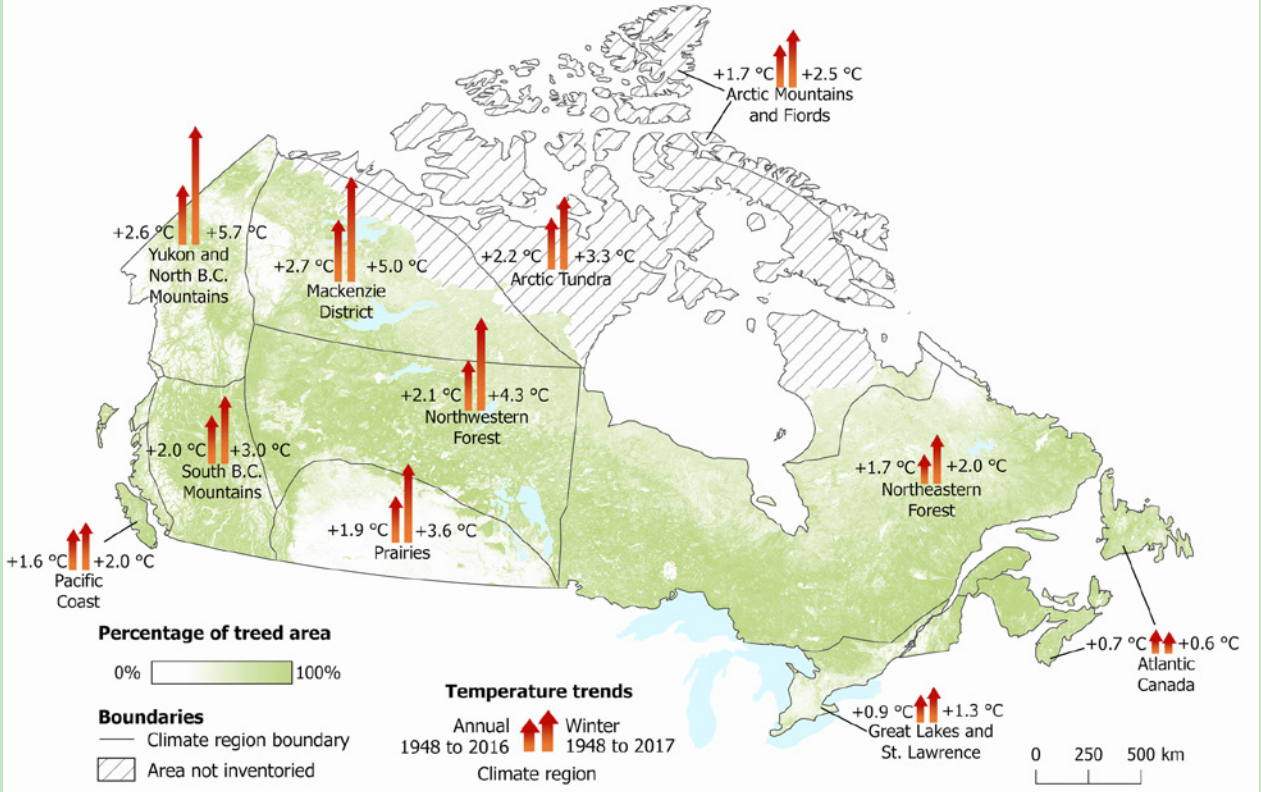
53 Natural Resources Canada, 2017, "Climate change and fire," *Forest Fires*, http://www.nrcan.gc.ca/forests/fire-insects-disturbances/fire/13155 (accessed June 27, 2017).

54 Kurz, W.A. et al., 2013, "Carbon in Canada's boreal forest—A synthesis," *Environmental Reviews*, Vol. 21, no. 4, p. 260–292, https://doi.org/10.1139/er-2013-0041 (accessed September 25, 2017).

55 Environment and Climate Change Canada, 2016, "Annual 2016," *Climate Trends and Variations Bulletin,* http://www.ec.gc.ca/sc-cs/default.asp?lang=En&n=439E7F88-1 (accessed June 28, 2017).

Textbox 2.1 Continued

Map 2.5
Treed area and long-term temperature trends by climate region



Notes: This map displays the increase in annual and winter temperature trends by climate region and provides a visual representation of the distribution of treed area. The long-term temperature trend refers to the linear trend in temperature departures from the 1961 to 1990 climate normal over the period of 1948 to 2017. Positive values indicate that temperatures have warmed. Data for forest area are available from the National Forest Inventory by ecozone and have been adjusted to provide climate region totals. Treed area is different from forest area—the former includes areas with trees on non-forest land use areas (e.g., agricultural or urban lands) while forest area includes lands that are temporarily unstocked with trees (e.g., after disturbance or harvesting) and that are expected to regenerate. Non-inventoried land includes the Arctic ecozones (Arctic Cordillera, Northern Arctic, Southern Arctic) and small portions of the Taiga Plains and Hudson Plains ecozones located in Nunavut—areas that are largely devoid of tree cover.

Sources: Statistics Canada, Environment, Energy and Transportation Statistics Division, 2018; Environment and Climate Change Canada, 2017, "Annual 2016" and "Winter 2016-2017," *Climate Trends and Variations Bulletin,* www.ec.gc.ca/sc-cs/default.asp?lang=En&n=A3837393-1 (accessed December 5, 2017); Canada's National Forest Inventory (NFI), 2016, Grouped *k*NN Map layers, http://tree.pfc.forestry.ca (accessed April 7, 2017); NFI, 2013, Table 4.1 Area (1000 ha) of forest and non-forest land by terrestrial ecozone in Canada, revised 2006 baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

The largest increase in mean annual temperature from 1948 to 2016 occurred in the Mackenzie District climate region at 2.7 °C (Table 2.3). This climate region contains an estimated 388,751 km^2 of forest area and spans most of the mainland Northwest Territories. Most of the forest area is evergreen needleleaf, with patches of shrubland and barren land towards the neighbouring territories.

Textbox 2.1 Continued

Table 2.3
Forest area and long-term temperature trends by climate region, 1948 to 2017

	Annual temperature trend, 1948 to 2016	Summer temperature trend, 1948 to 2016	Winter temperature trend, 1948 to 2017	Forest area, 2006
	degrees Celsius			km^2
Canada	**1.7**	**1.5**	**3.4**	**3,475,757**
Arctic Mountains and Fiords	1.7	1.2	2.5	576
Arctic Tundra	2.2	1.7	3.3	46,026
Atlantic Canada	0.7	1.3	0.6	173,370
Great Lakes and St. Lawrence	0.9	1.1	1.3	92,359
Mackenzie District	2.7	1.9	5.0	388,751
Northeastern Forest	1.0	1.3	2.0	1,317,441
Northwestern Forest	2.1	1.6	4.3	738,947
Pacific Coast	1.6	1.5	2.0	66,752
Prairies	1.9	0.9	3.6	71,292
South British Columbia Mountains	2.0	1.5	3.0	318,113
Yukon and North British Columbia Mountains	2.6	1.3	5.7	262,130

Notes: The long-term temperature trend refers to the linear trend in temperature departures from the 1961 to 1990 climate normal over the period of 1948 to 2017. Positive values indicate that temperatures have warmed. Data for forest area are available from the National Forest Inventory by ecozone and have been adjusted to provide climate region totals. Excludes non-inventoried land in the Arctic ecozones (Arctic Cordillera, Northern Arctic, Southern Arctic) and small areas of the Taiga Plains and Hudson Plains ecozones located in Nunavut—areas that are largely devoid of tree cover.
Sources: Statistics Canada, Environment, Energy and Transportation Statistics Division, 2018; Environment and Climate Change Canada (ECCC), 2017, "Annual 2016," "Summer 2016," and "Winter 2016-2017," Climate Trends and Variations Bulletin, www.ec.gc.ca/sc-cs/default.asp?lang=En&n=A3837393-1 (accessed December 5, 2017); Canada's National Forest Inventory (NFI), 2016, Grouped kNN Map layers, http://tree.pfc.forestry.ca (accessed April 7, 2017); NFI, 2013, Table 4.1. Area (1000 ha) of forest and non-forest land by terrestrial ecozone in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

The Yukon and North British Columbia Mountains climate region—with 262,130 km^2 of forest area—experienced an increase of 2.6 °C in mean annual temperature from 1948 to 2016, the second largest increase overall. This climate region has similar characteristics to the Mackenzie District, consisting of evergreen needleleaf forest, shrubland and barren land.

Temperature increases were observed in every climate region during every season over the 1948 to 2016 time period. In 10 of the 11 climate regions, the winter months experienced the greatest warming. Nationally, winter temperatures increased by 3.4 °C on average. The climate regions with the largest winter temperature increases were the Yukon and North British Columbia Mountains at 5.7 °C, the Mackenzie District at 5.0 °C and the Northwestern Forest at 4.3 °C. Collectively, these regions contain 1,389,828 km^2 of forest land.

From 1948 to 2016, Canada's average annual precipitation increased steadily compared to the baseline average.[56] An increasing trend was observed in all four seasons.[57] The northern ecozones experienced a larger percentage change in annual precipitation than southern ecozones, though these regions receive much less precipitation than southern and coastal regions in general. Droughts have also become more frequent and severe in some regions.[58] Scientists expect that this trend will continue, which will have an impact on Canada's forest regions.

56 Environment and Climate Change Canada, 2017, "Historical climate change and variability in Canada," *Climate Data and Scenarios for Canada: Synthesis of Recent Observation and Modelling Results*, https://ec.gc.ca/sc-cs/default.asp?lang=En&n=80E99404-1&offset=1&toc=hide (accessed June 9, 2017).

57 Environment and Climate Change Canada, 2016, "Precipitation change in Canada," *Canadian Environmental Sustainability Indicators (CESI)*, p. 6, http://publications.gc.ca/collections/collection_2016/eccc/En4-144-76-2016-eng.pdf (accessed June 16, 2017).

58 Natural Resources Canada, 2017, "Drought," *Forest Change indicators*, http://www.nrcan.gc.ca/forests/climate-change/forest-change/17772 (accessed June 16, 2017).

Textbox 2.1 Continued

Effects of a changing climate on Canada's forests

Many of the effects of climate change on forests are interconnected and occur simultaneously. Climate change-induced droughts and warming temperatures increase vulnerability to disturbance such as forest fires, insects and disease.[59]

Conifer species are better adapted to cooler conditions, which may prompt a decrease in photosynthetic productivity in warmer conditions.[60] As warming continues, some trees may be unable to adapt to the changes in their local climate in a timely manner.

Recent scientific evidence indicates that in some areas, boreal forests have experienced declines in productivity, which can be partially attributed to heat stress triggered by droughts.[61] Canada's boreal forests have experienced more frequent drought since the 1950s, and this trend is projected to continue.[62] Prairie regions that are already drought-prone are also expected to experience more severe and frequent droughts.

In regions where moisture is not a limiting factor, productivity may increase. With increased temperature and moist conditions, higher productivity has been observed at a higher latitude in the boreal forest, towards newly warmer tundra regions.

The climatic conditions that support Canadian tree species are not only shifting towards higher latitudes, but also towards higher altitudes. Scientists and professional foresters are developing strategies to help ensure forest adaptation, such as in mountainous alpine regions in British Columbia where assisted migration may help trees to adapt to warmer temperatures.[63]

2.2 Forest products and ecosystem services

Timber harvests are the main economic good originating from forests. In recent years, there has been growing interest in understanding and valuing the contributions of other goods and services provided by forest ecosystems. For example, non-timber forest products can include berries, mushrooms and ornamental plants, while ecosystem services provided by forests can include soil and water conservation, carbon sequestration, air filtration, habitat provision and recreational and tourism opportunities.

Timber

Canada's timber assets are a component of the country's natural resource wealth. The value of Canada's accessible timber stocks was estimated at $215.4 billion in 2016.[64] This value fluctuates, based on market conditions for timber and other factors (Chart 2.9). Timber assets provide the foundation for a sustained yield in forests managed for timber production.

59 Natural Resources Canada, 2017, "Drought," *Forest Change Indicators*, http://www.nrcan.gc.ca/forests/climate-change/forest-change/17772 (accessed June 16, 2017).

60 Settele, J. et al., 2014, "Terrestrial and inland water systems," *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*, C.B. Field et al. (eds.), Cambridge University Press, p. 301–318, http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap4_FINAL.pdf (accessed June 29, 2017).

61 Settele, J. et al., 2014, "Terrestrial and inland water systems," *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*, C.B. Field et al. (eds.), Cambridge University Press, p. 301–318, http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap4_FINAL.pdf (accessed June 29, 2017).

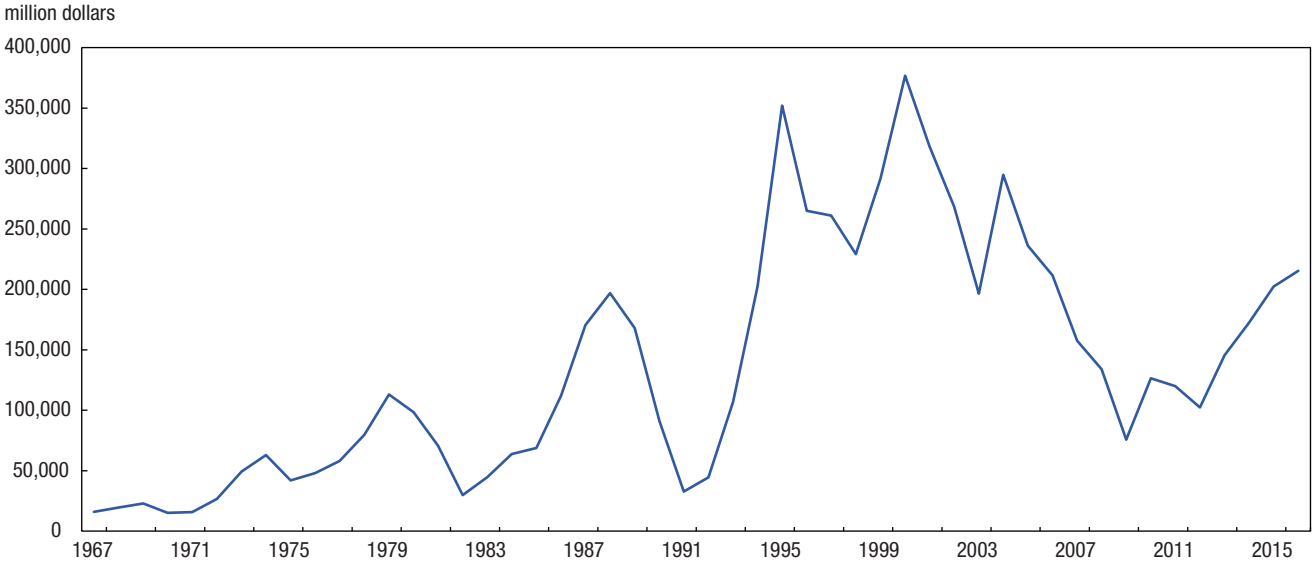
62 Wang Y. et al., 2014, "Past and projected future changes in moisture conditions in the Canadian boreal forest," *The Forestry Chronicle*, Vol. 90, no. 5, http://pubs.cif-ifc.org/doi/abs/10.5558/tfc2014-134 (accessed June 30, 2017).

63 Johnston, 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*, Canadian Council of Forest Ministers, Cat. No. Fo4-28/2009E, p. 1–40, http://www.ccfm.org/pdf/TreeSpecies_web_e.pdf (accessed June 29, 2017).

64 Statistics Canada, CANSIM Table 153-0121, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1530121&&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid=#F5 (accessed January 16, 2018). The timber asset account estimates the annual value of standing timber on timber-productive, stocked and accessible forest land using the present value of the stream of rent assumed to be generated from future timber harvests.

Revenues from the sale of timber from Crown land were $1.346 billion in 2015.[65] British Columbia accounted for the largest share of revenues (60%), followed by Quebec (20%), Ontario (8%) and New Brunswick (7%). These revenues are based on stumpage charges, rents, reforestation levies, protection fees, permit and license fees, sales and rentals, and other charges including bonuses, penalties and interest. Farms—some of which operate woodlots—reported forest product sales of $70.5 million in 2015 including receipts for firewood, pulpwood, logs, fence posts and pilings.[66]

Chart 2.9
Value of timber stocks, 1967 to 2016



Note: Represents the net present value of the closing timber stock, based on the economic rent calculated using a positive return to capital.
Source: Statistics Canada, CANSIM Table 153-0121 http://www5.statcan.gc.ca/cansim/home-accueil?&lang=eng&MM=as (accessed January 16 2018).

Timber extracted from forests is generally referred to as roundwood. The total volume of roundwood harvested in Canada was 160.5 million m^3 in 2015, up 35% from the most recent low in 2009, which followed the 2008 financial crisis and U.S. housing crash (Chart 2.10).

Most roundwood is categorized as logs and bolts, which are used as raw materials to produce lumber, plywood, shingles, shake and other wood products (Table 2.4). Pulpwood, which is generally smaller or lower quality wood, or the wrong species to be used for lumber, accounted for 11% of timber harvests in 2015, with smaller amounts used for other purposes including fuelwood or firewood. By volume, British Columbia accounted for the greatest proportion of roundwood harvested in 2015 at 42%, followed by Quebec (18%) and Alberta (17%) (Table 2.5).

Softwood species such as spruce, pine, fir, cedar and hemlock accounted for 81% (128.8 million m^3) of the harvested volume (Chart 2.11). This proportion was highest in British Columbia (97%). Quebec produced the largest volume of hardwoods (7.7 million m^3)—over a quarter of which was collected for fuelwood and firewood.[67]

On average 86% of the total volume of wood harvested came from provincial Crown land, with the remainder, 14%, from private land. However, this proportion differed by province.[68]

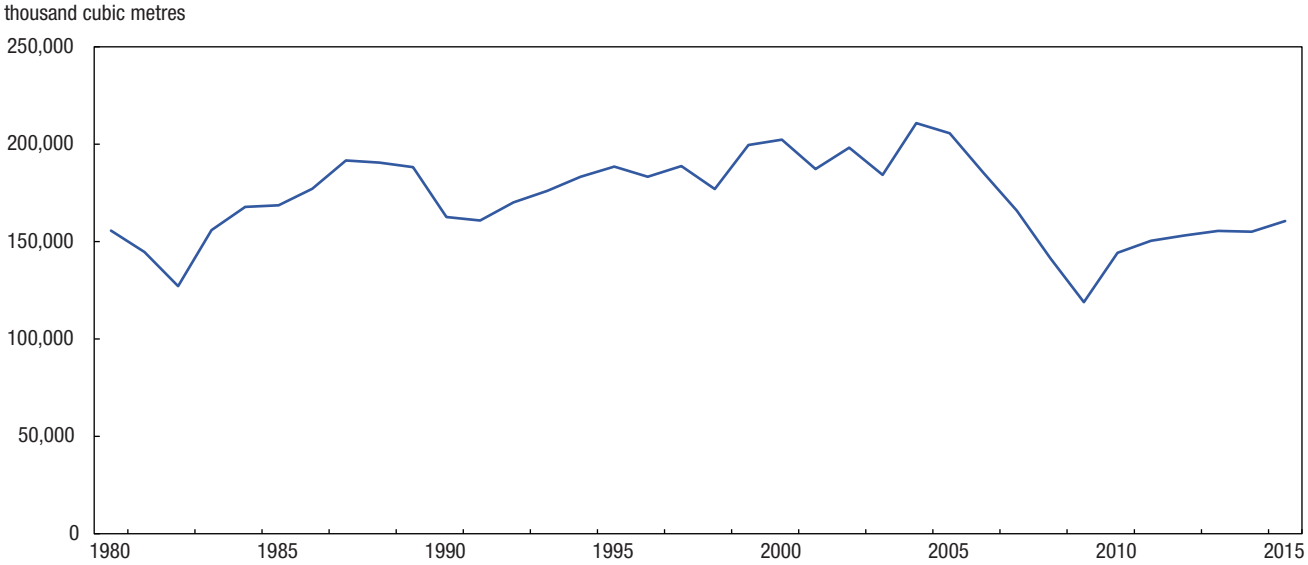
65 National Forestry Database, 2017, Table 8.1 Statement of revenues from the sale of timber from provincial Crown land, http://nfdp.ccfm.org/revenues/national_e.php (accessed August 11, 2017).

66 Statistics Canada, CANSIM Table 004-0219 http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0040219&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid= (accessed June 15, 2017). Note that receipts are for the year prior to the 2016 Census of Agriculture, reported either by calendar year or fiscal year.

67 National Forestry Database, 2017, Table 5.1.2.0 Volume of roundwood harvested by ownership, category and species group, 1990 to 2015, http://nfdp.ccfm.org/data/detailed/html/detailed_5120_p_QC.html (accessed October 12, 2017).

68 National Forestry Database, 2017, Table 5.2 Net merchantable volume of roundwood harvested by species group, ownership and province/territory, http://nfdp.ccfm.org/products/national_e.php (accessed May 15, 2017).

Chart 2.10
Volume of roundwood harvested, 1980 to 2015



Note: Data not available for Nunavut from 1999 to 2015.
Source: National Forestry Database (NFD), 2017, Table 5.1 Net merchantable volume of roundwood harvested by category, ownership, and province/territory, http://nfdp.ccfm.org/products/national_e.php (accessed July 26, 2017) and NFD, 2017, Create Your Own Report, http://nfdp.ccfm.org/dynamic_report/dynamic_report_ui_e.php (accessed July 26, 2017).

