Montréal Process

Synthesis of indicator trends 1990 to 2020 and future outlooks

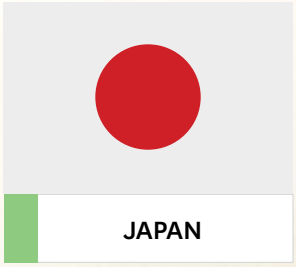

ARGENTINA


AUSTRALIA

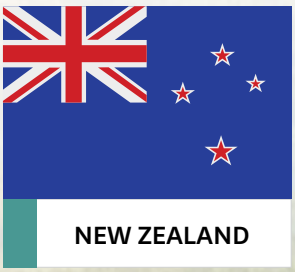

CANADA


CHILE


CHINA


JAPAN


MEXICO


NEW ZEALAND


REPUBLIC OF KOREA


RUSSIAN FEDERATION


UNITED STATES OF AMERICA


URUGUAY

September, 2023
www.montreal-process.org

Acknowledgments

Lead Author and Editor – Tim Payn, Scion, New Zealand

Indicator chapter lead authors:

Hee Han, Seoul National University, Republic of Korea (1.1.a and 2.a);

Claire Howell, Australian Bureau of Agricultural and Resource Economics and Sciences, Australia (1.1.b and 7.1.a);

Tim Payn, Scion, New Zealand (2.c);

Guy Robertson, United States Forest Service, United States of America (3.a and 3.b);

Sebastian Klinger, Scion, New Zealand (4.1.a);

Toshiya Matsuura, Forestry and Forest Products Research Institute, Japan (5.a);

Talha Sadiq, Natural Resources Canada – Ressources Naturelles Canada (6.1.a);

Margot Downey, Natural Resources Canada – Ressources Naturelles Canada (6.1.a).

Report Development team: Margot Downey (Canada), Hee Han (Republic of Korea), Claire Howell (Australia), Hideki Kawai (Japan), Sebastian Klinger (New Zealand), Jingpin Lei (China), Toshiya Matsuura (Japan), Tim Payn (TAC Convenor), Guy Robertson (United States of America), Glenda Russo (Canada), Shen Tong (China), Lorie Wagner (Canada)

Technical Editor: Paul Charteris, Scion, New Zealand

Graphics design and layout: Nick Lambert, Dale Corbett, Scion, New Zealand

Especial thanks to Steve Read (Australia) for a very thorough review of the first draft

Initial development of the report concept and approach was undertaken at the 17th Montréal Process Technical Advisory Committee hosted in Montevideo, Uruguay in 2019 by the Forestry Directorate, Ministry of Livestock, Agriculture and Fishing.

The support of the Global Forest Resources 2020 team of the UNFAO Forestry Department led by Anssi Pekkarinen is greatly appreciated.

ISBN number: 978-0-473-67374-1

Published by Scion, New Zealand

Printed on FSC certified sustainable paper

Citation: Montréal Process Working Group. 2023. Montreal Process: Synthesis of indicator trends 1990 to 2020 and future outlooks. Editor: Payn, T.W. Authors: Payn T.W., Downey, M., Han, H., Howell, C., Klinger, S., Matsuura, T., Robertson, G., Sadiq, T.

Scion, New Zealand. 44pp.

Contents

Introduction

This report explores trends in 11 indicators spanning all seven Montréal Process criteria, that are important to ensuring the sustainable management of our forests. The trends in these indicators will allow us to gain perspectives on the past and what the future may hold for forests within Montréal Process countries in the context of global drivers such as deforestation, population growth and climate change. It builds on a wealth of past information including individual country reports and the 2020 Overview and Country Highlights report.

Since the Earth Summit in Rio in 1992 there have been many initiatives supporting the conservation and sustainable management of forests.

Most recently individual countries have pledged to reduce deforestation rates (26th United Nations Climate Change conference) and committed to planting more trees to restore degraded lands and forests (e.g., New Zealand One Billion Trees Programme, Trillion Trees: India Challenge), and included trees and forests as a key component to mitigate climate change (Paris Agreement and Nationally Determined Contributions).

These initiatives are underpinned by the understanding that for forests to be managed sustainably decision makers must take into account cultural, social, environmental and economic values, and that these values need to be described. To this end, the concept of criteria and indicators of sustainable forest management was developed in the 1990s following the Earth Summit and subsequently refined. These criteria and indicators comprehensively describe the state of forests, using a common or standardised set of descriptors. Today many countries subscribe to one or more of the 10 regional criteria and indicator processes.

The Montréal Process, Forest Europe, and the International Tropical Timber Organization are the most widely used indicator processes.

Recently these three processes have worked closely with the United Nations Food and Agriculture Organization to develop and refine the concepts and systems needed to ensure they are widely used, complementary, and link to the Global Forest Resources Assessment through, for example, the Collaborative Forest Resources Questionnaire. All these processes have been active since the 1990s and have been reporting on the state of forests by individual country and also collectively. This has led to valuable and powerful data that have informed changes in forest policy and management and moved countries and groups towards the goal of sustainable forest management.

The Montréal Process Working Group was established in 1994 with 12 member countries (Argentina, Australia, Canada, Chile, China, Japan, Republic of Korea, Mexico, New Zealand, Russian Federation, United States of America and Uruguay). It focuses on the conservation and sustainable management of temperate and boreal forests. An initial set of seven criteria and 67 indicators were developed in 1995 and have been revised to the current 5th edition of seven criteria (biodiversity, forest productivity, health and vitality, soil and water, carbon cycle, socio-economic, and legal and institutional frameworks) and 54 indicators (Appendix 1). Countries have reported on the state of their forests on a roughly five-year cycle and have built up a significant body of data and knowledge of trends over time.

Photo: Korea Forest Service – Republic of Korea

The importance of forests and Sustainable Forest Management

The contribution of forests and sustainable forest management to sustainable development first received global recognition in 1992 when the United Nations Conference on Environment and Development adopted the "Rio Forest Principles" and Chapter 11 of Agenda 21.

Forests are essential to the long-term well-being of local populations, national economies and the earth's biosphere as a whole. They provide food, fuel, shelter, clean water and air, medicine, livelihoods and employment for people around the world. They reduce concentrations of greenhouse gases in the atmosphere, minimize sedimentation in lakes and rivers, and protect against flooding, mudslides and erosion. Forests are home to 80% of the world's terrestrial animals and plants. When managed sustainably, forests can provide a wide range of economic, social and environmental goods and services for the benefit of current and future generations.

The contribution of forests and sustainable forest management to sustainable development first received global recognition in 1992 when the United Nations Conference on Environment and Development adopted the "Rio Forest Principles" and Chapter 11 of Agenda 21. At about the same time, the International Tropical Timber Organization (ITTO) pioneered work on "Criteria for the Measurement of Sustainable Tropical Forest Management."

Following the Rio Earth Summit in 1992, the concept of "criteria and indicators for sustainable forest management" gained increasing international attention as a tool to monitor, assess and report on forest trends at national and global levels. By 1995, the Ministerial Conference on the Protection of Forest in Europe (MCPFE) and the Montréal Process had adopted comparable sets of national level criteria and indicators for the sustainable management of temperate and boreal forests.

The importance of criteria and indicators as tools to assess progress toward sustainable forest management has been recognized by the Intergovernmental Panel on Forests (1995–1997) and its successor the Intergovernmental Forum on Forests (1997–2000), the United Nations Forum on Forests (UNFF), and the Food and Agriculture Organization of the United Nations (FAO).

These criteria are also relevant to the forest-related programs of member organizations of the Collaborative Partnership on Forests (CPF), including the Rio Conventions on biodiversity, climate change and desertification.

More recently, a project carried out by the International Union of Forest Research Organizations (IUFRO) Working Party on criteria and indicators for sustainable forest management analysed how criteria and indicator processes have made a difference over the 25 years since they were first established, and identified which factors contributed to their success. The IUFRO Working Party contains members from a number of active processes and the project developed out of an international experts workshop held in Ottawa, Canada in 2016.

Six areas of positive impact towards sustainable forest management were identified:

- Enhanced discourse and understanding of sustainable forest management
- Shaped and focused engagement of science in sustainable forest management
- Improved monitoring and reporting on sustainable forest management to facilitate transparency and evidence-based decision making
- Strengthened forest management practices
- Facilitated assessment of progress towards sustainable forest management goals, and
- Improved forest-related dialogue and communication.

Some of the 10 criteria and indicator processes established post Rio have prospered, some have become inactive. There are a number of reasons for this. Factors for success include ongoing political commitment to criteria and indicators for sustainable forest management, a commitment to collect significant amounts of data on a wide range of indicators, coordination, efficient tools for monitoring, communication and capacity building and good linkages to official statistics. The criteria and indicator frameworks also need to be responsive to change as new global challenges or market opportunities emerge.

Why the Montréal Process Working Group works together on Sustainable Forest Management

The Montréal Process is one of the more active criteria and indicator processes and brings together countries with diverse social, economic and political situations in a voluntary forum to share ideas, address common problems, and foster collaboration toward a shared goal of sustainably managing temperate and boreal forests. The Montréal Process provides countries with an internationally agreed framework of seven criteria and 54 indicators to monitor, assess and report to their citizens. This credible, consistent and relevant framework is used to demonstrate progress towards the sustainable management of their forests.

Together the 12 Montréal Process countries account for:

- 90% of the world's temperate and boreal forests
- 49% of the world's forests
- 59% of the world's planted forests
- 49% of the world's roundwood production and
- 31% of the world's population.

Through the development of the criteria and indicators and working together nearly 30 years the Montréal Process has developed a significant network of knowledge across member countries where sharing of experiences has helped individual countries progress towards sustainable forest management.