Table 2.4
Volume of roundwood harvested by forest product category, selected years

	Industrial roundwood					
	Logs and bolts[1]	Pulpwood	Other	Total	Fuelwood and firewood	Total roundwood harvested
	thousand cubic metres					
1940	32,625	20,981	2,109	55,715	19,732	75,447
1945	30,596	26,412	2,039	59,047	17,188	76,235
1950	40,095	32,311	1,701	74,107	11,508	85,615
1955	44,262	38,721	1,691	84,674	8,208	92,882
1960	51,118	33,924	1,524	86,566	6,750	93,316
1965	62,618	34,164	1,838	98,620	5,125	103,745
1970	75,645	40,553	1,294	117,492	4,133	121,625
1975	73,542 r	37,270 r	915	111,727 r	3,783	115,510 r
1980	109,952	38,909	1,923	150,784	4,840 r	155,624 r
1985	119,317 r	40,620 r	2,077 r	162,014 r	6,708	168,722 r
1990	118,941 r	35,876[2]	1,581 r	156,398 r	6,169[2]	162,567 r
1995	150,150 r	30,926[3]	2,081 r	183,157 r	5,340 r	188,497 r
2000	166,415 r	28,988 r	4,052 r	199,455 r	2,916 r	202,372 r
2001	154,910 r	23,827 r	5,663 r	184,400 r	2,900 r	187,300 r
2002	165,146[2]	26,591[2]	3,618[2]	195,355[2]	2,875[2]	198,231[2]
2003	147,847 r	29,587 r	4,010 r	181,444 r	2,829[2]	184,273 r
2004	174,098 r	29,472 r	4,526 r	208,096 r	2,775[2]	210,871 r
2005	173,064 r	24,171 r	4,074 r	201,309 r	4,326[2]	205,665 r
2006	154,017[2]	23,836[2]	4,568[2]	182,421[2]	2,905[2]	185,359[2]
2007	135,529[2]	24,295[2]	2,255[2]	162,079[2]	3,841[2]	165,921[2]
2008	111,396 r	24,026 r	2,819 r	138,241 r	3,140 r	141,397 r
2009	90,935 r	21,859 r	2,997 r	115,791 r	3,123 r	118,935 r
2010	114,441 r	23,128 r	3,384 r	140,953 r	3,321 r	144,274 r
2011	118,525 r	25,908 r	2,323 r	146,756 r	3,727 r	150,483 r
2012	125,486 r	21,367 r	2,377 r	149,230 r	3,955 r	153,185 r
2013	130,003 r	18,637 r	2,318 r	150,958 r	4,572 r	155,531 r
2014	127,868 r	20,032 r	2,386 r	150,286 r	4,824 r	155,110 r
2015	109,507[2]	18,032[2]	1,796[2]	153,034[2,4]	4,507[2]	160,541[2]

r revised

1. Logs are defined as the stem of a tree after it has been felled; the raw material from which lumber, plywood, and other wood products are processed. Bolts are defined as raw material used in the manufacture of shingles and shakes; short logs to be sawn for lumber or peeled for veneer.
2. Estimated by provincial or territorial forestry agency.
3. Estimated by the Canadian Forest Service or by Statistics Canada.
4. In 2015, the forest product category was unspecified for 26,699 thousand m^3 of industrial roundwood production.

Source: National Forestry Database (NFD), 2017, Industrial roundwood production, 1940-2015, http://nfdp.ccfm.org/data/graphs/graph_51_a_e.php (accessed July 26, 2017); NFD, 2017, Fuelwood and firewood production, 1940-2015, http://nfdp.ccfm.org/data/graphs/graph_51_b_e.php (accessed July 26, 2017).

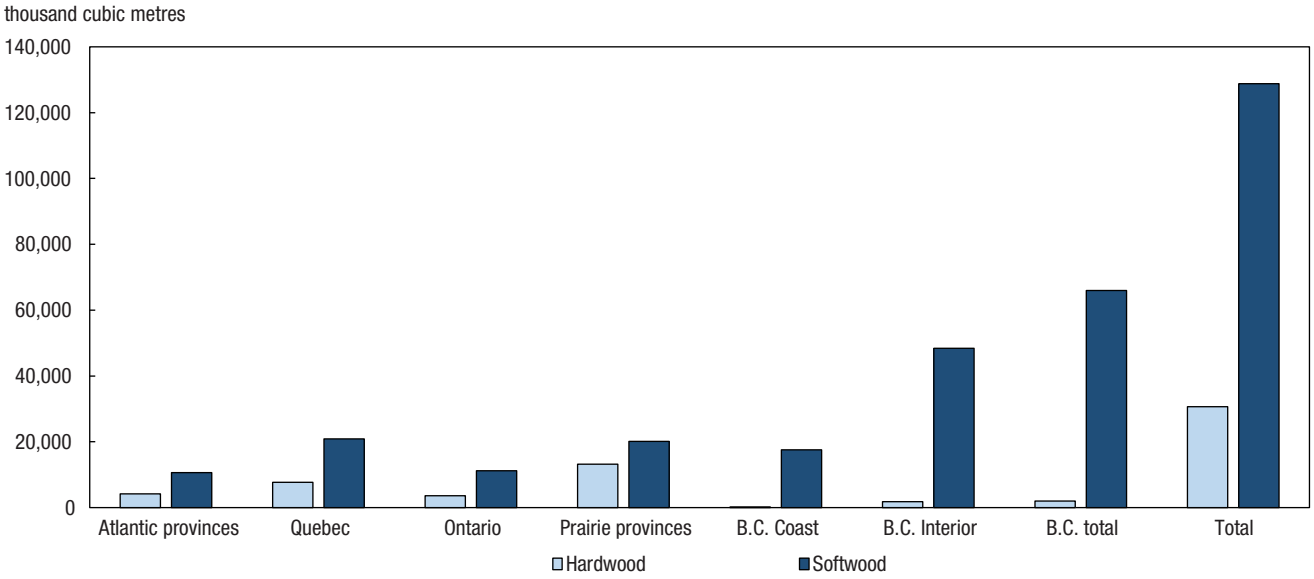
Table 2.5
Volume of roundwood harvested by province, 1980 to 2015

	Newfoundland and Labrador	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Yukon	Northwest Territories[1]	Nunavut	Canada
	thousand cubic metres													
1980	2,795[r]	381	4,686	8,387	31,686	21,322	2,335	3,330	5,933	74,654	115	..	..	155,624[r]
1981	2,568	371[r]	4,112	7,795	34,234	22,808	1,803	3,555	6,586	60,780	124	..	..	144,736[r]
1982	2,379	357[r]	3,105	6,320	29,133	19,778	1,498	2,526	5,714	56,231	161	..	..	127,202[r]
1983	2,429	381[r]	2,596	7,442	36,288	23,736	1,520	2,612	7,344	71,443	192	..	..	155,983[r]
1984	2,889	400[r]	3,894	8,378	36,519	28,130	1,698	2,726	8,457	74,556	177	..	..	167,824[r]
1985	2,509	411[r]	3,515	7,896	35,400	28,225	1,717	3,016	8,979	76,868	186	..	..	168,722[r]
1986	2,408	424[r]	4,004	8,720	38,127	30,186	1,703	3,529	10,387	77,503	199	..	..	177,190[r]
1987	2,524	480	4,789	7,869	39,503	29,692	1,887	3,666	10,496	90,591	188	..	..	191,685
1988	2,513	476[r]	5,039	9,199	39,381	29,338	1,883	3,818	11,990	86,807	172	..	..	190,616[r]
1989	2,535	416[r]	4,772	9,281	36,192	29,642	1,848	3,685	12,293	87,414	176	..	..	188,254[r]
1990	2,876[2]	448[r]	4,639[2]	8,824[2]	30,148[2]	25,420[2]	1,563[2]	2,758[2]	11,911	73,861	82	38	..	162,567[r]
1991	2,680	452[r]	4,348	8,643	28,943[2]	23,829[3]	1,278	2,957[2]	12,926[2]	74,706	79	40	..	160,880[r]
1992	2,821[2]	510[2]	4,248[2]	9,205	31,001[r]	24,286[3]	1,598	3,081[2]	14,594[2]	78,579	162	46	..	170,131[r]
1993	3,131[2]	534[2]	4,585[2]	8,959	34,091[2]	25,432[3]	1,539	4,433[r]	14,897	78,004	193	203	..	175,999[r]
1994	2,445	519[2]	5,106[2]	9,269	38,231[2]	25,952[3]	1,786	4,468	19,790	75,093	421	181	..	183,261[2]
1995	2,983	638	5,483[2]	10,055	41,438[2]	26,260[3]	1,987	4,258	20,287	74,622[3]	357[r]	127[2]	..	188,497[r]
1996	2,742[2]	557[3]	6,012[2]	10,902[3]	38,267[2]	25,871[3]	2,148	4,126	20,037	72,252[3]	254[r]	207[2]	..	183,375[r]
1997	2,558[2]	514[r]	6,989[2]	11,253[3]	42,543[2]	26,595[3]	2,183	4,205	22,217	69,298[3]	253[r]	143	..	188,750[r]
1998	2,398[2]	520	5,903[r]	11,534[2]	43,427[2]	24,126[2]	2,328	3,348	17,172	65,938[2]	110[r]	154	..	176,957[r]
1999	2,720[2]	693	6,164	11,294	45,646[2]	26,130[2]	2,171	3,882	23,729	76,930	145[r]	71	..	199,574[r]
2000	2,868[2]	716[2]	6,470[r]	11,872	43,485[2]	28,647[2]	2,188	4,197	23,418	78,457[r]	33	20[2]	..	202,372[r]
2001	2,556[2]	626[2]	6,182[r]	10,186	40,579[2]	25,545[2]	2,079	4,119	23,474	71,896	39	19[2]	..	187,300[r]
2002	2,561[2]	635[2]	6,066	9,989	41,525[2]	28,431[2]	2,106	4,309	24,673	77,864	42	30	..	198,231[2]
2003	2,289[2]	650[2]	6,085	10,788	40,247[r]	27,566[2]	2,106[2]	4,898	24,228	65,358	32	26	..	184,273[r]
2004	2,327[2]	657[2]	6,889	11,004	43,126[r]	28,100[2]	2,106[2]	6,103	23,510[2]	86,998	26	26	..	210,871[r]
2005	2,400[2]	569[2]	6,249	9,968	38,464[r]	25,711[2]	2,498	5,330	27,546	86,880	24	24[2]	..	205,665[r]
2006	2,050[2]	602[2]	5,209	10,451	33,575[2]	22,090[2]	2,511[2]	3,502	25,269	80,059	19	24[2]	..	185,359[2]
2007	2,050[2]	570[2]	5,260	8,944	30,970[2]	17,519[2]	2,160[2]	2,412	20,513	75,478	22	24[2]	..	165,921[2]
2008	2,050[2]	404[2]	4,899	8,931[2]	25,634[r]	14,184	2,216[2]	1,354	19,824	61,858	19	24[2]	..	141,397[r]
2009	2,050[2]	404[2]	4,127	7,940[2]	21,469[r]	11,790	1,284	1,775	20,014	48,031	27	24[2]	..	118,935[r]
2010	1,501[2]	388[2]	4,482	9,219[2]	26,424[r]	15,287	1,275	2,340	21,052	62,246	27	30	..	144,274[r]
2011	1,344	389[2]	3,903	9,231[2]	23,738[r]	14,310[2]	1,243	2,180	24,886	69,204	27[2]	28	..	150,483[r]
2012	1,107	449[2]	3,447	9,437	28,316[r]	14,356	1,258	2,914	23,031	68,832	27[2]	11	..	153,185[r]
2013	1,182	360[2]	3,453	9,902	26,384[r]	15,548[2]	1,267	3,717	22,528[r]	71,135	37[2]	17[2]	..	155,531[r]
2014	1,696	371[2]	3,643	10,168	28,430[E,2]	15,715	1,496	3,717[2]	23,333[r]	66,500	23[2]	18[2]	..	155,110[r]
2015	1,392	371[2]	3,749	9,363	28,559	15,829[2]	1,498[2]	3,712	28,064[p]	67,970	17[2]	18[2]	..	160,541[e]

.. not available for a specific reference period
[p] preliminary
[r] revised
[E] use with caution
1. Includes Nunavut up to 1998. Figures not available for Nunavut from 1999 to 2015.
2. Estimated by provincial or territorial forestry agency.
3. Estimated by the Canadian Forest Service or by Statistics Canada.

Source: National Forestry Database, 2017, Table 5.1 Net merchantable volume of roundwood harvested by category, ownership, and province/territory, http://nfdp.ccfm.org/products/national_e.php (accessed August 4, 2017) and Create Your Own Report, http://nfdp.ccfm.org/dynamic_report/dynamic_report_ui_e.php (accessed August 4, 2017).

Chart 2.11
Volume of roundwood harvested by type and province or region, 2015



Notes: The Atlantic provinces include Newfoundland and Labrador, Prince Edward Island, Nova Scotia and New Brunswick. The Prairie provinces include Manitoba, Saskatchewan and Alberta. British Columbia total is the sum of B.C. Coast and B.C. Interior. Data for the Yukon and Northwest Territories are included in the total. Data for Nunavut is not available. The type of roundwood harvested, i.e., hardwood or softwood, is unspecified for a small amount of the harvested volume.
Source: National Forestry Database, 2017, Table 5.2 Net merchantable volume of roundwood harvested by species group, ownership and province/territory, http://nfdp.ccfm.org/products/national_e.php (accessed July 27, 2017).

Non-timber forest products

Non-timber forest products can include a variety of goods such as maple syrup, mushrooms, berries, ornamentals, medicinal products, game and fur-bearing animals among many others. These may be obtained from wild or managed forests and from agro-forestry systems. Although some non-timber forest products can have significant monetary values, data are difficult to acquire as there is little widespread accounting.[69] Some of the most comprehensive statistics relate to the production of maple syrup.

There is a long history in eastern Canada and the Northeastern United States of collecting maple sap and boiling it down to produce maple syrup, taffy and sugar. Canada produced 12.2 million gallons of maple syrup in 2016, valued at $484.1 million[70] and accounting for close to three-quarters of North American production.[71] The majority (92%) of maple syrup production in 2016 occurred in Quebec, with the remainder produced mainly in New Brunswick, Ontario and Nova Scotia. In recent years, farms in other areas have also begun tapping maple trees including bigleaf maple in British Columbia and Manitoba maple on the Prairies (Table 2.6). Birch trees are also occasionally tapped for syrup production.

Botanical products gathered from forests include wild mushrooms, berries and nuts, as well as floral products, greenery and Christmas trees. These products may be gathered for personal use, but commercial harvesting occurs for local, national and international markets.[72] Although little data is available to characterize these industries, some

69 Sorrenti, S., 2017, "Non-wood forest products in international statistical systems," *Non-wood Forest Products Series*, FAO, No. 22, Rome, http://www.fao.org/3/a-i6731e.pdf (accessed October 16, 2017).

70 Statistics Canada, CANSIM Table 001-0008, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0010008&tabMode=dataTable&p1=1&p2=50&srchLan=-1 (accessed December 12, 2017).

71 Note that the United States produced 4.2 million gallons of maple syrup in 2016 according to the United States Department of Agriculture, 2016, *Northeast Maple Syrup Production*, p. 1, https://www.nass.usda.gov/Statistics_by_State/New_England_includes/Publications/Current_News_Release/2016/Maple.pdf (assessed August 14, 2017).

72 Gordon, D., 2012, *Tracking the Wild Mushroom: Canada's Wild Mushroom Commodity Chain*, Rural Opportunities Network, p. 1–7, http://ruralnetwork.royalroads.ca/sites/default/files/tools_resources/canadas-wild-mushroom-chaine.pdf (accessed August 14, 2017).

studies have found wild mushroom harvesting and floral and greenery harvesting in British Columbia to be valued in the millions of dollars, with some major crops including pine mushrooms, chanterelles and morels; salal foliage and cedar and pine boughs.[73]

Table 2.6
Maple taps by province, 1991 to 2016

	Number of farms reporting maple taps						Number of maple taps					
	1991	1996	2001	2006	2011	2016	1991	1996	2001	2006	2011	2016
Canada	**8,765**	**9,546**	**10,305**	**9,731**	**10,847**	**11,468**	**18,297,386**	**23,026,708**	**33,680,376**	**38,075,953**	**44,440,024**	**46,995,360**
Newfoundland and Labrador	0	0	0	0	1	0	0	0	0	0	0	0
Prince Edward Island	5	5	10	9	11	17	2,015	0	11,511	11,619	9,693	9,760
Nova Scotia	103	118	128	113	152	187	218,483	292,330	330,513	346,114	372,452	446,300
New Brunswick	155	174	206	189	191	212	463,743	921,693	1,318,866	1,702,530	1,896,773	2,285,785
Quebec	6,659	6,997	7,254	7,054	7,639	7,863	16,606,467	20,675,901	30,695,200	34,675,949	40,632,512	42,529,033
Ontario	1,835	2,240	2,588	2,240	2,673	3,003	1,004,560	1,127,373	1,304,995	1,311,599	1,508,651	1,713,022
Manitoba	8	11	92	63	67	81	2,118	7,395	14,116	11,408	8,251	5,961
Saskatchewan	0	1	27	28	24	29	0	0	5,175	14,373	5,917	1,490
Alberta	0	0	0	3	7	0	0	0	0	120	0	0
British Columbia	0	0	0	32	82	76	0	0	0	2,241	3,609	4,009

Note: In 2006 and 2011, some respondents may have reported taps on trees other than maple (for example: birch).
Source: Statistics Canada, CANSIM Tables 004-0220 and 004-0009 http://www5.statcan.gc.ca/cansim/home-accueil?&lang=eng&MM=as (accessed May 26, 2017).

There is a long history of hunting and trapping activities in Canada, though a decline in participation has been documented in recent decades.[74] Waterfowl primarily use wetland and grassland habitat in coastal areas, on the Prairies and the boreal forest.[75] Environment and Climate Change Canada's Waterfowl Harvest Survey indicates that an estimated 1,153,000 ducks, 1,014,900 geese and 54,000 non-waterfowl birds were harvested in 2015.[76] In 2009, 730,900 pelts from muskrat, beaver, martens, ermines, foxes, bears and other fur-bearing animals were harvested, with a total reported value of $14.8 million.[77] Hunting licenses for big game, for example deer, moose, bear, elk and caribou among other animals, are issued by the provinces and territories.

Biodiversity and ecosystem services

Biodiversity plays an important role in supporting human well-being since it affects the productivity and resilience of ecosystems that provide us with ecosystem services. For example, trees provide carbon storage services, mitigating climate change; insects, birds, bats and rodents help disperse seeds, regenerating forests; birds and bats eat insects, controlling pest populations; plants help reduce water runoff and reduce soil erosion.[78] Sustainable management of forest ecosystems considers the benefits of these services in addition to those provided by the production of timber and other forest products.

73 British Columbia, Ministry of Forests and Range, 1995, *Botanical Forest Products in British Columbia – An Overview*, https://www.for.gov.bc.ca/hfp/publications/00002/index.htm (accessed April 21, 2017).

74 Canada, Parliament, House of Commons, *Licensed Hunting and Trapping in Canada: Report of the Standing Committee on Environment and Sustainable Development*, 41st Parliament, Second Session, June 2015, H. Albrecht (Chair), p. 2–3, http://www.publications.gc.ca/site/eng/9.801728/publication.html (accessed May 30, 2017).

75 Ducks Unlimited Canada, 2017, *Waterfowl*, http://www.ducks.ca/our-work/waterfowl/ (accessed May 31, 2017).

76 Gendron, M.H. and A.C. Smith, 2017, *National Harvest Survey*, Canadian Wildlife Service, National Wildlife Research Centre, Bird Populations Monitoring, Ottawa, Ontario, http://www.ec.gc.ca/reom-mbs/enp-nhs/index.cfm?do=def&lang=e (accessed August 14, 2017). Note that the National Harvest Survey provides estimates on harvests of migratory game bird species based on surveys of purchasers of migratory game bird hunting permits.

77 Statistics Canada, CANSIM Table 003-0013 http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0030013&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid= (accessed May 31, 2017). Note that the collection of statistics on the number and value of wildlife pelts harvested has been discontinued—2009 is the most recent year for which Canada-level statistics are available.

78 Thompson, I.D., et al., 2011, "Forest biodiversity and the delivery of ecosystem goods and services: Translating science into policy," *BioScience*, December 2011, Vol. 61, no 12, p. 972–981, https://doi.org/10.1525/bio.2011.61.12.7 (accessed June 15, 2017).

Biodiversity

Canada's forests are diverse ecosystems with differing vegetation due to site-specific differences in latitude, climate, elevation, moisture, nutrients and other ecological processes.[79] These areas include trees, shrubs, open spaces, rock outcrops, wetlands and lakes.

The spatial distribution of Canadian forest ecosystems varies greatly—approximately 1,000 forest and woodland vegetation communities will be identified and described as part of the ongoing Canadian Forest Ecosystem Classification project, a component of the Canadian National Vegetation Classification.[80]

Natural forests generally have greater biodiversity than plantation forests and intensively managed semi-natural forests.[81] Canada's managed forests are mostly natural or semi-natural, comprised of native species and managed with long harvest rotations followed by natural regeneration or planting and seeding of native species. To maintain biodiversity, 240,410 km^2 of forests, 7% of Canada's forest area, is protected in areas such as conservation areas, large national, provincial and territorial parks (see section 2.4 Protected Areas for more information).[82]

Canada has some of the largest areas in the world of remote and inaccessible forest landscapes.[83] Most Canadians live, and most human activities occur, in the southern part of the country; however, many activities, roads and other infrastructure for forestry, mining, oil and gas, and hydrological reservoirs are located in the boreal zone.[84] Linear features from roads, rail lines, electrical transmission lines and cutlines fragment landscapes, affecting wildlife habitat (see Textbox 2.3 for more information).

Driven by the influence of roads, linear feature density is highest in more densely populated ecoregions (http://www.statcan.gc.ca/eng/subjects/standard/environment/elc/elc2017) such as the Lower Mainland in the Pacific Maritime ecozone and the Lake Erie Lowland and St-Laurence Lowlands of the Mixedwood Plains ecozone.[85] However, it is also elevated in other less densely populated areas of the Boreal Plains and Taiga Plains ecozones, largely due to the influence of cutlines or seismic lines for resource-based activities (Map 2.6).

Canada is home to about 80,000 known species.[86] Forests provide habitat for a wide array of species including microorganisms, fungi, mosses, lichens, plants and trees, insects, fish, amphibians, reptiles, birds and mammals. Canada's forests contain an estimated 32 native conifer, 125 native hardwood and more than 55 exotic tree species.[87] The boreal zone provides habitat for 150 bird species, half of the bird species that occur in Canada.[88] Habitat needs—including forest type, size, age class and connectivity of stands will vary greatly for different species.[89]

79 Natural Resources Canada, 2010, "Canadian Forest Ecosystem Classification System (CFEC)," *Frontline Express*, Bulletin 38, http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/31511.pdf (accessed May 30, 2017).

80 Natural Resources Canada, 2016, Canadian Forest Ecosystem Classification, http://www.nrcan.gc.ca/forests/measuring-reporting/classification/13209 (accessed May 31, 2017).