Photo: Sebastian Klinger – New Zealand

The common language and comparable data of the criteria and indicator framework also helps countries engage in international discussions on emerging issues. Through the Montréal Process, countries have engaged with other criteria and indicator processes and forest-related international organizations to streamline reporting and improve the consistency of global forest information.

The jointly developed framework of criteria and indicators is now embedded into national reporting processes. It informs the development of national policies and programs, is referenced in national legislation and forest law, is aligned with national forest inventory programs, informs the development of national forestry standards, underpins national certification systems and harmonizes with international reporting activities.

A report prepared by the Montréal Process in 2009 'A vital process for addressing global forest challenges', shared responses to climate change, energy, water and biodiversity issues, and the Montréal Process Technical Advisory Committee has worked on issues of common interest such as forest degradation, ecosystem services and the impacts of the COVID-19 pandemic.

The common language and comparable data of the criteria and indicators helps countries engage in international discussions on emerging issues. Through the Montréal Process, countries have engaged with other Criteria and Indicator processes and forest-related international organizations to streamline reporting and improve the consistency of global forest information. The result is that national data on forests are more useful for multiple reporting requirements, more accessible to a larger audience, and more robust for improving management practices and addressing emerging policy issues.

Summary of progress

Approach

The intent of the report is to analyse trends in 11 selected indicators within the period between 1990 and 2020, and to explore possible future trends.

The indicators were agreed at the 28th Working Group meeting in Japan in 2019. The indicators are a subset of the 54 Montréal Process indicators and span all seven criteria and were chosen predominantly as most countries had reported on them in the past. This could then give a comprehensive view of trends.

The 11 indicators are:

- 1.1.a Area of forest
- 1.1.b Area of forest in protected areas
- 2.a Area of forest available for wood production
- 2.c Area and growing stock of plantations
- 3.a Area affected by biotic processes (insects)
- 3.b Area affected by abiotic processes (fire)
- 4.1.a Area of forest designated for protection of soil and water
- 5.a Carbon pools and fluxes (carbon pools)
- 6.1.a Value and volume of wood and wood products production (industrial roundwood production)
- 6.3.a Employment
- 7.1.a Legislation supporting sustainable forest management.

Data was collected in parallel to the Global Forest Resources Assessment 2020 (FRA 2020) process and included both data collected for FRA variables (these were mapped to the Montréal Process indicators), and country specific data not included in the FRA survey. All these data were compiled into a dataset for analysis. A questionnaire was completed by Montréal Process countries in order to gain country specific commentary on the drivers of indicator trends and perspectives on the future.

A narrative was developed for each indicator that presents and discusses past trends and future perspectives collectively and individually, and summarises key findings.

Findings from each indicator narrative were then combined to give an overall perspective of Montréal Process forests past, present and future. The following section outlines the overview of state, trends and future for the indicators collectively, followed by the individual indicator narratives.

Photo: Margot Downey — Canada

What the data shows – indicator trends in Montréal Process countries

The Montréal Process reflects the diversity of its member countries, each with different forest types, institutional characteristics, reporting capacities, and histories of forest use and management. Countries engage in the Montréal Process as a forum for sharing information and a framework for comprehensive sustainable forest monitoring and management.

The accuracy and consistency of data needed to assess forest sustainability remains a perennial problem for all countries including those participating in the Montréal Process. The FAO FRA data used in this report represents an international baseline for forest reporting, but even at this foundational level inconsistencies and data gaps are common and aggregation or comparison across countries is challenging. The diversity of Montréal Process countries (in terms of size, forest types, and reporting conventions) compounds these challenges.

Forest area is generally stable to increasing in Montréal Process countries. While some countries have experienced significant loss of forest area (on a percentage basis) since 1990, these losses have been more than offset by large gains in China and a stable forest area in the Russian Federation and North America. In terms of this limited but crucial measure of forest sustainability, we find no general evidence of unsustainable conditions across all Montréal Process countries. Similarly, the area of protected forest has increased slightly. Many of the Montréal Process indicators for biological diversity covered in Criterion 1, are not addressed in the FAO FRA data nor in this report (e.g. forest-associated species), and biodiversity conservation remains a concern.

Photo: Sebastian Klinger – New Zealand

Total area of plantation forests in Montréal Process countries has increased steadily and growing stock on these forests has nearly tripled since 1990. If they are managed sustainably, the enhanced productivity associated with these forests can provide substantial benefits. Increased stocking levels are also evident in natural and semi-natural temperate forests in many countries, and this increase in stocking is correlated with an increase in captured carbon in many countries. In general, we are not running out of wood in Montréal Process countries, though this conclusion cannot be automatically extended to specific locations or forest types.

Aggregate data for insect and fire disturbance in Montréal Process countries show an overall increasing trend. This is mainly from increases in Canada, the Russian Federation, the United States of America, and (in the case of fire) Australia. Forest disturbance processes are considered to be a large and increasing threat to forest sustainability globally, and the statistics presented here tend to support this concern. The observed trends, however, are somewhat obscured by the high variability of disturbance activity year-to-year and between countries. Gathering disturbance data in a consistent fashion is difficult, and reporting is uneven across countries.

Photo: Jingpin Lei – China

Carbon stock densities in above-and below-ground biomass have increased in nine of the twelve Montréal Process countries, particularly in East Asia and the United States of America. Carbon stock in forest soils is relatively high in high latitude, cool temperate regions. Expected change in carbon stock per hectare varies among countries, depending on their situation (e.g., forest age distribution, forest types, forestry activities), and various natural disturbances such as fires and pests.

Industrial roundwood production has increased in most Montréal Process countries, with the exception of North American countries where the economic recession in 2008 affected harvest, and production levels were slow to recover. In many countries, increasing roundwood production occurred alongside stable forest area and increased wood stocking.

Area of forests designated or managed primarily for the protection of soil and water in the Montréal Process countries showed a steady increase from 1990 to 2020. The reported area is dependent on land-use designations and associated definitions. Some countries (for example, the United States of America) include soil and water protection under a general "multiple-use" designation, resulting in relatively high levels of reported protection designation.

Forest-based employment totals across all Montréal Process countries have been steadily declining throughout the reporting period, decreasing by 40% between 1990 and 2015. The FAO FRA employment data used in this report include only forestry, logging and associated in-forest activities. Sawmills and other manufacturing activities are excluded, and the resulting data do not encompass the total contribution of forestry and wood products to national and local economies. There are many reasons for the decline in employment, including increased mechanization and re-prioritization of forest uses.

Distilling the information from all of the indicator narratives we identified three common drivers of change affecting the forests:

(1) climate change;

(2) increasing environmental concerns and recognition of forest-based ecosystem services; and

(3) developments in technology and forest management.

What the future may hold for forests in Montréal Process countries

The total forest area in the Montréal Process group of countries is expected to grow steadily if China (which has the largest increase in forest area in the past 30 years) maintains its upward trend. Given current legislations, policies and regulations in Australia, New Zealand and Uruguay, the pattern of increase in forest area is expected to be maintained.

Forest area in some countries, such as the Republic of Korea, is expected to decrease slightly. This is due to a high demand for forested land to be converted to other uses such as food production or real estate development.

The area of forest protected for conservation is expected to continue to grow across Montréal Process countries. This could include protection of forest types that are currently under-represented in protected areas, the expansion of existing protected areas of forest, and the protection of forest in regions not previously considered for protection. China has developed a national park-based system of nature reserves and moved forward with large-scale afforestation to better protect and improve ecosystems. The proportion of forest area protected could decrease if the total forest area increases outside protected areas.

Research may show whether passive management through protection alone is having the expected conservation impact on biological diversity. This may result in increased active management of protected forests for conservation, through sustainable regimes of planned disturbance customised to each forest ecosystem.

Increased protection of forests from the risk of illegal logging could also occur as more Indigenous and non-Indigenous communities see the need to protect the tangible and intangible values that forests provide.

Most Montréal Process countries are expected to maintain their current size of wood production area. It is also estimated that the area of production forests will continue to increase in Uruguay, given the recent industrial projects approved in the country.

Future land claim settlements with Canada's Indigenous peoples could reduce the area of forest land managed for wood production as ownership of these lands are transferred to Indigenous peoples who may manage the land for non-timber objectives. The establishment of additional protected areas could further reduce the area of publicly-owned forest land managed for wood production in Canada.

A survey of member countries indicates that the overall expectation is for the plantation area to either remain stable or grow moderately in coming years, as will the growing stock. The rate of increase in area may slow with more focus on producing higher volumes of timber per unit area. There may be a move to more planting of native species in some countries (New Zealand, Republic of Korea). The importance of plantations for timber supply will remain high reflecting likely increased demands at the national and global level.

Given the variable life-cycles and impacts of different insects, it is difficult to predict future insect activity across the Montréal Process countries. Climate change may be a common factor driving increasing insect activity across all or most countries, particularly in regions where changing climate results in increased stress to forests or expanding ranges for insect species. The introduction of invasive insect species is another factor, though whether the rates of introduction through human commerce and travel will increase in the future is unknown.

Given the high visibility and impact of catastrophic forest fires in recent years, and their linkage to climate change as an underlying driver, measures of forest fire activity are receiving growing attention within reporting countries. Current trends and anecdotal information support the expectation of increasing fire extent, severity, and impact in the future.

Australia, Canada, Japan, the Republic of Korea, Uruguay and the United States of America all expect the area of forest designated for soil and water protection to remain stable or increase slightly with new designated areas mostly to be established on state/national forest land.

China has successfully reduced erosion and run-off around major rivers with strong and successful afforestation efforts. Since natural and plantation forest area are expected to increase in China and there is a strict natural forest protection policy, the area of forest designated for soil and water protection can be expected to increase similarly.

Carbon stock per hectare is controlled by several factors such as forest age distribution, forest types, various natural disturbances such as fires and pests, and human activities of afforestation, reforestation, and deforestation. The rate of increase of carbon stocks in forest biomass is expected to slow down in Japan and the Republic of Korea as planted or restoration forests mature. In China, the rise of biomass carbon is expected to continue due to the current high proportion of young forests.

Photo: Glenda Russo – Canada

An increased carbon stock is expected in the United States of America in the short to medium-term but long-term futures are unclear and will depend in part on trends in forest disturbance activity, notably fire. In Australia, forest carbon stocks are expected to remain at the present level, except for commercial plantation forests on previously cleared agricultural land. Based on the current trends in Canada, carbon stocks in biomass and litter pools are expected to decline due to natural disturbances such as fires and pests, whereas it will increase in the soil pool. Climate change would also affect changes in forest growth and distribution.

Australia, China, Argentina and Uruguay are forecasting continued growth in wood production and log volumes. In Australia, this future volume growth will depend on key consumer markets, particularly in the home building sector. Following recent bushfires, there are also supply limitations in Australia. In China, forestry investments and promotional policies should increase production forest area. Japan has targets of an increased production volume for 2030 and Uruguay expects recent trends to continue. In the Republic of Korea, future domestic wood production is expected to decrease due to a slowdown in the construction industry and economic growth; competition from imported wood products will also contribute.

In China and the Republic of Korea, forest sector employment levels are expected to continue to decline due to reduced traditional wood-based forest product manufacturing. However, potential increases may occur in relation to the promotion of tourism and conservation.

In Canada, United States of America, and Australia, an overall reduction in employment is expected due to continued mechanization and market restructuring. However, potentially significant fluctuations can be expected in some production sectors due to new product development such as cross laminated timber and expansion of use of wood in multi-storey buildings. For example, in Canada, though employment in the pulp and paper product manufacturing sub-sector continued to decrease after 2015, the wood product manufacturing sub-sector grew in importance, accounting for nearly 50% of total forest sector employment in 2018.

In Uruguay, employment is expected to continue to increase due to the new pulp mill. In Argentina the hope is that the recent legal framework changes will continue to promote forest sector employment.

Photo: Tim Payn – New Zealand

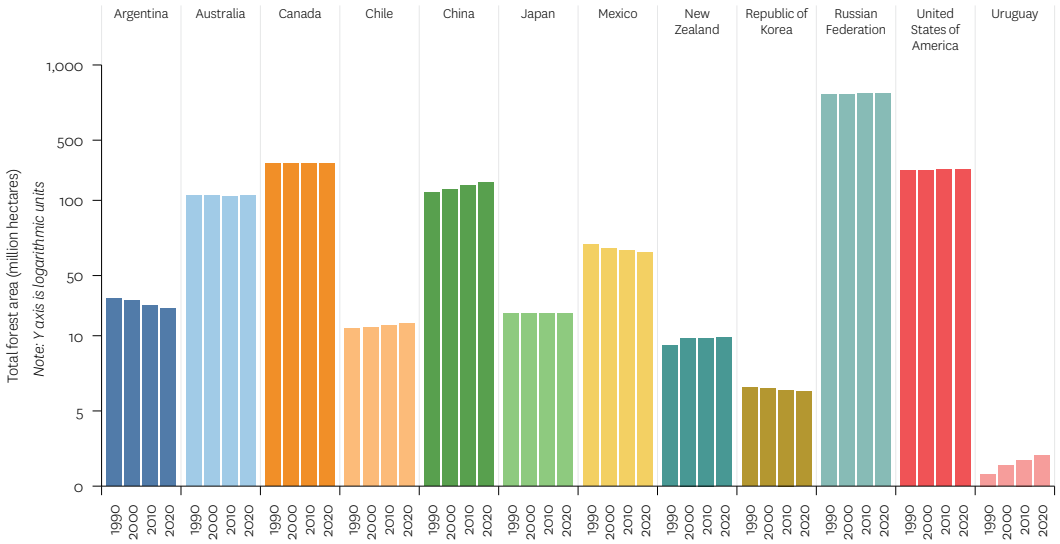
Individual indicators – status, trends and future perspectives

The following section presents the findings from the analysis of the 11 indicators. The analysis focuses on trends since 1990, and perspectives on future trends. In some cases data for all countries was not available for all years or indicators. The coverage was wide enough to draw a range of conclusions, and key findings are presented for each indicator.

Criterion 1 – Conservation of biological diversity

1.1.a Area of forest

Total forest area (1990, 2000, 2010, 2020)



Why is this indicator important?

This indicator provides information on the current forest area[1] and its changes in Montréal Process countries. The sustainability and stability of forest ecosystems is largely related to their size. If this is not maintained, forests may become vulnerable to habitat degradation and loss.

What do the data show?

Since 1990 total forest area over the 12 Montréal Process countries has increased by 69 million hectares. This is due to a large increase in forest area in China (63 million hectares). Forest areas in Australia, Chile, New Zealand, the Russian Federation, the United States of America, and Uruguay have also increased over the same period. Argentina, Mexico, and the Republic of Korea experienced a decline in total forest area. Canada and Japan's forest area have not changed greatly over the same period.

The significant increase in China's forested area results from strict natural forest protection policies implemented together with greater importance attached to nurturing plantation resources, and large-scale afforestation and re-greening. The modest increase in forest area in the United States in recent decades is largely the result of natural forest regeneration and tree planting on abandoned agricultural lands.

Times-series data of Australia's forest area shows a decrease from 1990 to 2010, followed by a progressive increase in the five-year period to 2020. The net increase in forest area over the period 2010–2020 was 4.5 million hectares. This recent increase in forest area is due to regrowth of forest on areas previously cleared for agricultural use, expansion of forest onto areas not recently containing forest; establishment of environmental plantings and changes in the commercial plantation estate.

[1] We generally followed the definition of a forest from FAO, which is "Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. Some countries, (e.g. Australia), use similar but differing definitions. It does not include land that is predominantly under agriculture or urban land use." (FAO. 2020. Global Forest Resources Assessment (FRA) 2020)

Total forest area (million hectares)

Country	Year				Percent change
	1990	2000	2010	2020	
Argentina	35.2	33.4	30.2	28.6	-18.8
Australia	133.9	131.8	129.5	134.0	0.1
Canada	348.3	347.8	347.3	346.9	-0.4
Chile	15.2	15.8	16.7	18.2	19.5
China	157.1	177.0	200.6	220.0	40.0
Japan	25.0	24.9	25.0	24.9	-0.1
Mexico	70.6	68.4	66.9	65.7	-6.9
New Zealand	9.4	9.9	9.8	9.9	5.6
Republic of Korea	6.6	6.5	6.4	6.3	-4.0
Russian Federation	809.0	809.3	815.1	815.3	0.8
United States of America	302.5	303.5	308.7	309.8	2.4
Uruguay	0.8	1.4	1.7	2.0	154.5
All Montréal Process countries	1,913.4	1,929.6	1,958.1	1,981.6	3.60

An increase in forest area in Uruguay is due to legislation which has two fundamental objectives, the conservation of the native forest and the expansion of the forest base through the promotion of forest plantations. This legislation prohibits the felling of native forests while creating a forest fund for the payment of plantation subsidies.

The coverage of forests in Japan has been maintained for more than 50 years. This is mainly due to the low pressure of conversion to other lands uses as well as existing legislative framework on forest management such as forest planning system, protection forest, and forest development permission system. The area of forest in Republic of Korea has been decreasing. This is mainly due to the land-use conversion in forests. Approximately 8–10 thousand hectares of forests (0.1–0.2% of total forest area) per year have been converted to other land uses, such as industrial sites, roads and housing.

What could change in the future?

The total forest area in Montréal Process countries is expected to grow steadily if China, which has had the largest increase in forest area in the past 30 years, maintains its trend. Given current legislations and regulations in both Australia and Uruguay, an increase in forest area in those two countries is expected to be maintained.

The forest areas in the Republic of Korea is expected to decrease owing to forest conversion to other uses.

Key findings:

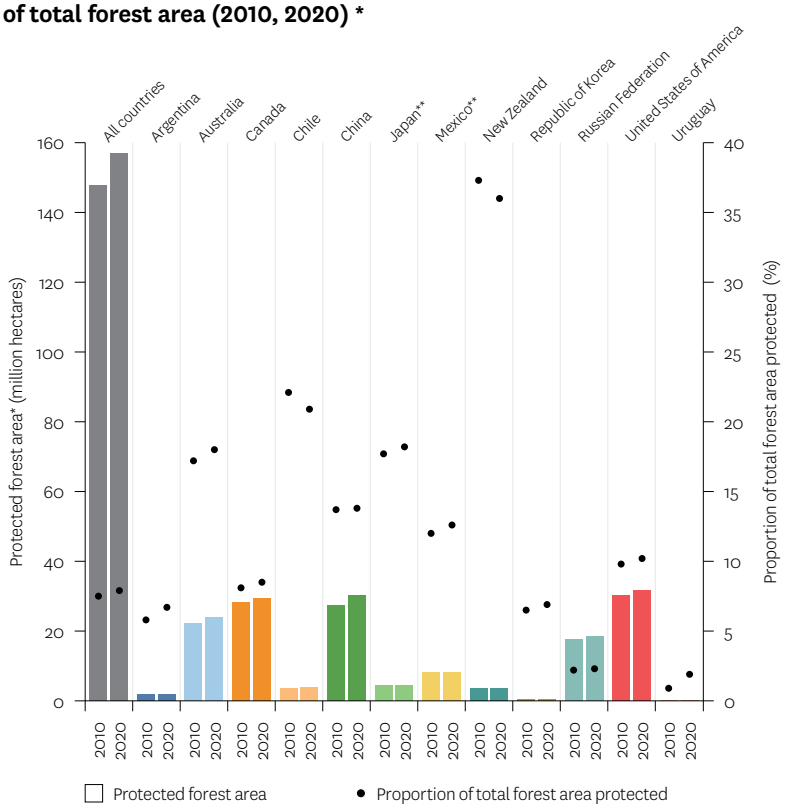
- The total forest area among the 12 Montréal Process countries has increased by 69 million hectares from 1990 to 2020. More than 90% of this increase is due to a large increase in forest area in China.
- For those countries that reported an increase of forest area, strict natural forest protection policies, legislations and regulations, afforestation, or re-afforestation have been implemented. Some other countries have a high demand for land-use conversion which reduce the forested area.
- Expectations for this indicator are to remain stable or increase in most countries. A few countries expect a slight decrease.