81 Federal, Provincial and Territorial Governments of Canada, 2010, *Canadian Biodiversity: Ecosystem Status and Trends, 2010*, Canadian Councils of Resource Ministers, p. 16, http://www.biodivcanada.ca/default.asp?lang=En&n=83A35E06-1 (accessed May 10, 2017); Thompson, I.D., et al., 2011, "Forest biodiversity and the delivery of ecosystem goods and services: Translating science into policy," *BioScience*, December 2011, Vol. 61, no. 12, p. 972–981, https://doi.org/10.1525/bio.2011.61.12.7 (accessed June 15, 2017).

82 Canada's National Forest Inventory, 2013, Table 9.1 Area (1000 ha) of forest land by IUCN category, age class and terrestrial ecozone in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 24, 2017).

83 Federal, Provincial and Territorial Governments of Canada, 2010, p. 16; FAO, 2016, *Global Forest Resources Assessment 2015: How are the world's forests changing?* Second edition, http://www.fao.org/3/a-i4793e.pdf (accessed May 1, 2017); FAO, 2014, *Global Forest Resources Assessment 2015: Country Report Canada*, http://www.fao.org/3/a-az181e.pdf (accessed May 1, 2017).

84 Brandt, J.P., et al,, 2013, "An introduction to Canada's boreal zone: ecosystem processes, health, sustainability, and environmental issues," *Environmental Reviews*, Vol. 21, no. 4, p. 207–226, https://doi.org/10.1139/er-2013-0040 (accessed October 10, 2017).

85 Statistics Canada, CANSIM Table 153-0057, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1530057&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid= (accessed December 13, 2017).

86 Canadian Endangered Species Conservation Council, 2016, *Wild Species 2015: The General Status of Species in Canada*, p. 2, https://www.wildspecies.ca/reports (accessed June 30, 2017).

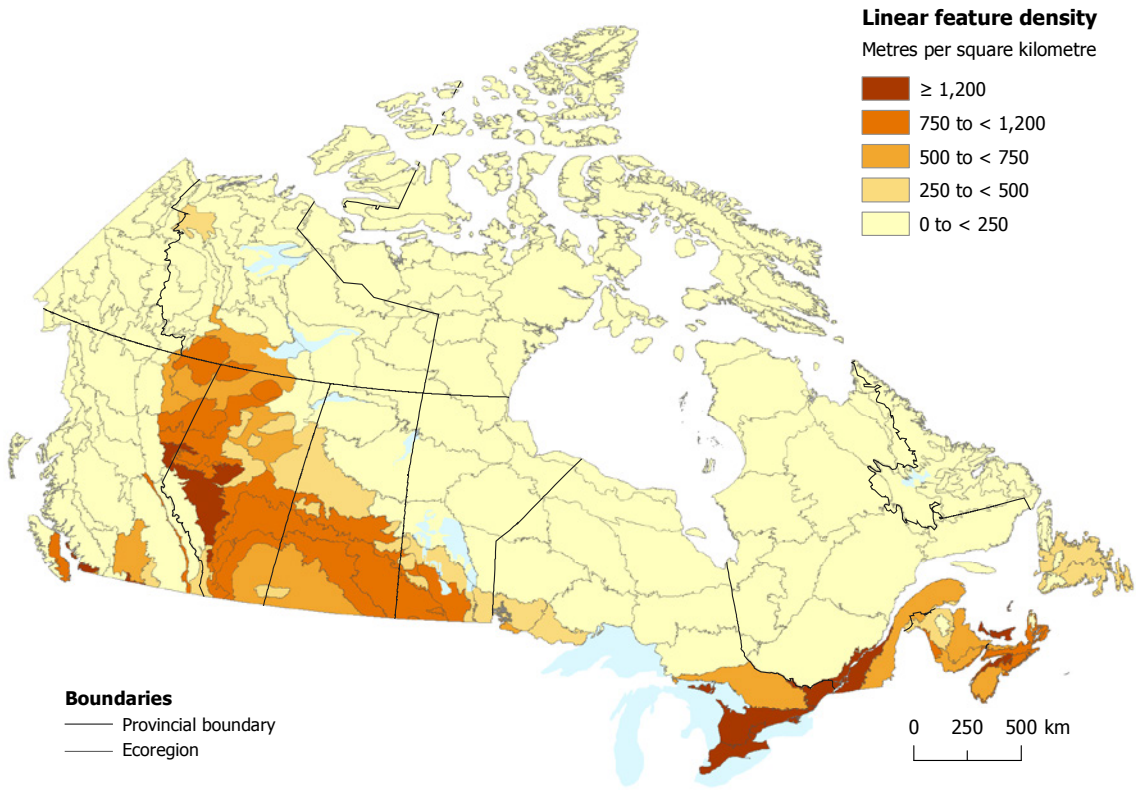
87 Canada's National Forest Inventory, 2014, *Canada's National Forest Inventory: Tree Species List*, September 2014, Version 4.5, https://nfi.nfis.org/resources/general/3-TreeSpeciesList-Version4.5.pdf (accessed May 15, 2017). Note that this tabulation excludes hybrids and variants.

88 Natural Resources Canada, 2017, "8 Facts about Canada's boreal forest," *Boreal Forest*, http://www.nrcan.gc.ca/forests/boreal/17394 (accessed May 31, 2017).

89 British Columbia, Ministry of Forests, 1995, "Biodiversity Guidebook," *Forest Practices Code of British Columbia*, September 1995, p. 1–4, https://www.for.gov.bc.ca/hfd/library/documents/bib19715.pd (accessed May 15, 2017).

Forests provide habitat for some endangered, threatened and iconic species. For example, eight mammals that may use forests for some part of their habitat are listed as endangered under the Species at Risk Act (Table 2.7). Various populations of forest-dwelling woodland caribou—an iconic species—are also threatened and face pressures due to the loss and fragmentation of their habitat.[90] Other endangered forest-associated species include birds such as the Spotted Owl, White-headed Woodpecker, Williamson's Sapsucker, Acadian Flycatcher and Cerulean Warbler; amphibians such as the Oregon Spotted Frog; molluscs such as the Oregon Forestsnail and others.[91]

Map 2.6
Linear feature density by ecoregion, 2011



Notes: Linear feature density refers to the density of roads, rail lines, electrical transmission lines and cutlines (e.g., from seismic lines and firebreaks), measured in metres of linear features per square kilometre. Other infrastructure such as pipelines are not included. Data are aggregated into 194 ecoregions of Canada (Ecological Land Classification 2017).

Source: Statistics Canada, Environment, Energy and Transportation Statistics Division, 2018, special tabulation of Natural Resources Canada, 2012, *CanVec,* Earth Science Sector, Mapping Information Branch, Centre for Topographic Information, www.geogratis.gc.ca (accessed October 9, 2017); Statistics Canada, 2013, "Measuring ecosystem goods and services in Canada," *Human Activity and the Environment,* Catologue no. 16-201-X.

90 Federal, Provincial and Territorial Governments of Canada, 2010, *Canadian Biodiversity: Ecosystem Status and Trends, 2010*, Canadian Councils of Resource Ministers, p. 93, http://www.biodivcanada.ca/default.asp?lang=En&n=83A35E06-1 (accessed May 10, 2017).

91 Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 2017, *Species at Risk Public Registry*, http://www.registrelep-sararegistry.gc.ca/sar/index/default_e.cfm (accessed May 5, 2017).

Table 2.7
Endangered species, terrestrial mammals with forest habitat, 2017

Species	Critical habitat	Observations	Probable stress or limiting factors
Wolverine Eastern population (Gulo gulo)	Northern Quebec and Labrador; low population density is mobile across large habitat area. Requires vast undisturbed area. May occupy treed or treeless areas.	Populations are difficult to monitor because of their low density across a large area, remote locations and frequent traveling. May travel long distances for food. Numbers have declined to a very low level; no verified reports of wolverines in Quebec since 1978 or in Labrador since 1950, though there are unconfirmed reports most years. Eastern population may be extirpated.	Related to a combination of factors: hunting and trapping in the late 19th century, dwindling caribou herds and wolves, habitat loss due to human activity, use of poison baits. Low reproductive rate decreases ability to recover from population declines.
Caribou Atlantic-Gaspésie population (Rangifer tarandus)	Lives south of the St. Lawrence River. Important winter habitat includes mature fir and white spruce forest with abundant terrestrial and arboreal lichens. Summer habitat includes tundra located on Mont Albert and Mont Jacques-Cartier, Parc national de la Gaspésie, Quebec.	Atlantic-Gaspésie population is completely isolated from main population. Population declined from the 1970s to the 1990s and stabilized between 200 and 250 individuals. Recent reports indicate the population may be declining again.	Isolated species with low population numbers make it vulnerable to catastrophic events and inbreeding, limited habitat, predation, human disturbance, fire and climate change.
Little brown bat or Little brown myotis (Myotis lucifugus)	Hibernacula (e.g., caves and mines) for overwinter survival and summering areas with suitable foraging near roosting structures or maternity colonies. Maternity colonies often found in attics of buildings, under bridges, in rock crevices or in tree cavities.	Approximately 50% of the global range of this species occurs in Canada. White-nose syndrome has affected 17% of the Canadian range of this species. The range of White-nose syndrome is expanding by over 200 kilometres per year and is predicted to affect entire population within two decades. A decline in the number of mature individuals has been observed.	Undergoing rapid population decline due to a wildlife disease known as white-nose syndrome. Additional stressors include wind turbines, eradication of bat colonies in buildings, disturbances from humans, habitat loss (particularly old-age forests), chemical contaminants and climate change.
Northern long-eared bat or Northern myotis (Myotis septentrionalis)	Hibernacula (e.g., caves and mines) for overwinter survival and summering areas with suitable foraging near roosting structures or maternity colonies. Maternity colonies often found in attics of buildings, under bridges, in rock crevices or in tree cavities.	Approximately 40% of global range of this species occurs in Canada. White nose syndrome has affected 28% of the Canadian range of this species. A decline in the number of mature individuals has been observed.	Undergoing rapid population decline due to white-nose syndrome. Additional stressors include wind turbines, eradication of bat colonies in buildings, disturbances from humans, habitat loss (particularly old-age forests), chemical contaminants and climate change.
Tri-colored bat (Perimyotis subflavus)	Hibernacula for overwinter survival typically located in deeper parts of caves where temperature is least variable. Summer roosting areas include a range of tree species in forest adjacent to watercourses where they forage.	Approximately 10% of the global range of this species occurs in Canada. White nose syndrome has affected 100% of the Canadian range of this species. A decline in the number of mature individuals has been observed.	Undergoing rapid population decline due white-nose syndrome. Additional stressors include wind turbines, eradication of bat colonies in buildings, disturbances from humans, habitat loss (particularly old-age forests), chemical contaminants and climate change.
Pacific water shrew (Sorex bendirii)	Habitat includes marshes, riparian zones, wetland and dense, wet western cedar forest in the Pacific coastal lowlands of Southwestern British Columbia.	Species is rare within its limited range. No Canadian population estimates are available.	Habitat loss, fragmentation and degradation from development, agriculture and forest harvesting activities.
Vancouver Island marmot (Marmota vancouverensis)	Found on Vancouver Island. Subalpine meadows with soil structures suitable for burrows, grass-forb vegetation for food and microclimate conditions suitable for foraging and hibernation.	Some habitat created by logging of high-elevation forests. This habitat becomes unsuitable as the forest regenerates.	Natural habitat area is limited. Predation, small size of the population may lead to inbreeding and loss of genetic variation.
Western harvest mouse dychei subspecies (Reithrodontomys megalotis dychei)	Found in Alberta. Occupies habitats with dense vegetation of grass or shrubs, grasslands, old fields and ponderosa pine stands.	Species is rare – there are no population estimates available for Canada.	Habitat change resulting from fire, fragmentation and loss due to urban development, grazing, mowing and agriculture.

Source: Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 2017, *Species at Risk Public Registry*, www.registrelep-sararegistry.gc.ca/sar/index/default_e.cfm (accessed May 5, 2017); Environment Canada, 2015, *Recovery Strategy for Little Brown Myotis (Myotis lucifugus), Northern Myotis (Myotis septentrionalis), and Tri-colored Bat (Perimyotis subflavus) in Canada [Proposed], Species at Risk Act*, Recovery Strategy Series, Ottawa, www.registrelep-sararegistry.gc.ca/document/default_e.cfm?documentID=2475 (accessed May 5, 2017); COSEWIC, 2008, COSEWIC assessment and update status report on the Vancouver Island marmot *Marmota vancouverensis in Canada*, Ottawa, http://www.registrelep-sararegistry.gc.ca/document/default_e.cfm?documentID=1650 (accessed May 5, 2017).

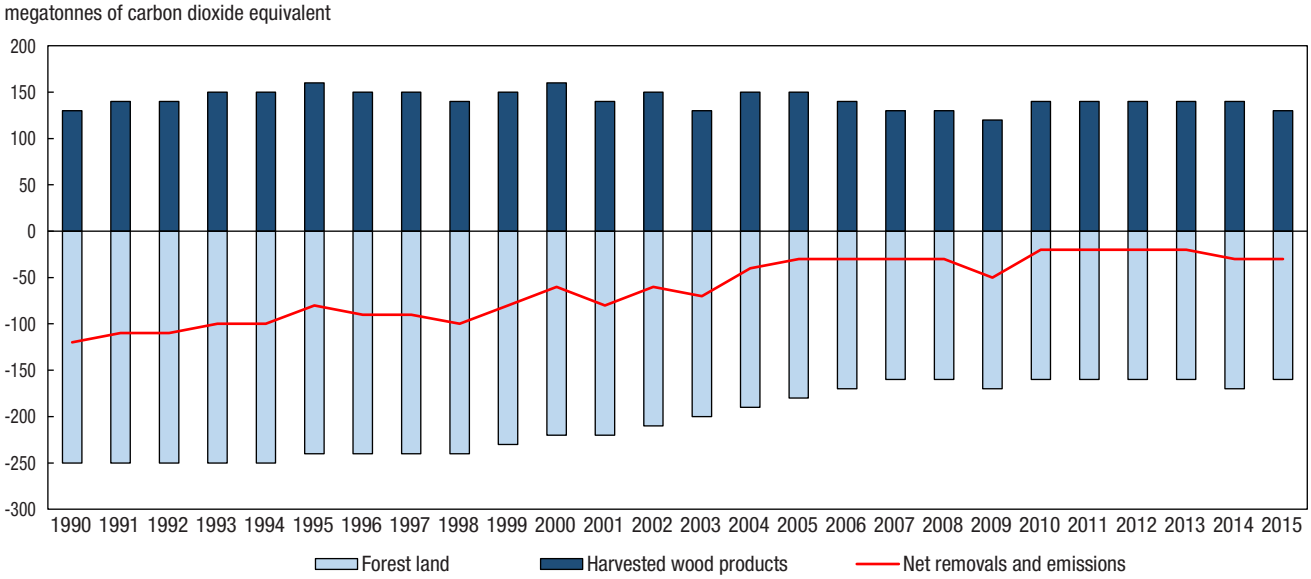
Ecosystem services

Forests provide essential regulating services by filtering and cleaning air and water, cycling nutrients, regulating local climates, sequestering carbon and protecting against erosion and natural hazards such as flooding, among many others. They also provide opportunities for recreation, tourism and aesthetic appreciation (Textbox 2.2) and can

have a great spiritual significance for Indigenous peoples and many others. Although there is increasing recognition of the multiple services provided by forests and other natural areas, data to measure the value and benefits of these services are limited.[92]

Forests store carbon in vegetation and soil and emit it through respiration, decomposition and fires. Global estimates indicate that overall, forests are an important net carbon sink, while those affected by deforestation may contribute net emissions.[93] In most years, Canada's managed forests are a net carbon sink—they absorb more carbon than they release. However, natural disturbances such as forest fires and insect outbreaks can have large impacts on the carbon balance since burning or decaying trees release stored carbon back into the atmosphere. Excluding the impact of these natural disturbances, forest land removed 164 Mt of carbon dioxide equivalent emissions in 2015, while emissions associated with harvested wood products[94] were 135 Mt, resulting in net removals of 29 MT by the forest sector (Chart 2.12).[95]

Chart 2.12
Greenhouse gas emissions and removals from forest land and harvested wood products, 1990 to 2015



Notes: Forest land includes emissions and removals resulting from managed forests and lands converted to forests; includes growth and anthropogenic disturbances related to forest management. It excludes fire and most insect disturbances. In previous years, the National Inventory Report values for forest land also included natural disturbance. Harvested wood product emissions result from the use and disposal of harvested wood products manufactured from wood coming from forest harvest and forest conversion activities in Canada. Net removals and emissions include only the forest land and harvested wood products categories and do not consider emissions associated with deforestation. Data has been rounded to two significant figures.
Source: Environment and Climate Change Canada, 2017, *National Inventory Report, 1990–2015: Greenhouse Gas Sources and Sinks in Canada, Canada's Submission to the United Nations Framework Convention on Climate Change, Part 3*, Catalogue no. EN81-4E-PDF, http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php (accessed June 5, 2017).

92 For more information and case studies on this topic see: TD Economics and Nature Conservancy of Canada, 2017, *Putting a Value on the Ecosystem Services Provided by Forests in Canada: Case Studies on Natural Capital and Conservation*, http://www.natureconservancy.ca/assets/documents/nat/Natural-Capital_2017_draft.pdf (accessed June 28, 2017).

93 Le Queré, C. et al., 2016, "Global carbon budget 2016," *Earth Systems Science Data*, Vol. 8, p. 605–649, https://doi.org/ 10.5194/essd-8-605-2016 (accessed September 25, 2017); Pan, Y. et al., 2011, "A large and persistent carbon sink in the world's forests," *Science*, Vol. 333, August 19, 2011, p. 988–993, https://doi.org/10.1126/science.1201609 (accessed September 25, 2017).

94 Note that emissions from harvested wood products reflect emissions of carbon released during the decay of long-lived wood products and the end-of-life emissions for short-lived products such as pulp and paper and bio-energy products.

95 Environment and Climate Change Canada, 2017, *National Inventory Report 1990–2015: Greenhouse Gas Sources and Sinks in Canada, Part 1*, Catalogue no. EN81-4/1E-PDF, p. 54, http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php (accessed June 5, 2017). Note that this report, Canada's submission to the United Nations Framework Convention on Climate Change, reports the anthropogenic GHG fluxes between the atmosphere and Canada's managed lands. In previous years, the impact of natural disturbances including wildfires and insects on the flux of emissions and removals was included.

Canada's national parks and reserves protect over 328,198 km^2 representing the diversity of Canada's landscapes and provide opportunities for appreciation and enjoyment of natural areas.[96] In 2015/16, 13.1 million visitors attended national parks and park reserves.[97] Over half of visitors attended parks in Alberta, followed by about 22% in British Columbia, 6% in Ontario and 4% in Prince Edward Island.

According to the 2012 Canadian Nature Survey, more than two-thirds of Canadians spent time outdoors in order to experience nature and almost half travelled to experience nature.[98] The most popular nature-based activity was picnicking or relaxing in nature, with 71% of adult Canadians participating in this activity. Other nature-based activities that were popular included gathering nuts, berries or firewood (36%), camping (21%), fishing (21%), birding (18%) and hunting (8%). Spending on nature-based recreation[99] (including non-forest related activities) totalled $14.5 billion in the previous year.

Textbox 2.2 Urban forest cover in Canadian metropolitan areas

Trees in urban areas provide a wide range of benefits. Trees can improve cities' aesthetics and increase property values. They can provide physical and mental health benefits to humans such as lower stress levels and may even lead to increases in longevity.[100] Urban forests can provide wildlife habitat, provide shade and cooling, filter and clean air and water and can provide areas for recreation and enjoyment of nature.

Trees are present in most cities in Canada, for example in yards, parks and lining streets. Several Canadian cities have urban forest management plans to protect these trees and maintain and increase tree cover in urban environments.[101] Some cities also have extensive areas of tree cover—areas that are predominantly composed of coniferous, broadleaf or mixedwood tree cover; however, the total area covered can vary significantly (Table 2.8).

Canada's largest cities had significant areas of tree cover within the boundaries of their metropolitan regions. The area of coniferous, broadleaf or mixedwood tree cover in census metropolitan areas (CMAs) ranged from a low of 29 km^2 in Windsor to a high of 3,959 km^2 in Halifax in 2011.[102] The proportion of treed area also varies, with Toronto having 16% tree cover, Montréal 20% and Vancouver 48%. The natural environment surrounding a city has an effect on the type of trees and the percentage of urban forest cover.[103]

The average CMA tree cover was 1,342 m^2 per person. In general, the most populated cities have less tree cover per person than average while the least populated cities have more forest cover per person than average. For example, Saint John, Moncton and Saguenay had among the highest amounts of tree cover per person.

96 Parks Canada, 2017, *The System of National Parks in Canada*, http://www.pc.gc.ca/en/pn-np/cnpn-cnnp/carte-map-txt (accessed October 10, 2017).

97 Parks Canada, 2017, *Parks Canada Attendance, 2011-12 to 2015-16*, http://www.pc.gc.ca/en/docs/pc/attend (accessed June 6, 2017). Data excludes attendees at marine conservation areas and marine parks.

98 Federal, Provincial and Territorial Governments of Canada, 2014, *2012 Canadian Nature Survey: Awareness, Participation, and expenditures in nature-based recreation, conservation, and subsistence activities*, Catalogue no. EN4-243-2014E-PDF, Ottawa, Canadian Councils of Resource Ministers, http://www.biodivcanada.ca/default.asp?lang=En&n=2A0569A9-1 (accessed April 18, 2017). Note that these data include activities to experience nature that may or may not have been located in or near forests.

99 Note that nature-based recreation includes hiking, climbing, horse riding; cycling and mountain biking, camping in tents, non-motorized water and beach activities; alpine skiing and snowboarding, cross country skiing, snowshoeing and golfing.

100 Van den Berg, A.E., T. Hartig and H. Staats, 2007, "Preference for nature in urbanized societies: Stress, restoration and the pursuit of sustainability," *Journal of Social Issues*, Vol. 63, no. 1, p. 79–96; James, P. et al., 2016, "Exposure to greenness and mortality in a nationwide prospective cohort study of women," *Environmental Health Perspectives*, Vol. 124, no. 9, p. 1–9, https://ehp.niehs.nih.gov/15-10363/ (accessed July 10, 2017).

101 Canadian Urban Forest Network, 2016, *Canadian Municipalities with Urban Forestry Mandates*, http://docs.wixstatic.com/ugd/64e90e_fdb8b6ce39f94cccabe290fb1d21f9ee.pdf (accessed July 10, 2017).

102 Note that some of the differences in size may be attributable to the geographic boundaries of the CMA area.

103 Nowak, D.J. et al., 1996, "Measuring and analyzing urban tree cover," *Landscape and Urban Planning*, Vol. 36, p. 49–57, https://www.nrs.fs.fed.us/pubs/jrnl/1996/ne_1996_nowak_001.pdf (accessed October 16, 2017).

Textbox 2.2 Continued

Table 2.8
Tree cover by census metropolitan area, 2011

Census metropolitan area	Land area	Tree cover	Built-up	Proportion of tree cover	2011 population	Tree cover per person
	km^2			percent	number	m^2/person
Abbotsford–Mission	605	258	139	43	170,191	1,518
Barrie	898	195	155	22	187,013	1,041
Brantford	1,073	206	155	19	135,501	1,520
Calgary	5,108	319	700	6	1,214,839	263
Edmonton	9,427	1,216	1,094	13	1,159,869	1,048
Greater Sudbury	3,411	1,710	269	50	160,770	10,636
Guelph	594	152	112	26	141,097	1,078
Halifax	5,496	3,959	467	72	390,328	10,142
Hamilton	1,372	241	420	18	721,053	334
Kelowna	2,905	2,252	185	78	179,839	12,521
Kingston	1,939	659	208	34	159,561	4,133
Kitchener–Cambridge–Waterloo	827	114	281	14	477,160	239
London	2,666	265	415	10	474,786	557
Moncton	2,406	1,661	182	69	138,644	11,977
Montréal	4,258	842	1,571	20	3,824,221	220
Oshawa	904	166	236	18	356,177	466
Ottawa–Gatineau (Ont.)	3,287	979	635	30	921,823	1,062
Ottawa–Gatineau (Que.)	3,000	2,207	328	74	314,501	7,018
Peterborough	1,507	508	166	34	118,975	4,267
Québec	3,349	2,112	475	63	765,706	2,759
Regina	3,408	93	230	3	210,556	440
Saguenay	2,564	1,803	188	70	157,790	11,425
Saint John	3,363	2,597	250	77	127,761	20,324
Saskatoon	5,215	103	319	2	260,600	395
Sherbrooke	1,460	767	203	53	201,890	3,798
St. Catharines–Niagara	1,398	253	412	18	392,184	646
St. John's	805	472	181	59	196,966	2,397
Thunder Bay	2,556	1,342	193	53	121,596	11,038
Toronto	5,906	941	2,184	16	5,583,064	168
Trois-Rivières	1,041	357	147	34	151,773	2,349
Vancouver	2,883	1,383	995	48	2,313,328	598
Victoria	696	413	233	59	344,615	1,197
Windsor	1,022	29	258	3	319,246	92
Winnipeg	5,303	467	559	9	730,018	639

Note: Tree cover was estimated by summing the land cover classes 210–Coniferous, 220–Deciduous and 230–Mixedwood from AAFC Crop Inventory, 2011 (30 metres) for all land that was not otherwise categorized as built-up, arable or water.
Source: Statistics Canada, 2018, Environment, Energy and Transportation Statistics Division special tabulation from Agriculture and Agri-Food Canada (AAFC), 2013, *AAFC Crop Inventory, 2011*, http://open.canada.ca/data/en/dataset/58ca7629-4f6d-465a-88eb-ad7fd3a847e3 (accessed August 10, 2015); AAFC, 2015, *Land Use 1990, 2000 and 2010*, http://open.canada.ca/data/en/dataset/18e3ef1a-497c-40c6-8326-aac1a34a0dec (accessed September 16, 2015); and the Census of Population, 2011.

2.3 Forest sector

Forestry-related industries have played a large role in the social and economic development of Canada. In addition to the forestry and logging industry, which involves growing and harvesting timber, forests support a number of other activities related to forest conservation and management, and provide the raw materials required for wood product and paper manufacturing.[104] Other industries, such as construction, also rely heavily on goods produced by the forest sector.

104 The forest sector includes the following North American Industry Classification (NAICS) codes: 113 – forestry and logging; 1153 – support activities for forestry and logging (e.g., forest conservation services, forest fire fighting services, forestry maintenance, log hauling, pest control and timber cruising and valuation); 321 – wood product manufacturing and 322 – paper manufacturing.

The overall contribution of the forest sector to Canada's economy has declined in recent decades. However, the sector continues to have a significant role in many remote, smaller and Indigenous communities.

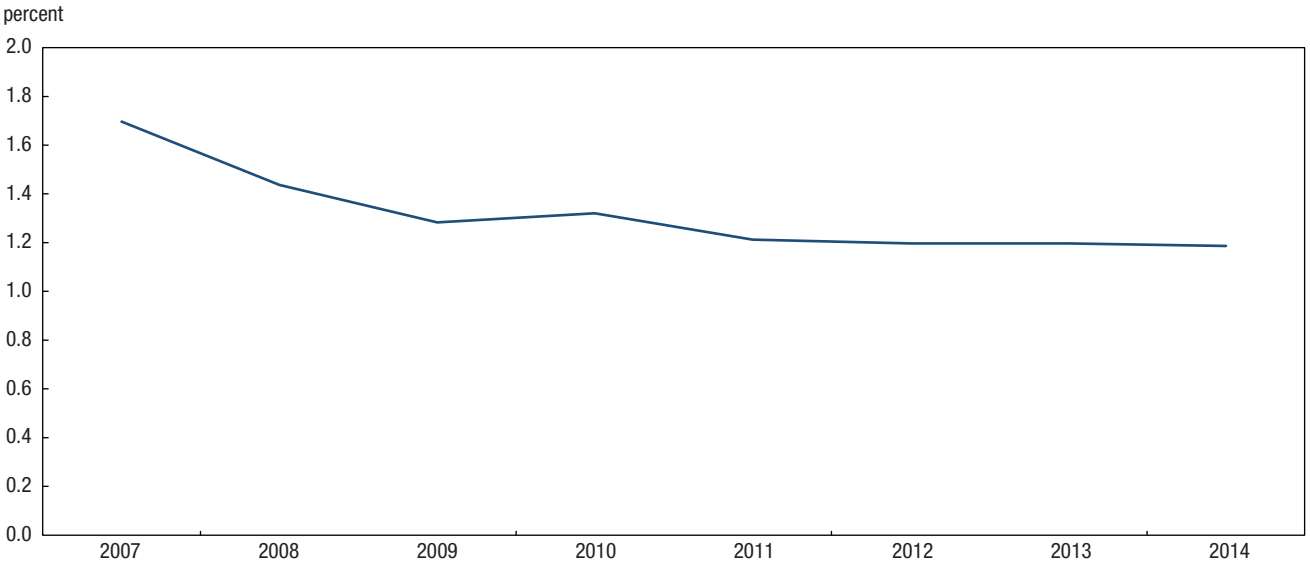
Contribution of forest sector to the economy

Canada's forest sector has faced several challenges since the mid-2000s—in particular, a decrease in demand for lumber in the U.S. following the collapse of the housing market, as well as a decrease in demand for paper and newsprint as a result of the rise of online media.

In 2014, gross domestic product (GDP) for the forest sector in Canada was $22.1 billion.[105] Wood product manufacturing was responsible for 39% of this total followed by paper manufacturing (36%), forestry and logging (17%) and support activities for forestry (8%). The forest sector's overall contribution to gross domestic product declined from 1.7% in 2007 to 1.2% in 2014 (Chart 2.13).

Forest sector activities in British Columbia, Quebec and Ontario contributed the largest proportion of the sector's national-level GDP in 2014—31%, 28% and 19% respectively.[106] However, the sector made the largest contributions to provincial GDP in New Brunswick, where it accounted for 3.5% of the provincial GDP, followed by British Columbia (3.1%).

Chart 2.13
Forest sector gross domestic product as a percent of total, 2007 to 2014



Note: Includes North American Industry Classification (NAICS) codes: 113 – forestry and logging; 1153 – support activities for forestry and logging; 321 – wood product manufacturing and 322 – paper manufacturing.
Source: Statistics Canada, CANSIM 379-0029, www5.statcan.gc.ca/cansim/home-accueil?&lang=eng&MM=as (accessed November 21, 2017).

Canada's forests provide the raw materials to produce wood and paper products for Canadian consumption, but also provide a significant contribution to world exports. Canada is one of the top producers and exporters of softwood lumber, newsprint and pulp in the world.[107]

105 Statistics Canada, CANSIM Table 379-0029, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=3790029&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid= (accessed November 21, 2017).

106 Statistics Canada, CANSIM Table 379-0030, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=3790030&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid= (accessed November 21, 2017).

107 Natural Resources Canada (NRCan), Canadian Forest Services, 2016, *The State of Canada's Forests: Annual Report, 2016*, Ottawa, Catalogue no. F01-6E-PDF, p. 40, http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/37265.pdf (accessed April 15, 2017); NRCan, 2017, "Forest Products and Applications," *Industry and Trade*, http://www.nrcan.gc.ca/forests/industry/products-applications/13317 (accessed July 12, 2017); Food and Agricultural Organization of the United Nations (FAO), 2017, *Forest Products 2015*, p. A3–A5, http://www.fao.org/3/a-i7304m.pdf (accessed July 13, 2017).

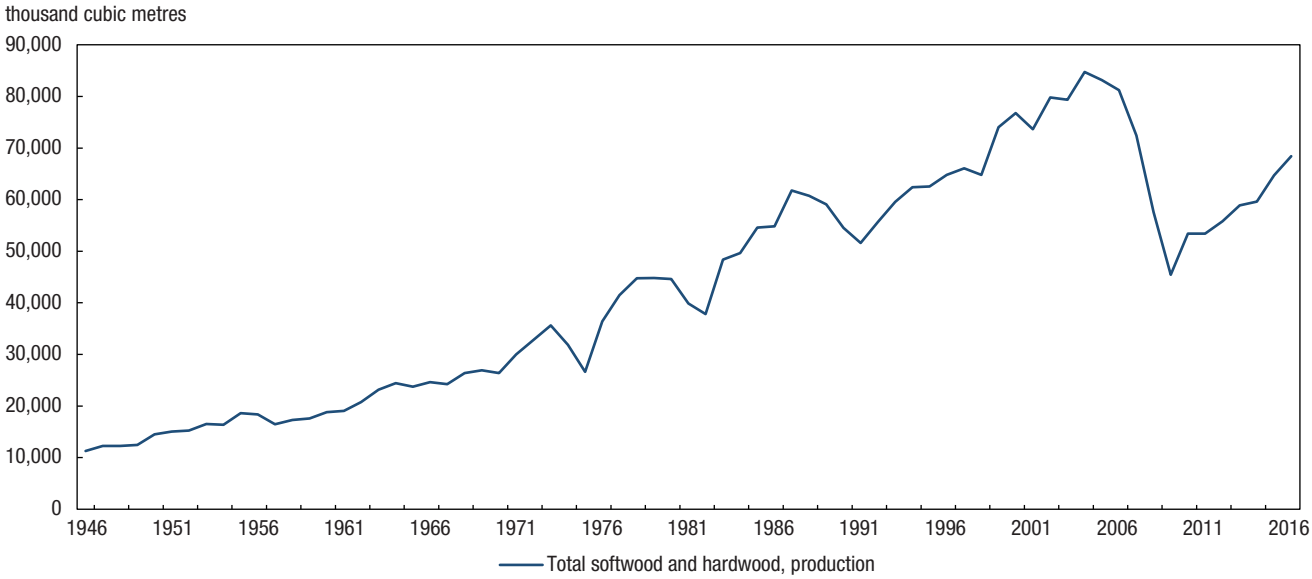
In 2016, sawmills produced 68.4 million m^3 of lumber, up just over 50% since a low in 2009 following the U.S. housing crash (Chart 2.14). Production of structural panels, such as plywood and oriented strandboard, totaled 8.7 million m^3. Other produced wood products include windows and doors, containers and pallets—many of which are used domestically by other industries. Wood chip production totaled 18.3 million tonnes.[108]

In 2016, the forest sector produced 16.5 million tonnes of wood pulp, 3.4 million tonnes of newsprint and 3.0 million tonnes of printing and writing paper.[109] Wood waste is also frequently used for energy production—11.1 million tonnes of solid wood waste and 18.4 million tonnes of spent pulping liquor were used for energy production in 2016.[110]

Exports of lumber and sawmill and millwork products totaled $15,658 million and $13,018 million for pulp and paper in 2016.[111] As a proportion of total Canadian exports, forest products including logs and pulpwood, lumber and pulp and paper, have declined from 12% in 1997 to 6% in 2016 (Chart 2.15).

Exports of forestry, lumber and pulp and paper products were particularly important in British Columbia, where they account for 23% of provincial exports, followed by New Brunswick (11%), Nova Scotia (9%) and Quebec (9%).[112]

Chart 2.14
Lumber production, 1946 to 2016



Source: Statistics Canada, CANSIM Tables 303-0009 and 303-0064, www5.statcan.gc.ca/cansim/home-accueil?&lang=eng&MM=as (accessed June 15, 2017).

108 Statistics Canada, CANSIM Table 303-0065, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=3030065&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid= (accessed June 14, 2017).

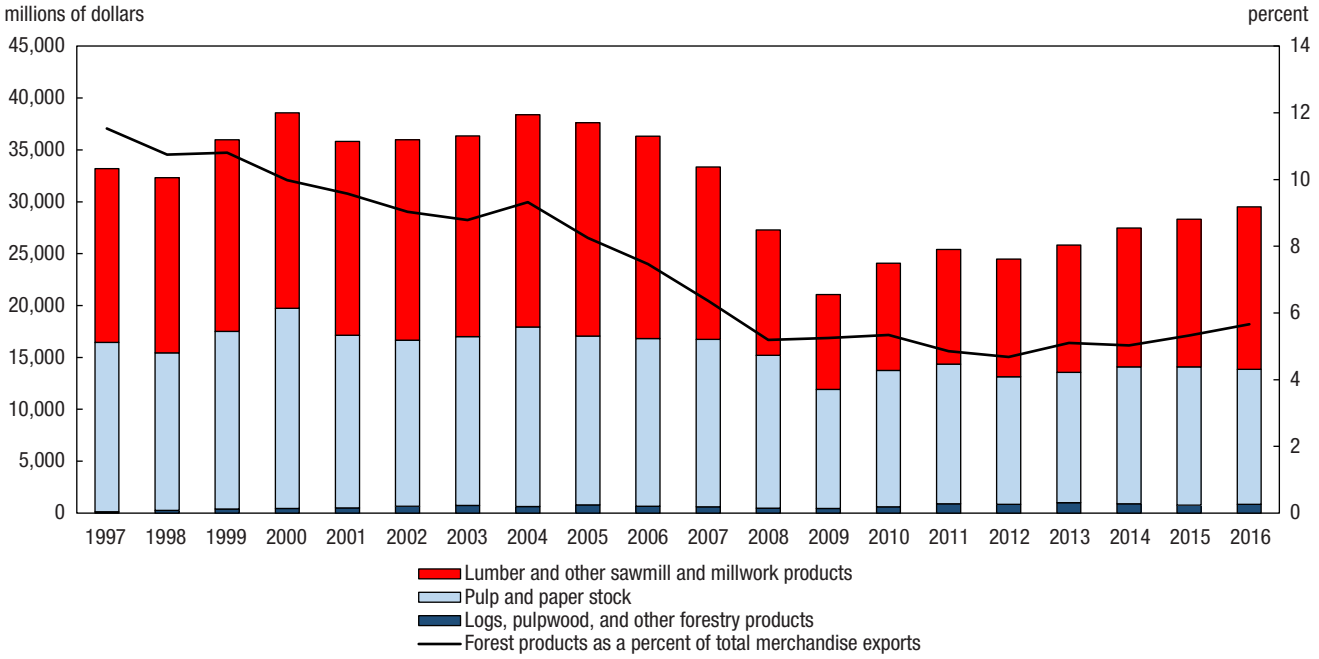
109 Natural Resources Canada, Canadian Forest Services, 2017, *The State of Canada's Forests: Annual Report 2017*, Ottawa, Catalogue no. F01-6E-PDF, p. 61, http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/38871.pdf (accessed October 3, 2017).

110 Statistics Canada, CANSIM Table 128-0018, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1280018&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid= (accessed January 5, 2018).

111 Statistics Canada, CANSIM Table 228-0059, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=2280059&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid= (accessed May 31, 2017).

112 Statistics Canada, 2017, "Softwood lumber satellite account, 2013 to 2015," *The Daily*, Catalogue no 11-001-X, March 27, 2017, http://www.statcan.gc.ca/daily-quotidien/170327/dq170327a-eng.htm (accessed July 12, 2017). Note that the categories used in the softwood lumber account differ from the balance of payments exports in CANSIM.

Chart 2.15
Exports of forest products, 1997 to 2016



Notes: Building and packaging materials such as wood containers, paperboard containers and pallets are not included. Forest product export values are adjusted to 2016 dollars using Paasche current weighted index.
Source: Statistics Canada, CANSIM Tables 228-0059 and 228-0063, http://www5.statcan.gc.ca/cansim/home-accueil?&lang=eng&MM=as (accessed January 4, 2018).

Contribution to employment, wages and communities

Despite the downturn in the forest sector in the last decade, the forest sector continues to be an important provider of jobs and income in communities across the country and has a particular importance in smaller and Indigenous communities.

In 2016, the forest sector provided Canadians with 205,660 jobs in the forestry and logging, support activities for forestry, wood product and paper manufacturing industries (Chart 2.16). The wood product manufacturing industry accounted for 47% of jobs in 2016, followed by 27% in the paper manufacturing industry, 16% in forestry and logging and 10% in support activities for forestry. Overall, 31% of these jobs were located in Quebec, 27% in British Columbia, 21% in Ontario, 8% in Alberta, 6% in New Brunswick, with smaller proportions elsewhere.[113]

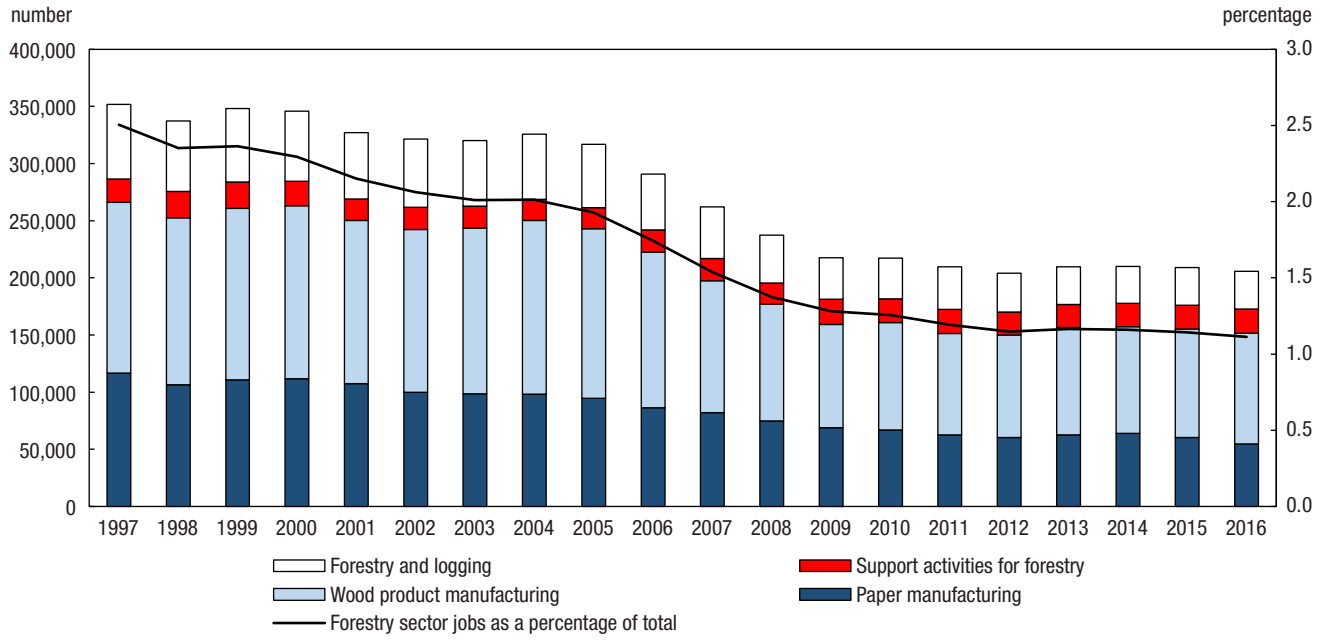
Since 1997, the total number of jobs in the sector has declined by 42%, with the largest number of jobs lost in manufacturing. Forest sector jobs accounted for 1.1% of jobs in Canada in 2016, down from 2.5% in 1997. However, the largest drops occurred in British Columbia, where sector employment fell from 5.8% in 1997 to 2.3% in 2016 and in New Brunswick from 5.6% to 3.5%.

Total compensation in the sector was valued at $16.0 billion in 2016, accounting for 1.5% of all compensation in Canada.[114] Hourly compensation was $39 in the forest sector, compared to the all-industry average of $35. Hourly compensation was highest in the paper manufacturing industry at $47 per hour, followed by $37 per hour in forestry and logging, $37 per hour in wood product manufacturing and $34 per hour in support activities for forestry.

113 Statistics Canada, CANSIM Table 383-0031, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=3830031&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid= (accessed July 12, 2017).

114 Statistics Canada, CANSIM Table 383-0031, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=3830031&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid= (accessed June 1, 2017). Total compensation includes salaries, social contributions and imputed labour income for self-employed workers.

Chart 2.16
Forest sector jobs, 1997 to 2016



Note: Includes North American Industry Classification (NAICS) codes: 113 – forestry and logging; 1153 – support activities for forestry and logging; 321 – wood product manufacturing and 322 – paper manufacturing.
Source: Statistics Canada, CANSIM Table 383-0031, http://www5.statcan.gc.ca/cansim/home-accueil?&lang=eng&MM=as (accessed February 28, 2018).