Photo: Glenda Russo – Canada

Criterion 1 – Conservation of biological diversity

1.1.b Area of forest in protected areas

Protected forest area as a proportion of total forest area (2010, 2020) *



* *Protected forest area include both native (natural) and plantation (planted) forest.*

** *Japan and Mexico only reported for 2010 and 2017, therefore the 2017 data is a proxy for 2020.*

Why is this indicator important?

The biodiversity of forests supports the function, productivity, and resilience of forest ecosystems, and the conservation of biodiversity and the protection of forest ecosystems are key aims of sustainable forest management. The creation of protected areas has been recognised by individual countries and internationally as the principal mechanism for the conservation of biodiversity.

Montréal Process country reports for indicator 1.1b include information on area and proportion of forest in protected areas by forest ecosystem type, and by age class or successional stage. The reporting of the type, age and successional stage of forest ecosystems in protected areas can demonstrate progress over time towards forest conservation, including progress towards international targets and goals such as United Nations Sustainable Development Goal 15, Indicator 15.1.2, and the United Nations Strategic Plan for Forests Goal 3, Target 3.1.

The area of forest in protected areas is a measure of the conservation and sustainable management of temperate and boreal forests. The indicator uses the area and proportion of forest within protected areas of member countries of the Montréal Process as measures of the value that society places on forest protection for the conservation of biodiversity.

What do the data show?

All 12 Montréal Process countries have forest protection mechanisms in place.

In 2020, the total area of forest in protected areas in Montréal Process countries was 157 million hectares (see below). Five countries individually reported greater than 18 million hectares of forest within protected areas in 2020, and the total area of protected forest in the remaining seven countries was 23 million hectares.

The total area of forest within protected areas across all Montréal Process countries increased by nine million hectares between 2010 and 2020, including increases for almost all member countries (see Figure).

Drivers for the increase in protected forest area included the expansion of existing protected areas, and the protection of new forest areas.

The proportion of forest area within protected areas reported across all Montréal Process countries increased from 7.5% to 7.9% between 2010 and 2020. By 2020, all but two individual Montréal Process countries reported greater than 6% of their forest area within protected areas, and four countries reported greater than 17% of their forest area within protected areas.

What could change in the future?

Further areas of forest are likely to become protected for conservation across the Montréal Process countries. This could include protection of forest types that are currently under-represented in protected areas, the expansion of existing protected areas and the protection of forest in regions not previously considered for protection. However, the proportion of forest area protected could decrease in a country if the total forest area increases outside protected areas.

Scientific evidence will provide information on whether or not passive management approaches such as protection alone have the expected conservation outcomes for biological diversity. Additional more active conservation measures such as sustainable regimes of planned disturbance customised to each forest ecosystem may be required.

Increased protection of forests from illegal logging is expected with the growing effort by trading nations to improve due diligence requirements and tighten import assessments. It could also occur as more Indigenous and non-Indigenous communities see the need to protect the tangible and intangible values that forests provide.

Key findings:

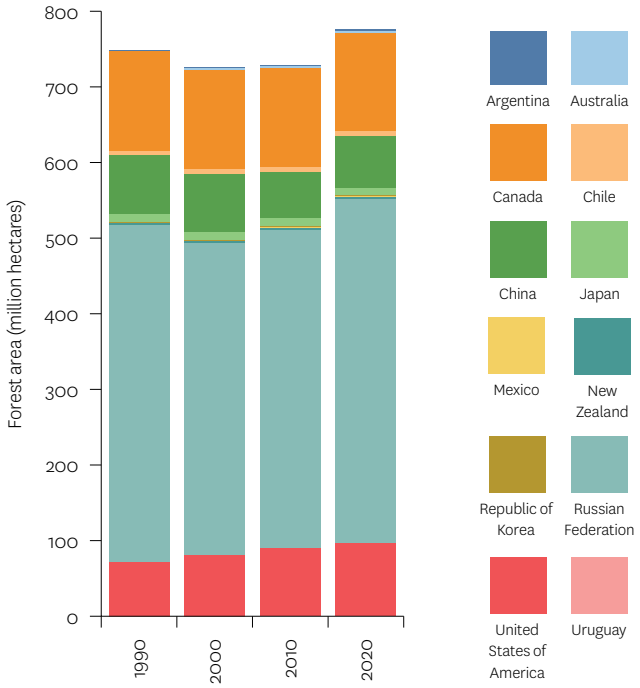
- The area of protected forest in Montréal Process countries has increased by 9 million hectares from 2010 to 2020.
- Four countries had more than 17% of their forest area with protected status.
- It is expected that the area of protected forest will continue to increase especially in areas of currently under-represented forest types.

Photo: Shen Ying – China

Criterion 2 – Maintenance of productive capacity of forests

2.a Area of forest available for wood production

Forest area with a primary designated management objective of wood production (1990, 2000, 2010, 2020) *



* *For Japan, the area of plantation forests is a proxy for the area with a primary designated management objective of wood production.*

Why is this indicator important?

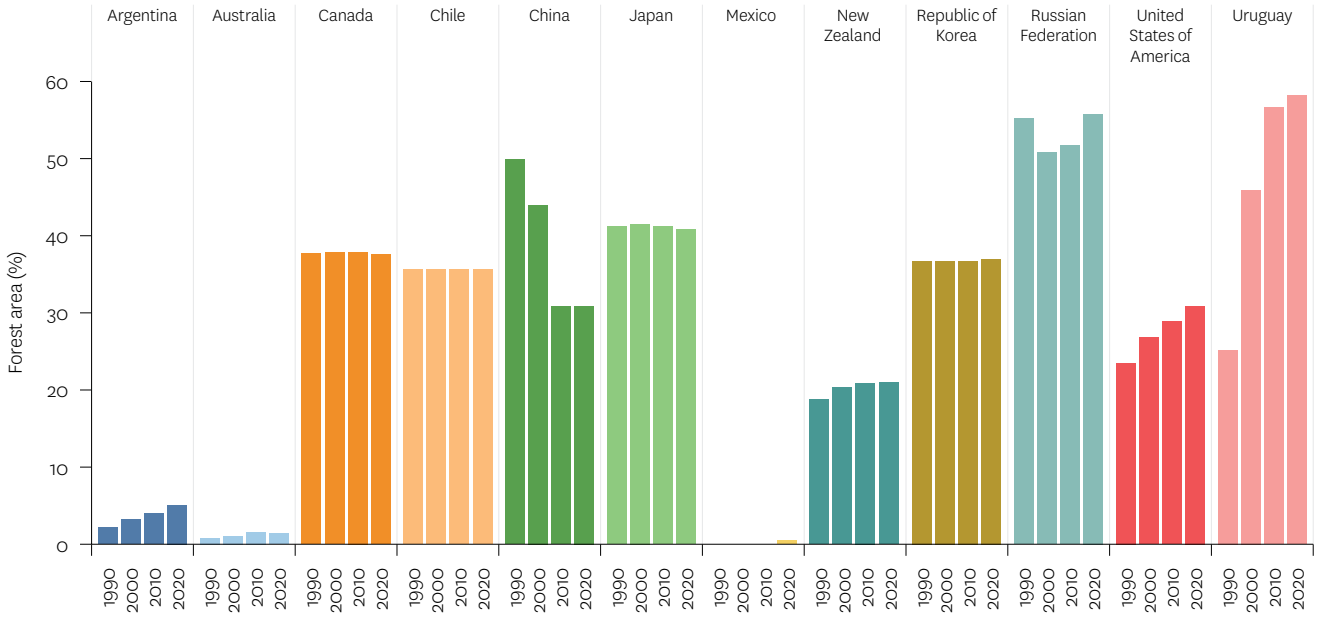
This indicator provides information fundamental to calculating the annual wood production capacity of forests and shows the area of forest land where trees are mature enough to harvest.

This indicator measures the area of forest that is primarily designated for wood production relative to total forest area for each of the 12 Montréal Process countries. This indirectly represents whether a country has the capacity to maintain a stable and sufficient wood supply at the national level.

What do the data show?

From 1990 to 2020, the total forest area with a primary designated management objective of production across Montréal Process countries has remained relatively stable. The primary production area in countries such as Argentina, Chile, Mexico, New Zealand, the United States of America, and Uruguay increased whereas the primary production area in Australia and China decreased during the same period.

Proportion of forest area with a primary designated management objective of wood production (1990, 2000, 2010, 2020)



The primary production areas in Canada, Japan and the Republic of Korea remain invariant. The primary production area in the Russian Federation has been on the decline but has recently expanded again.

The total area of Canada's forest managed primarily for wood production has remained relatively constant at about 131 million hectares since 1990. The stability of the wood production area reflects the forest management planning objectives for Crown land in Canada.