Forest sector-based communities

In 2016, the forest sector was a major economic driver for at least 105 communities located across six provinces (Table 2.9). These communities derived at least 20% of income from the forest sector.[115] These communities are generally small, reliant on relatively few industries and may therefore be more vulnerable to changes in the economic strength of the forest sector.[116]

In recent decades, there has been a significant decline in the number of forest sector-based communities. In 2001, 463 communities across 9 provinces, and with a total population close to 863,000, generated at least 20% of income from the forest sector.[117] Increasingly, communities that received a significant proportion of their income from the forest sector are smaller. The number of communities with a population of 5,000 or more dropped from 31 in 2001 to 4 in 2016 (Chart 2.17), while the share of population in these communities dropped from 34% to 7%.

The overall share of forest sector employment income generated by forest sector-based communities decreased from 30% in 2000 to 11% in 2015. Communities that had the highest ratios of forest income to market income in 2000 were the most likely to remain reliant on the sector for at least 20% of income in 2015.

115 This analysis is based on a definition developed by Natural Resources Canada, Canadian Forest Services, Economic Analysis Division. It defines these communities as census subdivisions (CSDs) where forest sector employment income represents 20% or more of market income (i.e., total income excluding government transfers). Some data were suppressed for data quality reasons or to meet the confidentiality requirements of the Statistics Act. Income data were available for 4,009 of 5,600 CSDs in 2001 and 3,675 of 5,162 CSDs in 2016. This analysis may therefore underreport the total number of communities for which the forest sector is a major economic driver. Note that a decline in the percentage of forest sector income may be due to a decrease in forest sector income or an increase in income from other sources. The reference period for income data in the Census of Population is the calendar year prior to the census.

116 Williamson, T., R. Samson and D. Korber, 1999, "Economic performance of forest-reliant census subdivisions between 1981 and 19911", *The Forestry Chronicle*, Vol. 75, no. 1, p. 93–109, http://cfs.nrcan.gc.ca/publications?id=18705 (accessed June 26, 2017); Stedman, R., W. White, M. Patriquin and D. Watson, 2007, "Measuring community forest-sector dependence: Does method matter?," *Society and Natural Resources*, Vol. 20, p. 629–646, https://doi.org/10.1080/08941920701329660 (accessed January 20, 2018).

117 Note that changes occur to the number and the boundaries of census subdivisions (CSDs) between censuses. These data have not been adjusted for changes in the boundaries between census periods. Of the 463 forest sector-based CSDs in 2001, the total area remained essentially the same for 64%; grew from 1% to 10% for 20% of CSDs; and by over 20% for 8% of CSDs. A further 8% were amalgamated into other areas.

Although aggregate forest sector employment income was down in 2015, the remaining jobs continue to pay better than average. Average employment income per person in forest sector-based communities increased from $36,620 in 2000 to $40,075 in 2015, while average forest sector employment income rose from $55,120 to $62,750.[118]

Table 2.9
Forest sector-based communities by province, 2001 and 2016

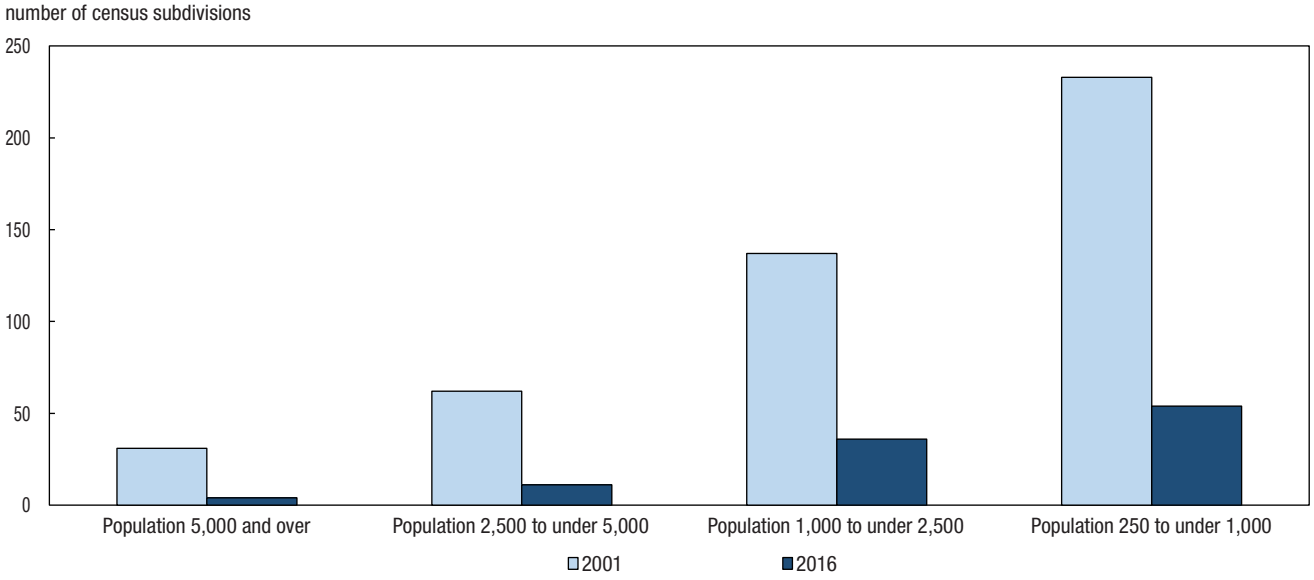
	2001		2016	
	Census subdivisions	Population	Census subdivisions	Population
	number			
Total	**463**	**863,007**	**105**	**159,420**
Newfoundland and Labrador	16	9,421	0	...
Prince Edward Island	0	...	0	...
Nova Scotia	4	23,300	0	...
New Brunswick	53	61,563	12	13,203
Quebec	194	252,141	40	45,096
Ontario	51	119,775	7	9,880
Manitoba	8	13,445	0	...
Saskatchewan	8	10,612	4	5,399
Alberta	8	31,115	1	1,320
British Columbia	121	341,635	41	84,522

... not applicable

Notes: Changes occur to the number and the boundaries of census subdivisions (CSDs) between censuses. In 2016 there were 5,162 CSDs compared to 5,600 CSDs in 2001. These data have not been adjusted for changes in the boundaries between census periods. Of the 463 forest sector-based CSDs in 2001, the total area remained essentially the same for 64%; grew from 1% to 10% for 20% of CSDs; and by over 20% for 8% of CSDs. A further 8% were amalgamated into other areas. This analysis is based on a definition developed by Natural Resources Canada, Canadian Forest Services, Economic Analysis Division. It defines these communities as CSDs where forest sector employment income represents 20% or more of market income (i.e., total income excluding government transfers). Some data were suppressed for data quality reasons or to meet the confidentiality requirements of the Statistics Act. Income data were available for 4,009 CSDs in 2001 and 3,675 CSDs in 2016. This analysis may therefore underreport the total number of communities for which the forest sector is a major economic driver. Note that a decline in the percentage of forest sector income may be due to a decrease in forest sector income or an increase in income from other sources. The reference period for income data is the calendar year prior to the census. The forest sector includes North American Industry Classification codes 113 – forestry and logging, 1153 – support activities for forestry and logging, 321 – wood product manufacturing and 322 – paper product manufacturing.
Source: Statistics Canada, 2018, special tabulation from the 2001 and 2016 Census of Population.

118 Statistics Canada, 2018, special tabulation from the 2001 and 2016 Census of Population. Average employment income among recipients for persons 15 years or older, adjusted to 2015 constant dollars using the Consumer Price Index (CANSIM 326-0021).

Chart 2.17
Forest sector-based communities by size, 2001 and 2016



Notes: Changes occur to the number and the boundaries of census subdivisions (CSDs) between censuses. In 2016 there were 5,162 CSDs compared to 5,600 CSDs in 2001. These data have not been adjusted for changes in the boundaries between census periods. Of the 463 forest sector-based CSDs in 2001, the total area remained essentially the same for 64%; grew from 1% to 10% for 20% of CSDs; and by over 20% for 8% of CSDs. A further 8% were amalgamated into other areas. This analysis is based on a definition developed by Natural Resources Canada, Canadian Forest Services, Economic Analysis Division. It defines these communities as CSDs where forest sector employment income represents 20% or more of market income (i.e., total income excluding government transfers). Some data were suppressed for data quality reasons or to meet the confidentiality requirements of the Statistics Act. Income data were available for 4,009 CSDs in 2001 and 3,675 CSDs in 2016. This analysis may therefore underreport the total number of communities for which the forest sector is a major economic driver. Note that a decline in the percentage of forest sector income may be due to a decrease in forest sector income or an increase in income from other sources. The reference period for income data is the calendar year prior to the census. The forest sector includes North American Industry Classification codes 113 – forestry and logging, 1153 – support activities for forestry and logging, 321 – wood product manufacturing and 322 – paper product manufacturing.
Source: Statistics Canada, 2018, special tabulation from the 2001 and 2016 Census of Population.

In 2016, over half (53%) of the population of forest sector-based communities lived in British Columbia, with a further 28% in Quebec and 8% in New Brunswick (Map 2.7). Overall, the population of these 105 communities declined 10% from close to 177,460 in 2001 to 159,420 in 2016, compared to a 17% increase in population at the Canada-level.[119] At the same time, population increased 2% in smaller communities.[120]

These communities, like other small census subdivisions, had proportionally more seniors than the Canadian average—in 2016, 19.6% of the population of these communities were seniors 65 years of age and older compared to 16.9% for the country as a whole.[121]

In 2016, 13.8% of the residents of these communities were First Nations people, Métis or Inuit compared to 4.9% of the population of Canada.[122] This proportion was highest in Saskatchewan (19%), Ontario (18%) and British Columbia (18%).

119 Statistics Canada, Environment, Energy and Transportation Statistics Division, 2018, special tabulation from the 2001 and 2016 Census of Population. Adjustments were made to account for changes in the census subdivision boundaries between census periods.

120 Statistics Canada, Environment, Energy and Transportation Statistics Division, 2018, special tabulation from the 2001 and 2016 Census of Population. Includes 2,726 census subdivisions (CSDs) not located in a census metropolitan area or census agglomeration for which the CSD boundary did not change significantly (under 10% change) over this period.

121 Statistics Canada, 2017, Population by broad age groups and sex, *2016 Census*, Catalogue no 98-402-X2016002, http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/hlt-fst/as/index-eng.cfm (accessed January 2, 2018).

122 Statistics Canada, 2017, Aboriginal identity population by age and sex, *2016 Census*, Catalogue no 98-402-X2016009, http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/hlt-fst/abo-aut/index-eng.cfm (accessed January 2, 2018).

Labour force participation in forest sector-based communities was 61%, slightly lower than the Canada-average of 65%, while the unemployment rate was 11.4% compared to a rate of 7.7% overall.[123] Service-producing industries accounted for 58% of the labour force in forest sector-based communities compared to 77% nationally. The proportion of the labour force working in goods-producing industries meanwhile, at 41%, was double the national average.[124] The average employment income in these communities was $40,090, 13% lower than the national average of $46,060.[125]

The proportion of adults aged 25 to 65 with a college or university-level education was lower than the Canadian average—32% of those in forest sector-based communities compared to 54% overall, while the percentage of those with no certificate, diploma or degree was 21% compared to 11% nationally.[126] However, the level of apprenticeship or trades certificate or diploma was 19% compared to 11% nationally.

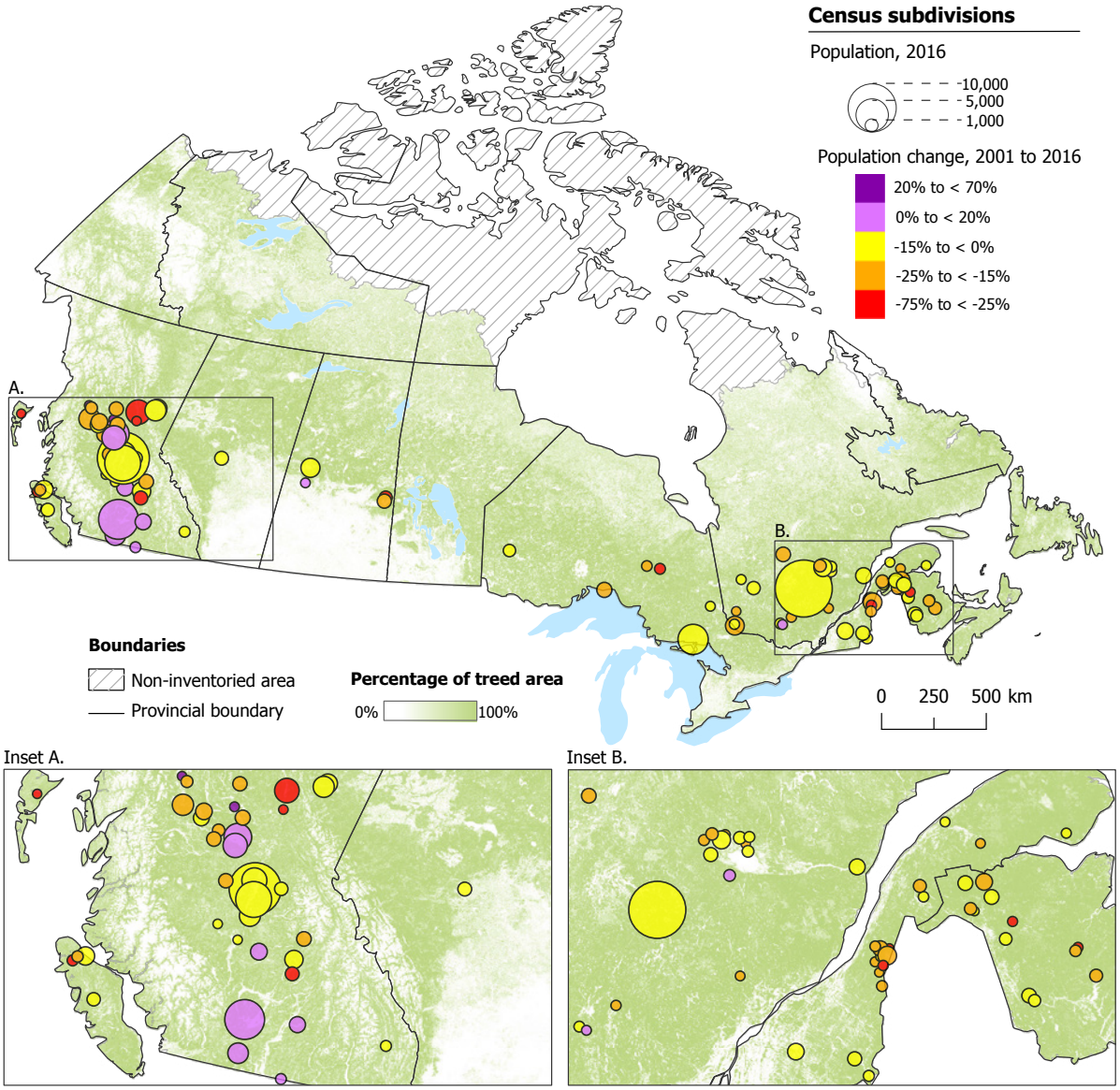
123 Statistics Canada, 2017, *Census Profile*, 2016 Census, http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E (accessed January 2, 2018).

124 Labour force by industry is not applicable for unemployed persons who had never been self-employed or worked for pay or who had last worked prior to January 1, 2015.

125 Average employment income of recipients in 2015 for persons aged 15 years and over in private households.

126 Statistics Canada, 2017, Census Profile, *2016 Census*, http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E (accessed January 2, 2018).

Map 2.7
Population size and variation of 2016 forest sector-based communities, 2001 to 2016



Notes: This map displays population size and variation for census subdivisions (CSDs) for which the forest sector is a major source of employment income–defined by Natural Resources Canada as 20% or more of total CSD income excluding government transfers. Data from the 2016 Census of Population were used to identify the 105 CSDs represented on this map. Adjustments were made to account for changes in the CSD boundaries between census periods. Some data were suppressed for data quality reasons or to meet the confidentiality requirements of the Statistics Act. Income data were available for 3,675 of 5,162 CSDs. This analysis may therefore underreport the total number of communities for which the forest sector is a major economic driver. Note that a decline in the percentage of forest sector income may be due to a decrease in forest sector income or an increase in income from other sources. The reference period for income data is the calendar year prior to the census. The forest sector includes North American Industry Classification codes 113 – forestry and logging, 1153 – support activities for forestry and logging, 321 – wood product manufacturing and 322 – paper product manufacturing. The map also provides a visual representation of the distribution of treed area.

Sources: Statistics Canada, Environment, Energy and Transportation Statistics Division, 2018, special tabulation from the 2001 and 2016 Census of Population; Natural Resources Canada, Canadian Forest Services, Economic Analysis Division; Canada's National Forest Inventory, 2016, Grouped kNN Map layers, http://tree.pfc.forestry.ca (accessed April 7, 2017).

2.4 Forest management

Forest sector activities, like other natural resource activities, can have a range of impacts on the environment. For example, harvesting and the loss of mature tree cover alters wildlife habitat and can affect biodiversity, runoff and erosion if not well managed (see Textbox 2.3 for more information).

Canada's publicly-owned forests—which make up 94% of Canada's forest area[127]—are managed according to the principles of sustainable forest management to ensure forests maintain their environmental, economic and social benefits over the long-term. Forest management planning has evolved—important considerations now include how forest practices can be designed to better mimic the natural disturbances that occur in forests and the best ways to protect biodiversity.[128]

Harvesting and regeneration

In 2015, Canada harvested 7,796 km^2 of forest, which accounted for 0.2% of Canada's 3.47 million km^2 of forest area. In forests managed for timber production, harvesting and regeneration practices are timed to produce a steady and sustainable forest yield resulting in harvesting occurring in different areas as forests mature (Map 2.8).

Harvesting on publicly-owned land is monitored through regular audits of forest management plans that outline approved harvesting amounts. Acts and regulations stipulate the forest area eligible for harvest, reforestation requirements after harvesting, required buffers or reserves around waterways and riparian areas, and preservation of wildlife habitat.[129] In 2015, 90% of all harvesting—7,032 km^2—took place on provincial Crown lands (Chart 2.18). Most of the remaining harvested area occurred on private lands, with a very small amount coming from federal and territorial land.

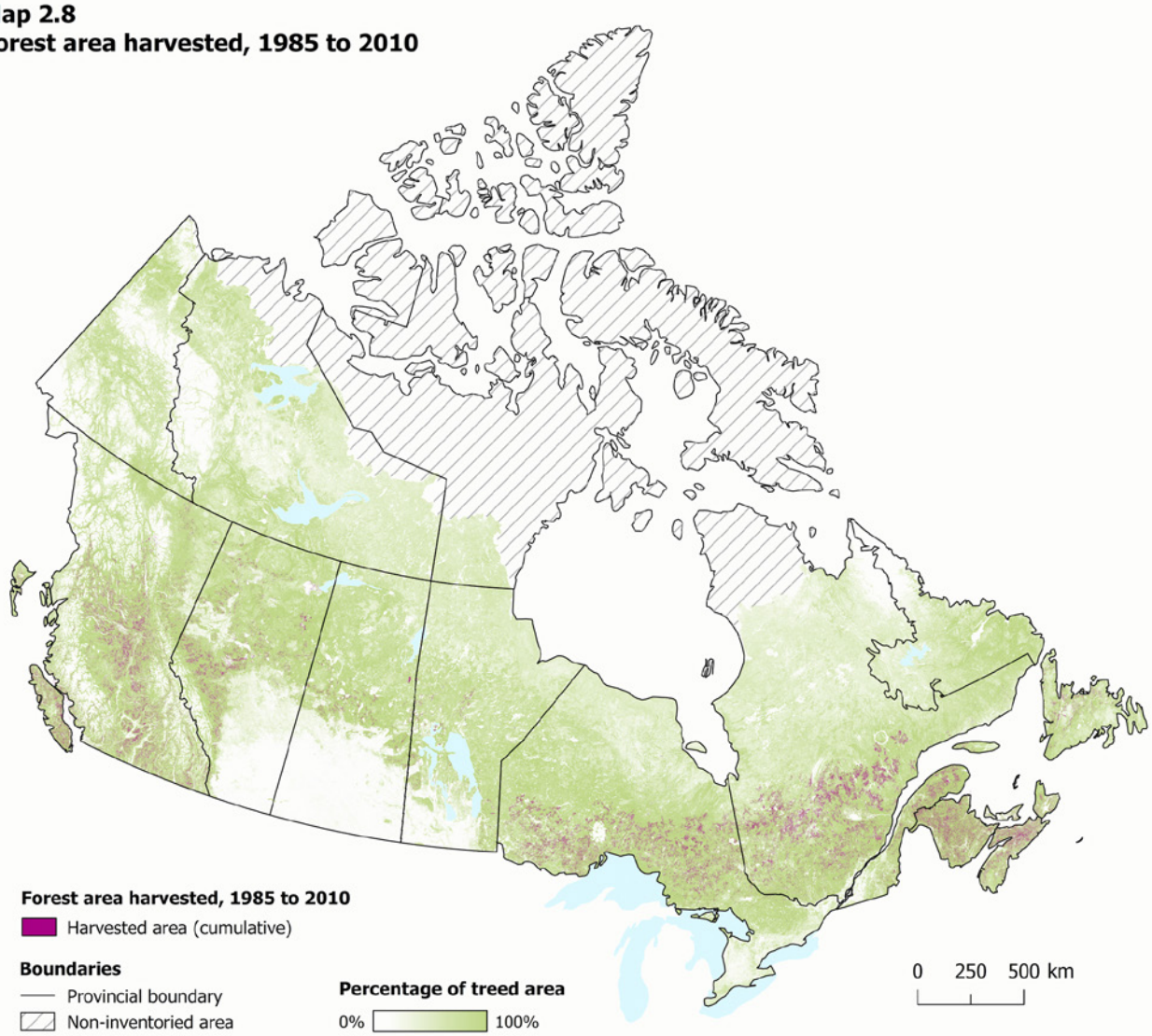
Trends in harvested area have changed over time (Chart 2.19). Canada's total harvested area dropped 42% from 10,568 km^2 in 2005 to 6,132 km^2 in 2009 and has not since completely recovered to previous levels (Table 2.10). Quebec had on average the highest harvested area from 1975 to 2015, accounting for 30% of Canada's harvested area, followed by Ontario at 22% and British Columbia at 21%. However, Quebec and Ontario experienced the largest declines in harvested area over the past decade. Harvested areas were 2,021 km^2 and 1,317 km^2 respectively in 2015. In British Columbia, the harvested area was 1,926 km^2 in 2015, more consistent with levels over the long term.

127 Natural Resources Canada, 2017, "Forest Land Ownership," *Forestry in Canada*, http://www.nrcan.gc.ca/forests/canada/ownership/17495 (accessed June 5, 2017).

128 Natural Resources Canada, 2016, "Forest management and natural disturbances research," *Fire, Insects and Disturbances*, http://www.nrcan.gc.ca/forests/fire-insects-disturbances/emulation/13187 (accessed June 30, 2017); North, M.P. and W.S. Keeton, 2008, "Chapter 17 Emulating natural disturbance regimes: an emerging approach for sustainable forest management," *Patterns and Processes in Forest Landscapes*, R. Laforezza, et al. (eds.), p. 341–372, https://www.fs.fed.us/psw/publications/north/psw_2008_north002.pdf (accessed July 4, 2017).

129 British Columbia, Ministry of Forests, Mines and Lands, 2010, *The State of British Columbia's Forests*, Third Edition, p. 99, https://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/reporting/envreportbc/archived-reports/sof_2010.pdf (accessed June 5, 2017); Canadian Council of Forest Ministers, n.d., "Always Changing: Canada's Boreal Forest," *Fact Sheet*, http://www.sfmcanada.org/images/Publications/EN/Boreal_Forests_EN.pdf (accessed June 9, 2017).

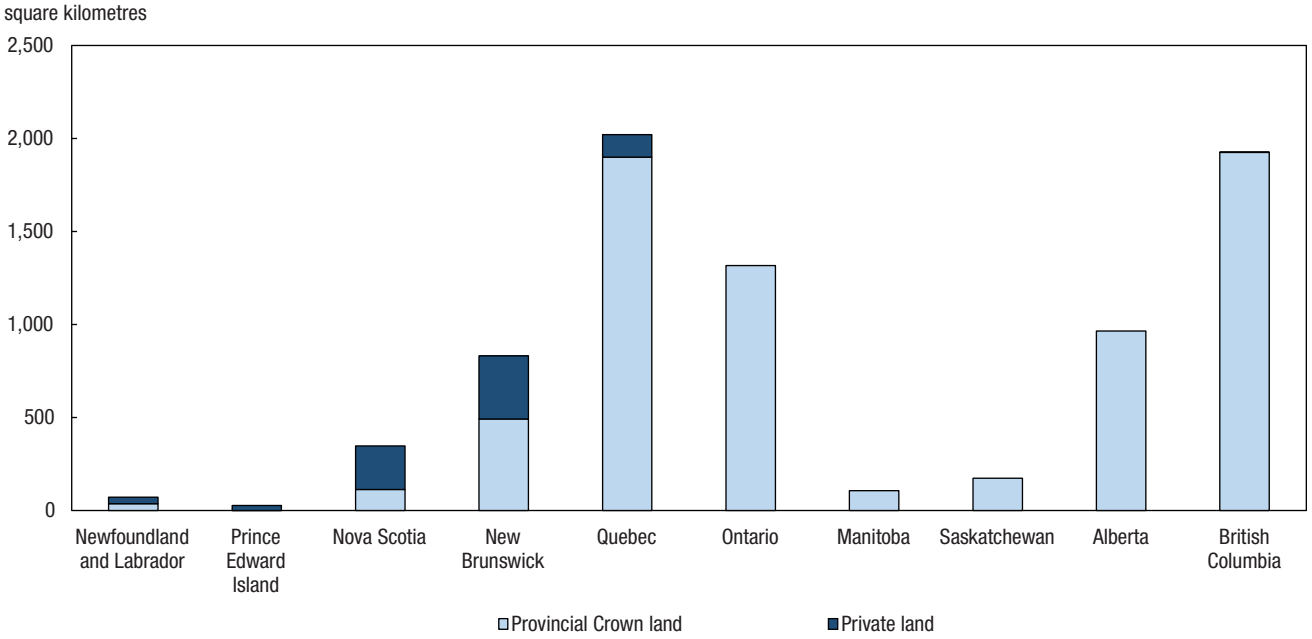
Map 2.8
Forest area harvested, 1985 to 2010



Notes: This map displays the cumulative forest area harvested between 1985 and 2010. Harvested areas are normally replanted or allowed to regenerate naturally and will therefore be in varying phases of succession. Data are derived from time series Landsat data with a 30 metre spatial resolution. The map also provides a visual representation of the distribution of treed area.

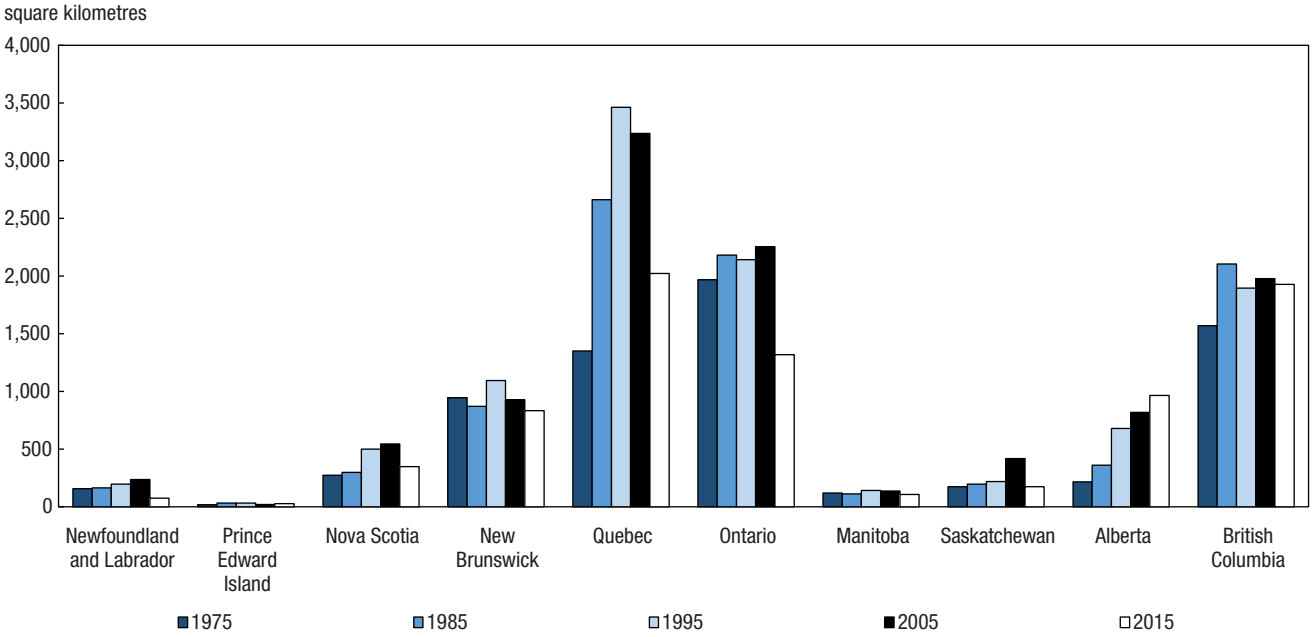
Sources: White, J.C., et al., 2017, "A nationwide annual characterization of 25 years of forest disturbance and recovery for Canada using Landsat time series," *Remote Sensing of Environment*, Vol. 192, p. 303–321, https://doi.org/10.1016/j.rse.2017.03.035, Data downloaded from https://opendata.nfis.org/mapserver/nfis-change_eng.html (accessed July 22, 2017); Canada's National Forest Inventory, 2016, Grouped *k*NN Map layers, http://tree.pfc.forestry.ca (accessed April 7, 2017); Statistics Canada, Environment, Energy and Transportation Division, 2018.

Chart 2.18
Forest area harvested by ownership and by province, 2015



Notes: Harvest data for the Territories and Federal land are not included in this chart. The total harvest area including the Territories and Federal land is 7,796 km².
Source: National Forestry Database, 2017, Table 6.2 Area harvested by ownership, harvesting method, and province/territory, http://nfdp.ccfm.org/silviculture/national_e.php (accessed July 19, 2017).

Chart 2.19
Forest area harvested by province at ten year increments, 1975 to 2015



Notes: Data are presented as a snapshot of the annual harvested area at ten-year increments. Harvest data for the Territories are not included in this chart.
Source: National Forestry Database, 2017, Table 6.1 Silvicultural Statistics by Province/Territory, http://nfdp.ccfm.org/silviculture/national_e.php (accessed July 19, 2017) and Create Your Own Report, http://nfdp.ccfm.org/dynamic_report/dynamic_report_ui_e.php (accessed July 19, 2017).

Table 2.10
Forest area harvested by province and territory, 1975 to 2015

	Newfoundland and Labrador	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Yukon	Northwest Territories[3]	Nunavut	Canada
	square kilometers													
1975	157[1]	16[1]	273	944[1]	1,351[2]	1,968[2]	120[r]	175	217	1,570[2]	6[2]	7	..	6,803[r]
1976	147[1]	16[1]	263	928[1]	1,817[2]	1,567[2]	170[1]	169	215	1,760[2]	6[2]	4	..	7,061[1]
1977	143[1]	16[1]	283	865[1]	1,933[2]	1,880[2]	180[1]	162	224	1,661[2]	7[2]	7	..	7,361[1]
1978	176[1]	16[1]	321	892[1]	2,261[2]	1,950[2]	200[1]	211	256	1,965[2]	9[2]	7	..	8,265[1]
1979	177[1]	18[1]	337	1,000[1]	2,418[2]	2,186[2]	246[1]	251	260	1,875[2]	3	6	..	8,778[1]
1980	152	25[1]	364[1]	859[1]	2,450[2]	2,427[2]	155[r]	169	323	1,878[2]	1	7	..	8,810[r]
1981	135	27[1]	364[1]	655[1]	2,500[2]	2,276[2]	119[r]	183	313	1,479[2]	0	9	..	8,060[r]
1982	80	27[1]	357[1]	724[1]	1,950[2]	2,229[2]	99[r]	158	376	1,622[2]	0	4	..	7,627[r]
1983	139	25[1]	207[2]	816[1]	2,721[2]	1,832[2]	100[r]	197	456	1,882[2]	3	9	..	8,387[r]
1984	176	25[1]	306[2]	830[1]	2,807[2]	2,178[2]	112[r]	219	323	1,985[2]	6	11	..	8,977[r]
1985	164	32[1]	298[2]	871[1]	2,662[2]	2,180[2]	113[r]	197	362	2,104[2]	1	10	..	8,992[r]
1986	174	24	341[2]	869	2,976[2]	2,235[2]	111	194	416	2,399[2]	3	4	..	9,746[2]
1987	189	27	423[2]	890	3,293[2]	2,285[2]	124	257	435	2,600[2]	12	7	..	10,541[2]
1988	196	27	414[2]	992	3,377[2]	2,372[2]	124	221	501	2,704[2]	5	4	..	10,937[2]
1989	194	24	367[2]	901	3,422[2]	2,303[2]	122	223	468	2,184[2]	16	5	..	10,230[2]
1990	221[1]	25[1]	399[1]	889[1]	2,620	2,382	103	165	519	1,815	4[1]	5	..	9,148[1]
1991	190	23[r]	382[1]	898[1]	2,390[1]	1,997	85	175	523	1,937[1]	4[1]	4	..	8,608[r]
1992	186	28[r]	348[1]	998[1]	2,629	1,907	114	185	556	2,216	6[1]	5	..	9,177[r]
1993	211	31[r]	436[1]	978[1]	2,932	2,094[r]	110	195	581	2,077	6[1]	6	..	9,657[r]
1994	196	32[r]	491	928[1]	3,278	2,115[r]	127	242	775	1,902	21[1]	5[1]	..	10,112[r]
1995	197	32[r]	500	1,093[1]	3,463	2,141[r]	142	219	680	1,896	8	7[1]	..	10,377[r]
1996	176	28[1]	591	1,146[1]	3,423	2,132[r]	153	214	713	1,990	19[1]	4	..	10,591[r]
1997	200[1]	43[r]	698	1,159[1]	3,844	2,093[r]	155	175[1]	719	1,738[r]	15[1]	6	..	10,844[r]
1998	174[1]	44[r]	542	1,169[1]	3,699	2,251	166	212[1]	711	1,761	5[r]	6[1]	..	10,740[r]
1999	227	58[r]	497[1]	1,105[1]	3,702	2,077	155	212[1]	792	1,763	6[r]	2[1]	..	10,597[r]
2000	232[p]	55[r]	544	1,134[1]	3,441	2,133[r]	156	212[1]	735	2,045	0[1]	0[1]	..	10,688[r]
2001	230[r]	49[1]	532[r]	1,035[1]	3,236	2,206[r]	148	232	794	1,691	0[1]	0[1]	..	10,153[r]
2002	220	46[1]	497[1]	986[1]	3,391	1,949	150	251[1]	820	1,678[r]	0[1]	0[1]	..	9,988[r]
2003	221	58[1]	529[1]	1,000[1]	2,846	2,312[r]	156	291	797	1,741	0[1]	0[1]	..	9,951[r]
2004	229	55[1]	596[1]	983[1]	3,063[p]	2,102	175	292	800	1,810	0	1	..	10,106[1]
2005	237[1]	20[1]	544[1]	928[1]	3,236[p]	2,252	136	418	819	1,976	0[1]	1[1]	..	10,568[1]
2006	173[1]	22[1]	440[1]	772[1]	2,161	2,119	136[1]	154	747	1,623	2[1]	1[1]	..	8,350[1]
2007	170[1]	21[1]	440[1]	722[1]	2,105	1,840	136[1]	146	678	1,683	2[1]	1[1]	..	7,945[1]
2008	170[1]	21[1]	453[1]	722[1]	1,623	1,587	137[1]	131[1]	650	1,446	2[1]	1[1]	..	6,944[1]
2009	170[1]	24[1]	387[1]	631[1]	1,535[p]	1,240	136[1]	79	701	1,226	3[1]	1[1]	..	6,132[1]
2010	170[1]	29[1]	410[1]	715[1]	2,014[r]	1,001	...	97[1]	767	1,680	3[1]	1[1]	..	6,886[r]
2011	171[1]	29[1]	344[1]	593	1,679[p]	1,209	76[1]	148[1]	778	1,746	3[1]	1[1]	..	6,776[1]
2012	60[1]	33[1]	302[1]	578[1]	2,055[p]	1,154	90[1]	146	797	1,889	3[1]	1[1]	..	7,108[1]
2013	59[1]	26[1]	291[1]	696	2,068[1]	1,249[1]	91[1]	177[1]	827	1,970[r]	3[1]	2[1]	..	7,458[r]
2014	70	28[1]	322[1]	721	2,059[1]	1,172	107[1]	174[p]	815[r]	1,672	3[1]	2[1]	..	7,145[r]
2015	74	28[1]	348[1]	833	2,021[1]	1,317[1]	107[1]	174[1]	965[p]	1,926	2[1]	2[1]	..	7,796[1]

.. not available for a specific reference period
... not applicable
[p] preliminary
[r] revised
1. Estimated by provincial or territorial forestry agency.
2. Estimated by the Canadian Forest Service or by Statistics Canada.
3. As of 1990, figures include provincial and private lands and federal land.

Source: National Forestry Database, 2017, Table 6.1 Silvicultural Statistics by Province/Territory, http://nfdp.ccfm.org/silviculture/national_e.php (accessed July 19, 2017) and Create Your Own Report, http://nfdp.ccfm.org/dynamic_report/dynamic_report_ui_e.php (accessed July 19, 2017).

Harvesting methods

There are a number of different harvesting methods in use corresponding to different silviculture systems that cover aspects of harvesting, regenerating and tending forests.[130] Even-aged management systems including clearcutting, shelterwood and seed tree harvesting are the most widely used—they accounted for 94% of Canada's total harvested forest area in 2015 (Chart 2.20).

Clearcutting typically involves harvesting all trees in an area, although there are several variants in how it may be carried out and practices have evolved in recent decades to reduce environmental impacts and aesthetics concerns. For example cutblocks may be in strips, blocks, patches or may follow natural boundaries and reserves and uncut trees may be left in riparian areas and for wildlife habitat.[131]

In 2015, clearcutting was used to harvest 6,608 km^2 of forest—85% of the total harvested area in Canada. This practice is often the most economic and efficient and it can mimic the role of fire by providing open areas that promote regeneration.[132]

Shelterwood harvesting is a partial cutting method that leaves an overstorey of trees to protect or shelter regrowth.[133] Of the total forest area harvested in 2015, shelterwood methods were used for 644 km^2 (8%). Seed tree harvesting, which involves leaving a supply of trees as a source of seed for natural regeneration, was used to harvest 27 km^2—less than 1% of harvested area—in 2015.

Selection harvesting involves harvesting single mature or small groups of trees resulting in uneven-aged stands. This type of harvesting can be suitable for species that can become established in shade.[134] In 2015, selection practices were used to harvest 221 km^2, 3% of the total harvested area.

Commercial thinning is a stand tending practice that is used to provide growing space and reduce mortality that can be as high as 30% of total volume production.[135] However, due to high logging cost, low stumpage fees, and unsuitable tree stands and species, little commercial thinning is currently being done in Canada.[136] Commercial thinning occurred on 3% of harvested land in 2015. It was more commonly used on privately-owned land—where it accounted for 16% of harvested area compared to 1% of Crown land.[137]

In 2015, British Columbia and Quebec accounted for half of the total area harvested by clearcutting. Quebec also accounted for nearly three-quarters (73%) of shelterwood harvesting, while selection harvesting was used most in Ontario, Quebec and New Brunswick.

130 Government of Ontario, 1999, "Choosing a silviculture system," *Extension Notes*, http://www.lrconline.com/Extension_Notes_English/pdf/slvcltr.pdf (accessed June 15, 2017).

131 Canadian Council of Forest Ministers, n.d., "Growing Canada's Forests," *Factsheet*, www.sfmcanada.org/images/Publications/EN/Growing_Canadas_Forests_EN.pdf (accessed July 4, 2017).

132 Ilisson, T. and H.Y.H Chen, 2009, "Response of six boreal tree species to stand replacement fire and clearcutting," *Ecosystems*, p. 820–829, https://link.springer.com/article/10.1007/s10021-009-9259-z (accessed July 4, 2017).

133 British Columbia, Ministry of Forests, Lands and Natural Resource Operations, 1999, "Even-aged silviculture systems," *Introduction to Silvicultural Systems*, https://www.for.gov.bc.ca/hfp/training/00014/evenage.htm (accessed June 15, 2017).

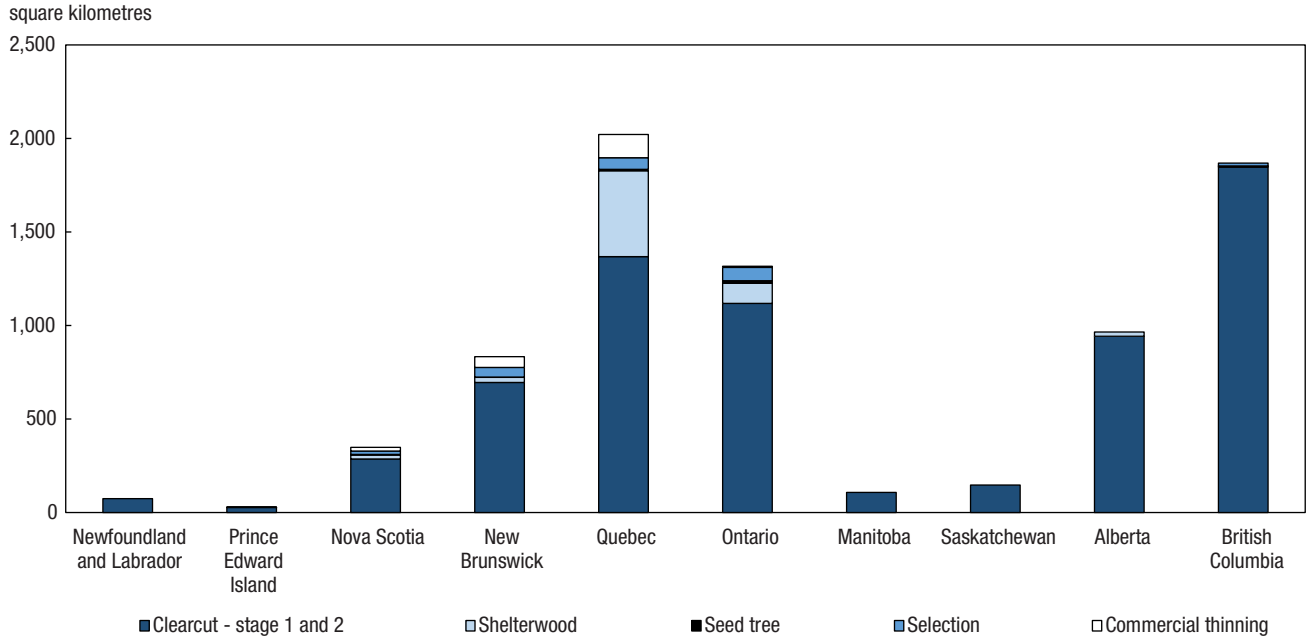
134 British Columbia, Ministry of Forests, Lands and Natural Resource Operations, 1999, "Uneven-aged silviculture systems," *Introduction to Silvicultural Systems*, https://www.for.gov.bc.ca/hfp/training/00014/uneven.htm (accessed June 15, 2017); Canadian Council of Forest Ministers, n.d., "Growing Canada's Forests," *Factsheet*, http://www.sfmcanada.org/images/Publications/EN/Growing_Canadas_Forests_EN.pdf (accessed July 4, 2017).

135 Natural Resources Canada, Canadian Forest Services, 1995, *Silviculture Terms in Canada*, Ottawa, http://nfdp.ccfm.org/terms/intro_e.php#ct (accessed May 16, 2017).

136 Natural Resources Canada, Canadian Forest Services, 1995, *Silviculture Terms in Canada*, Ottawa, http://nfdp.ccfm.org/terms/intro_e.php#ct (accessed May 16, 2017).