From the nine national forest inventories conducted between 1973 and 2018, the productive forest cover in China has increased from 12% to 23%. Since the late 1980s, China has maintained "dual growth" in both forest area and stock volume. It is the country with the largest growth in forest resources worldwide for the period of 1990 to 2020. The area of forest available for wood production in China has decreased, however, it is mainly because of the expansion of protection policy to the natural forest over the country.

Around 37% of the total forest area in the Republic of Korea is production forest. The area of production forest in the United States of America increased 28% from 1990 to 2015. This was the result of non-designated forest lands being assigned to production forests rather than changes to forest land use.

Uruguay has allocated forest plantations for timber production while protecting and limiting the cutting of native forest. The area available for timber production is equal to the plantation area and the size of these areas is increasing rapidly.

The area in production forestry in planted forests has remained largely static in Japan over the past 30 years.

Photo: Forestry Agency of Japan – Japan

What could change in the future?

Most Montréal Process countries expect to maintain the current size of wood production area for a while. Given recent industrial projects approved in Uruguay, its wood production area is expected to increase through the expansion of planted forests. Uruguay's native forest cover is expected to remain constant or increase slightly.

There are a number of initiatives underway in Australia to increase the area managed for wood production with the establishment of new areas of plantation forests

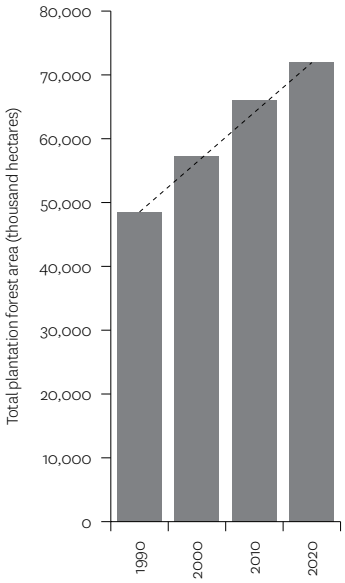
The area of Canada's forest managed for wood production is expected to remain relatively stable given the predominance of public land ownership and the long-term nature of forest land use plans. However, future land claim settlements with Canada's Indigenous peoples could reduce the area of forest land managed for wood production as ownership of these lands is transferred to Indigenous peoples who may manage the land for non-timber objectives. The establishment of additional protected areas could further reduce the area of publicly-owned forest land managed for wood production in Canada.

Key findings:

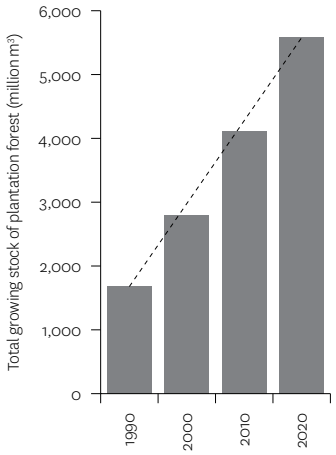
- From 1990 to the present, total forest area with a primary designated management objective of production in Montréal Process countries has remained unchanged but there were differences by countries.
- China and Uruguay have seen the biggest changes in their forest area available for wood production. While the production area in China has decreased with the expansion of protection policy to the natural forests, the size of production area is increasing rapidly in Uruguay.
- Most Montréal Process countries expect to maintain the current size of their wood production area. Uruguay expects their wood production area will expand whereas Canada notes future changes in land ownership could result in a decreased area of forest land managed for wood production.

2.c Area and growing stock of plantations

Total plantation forest area (1990, 2000, 2010, 2020)



Total growing stock of plantation forest (1990, 2000, 2010, 2020)



Why is this indicator important?

Plantations are defined as a forest that is intensively managed and is composed of one or two species of even ages with regular spacing. Plantation forests with their characteristic high management intensity and rotational cropping cycle are able to produce much more fibre and timber than the same area of natural forest and therefore can act as a safety valve and reduce pressure on harvesting of natural forests. It is important to understand how much plantation resource exists and estimate future timber supplies to meet demand.

While the predominant purpose for establishment of plantations is for timber production they also contribute many other ecosystem services such as erosion control, water flow regulation, water quality protection, carbon sequestration, recreation, and aesthetic values.

Photo: Scion – New Zealand

What do the data show?

Plantation area: Of the Montréal Process countries, Argentina, Australia, Chile, China, New Zealand, Republic of Korea, Mexico, the United States of America and Uruguay report on plantation areas. Plantation data for Canada, Japan, and the Russian Federation is an integral part of their planted forest area so plantation data cannot be reported separately. For those countries reporting it, plantation area increased from 48.5 million hectares in 1990 to 71.9 million hectares in 2020. There was some fluctuation in areas over this time for individual countries. Australia decreased its area in the mid–2000s from a peak in 2010 as plantations were returned to agricultural use. New Zealand showed a similar change to agricultural land use in the late 2000s. The total (2020) plantation area reported here accounts for 55% of the global total of 131.1 million hectares.

Plantation growing stock: While forest area is important, a measure of growing stock gives an indication of the volume of timber available over time and changes in those volumes. Only Argentina, Chile, China, New Zealand, the United States of America and Uruguay were able to provide data for this variable. As with area growing stock shows an increase, from 1.67 billion cubic meters to 5.57 billion cubic meters. In China, New Zealand and the United States of America the growing stock per hectare increased from 1990 to 2020.This may reflect the age class distribution of the forests, or potentially improvements in productivity through enhanced silviculture.

What could change in the future?

The total plantation area in Montréal Process countries is expected to either remain stable or grow moderately in coming years. The increasing recognition of forests' ability to sequester carbon and thereby mitigate climate change may result in policies and programs supporting the expansion of forest area. The rate of increase in area may slow with more focus on producing higher volumes of timber per unit area. Total growing stock is expected to continue its increase.

There are suggestions that there may be a move to more planting of native species in some countries (New Zealand, Republic of Korea). The growing recognition of forests' ability to sequester carbon and thereby help mitigate climate change may result in policies and programs supporting expanded tree planting, including afforestation of currently non-forest lands. However, whether these "planted" forests constitute "plantations" will need to be assessed on a case-by-case basis.

Key findings:

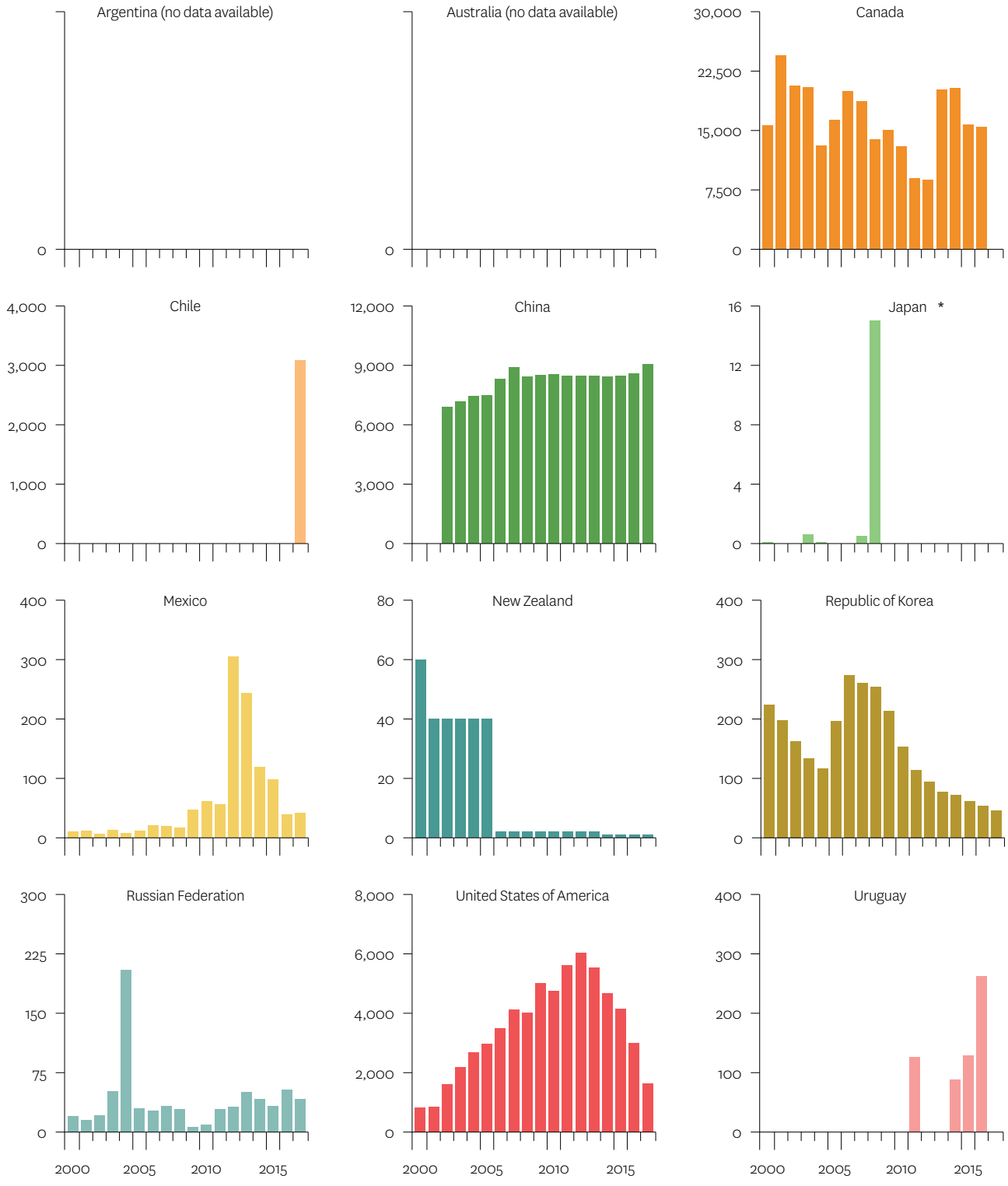
- Plantation forest area has increased by 48% from 48.5 to 71.9 million hectares between 1990 and 2020 in nine Montréal Process countries reporting plantation forest area.
- Total growing stock increased from 1.67 billion cubic meters to 5.57 billion cubic meters or nearly threefold for those countries reporting data.
- Total area of plantations is projected to grow in some but not all countries, and focus will move to increased per hectare volume production.

Photo: Sebastian Klinger – New Zealand

Criterion 3 – Maintenance for forest ecosystem health and vitality

3.a Disturbance by insects (biotic disturbances)

Area of forest disturbed by insects, 2000 – 2017 (thousand hectares)



* *Japan has insect-damaged forests of pine and oak wilt recorded in terms of timber volume of damaged trees, but the area is unknown and not included in this graph.*

Why is this indicator important?

Insects are a major forest disturbance agent and are active in most, if not all, forest settings to a greater or lesser extent, causing tree mortality, foliar damage and stunted growth. In many forests, insect activity is endemic and fully compatible with ecosystem functions, biodiversity conservation, and the provision of ecosystem goods and services. In other instances, particularly in tree plantations and other settings where wood production is the primary objective, insects can negatively impact productivity. In some cases, insect infestations may reach epidemic proportions causing extensive mortality in particular forest types and resulting in dramatic changes in forest structure, species composition and ecosystem goods and services. In these cases, insects often act in combination with other forest disturbance agents, such as drought and fire. Moreover, climate change may affect both the range and life-cycle of certain insects as well as the susceptibility of their host trees.

As a result, broad scale increases in insect activity may signal the influence of a changing climate and the transition to different ecosystem types. Invasive insects are an important subtype, but they are not delineated in the data displayed here.

Photo: Tony Hunn – Australia

What do the data show?

Aggregate data for insect disturbance across all Montréal Process countries show an increasing trend; on average, 25 million hectares of forests were reported to be impacted annually by insects from 2000 to 2004.This increased to around 30 million hectares in 2012 to 2017. Year-on-year differences in insect impact were relatively high, ranging from a low of 17 million hectares in 2000 to 35 million hectares in 2013. Each insect species is unique in terms of its life cycle and impact to forests, and the aggregate statistics shown here represent the sum-total of impacts from many different insect infestations rising and falling at different points in time.

Country level data show large differences in impact extent across countries and within certain countries over time. Canada displays the highest levels of insect disturbance in all years, and it exemplifies the varying dynamics of insect infestation and damage.

Canada's high reporting levels are driven by mountain pine beetle infestations, which peaked at nine million hectares in 2009 and have since declined to well under one million hectares. More recently, eastern spruce budworm and jack pine budworm impacts have expanded to upwards of seven million hectares in the boreal forests of northern Canada. Climate change is identified as an important factor as warming temperatures have allowed both the mountain pine beetle and the budworms to expand their range into northern territories where they previously were rare.

When viewed in terms of proportion of total forest area impacted (calculated here from mean values for all years with positive reporting), insect damage is high in Canada and China, where approximately four percent of forests have been affected annually. The Republic of Korea had similar rates throughout the first half of the reporting period, but these rates have dropped steadily in the last decade in part because of management response. Chile and Uruguay report the highest rates for recent years, between about 10 and 20 percent, but statistics for earlier years are unavailable. Measuring insect impacts is a difficult undertaking that is highly sensitive to measurement techniques, definitions, and underlying assumptions. Several countries are unable to report insect disturbance to the FAO, FRA, and the differences between countries that do report may be due to different reporting techniques and conventions as much as to different forest conditions.

What could change in the future?

Given the variable life-cycles and impacts of insect species, it is difficult to predict future activity across the Montréal Process countries. Climate change is a likely common factor driving increases in insect activity across all or most countries, particularly in regions where changing climate results in increased stress to forests or expanding ranges for insect species (particularly in the northern hemisphere). The introduction of invasive insect species through human commerce and travel is another factor driving insect impacts on forests, with uncertain and variable future trends.

Key findings:

- The area of insect disturbance for all Montréal Process countries reporting data shows an increasing trend, rising from 25 million hectares per year impacted between 2000–2004 to 30 million hectares between 2014–2017.
- The forest area affected by insects differs markedly across countries and years.
- Reporting insect damage is difficult, and country level reporting conventions likely drive a lot of the variance between countries.
- Major changes in country level data are often the result of specific insect outbreaks occurring within specific forest types and limited time spans.

Photo: Jessica Kerr / Scion – New Zealand

3.b Forest area affected by fire (abiotic disturbances)

Area of forest disturbed by fire, 2000 – 2017 (thousand hectares)

Why is this indicator important?

This indicator displays the area of forested ecosystems affected by fire. Some forested ecosystems are not adapted to fire, some are adapted to relatively frequent, low-intensity fire, and some are adapted to infrequent, high-intensity fire. In some forested ecosystems, fire can have a dramatic effect on forest structure, species composition, and many other forest characteristics. Large and intense fires pose a direct threat to human lives, health, and property. In some forested ecosystems, fire can have positive effects on ecosystem services and is a requirement for the regeneration of some forest species. Departures from previous fire regimes, especially departures involving an increase in fire extent, intensity or frequency or a change in spatial pattern, are cause for considerable concern.

Such increases signal potentially increased damage to ecological, social, and economic values, and may indicate major ongoing shifts in ecosystem types. Through increasing heat and shifting precipitation patterns, climate change has been linked to increasing fire activity. Changes in this indicator over the last 20 years may indicate greater change in the coming decades.

Photo: Margot Downey — Canada

What do the data show?

The total area reported to be disturbed by fire in Montréal Process countries varies substantially between countries, and within countries there are relatively large year-on-year differences (Figure on previous page). In recent years, Australia has reported a larger area of fire in forests than the other 11 Montréal Process countries combined, but the change in reported areas of fire disturbance in Australia mostly reflect methodological changes in sampling in 2006 and in 2011 rather than actual trends over time in on-the-ground fire activity. Omitting Australia, the total burned forest for the 11 other Montréal Process countries shows a significant increase (rising from an average of 6.5 million hectares per year in 2000–2005 to 9.4 million hectares in 2013–2017).

Countries in the Northern hemisphere with large forest areas dominate the data series when Australia is excluded, with countries elsewhere reporting levels that are one or more orders of magnitude lower than those reported by Australia, Canada, the Russian Federation, and the United States of America.

Largely, the difference between countries in area disturbed by fire can be explained by the relative size of total forest area, but forest structure, species composition, climatic conditions, and other factors play an important part in determining the relative extent of fire in all countries. Different reporting conventions may also affect reported outcomes. As a result of all these factors, the relative impact of fire when viewed as a proportion of total forest area varies widely: the mean annual proportion of total forest area impacted by fire (averaged for all years reported by each country in the 2000–2017 time period) ranges between 1.0 and 0.5 percent for Argentina, Canada and the United States of America; Australia stands out with 11 percent; and the remaining countries range between 0.2 percent (Russian Federation) and 0.01 percent or less (New Zealand and Japan). In general, the difference between countries and between years points to the fact that fire is a complex and heterogeneous phenomenon with different patterns, intensities and ecosystem effects, and with various measurement challenges.

The area affected by fire in Australia is reported for 2006 through 2015. Much of Australia's forest estate includes fire-adapted sub-tropical forests subject to frequent (sometimes annual) fire return. Moreover, planned fire is a common management technique with approximately one-third of the forest area disturbed by fire in Australia over the 2011–2015 period being attributed to fires that were purposefully set. In this context, directly comparing Australia's burn area with that of other countries is misleading. This issue no doubt applies to comparisons between other Montréal Process countries (and, in fact, comparisons between different regions within a single country), but it is most striking for Australia given the relatively large extent of its reported forest areas disturbed by fire. Other issues associated with measurement and definition may also apply. The United States of America, for example, includes grass and rangelands in its wild-land fire reporting to FAO FRA.

What could change in the future?

Given the high visibility and impact of catastrophic forest fires in recent years, and their linkage to climate change as an underlying driver, measures of forest fire activity are receiving growing attention. Current trends and anecdotal information support the expectation of increasing fire extent, severity, and impact in the future. However, the degree to which this is true will vary from place to place and year to year.

Key findings:

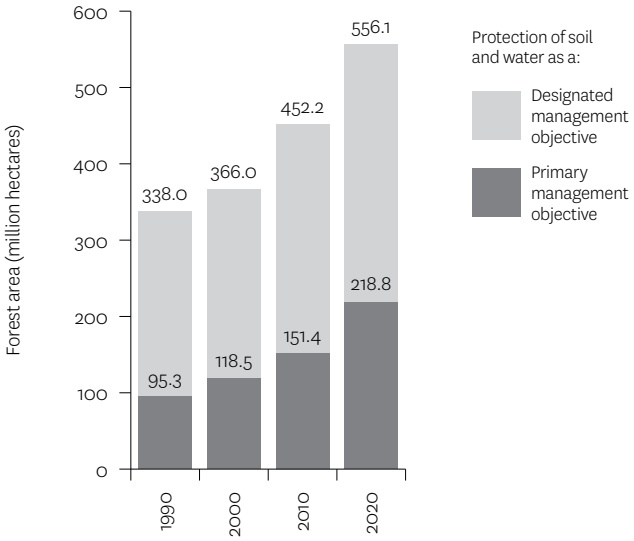
- Forest area impacted by fire is highly variable across countries owing to different climate, fire ecologies, and reporting conventions.
- Impacted area in the major forest countries of the north show an increasing trend with high annual variation.
- Australia, with its fire adapted forest ecologies subject to high burn frequency, shows the highest level of burn area that is ten times the levels reported by Canada, the United States of America, or the Russian Federation.
- Fire extent and intensity within the 12 Montréal Process countries is expected to rise as a result of climate change, requiring adaptation in management practices in line with evolving understanding of fire and forests.