137 National Forestry Database, 2017, Table 6.2 Area harvested by ownership, harvesting method and province/territory, http://nfdp.ccfm.org/silviculture/national_e.php (accessed July 19, 2017).

Chart 2.20
Forest area harvested by method and by province, 2015



Notes: Harvest data for the Territories are not included in this chart. The type of harvesting method is unspecified for a small amount of the harvest area.
Source: National Forestry Database, 2017, Table 6.2 Area harvested by ownership, harvesting method, and province/territory, http://nfdp.ccfm.org/silviculture/national_e.php (accessed July 19, 2017).

Regeneration methods

As part of sustainable forest management, regeneration objectives that correspond with harvesting operations are outlined and approved by provincial and territorial governments before licenses or supply agreements are granted.[138] Artificial regeneration methods are used where natural regeneration will not result in a healthy and abundant forest stock after harvesting, fire or insect attack.

In 2015, over 574 million seedlings were planted on 4,134 km^2 of forest. British Columbia planted the highest number of seedlings—222 million on over 1,709 km^2 of planted area, followed by Quebec with 125 million seedlings on 1,011 km^2 and Alberta with 92 million seedlings on its 628 km^2 of planted area (Chart 2.21).

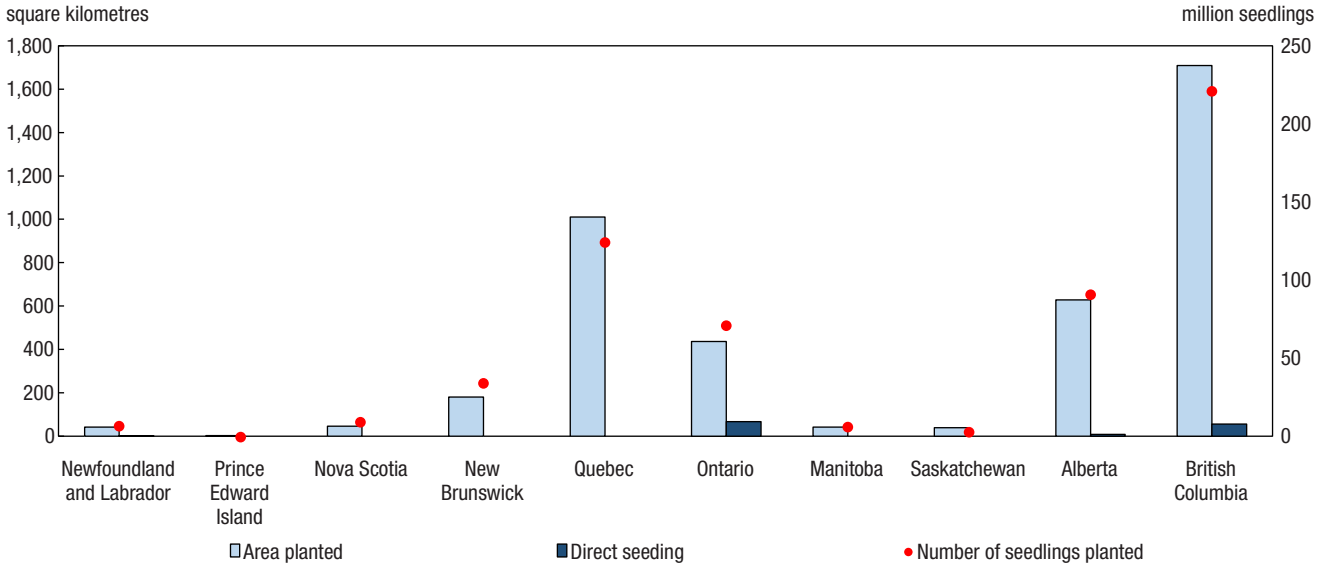
Direct seeding—including ground and aerial re-seeding—was used to regenerate 131 km^2.[139] Direct seeding is often less costly, but can result in variable stocking rates.[140] The use of direct seeding was highest in Ontario covering 67 km^2, followed by British Columbia at 55 km^2.

138 Natural Resources Canada, 2017, "Forest Management Planning," *Forestry in Canada*, http://www.nrcan.gc.ca/forests/canada/planning/17493 (accessed June 7, 2017).

139 National Forestry Database, 2017, Table 6.6 Area of Direct Seeding by Ownership and Province/Territory, http://nfdp.ccfm.org/silviculture/national_e.php (accessed July 19, 2017).

140 Adams, M.J. et al., 2005, *Direct Seeding Black Spruce and Jack Pine: A Field Guide for Northern Ontario*, Natural Resources Canada, Canadian Forest Service, Sault Ste. Marie, Ontario, http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/26195.pdf (accessed July 19, 2017).

Chart 2.21
Area planted, area of direct seeding and number of seedlings planted by province, 2015



Notes: Planting and seeding data for the Territories are not included.
Source: National Forestry Database (NFD), 2017, Table 6.6 Area of direct seeding by ownership and province/territory, http://nfdp.ccfm.org/data/compendium/html/comp_66e.html (accessed July 19, 2017); NFD, 2017, Table 6.7 Area planted by ownership, species, and province/territory, http://nfdp.ccfm.org/data/compendium/html/comp_67e.html (accessed July 19, 2017); NFD, 2017, Table 6.8 Number of seedlings planted by ownership, species, and province/territory, http://nfdp.ccfm.org/data/compendium/html/comp_68e.html (accessed July 19, 2017).

Textbox 2.3 Environmental impacts associated with the forest sector

Canada's forests experience a variety of impacts from forest operations including logging and other management practices. Harvesting, road construction for logging, prescribed burning and chemical use in plantation management can influence forest ecosystems. Wood product and pulp and paper manufacturing have other environmental impacts, including air pollutant and effluent emissions. As well, the use of wood and harvest residues for energy production can also have an effect on air quality and also on greenhouse gas emissions, although this latter effect may be positive where wood is substituted for fossil fuels.[141]

In recent decades, provincial and federal acts, regulations and standards have been revised to ensure appropriate practices are used to minimize impacts from forest operations. For example, British Columbia's *Forest and Range Practices Act* requires forest stewardship plans that describe plans for cutblocks, roads and reforestation, with objectives and specific requirements set for soils, timber, wildlife and biodiversity, riparian areas, fisheries-sensitive watersheds, visual quality and cultural heritage under the Forest Planning and Practices Regulation.[142]

In addition, the forest sector—logging, wood product and paper manufacturing industries—spent $659.2 million on environmental protection in 2014.[143] For example, spending covered waste management and sewerage, pollution abatement and control and pollution prevention processes. Operating expenditures were the largest portion of these expenditures 83% ($545.6 million) with capital expenditures accounting for 17% ($113.6 million). The paper manufacturing industry was responsible for 74% of forest sector expenditures on environmental protection.

141 Smyth, C., et al., 2017, "Climate change mitigation potential of local use of harvest residues for bioenergy in Canada," *Global Change Biology, Bioenergy*, Volume 9, p. 817–832, https://doi.org/10.1111/gcbb.12387 (accessed September 22, 2017).

142 Province of British Columbia, *Forest and Range Practices Act*, Forest Planning and Practices Regulations, B.C. Reg. 14/2004, Consolidated to June 27, 2017, Queens Printer, Victoria, British Columbia, http://www.bclaws.ca

143 Statistics Canada, CANSIM Table 153-0052, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1530052&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid= (accessed November 30, 2017).

Textbox 2.3 continued

Impacts associated with forest management and logging

Timber harvesting and the removal of forest vegetation can have a large influence on forest ecosystems. Removing forest vegetation can have a variety of environmental impacts such as reduced infiltration of water into soils and increased runoff resulting in changes in streamflow, water levels and water quality.[144] Increased soil erosion can result in sedimentation of streambeds, affecting fish habitat.[145]

The creation of forestry access roads can have a number of effects including soil compaction, disturbance of streams and impeded fish passage.[146] They can also have effects at the landscape level—roads fragment the landscape into smaller parcels, which can have effects on the size and quality of wildlife habitat.[147] Roads also create new access routes for recreational vehicles and may help the spread of predators and invasive species.[148] From 1990 to 2015, almost 750 km^2 of forest land was permanently converted to forestry roads.[149] Unpaved roads were responsible for about one-third of total emissions of particulate matter in Canada in 2015.[150]

Changes in landscape and forest composition that occur in response to forestry practices will have different effects for different species—positive for some and negative for others. For instance, certain species of trees grow better in the open conditions provided after harvesting. Some populations of animals, including snowshoe hare thrive in open conditions, whereas others like woodland caribou prefer continuous tracts of mature forest land.[151] Changes in the number and type of tree species may affect the biological diversity of forest ecosystems.[152]

Other silviculture practices include treating harvested sites to improve the success of tree regeneration. These practices include mechanical treatment to scatter or break-up slash and prepare soil; prescribed burning to remove underbrush and dead wood; and chemical treatment to help regenerate forest areas. In 2015, mechanical treatment was used on 1,805 km^2, prescribed burning—including burning for ecological restoration—was used on 112 km^2,[153] herbicides were used on 90 km^2, and mixed or other methods were used to prepare 74 km^2 of forest area.[154]

144 Natural Resources Canada, 2013, *Water Issues and Forests*, http://www.nrcan.gc.ca/plans-performance-reports/sustainable-development/freshwater/581 (accessed July 30, 2017).

145 Zimmerman, R.C., 1992, "Environmental impact of forestry," *FAO Conservation Guide 7*, FAO Forestry Department, Forest Resources Division, http://www.fao.org/docrep/t0550e/t0550e00.htm (accessed July 30, 2017).

146 British Columbia, Ministry of Forests, Mines and Lands, 2010, *The State of British Columbia's Forests*, Third Edition, p. 95–103, https://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/reporting/envreportbc/archived-reports/sof_2010.pdf (accessed June 5, 2017).

147 British Columbia, Ministry of Forests, Mines and Lands, 2010, *The State of British Columbia's Forests*, Third Edition, p. 59, https://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/reporting/envreportbc/archived-reports/sof_2010.pdf (accessed June 5, 2017); Ontario, Ministry of Natural Resources (OMNR), 2012, *State of Ontario's Forests*, p. 26, https://dr6j45jk9xcmk.cloudfront.net/documents/4572/stateofontforests-en-aoda.pdf (accessed July 6, 2017).

148 British Columbia, Ministry of Forests, Mines and Lands, 2010, *The State of British Columbia's Forests*, Third Edition, p. 59, https://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/reporting/envreportbc/archived-reports/sof_2010.pdf (accessed June 5, 2017); Mosquin, T., P.G. Whiting and D.E. McAllister, 1995, *Canada's Biodiversity: The Variety of Life, Its Status, Economic Benefits, Conservation Costs and Unmet Needs*, Canadian Centre for Biodiversity, Canadian Museum of Nature, Ottawa.

149 Natural Resources Canada, Canadian Forest Service, special tabulation from Canada's National Deforestation Monitoring System, May 12, 2017. Note that according to the OMNR, short term operational roads account for about 90% of forest access roads. Natural Resources, 2012, *State of Ontario's Forests*, p. 27, https://dr6j45jk9xcmk.cloudfront.net/documents/4572/stateofontforests-en-aoda.pdf (accessed July 6, 2017).

150 Environment and Climate Change Canada, 2017, *Air Pollutant Emission Inventory (APEI) Report*, https://ec.gc.ca/pollution/default.asp?lang=EN&n=A17452DA-1 (accessed June 30, 2017).

151 Natural Resources Canada, 2016, "Transcript" *Boreal biodiversity*, http://www.nrcan.gc.ca/forests/video/13601 (accessed May 2, 2017).

152 British Columbia, Ministry of Forests, Mines and Lands, 2010, *The State of British Columbia's Forests*, Third Edition, p. 74–91, https://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/reporting/envreportbc/archived-reports/sof_2010.pdf (accessed June 5, 2017).

153 Approximately 60% of prescribed burning occurs in parks for ecological restoration purposes.

154 National Forestry Database, 2017, Table 6.4 Area of Site Preparation by Ownership, Treatment and Province/Territory, http://nfdp.ccfm.org/silviculture/national_e.php (accessed July 30, 2017).

Textbox 2.3 continued

While these practices improve seedling growth and survival, they can have other impacts—for example, prescribed burning releases air pollutants,[155] although these emissions are a small fraction of those from wildfires. Use of pesticides and fertilizers can also have impacts on water quality and habitat, though some impacts are mitigated through the use of buffer zones around water bodies.[156]

Other environmental impacts from the forest sector

Overall, the forest sector, including the forestry and logging, wood product and paper manufacturing industries, was responsible for 4% of total water use in 2013.[157] The paper manufacturing industry was responsible for the vast majority of the sector's water withdrawals. Water intake for paper manufacturing was 1,537 million m^3 of which 1,481 million m^3 were discharged back into water bodies after use.[158]

The industry is regulated by the Pulp and Paper Effluent Regulations, which sets out requirements on the biochemical oxygen demand, total suspended solids and toxicity of effluent. In 2013, 82% of wastewater received secondary water treatment or higher and 3% received primary water treatment before being released.[159] Almost all effluent samples met regulatory requirements in 2014, a major improvement since the mid-1980s.[160]

Greenhouse gas (GHG) emissions associated with the forest sector totalled 39,931 kt in 2015, 5% of total industrial and household emissions.[161] Paper manufacturing industries were responsible for 74% of the sector's GHG emissions.

Forest management certification

Certification programs assess forest practices against internationally recognized standards for sustainable forest management. The standards address timber harvesting practices, but also issues related to biodiversity, wildlife habitat and soil, water and air quality.[162]

Under these programs, forest management practices are audited by an independent third-party. Systems are audited annually and findings are disclosed to the public.[163] Many world buyers only accept certified timber products and companies that meet certification requirements are able to use a product mark indicating that they have met the standards.[164] Canada has 37% of the world's certified forests—the largest area of any country.[165]

155 Environment and Climate Change Canada, 2016, *1990-2015 Air Pollutant Emission Inventory Report*, Catalog no. En81-26E-PDF, p. 31, http://www.ec.gc.ca/pollution/A17452DA-CFC0-4222-985F-36B12FCBAA0B/APEI2017-E-Feb%2015%202017.pdf (accessed May 17, 2017).

156 Pike, R. G., et al., 2010, "Chapter 12: Water quality and forest management," *Compendium of Forest Hydrology and Geomorphology in British Columbia*, Land Management Handbook, R.G. Pike et al. (eds.), Vol 1, p. 426–429, https://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh66/ (accessed June 6, 2017).

157 Statistics Canada, CANSIM Table 153-0116, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1530116&&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid=#F5 (accessed June 16, 2017). Physical flow accounts record the annual flows of natural resources, products and residuals between the Canadian economy and the environment. Data are presented to reflect the activities of industries, households and governments, and follow the classification system used in Statistics Canada's input-output accounts. These data are available at the national level only. They cover water withdrawals by industry and households and do not include rain fed water use in agriculture or forestry.

158 Statistics Canada, CANSIM Table 153-0047, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1530047&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid= (accessed June 30, 2017).

159 Statistics Canada, CANSIM Table 153-0072, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1530072&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid= (accessed June 30, 2017).

160 Environment and Climate Change Canada, 2016, *Canadian Environmental Sustainability Indicators: Managing pulp and paper effluent quality in Canada*, http://www.ec.gc.ca/indicateurs-indicators/E20C2E23-FC6C-457F-B760-8B8D2CE4DC0D/ManagingPulpPaperEffluentQuality_EN.pdf (accessed July 4, 2017).

161 Statistics Canada, CANSIM Table 153-0114, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1530114&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid= (accessed December 13, 2017). Note that these Greenhouse Gas Account data follow the methodological guidelines of the United Nations System of Environmental-Economic Accounting. The totals differ from those reported in the *National Inventory Report on Greenhouse Gas Sources and Sinks*.

162 Canadian Council of Forest Ministers, n.d., "Making the Case for Sustainable Forest Management Certification," *Fact Sheet*, http://www.sfmcanada.org/images/Publications/EN/Sustainable_Forest_Management_Certification_EN.pdf (accessed June 8, 2017).

163 Canadian Council of Forest Ministers, 2017, "Sustainable Forest Management in Canada," *Canada: Embracing Third-Party Forest Certification*, http://www.sfmcanada.org/en/sustainable-forest-management/embracing-third-party-certification (accessed May 17, 2017).

164 Canadian Council of Forest Ministers, n.d., "Making the Case for Sustainable Forest Management Certification," *Fact Sheet*, http://www.sfmcanada.org/images/Publications/EN/Sustainable_Forest_Management_Certification_EN.pdf (accessed June 8, 2017).

165 Natural Resources Canada, 2017, "Forest certification in Canada," *Forestry in Canada*, http://www.nrcan.gc.ca/forests/canada/certification/17474 (accessed September 15, 2017).

In 2016, close to half of Canada's forests were certified through either the Canadian Standards Association, Forest Stewardship Council or Sustainable Forestry Initiative® Program (Table 2.11).

Certification has grown relatively quickly in Canada. In 1999, none of Canada's forest areas were part of a certified standard.[166] This rose to 860,000 km^2 of certified forest in 2004 and then to 1.5 million km^2 in 2010, reaching 1.68 million km^2 in 2016.[167] British Columbia had the largest amount of certified forest in 2016 with 519,534 km^2, followed by Quebec with 451,552 km^2 and Ontario with 267,889 km^2.

Although all three of Canada's certification programs promote principles that support sustainable forest management, the Sustainable Forestry Initiative® Program was the most commonly used.

Table 2.11
Sustainable forest management certification by province, 2016

	Sustainable Forestry Initiative® Program (SFI)	Forest Stewardship Council (FSC)	Canadian Standards Association (CSA)	Sum of area certified under sustainable forest management programs	Total certified area[1]
			square kilometres		
Newfoundland and Labrador	0	14,934	14,178	29,112	14,934
Prince Edward Island	0	0	0	0	0
Nova Scotia	12,374	5,943	0	18,316	13,087
New Brunswick	41,907	0	0	41,907	41,907
Quebec	265,511	240,838	0	506,348	451,552
Ontario	154,872	188,597	6,807	350,277	267,889
Manitoba	25,958	0	87,777	113,735	113,735
Saskatchewan	33,916	18,320	19,012	71,247	52,928
Alberta	117,473	59,128	25,809	202,410	202,410
British Columbia	240,002	13,991	265,541	519,534	519,534
Total	**892,011**	**541,750**	**419,125**	**1,852,886**	**1,677,974**

1. The total certified area does not double count areas that were certified through more than one of the three sustainable forest management (CSA, FSC, SFI) standards.
Note: Data for the area under sustainable forest management certification are provided by the certification programs.
Source: Certification Canada, n.d., Provincial Statistics: 2016 Year-end Statistics, http://certificationcanada.org/en/statistics/provincial-statistics/ (accessed May 9, 2017).

Protected areas

Establishing protected areas is an important part of nature conservation.[168] These areas are created to preserve exceptional natural settings, to provide recreation and tourism opportunities, to offer environments for study and education and to support wildlife habitat. The enjoyment they provide, both physical and visual, also result in indirect benefits for health and well-being.[169]

To meet the 2020 Biodiversity Goals and Targets, Canada has set a target to conserve "at least 17% of terrestrial areas and inland water"[170] through the use of protected areas and proven conservation techniques.[171] At the end of 2015, 1.05 million km^2 was protected area. This represented 10.6% of Canada's terrestrial land including inland water, an increase from 9.8% in 2011.[172]

Canada's protected forests are an important part of Canada's overall protected areas. In 2006, 240,410 km^2 or 7% of Canada's total forest area was protected. The Boreal Shield ecozone had the largest area of protected forests, accounting for 37% of Canada's total, followed by the Montane Cordillera (19%) and the Boreal Plains (15%) ecozones (Chart 2.22).

166 Certification Canada, *Statistics*, http://certificationcanada.org/en/statistics/ (accessed May 9, 2017).

167 Certification Canada, n.d., *Canadian Statistics*, http://certificationcanada.org/en/statistics/canadian-statistics/ (accessed May 9, 2017).

168 Statistics Canada, 2000, *Human Activity and the Environment 2000*, Catalogue no. 11-509-XPE.

169 Environment and Climate Change Canada, 2016, *Canadian Protected Areas Status Report 2012-2015*, p. 61, https://www.canada.ca/en/environment-climate-change/services/wildlife-habitat/publications/protected-areas-report-2012-2015.html (accessed February 28, 2018).

170 Biodiversity Canada, 2016, *2020 Biodiversity Goals and Targets for Canada*, http://biodivcanada.ca/default.asp?lang=En&n=9B5793F6-1 (accessed May 31, 2017).

171 Biodiversity Canada, 2016, *2020 Biodiversity Goals and Targets for Canada*, http://biodivcanada.ca/default.asp?lang=En&n=9B5793F6-1 (accessed May 31, 2017).

172 Environment and Climate Change Canada, 2016, *Canadian Protected Areas Status Report 2012-2015*, Catalogue no. En81-9/2016E-PDF, p. V, https://www.canada.ca/en/environment-climate-change/services/wildlife-habitat/publications/protected-areas-report-2012-2015.html (accessed February 28, 2018).

Most protected forests are publicly owned—provincial Crown forests accounted for 77% of the protected forest area in Canada, followed by federally-owned forests at 19%.[173] Federal lands had the highest percentage of forest land in protected areas at 84%, accounting for 45,208 km^2.

Protected area classifications are established by the International Union for Conservation of Nature (IUCN) and define levels of restriction for conserving and protecting areas.[174] Forests in category 1a/1b have the highest degree of protection, while those in category VI have the highest level of permitted environmental modification.[175]

In 2006, 60% of protected forest area was categorized as Category II (Chart 2.23). These areas mainly include conservation areas and large national, provincial and territorial parks, such as Parc National des Pingualuit in Quebec and Wood Buffalo National Park in Alberta and the Northwest Territories.[176] Public access and recreational activities are generally permitted,[177] but commercial extractions—such as harvesting—are not allowed.[178]

The next largest proportion of protected forest area—28%—was in Category Ib, which also includes provincial and territorial parks, as well as federal Migratory Bird Sanctuaries. These protected forests have little built infrastructure, although public access may be allowed—the focus is on maintaining the natural condition.[179]

The proportion of protected area was highest for older forests—for stands aged 181 to 200 years, 27% of the forest area was protected, followed by 18% for stands aged 161 to 180 years and 16% for stands aged over 200 years. The oldest protected forests were located most frequently in the West. More than three-quarters (76%) of protected forests aged 181 to 200 and close to half (49%) of those aged 161 to 180 years were found in the Montane Cordillera ecozone. Protected forests aged over 201 years were found mostly in the Pacific Maritime ecozone (39%), Montane Cordillera (37%) and Boreal Cordillera (24%).[180]

173 Canada's National Forest Inventory, 2013, Table 22.0 Area (1000 ha) of forest land by IUCN category and ownership in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 24, 2017).