Photo: Michael F. Ryan – Australia

Criterion 4 – Conservation and maintenance of soil and water resources

4.1.a Area of forest designated for protection of soil and water

Forest area managed for protection of soil and water (1990, 2000, 2010, 2020)

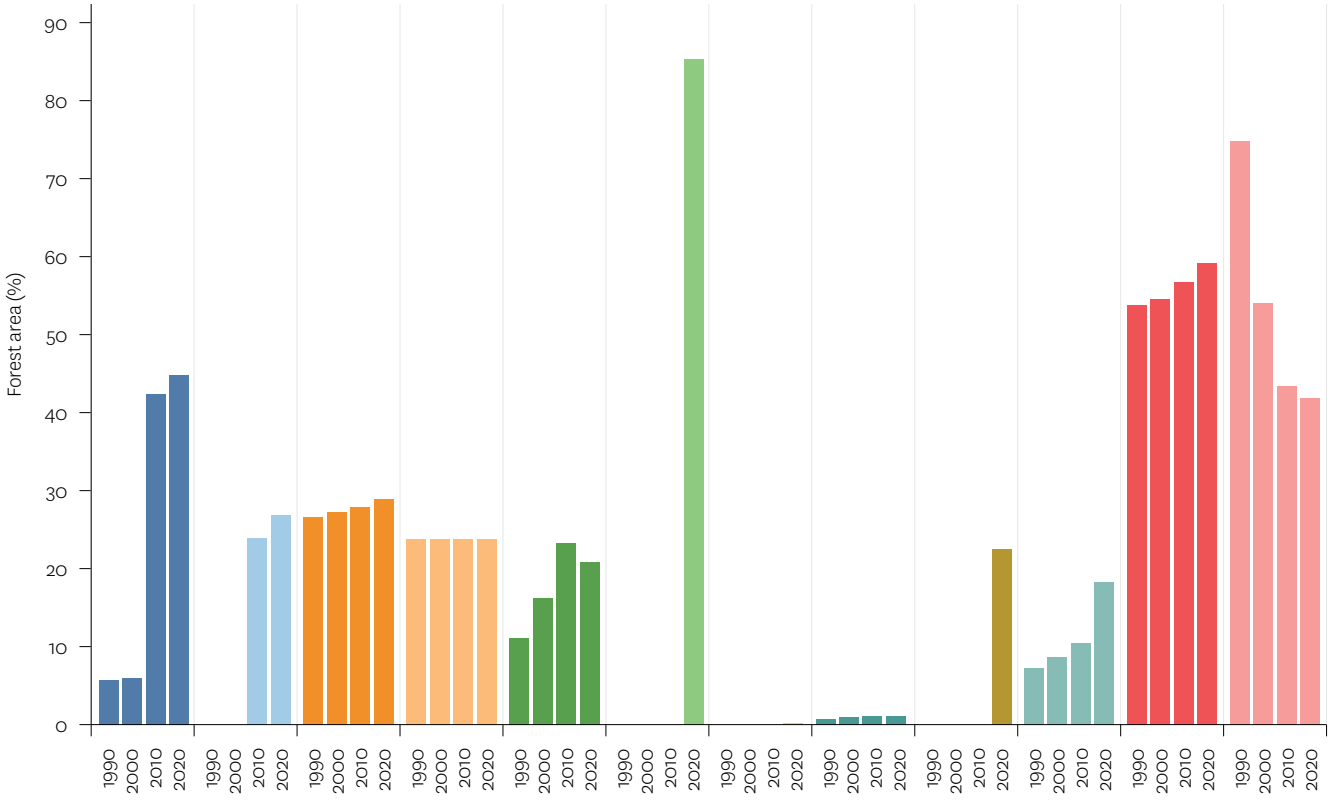


Why is this indicator important?

Forest ecosystems play an important role in the regulation of surface and groundwater flow which is essential to the quality of human life. Appropriate forest management can protect and conserve the soil and water values of a forest.

The area and proportion of forest designated or managed primarily for the protection and regulation of soil and water reflects the importance of these resources to society, including the trade-offs made between other uses.

Forest area with a designated management objective of soil and water protection as a proportion of total forest area (1990, 2000, 2010, 2020)



Total forest area with designated management objective of protection of soil and water (thousand hectares)

Country	Year			
	1990	2000	2010	2020
Argentina*	2,000	2,000	12,800	12,800
Australia	–	–	30,962	36,053
Canada	92,830	94,704	96,648	100,334
Chile	3,625	3,761	3,977	4,330
China	17,340	28,657	46,723	45,936
Japan**	–	–	–	21,285
Mexico	–	–	–	145
New Zealand	62	92	103	110
Republic of Korea	–	–	–	1,414
Russian Federation	58,695	70,388	85,111	149,364
United States of America	162,818	165,687	175,093	183,448
Uruguay	597	740	752	849
All countries	337,968	366,029	452,168	556,068

* *Argentina provided data directly, not through the FRA database.*
** *Japan only reported from 2013 to 2016, therefore the 2016 data is a proxy for 2020.*

What do the data show?

The total area of forests 'designated or managed primarily for the protection of soil and water' in the Montréal Process countries increased steadily from 1990 with around 336 million hectares to 522 million hectares in 2020. Particularly the share of protection of soil and water as a primary management objective more than doubled from around 95.3 million hectares in 1990 up to 218.8 million hectares in 2020.

While in some countries the area remained nearly constant or increased slightly, China's and the Russian Federation's designated and primarily managed areas for the protection of soil and water tripled in size from 1990 to 2020. Due to the simultaneous increase of total forest area in these two countries, the proportion of protection of soil and water of the total forest area only increased from around 10 percent to 20 percent in both countries.

Chile's area of forests designated or managed primarily for the protection of soil and water increased in the same amount as the total forest area in this country increased. Therefore, the proportion of forest for the protection of soil and water remained constant at around 24 percent.

The proportion of forests designated for the protection of soil and water in Uruguay decreased from around 75 percent to around 42 percent in 2020. However, Uruguay's area of forests designated for the protection of soil and water strongly increased from 597 thousand hectares in 1990 to 849 thousand hectares in 2020. The decline in share can therefore be explained by the extreme increase of total forest area in this country (2.5-times more forest area in 30 years).

In the United States of America, the functions for soil and water protection are included in a 'multiple use' designation which includes biodiversity conservation and social services but excludes production forestry as a primary designation. The proportion of forests designated for the protection of soil and water increased from around 54 percent in 1990 to over 59 percent in 2020 of the total forest which equates to an increase of 20 million hectares during that time. In Argentina, the conservation of soil and water resources is implemented together with the conservation of biodiversity and other purposes and is therefore not reported separately to FRA. Around 25% of the forest area is currently protected. The large increase in protected area shown in the table is a result of the Law for the Conservation of Native Forests from 2007.

What could change in the future?

Australia, Canada, Japan, the Republic of Korea, Uruguay and the United States of America expect the area of forest designated for soil and water to remain stable or, if any, expect a modest increase with new designated areas mostly to be established on state/national forest land.

China has successfully reduced erosion and run-off around major rivers with strong and successful afforestation efforts. Since natural and plantation forest area are expected to increase and there is a strict natural forest protection policy, the area of forest designated for soil and water protection can be expected to increase similarly.

Key Findings:

- There has been a steady increase of the area of forests designated or managed primarily for the protection of soil and water in the Montréal Process countries from 1990 to 2020.
- All countries reported an increase of area designated for the protection of soil and water over the past decades, conversely the proportion of designated area for the protection of soil and water of the total forest area is more variable in some countries.
- Expectations for this indicator are to remain stable or only have a modest increase in most countries.