174 Canadian Council of Ecological Area, 2008, "Canadian Guidebook: for the Application of IUCN Protected Area Categories," *CCEA Occasional Paper*, No. 18, p. 10, www.ccea.org/wp-content/uploads/2015/10/P18_Canadian-Guidebook-for-the-application-of-IUCN-protected-area-categories-2008-english.pdf (accessed May 31, 2017).

175 Canadian Council of Ecological Area, 2008, "Canadian Guidebook: for the Application of IUCN Protected Area Categories," *CCEA Occasional Paper*, No. 18, p. 10, www.ccea.org/wp-content/uploads/2015/10/P18_Canadian-Guidebook-for-the-application-of-IUCN-protected-area-categories-2008-english.pdf (accessed May 31, 2017).

176 Environment and Climate Change Canada, 2016, *Canadian Protected Areas Status Report 2012-2015*, Catalogue no. En81-9/2016E-PDF, p. 18, https://www.canada.ca/en/environment-climate-change/services/wildlife-habitat/publications/protected-areas-report-2012-2015.html (accessed February 28, 2018); Canadian Council of Ecological Area, 2008, "Canadian Guidebook: for the Application of IUCN Protected Area Categories," *CCEA Occasional Paper*, No. 18, p. 15, www.ccea.org/wp-content/uploads/2015/10/P18_Canadian-Guidebook-for-the-application-of-IUCN-protected-area-categories-2008-english.pdf (accessed May 31, 2017).

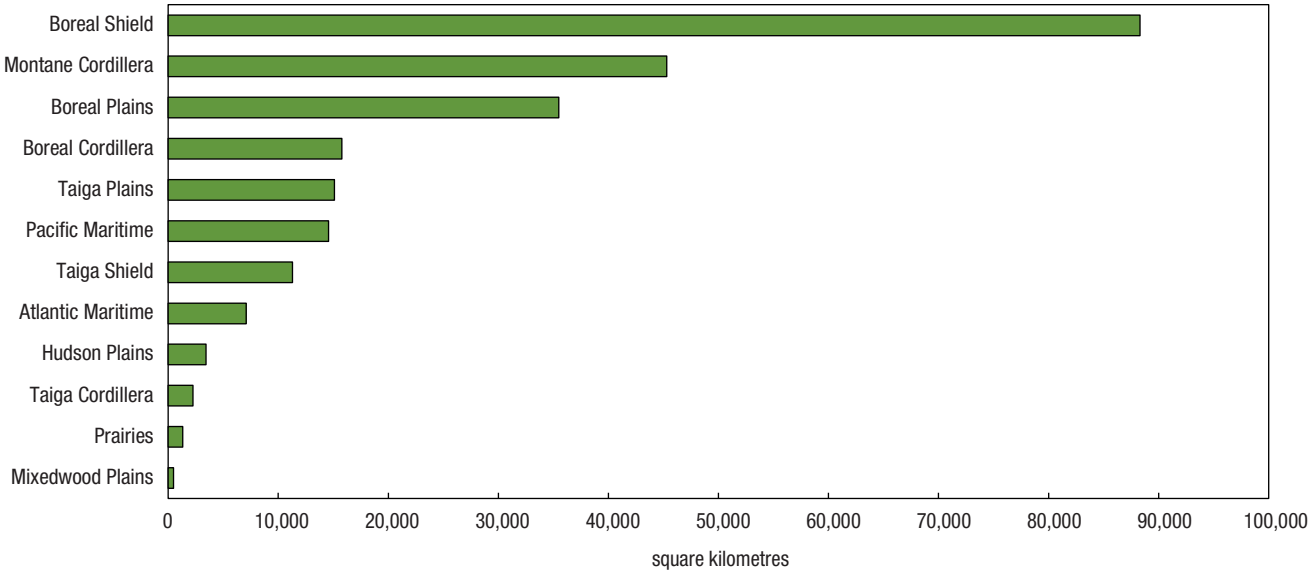
177 Environment and Climate Change Canada, 2016, *Canadian Protected Areas Status Report 2012-2015*, Catalogue no. En81-9/2016E-PDF, p. 18, https://www.canada.ca/en/environment-climate-change/services/wildlife-habitat/publications/protected-areas-report-2012-2015.html (accessed February 28, 2018).

178 Canadian Council of Ecological Area, 2008, "Canadian Guidebook: for the Application of IUCN Protected Area Categories," *CCEA Occasional Paper*, no. 18, p. 15, www.ccea.org/wp-content/uploads/2015/10/P18_Canadian-Guidebook-for-the-application-of-IUCN-protected-area-categories-2008-english.pdf (accessed May 31, 2017).

179 Environment and Climate Change Canada, 2016, *Canadian Protected Areas Status Report 2012-2015*, Catalogue no. En81-9/2016E-PDF, p. 18, https://www.canada.ca/en/environment-climate-change/services/wildlife-habitat/publications/protected-areas-report-2012-2015.html (accessed February 28, 2018).

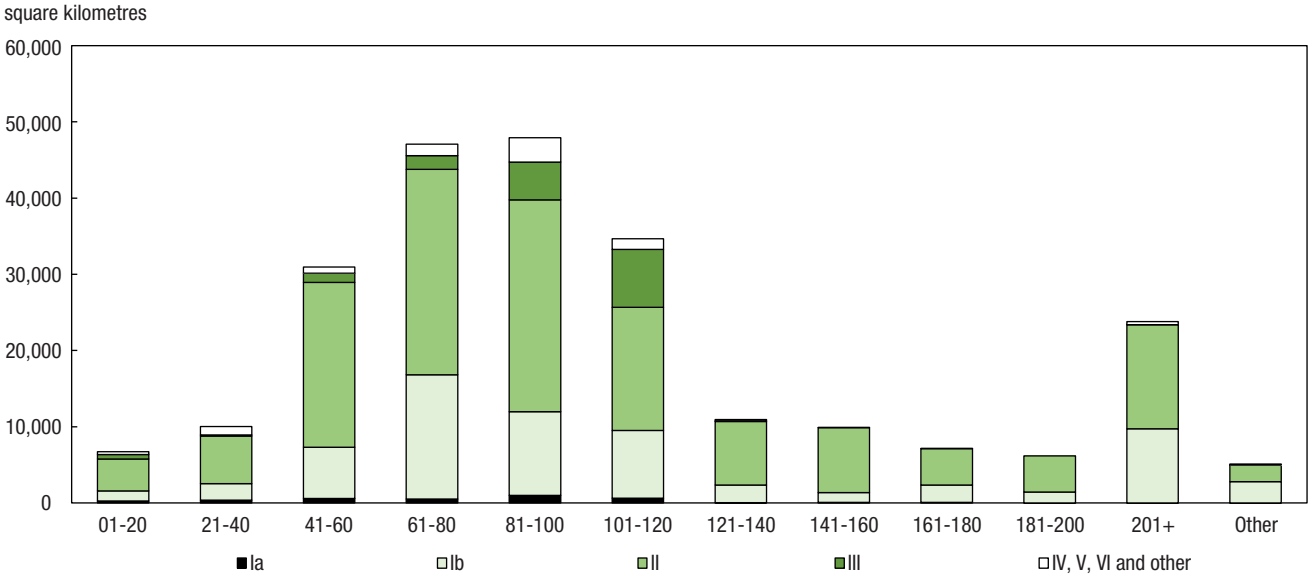
180 Canada's National Forest Inventory, 2013, Table 9.1 Area (1000 ha) of forest land by IUCN category, age class and terrestrial ecozone in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 24, 2017).

Chart 2.22
Protected forest area by ecozone, 2006



Notes: Planting and seeding data for the Territories are not included.
Source: National Forestry Database (NFD), 2017, Table 6.6 Area of direct seeding by ownership and province/territory, http://nfdp.ccfm.org/data/compendium/html/comp_66e.html (accessed July 19, 2017); NFD, 2017, Table 6.7 Area planted by ownership, species, and province/territory, http://nfdp.ccfm.org/data/compendium/html/comp_67e.html (accessed July 19, 2017); NFD, 2017, Table 6.8 Number of seedlings planted by ownership, species, and province/territory, http://nfdp.ccfm.org/data/compendium/html/comp_68e.html (accessed July 19, 2017).

Chart 2.23
Protected forest area by age class and category, 2006



Notes: Protected areas are defined by the International Union for Conservation of Nature (IUCN), https://iucn.org. Categories include: Ia - managed mainly for science; 1b - managed mainly for wilderness protection; II - managed mainly for ecosystem protection and recreation; III - managed mainly for conservation of specific natural features; IV - managed mainly for conservation through management intervention; V - managed mainly for landscape/seascape protection and recreation; VI - managed mainly for the sustainable use of natural resources; Other - with missing or unknown category. Canada's National Forest Inventory obtained data on protected areas from the Conservation Areas Reporting and Tracking System (CARTS).
Source: Canada's National Forest Inventory, 2013, Table 9.1 Area (1000 ha) of forest land by IUCN category, age class and terrestrial ecozone in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 24, 2017).

2.5 Conclusion

Canada's forest ecosystems are composed of a mosaic of treed land, shrubland, wetland and lakes and occupy close to two-thirds of Canada's total area.[181] Within this overall landscape, Canada's forests extend across 3.47 million km^2, the third largest forest area in the world.[182]

Forests provide us with timber and other forest products, as well as many ecosystem services such as water filtration, air purification, carbon sequestration, and recreational and spiritual services. They are shaped primarily through forest succession and regeneration and natural disturbance from fire and insect outbreaks, but are also affected by many human activities that occur both within and outside their boundaries.

Many resource-based activities including forestry, mining, oil and gas exploration and extraction and hydro-electric production can contribute to changes in forest landscapes. For example, forestry access roads, seismic lines, mines, well sites, dams and reservoirs, utility corridors and other temporary and permanent roads and infrastructure contribute to deforestation and habitat fragmentation when constructed through forest areas.[183]

Some other activities occurring within or on the boundaries of forests include the conversion of land for agriculture and urban development and recreational land use. However, activities occurring outside forests can also affect forest land, for example, through the introduction and spread of exotic and invasive species like the emerald ash borer[184] and long-range pollution transport and acid deposition on forest soils.[185] Some climate-induced changes in forests have already occurred and climate change is expected to continue to affect Canada's forests in multiple and interconnected ways.[186]

Timber harvesting—the largest direct human disturbance occurring in Canada's forests—only occurs on Crown lands after a forest management plan has been developed in consultation with the public and approved by government. These plans outline how social, economic and environmental sustainability will be achieved at the local and landscape scales. However, there is growing recognition of the need to assess not only the impacts of forestry activities in forests, but also the cumulative effects of all human activities, including their interactions with climate change. These various influences affect the condition of forest ecosystems, their biodiversity, and ultimately may have an impact on their ability to provide ecosystem goods and services.

181 Wulder, M.A., 2008, "Monitoring Canada's forests. Part 1: Completion of the EOSD land cover project," *Canadian Journal of Remote Sensing*, Vol. 34, no. 36, p. 549–562, http://cfs.nrcan.gc.ca/publications?id=29339 (accessed October 10, 2017); Canada's National Forest Inventory (NFI), 2013, Table 1.1 Area (1000ha) of land cover by terrestrial ecosystem in Canada, 2006 revised baseline, Version 3, December 2013, https://nfi.nfis.org/en/standardreports (accessed April 7, 2017).

182 Natural Resources Canada, Canadian Forest Services, 2017, *The State of Canada's Forests: Annual Report 2017*, Ottawa, Catalogue no. FO1-6E-PDF, p. 4, http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/38871.pdf (accessed October 3, 2017).

183 Brandt, J.P., et al., 2013, "An introduction to Canada's boreal zone: ecosystem processes, health, sustainability, and environmental issues," *Environmental Reviews*, Vol. 21, no. 4, p. 207–226, https://doi.org/10.1139/er-2013-0040 (accessed October 10, 2017).

184 Natural Resources Canada, 2016, "Emerald ash borer," *Top Forest Insects and Diseases in Canada*, http://www.nrcan.gc.ca/forests/fire-insects-disturbances/top-insects/13377 (accessed October 16, 2017).

185 Carou, S. et al., 2008, *A National Picture of Acid Deposition Critical Loads for Forest Soils in Canada*, Report prepared for the CCME Acid Rain Task Group, p. 1–8, www.ccme.ca/files/Resources/air/acid_rain/national_picture_acid_deposition_pn1412.pdf (accessed October 16, 2017); Fraser, G. A., et al., 1985, *The Potential Impact of the Long Range Transport of Air Pollutants on Canadian Forests: Report of a Scientific Opinion Survey*, Information Report E-X-36, http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/24756.pdf (accessed October 16, 2017).

186 Natural Resources Canada, 2017, *Impacts*, http://www.nrcan.gc.ca/forests/climate-change/impacts/13095 (accessed September 18, 2017).

Section 3 Glossary

Age class: an age range classification used to distinguish one group of trees from another by predominant tree age. Twenty years is a common age class interval for forest inventories.

Biodiversity (or biological diversity): "the variability among living species from all sources including, *inter alia*, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."[187]

Bolt: a short log, cut to length.

Broadleaf species: deciduous trees such as poplar, birch, maple, classified as angiosperms and collectively known as hardwoods.

Census subdivision (CSD): 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).

Commercial thinning: a thinning or cut made in an immature stand to accelerate the growth of remaining trees. The harvested material is then used for commercial purposes e.g., fence posts or poles.

Chemical management: the use of fertilizers, herbicides or pesticides to promote tree growth and maintain healthy forest stands.

Clearcutting: the removal of essentially all the trees from an area of forest land in a single cut, allowing for the development of a new age class.

Coniferous species: cone-bearing trees with needles or scales, classified as gymnosperms. These species include spruce, pine, fir, hemlock, cedar, larch and others and are also collectively known as softwoods.

Cutblock: a specified forest area authorized for harvesting that has defined boundaries.

Defoliator: a leaf-eating insect.

Deforestation: the clearing of forests to make way for new, non-forest land uses. It excludes forest harvesting when it is not a land use change, such as when forests are harvested and then replanted or allowed to regenerate naturally.

Direct seeding: an artificial forest regeneration method where a known amount of seeds are applied directly to the land.

Disturbance: a force such as a fire, earthquake or flood that causes significant changes in the natural environment.

Ecozone (http://www.statcan.gc.ca/eng/subjects/standard/environment/elc/elc2017): an area of the earth's surface representative of large and very generalized ecological units characterized by interactive and adjusting abiotic and biotic factors.

Endangered: a species that is facing extirpation (disappearance from a geographic area) or extinction if the factors threatening them continue to operate.

Even-aged: a forest stand consisting generally of one (or sometimes two) age class of trees of a similar height with a single canopy.

Forest: defined by the Food and Agriculture Organization of the United Nations (FAO) as "land spanning more than 0.5 hectares with trees higher than 5 metres and a canopy cover of more than 10% or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use."[188] Forest may include treed areas and non-treed areas (e.g., areas that have recently been harvested and that are temporarily unstocked).

187 Environment Canada, 1995, *Canadian Biodiversity Strategy: Canada's Response to the Convention of Biological Diversity*, www.biodivcanada.ca/560ED58E-0A7A-43D8-8754-C7DD12761EFA/CBS_e.pdf (accessed October 16, 2017).

188 Food and Agriculture Organization of the United Nations (FAO), 2012, *FRA 2015—Terms and Definitions, Forestry Department*, Forest Resources Assessment Program, Working Paper 180, Rome, p. 3, http://www.fao.org/docrep/017/ap862e/ap862e00.pdf (accessed May 1, 2017).

Forest management: a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner.

Forest sector: includes the following North American Industry Classification (NAICS) codes: 113 – forestry and logging; 1153 – support activities for forestry and logging (e.g., forest conservation services, forest fire fighting services, forestry maintenance, log hauling, pest control and timber cruising and valuation); 321 – wood product manufacturing and 322 – paper manufacturing.

Land cover: refers to the observed physical and biological surface of the earth and includes biotic (living, such as vegetation) and abiotic (non-living, such as rocks) surfaces. For example, tree cover, grassland, shrubland, cropland, barren land, built-up, wetland and open water are some typical land cover classes. Land cover is usually determined using aerial or satellite imagery.

Land use: describes the economic and social functions of land to meet human demands—how people are using land. For example, typical land use classes might include settlements, agricultural land, recreational areas or forest management areas. Land use can impact the natural environment and therefore may result in changes in land cover. Many land use classifications use land cover to describe natural and semi-natural vegetation, land use to describe agricultural and urban areas and a combination of the two to describe forests.[189]

Managed forest: a forest that is managed according to a forest management plan using the theories and practices of forestry.

Mixedwood: forest type of intermingled deciduous and coniferous trees.

Natural capital: The natural environment as the source of material resources and environmental services that are necessary for economic activity and human well-being. Also known as natural wealth. Natural capital includes land, natural resources, ecosystems and ecosystem goods and services.

Non-timber forest products: products of biological origin other than timber that are derived from forests. The range of products may include nuts, berries, mushrooms, ornamentals, medicinal products, foliage, game animals, fur-bearers and others, but excludes timber products. Note that differences exist in terminology—the Non-Timber Forest Products Network of Canada focuses on botanical and mycological resources.[190] The Food and Agricultural Organization of the United Nations uses the term "Non-wood forest products" and defines this term as goods of a biological origin other than wood that are derived from forests, other wood land and trees outside forests.

Other land: land that is not classified as forest or other wooded land according to the FAO definitions. Includes agricultural land, built-up areas and barrenland.

Other land with tree cover: according to the FAO definition, it is predominantly agricultural or built-up land that has patches of tree cover over 0.5 hectares, with a canopy cover of more than 10% and trees able to reach a height of 5 metres at maturity.

Other wooded land: land not defined as forest according to the FAO definition, but that covers more than 0.5 hectares and that has "trees higher than 5 m and a canopy cover of 5% to 10%, or trees able to reach these thresholds, or with a combined cover of shrubs, bushes and trees above 10%. It does not include land that is predominantly under agricultural or urban land use."[191]

Prescribed burning: the knowledgeable and controlled application of fire on designated areas of land to achieve forest management objectives.

189 Gong, X., L.G. Marklund and S. Tsuji, 2009, "Land use classification," *14th Meeting of the London Group on Environmental Accounting*, Canberra, April 27-30, 2009, p. 2, https://unstats.un.org/unsd/envaccounting/londongroup/meeting14/LG14_10a.pdf (accessed May 15, 2017).

190 Non-Timber Forest Products Network of Canada, 2010, Welcome, http://ntfpnetwork.ca/en (accessed May 16, 2017).

191 Food and Agriculture Organization of the United Nations (FAO), 2012, *FRA 2015—Terms and Definitions*, Forestry Department, Forest Resources Assessment Program, Working Paper 180, Rome, p. 3, http://www.fao.org/docrep/017/ap862e/ap862e00.pdf (accessed May 1, 2017).

Protected areas: According to the International Union for Conservation of Nature (IUCN), protected areas are: *"a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values."*[192]

Riparian: situated on the bank of a river or other water body. A riparian forest is the forest land along the banks of rivers, streams or other water bodies.

Roundwood: sections of trees stems, with or without bark and without branches, stumps and tops. It includes industrial roundwood (i.e. logs and bolts, pulpwood and other industrial roundwood) as well as fuelwood and firewood.

Seed tree harvesting: an even-aged silviculture system where all trees are removed except for a supply that is left as seed for natural regeneration, either as individual trees or in small groups. Once regeneration has been established, seed trees are often removed.

Selection harvesting: an uneven-aged silviculture system where mature or unhealthy trees are removed individually or in small groups. The process is continually repeated to promote regeneration and maintain an un-even stand.

Shelterwood harvesting: an even-aged silviculture system where trees are removed in stages—two or more cuttings. This creates an overstorey of trees to protect, or shelter, the regrowth of the new stand.

Silviculture: the art and science of controlling the creation, growth, composition, health, and quality of forest stands to achieve forest management objectives.

Silviculture system: a planned forest management program incorporating harvesting, regenerating, and stand tending practices to achieve desired stand outcomes and sustainable forest objectives. Silviculture systems are classified by the forest left after initial cutting.

Standing timber volume: timber volume is the amount of wood, or wood plus bark, present in an individual tree, group of trees, or stand. The timber volume of a tree includes the stem, branches, stump, and roots. For standing trees, aboveground volume is based on stem wood volume for conifers, but may include branch volume for broad-leaved tree species.

Threatened: species that are likely to be endangered if environmental factors are not changed.

Timber assets: accessible, timber-productive, non-reserved forest land. In the timber asset, commercial timber production is viable, harvesting is allowed and commercially valuable species grow to a merchantable size in reasonable length of time. This land accounted for approximately 1.44 million km^2 in 1991. The timber stock used to produce monetary estimates of Canada's timber asset is assumed to be static.[193]

Treed: Term used in site assessment of the National Forestry Inventory to indicate land cover where 10% or more of the area is covered in tree species of any size.

Uneven-aged stands: a forest stand with trees of different age classes—generally three or more.

White-nose syndrome: a disease affecting hibernating bats. It is named for the white fungal growth (*Geomyces destructans*) that appears on the muzzle and other body parts of hibernating bats and is associated with extensive mortality of bats.

Wood pulp: wood fibers, prepared from pulpwood, wood chips, particles or recovered paper using mechanical or chemical processes, for use in manufacturing paper, paperboard and other products.

192 Environment and Climate Change Canada, *Canadian Protected Areas Status Report 2012-2015*, Catalogue no. En81-9/2016E-PDF, p. V, https://www.canada.ca/en/environment-climate-change/services/wildlife-habitat/publications/protected-areas-report-2012-2015.html (accessed February 28, 2018).

193 Statistics Canada, 2006, *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts*, Catalogue no. 16-505-GIE.

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Analysis and reporting were performed by:

Catherine Burpee, Wilfreda Edward-Dolcy, Gabriel Gagnon, Katharine Strong and Jennie Wang

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