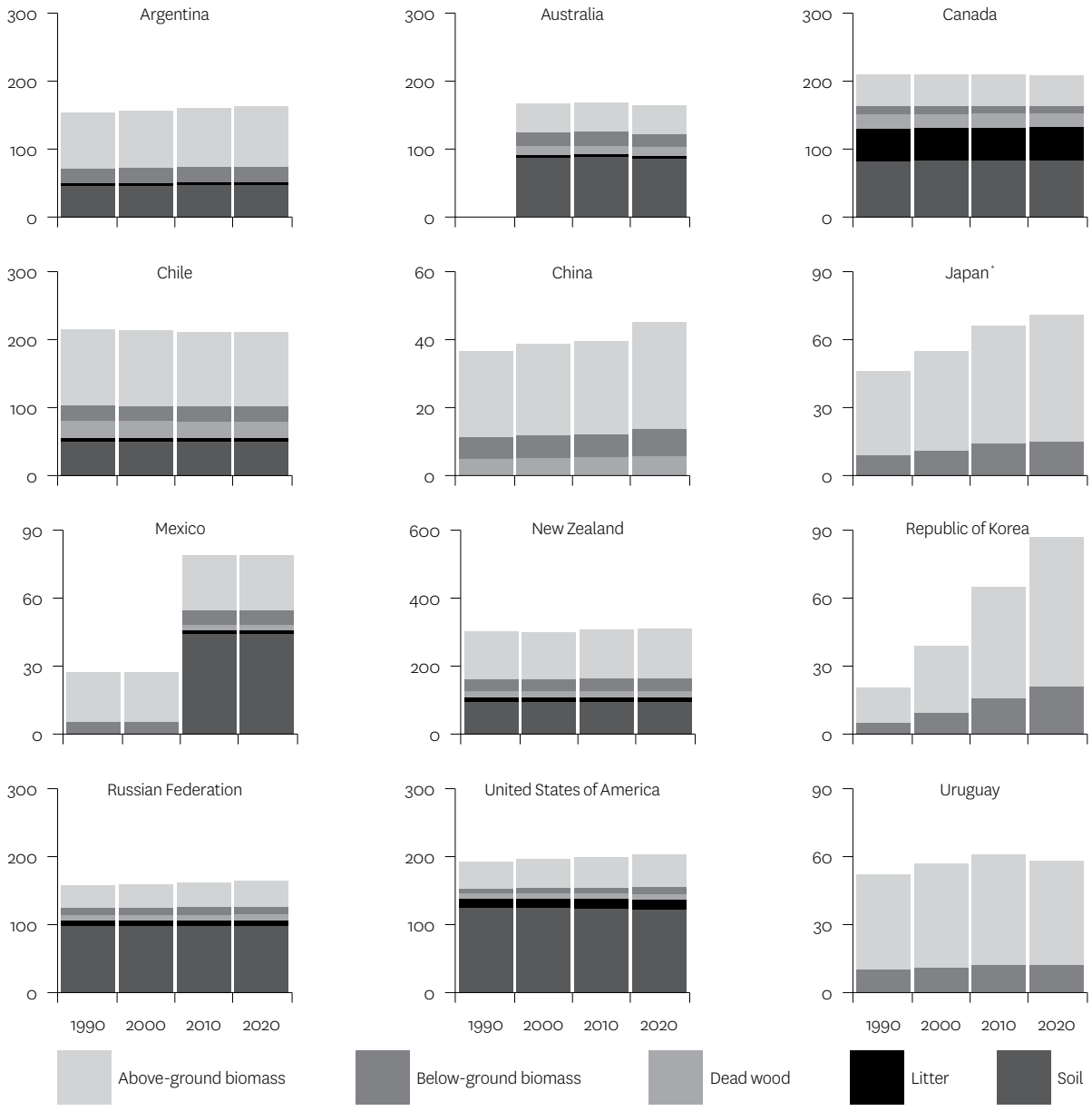
Photo: Forestry Agency of Japan – Japan

Criterion 5 – Maintenance of forest contribution to global carbon cycles

5.a Total forest ecosystem carbon pools and fluxes

Figure A.

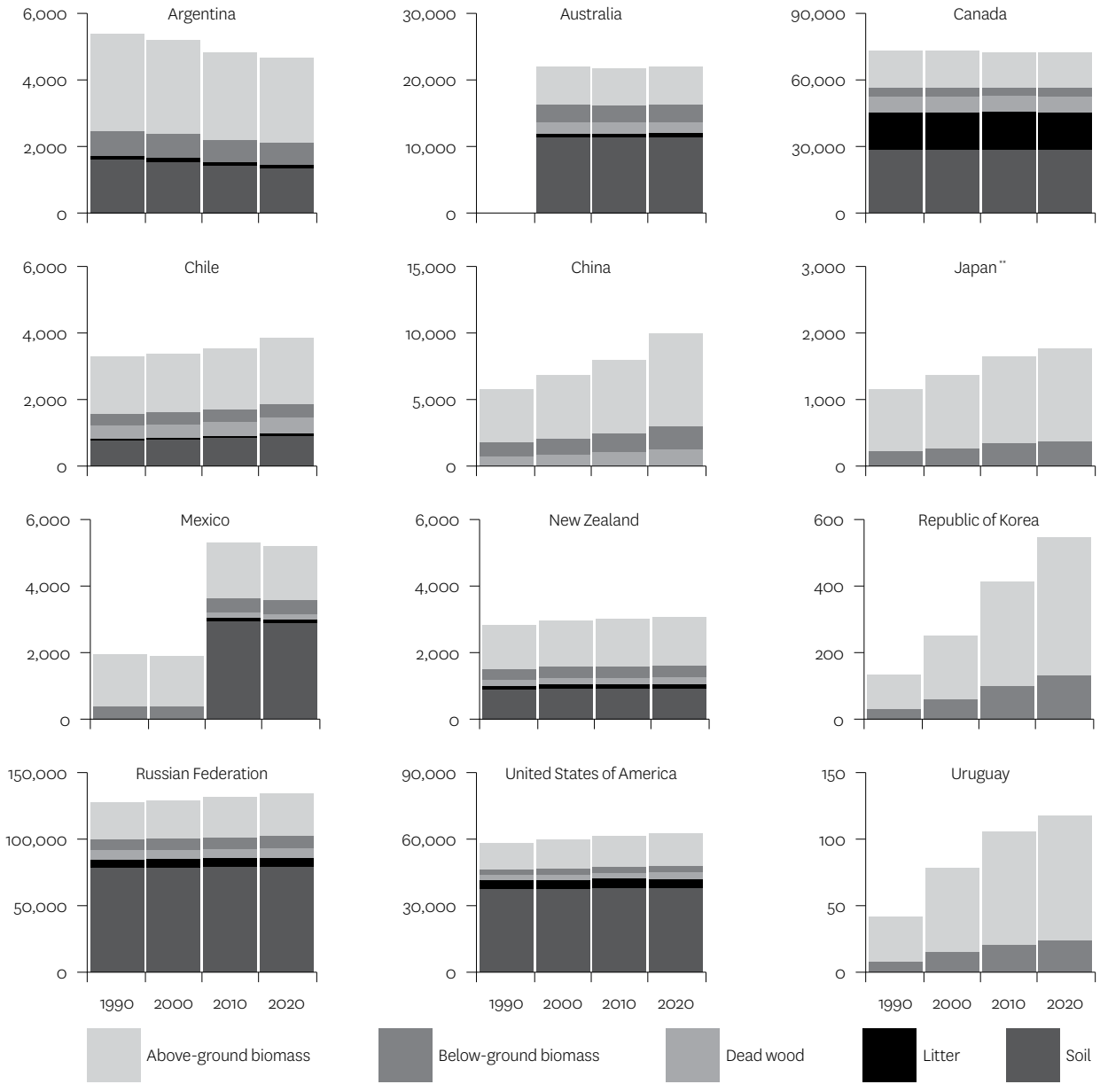
Carbon stock density, 1990, 2000, 2010, 2020 (tonnes per hectare)



** Japan reported the carbon stock density until 2017*

Figure B.

Estimated* carbon stock, 1990, 2000, 2010, 2020 (million tonnes)



* *Data is estimated by multiplying carbon stock density and total forest area.*

** *Japan reported the carbon stock density until 2017.*

Change* in carbon stock density by pool, 1990 – 2020 (%)

Country	Above-ground biomass	Below-ground biomass	Dead wood	Litter	Soil
Argentina	7.3	5.5	–	6.0	4.6
Australia	-1.8	-2.3	-2.3	-2.0	-1.4
Canada	-4.9	-4.6	-3.1	1.3	0.9
Chile	-2.5	-2.5	-2.5	-2.5	0.0
China	25.3	22.3	18.6	–	–
Japan	51.4	66.7	–	–	–
Mexico	12.1	11.7	–	–	–
New Zealand	5.3	4.3	8.1	-1.5	-0.4
Republic of Korea	321.0	326.5	–	–	–
Russian Federation	13.8	11.5	6.6	1.8	0.1
United States of America	20.6	24.9	24.4	-0.7	-1.4
Uruguay	9.4	19.4	–	–	–

** Percent change in carbon stock density between the earliest and latest measurements reported between 1990 – 2020.*

Why is this indicator important?

Forest carbon monitoring is essential because forests play a role in controlling climate change as a source and sink of carbon. Forests absorb carbon from the atmosphere through photosynthesis, and release carbon through respiration, decomposition, forest fires, and deforestation. Forest carbon stock in each pool varies widely in different climatic regions, depending on forest types and age distribution, controlled by natural and anthropogenic disturbances. Forest management and the use of forest products significantly affect the release and sequestration of carbon in the atmosphere.

What do the data show?

Figure A and the Table show changes in forest carbon stock density (tonnes per hectare) by carbon pool. Carbon stock density in aboveground biomass is consistently higher than below-ground biomass in all MP countries. Carbon stock densities in both above and below-ground biomass have increased between 1990 and 2020 in nine of the twelve MP countries. This increase is exceptionally high in East Asian countries such as the Republic of Korea (more than three-fold), Japan (more than 50%) and China (more than 20%), and the United States of America (more than 20%). In the Republic of Korea, after the successful restoration of forests in the 1970s and 1980s, biomass carbon stock density has steadily increased.

In Japan, the increase in biomass carbon stock density is mainly due to planted forest growth. Biomass carbon stock density rose more than 10% in Mexico, the Russian Federation, and Uruguay. In Canada, biomass carbon stocks have declined since 1990 primarily due to natural disturbances such as insects and fire. In most Montréal Process countries, approximately 80% (i.e., from 76 to 83%) of tree biomass carbon stock is stored aboveground, but it is slightly lower in Australia (i.e., about 68%), where arid areas dominate. Carbon stock in the soil is high in each country that reports soil carbon, particularly in high latitude, cool temperate regions such as Australia, Canada, New Zealand, the Russian Federation, and the United States of America. Forest soil carbon is a major carbon pool but is not reported in several countries.

Figure B shows the estimated changes in total carbon stock in each country by multiplying carbon stock per hectare and forest area (indicator 1.1.a). This graph shows that those countries with large forest areas have greater carbon stock, particularly in Canada, the Russian Federation and the United States of America.

What could change in the future?

Carbon stock density is controlled by several factors such as forest age distribution, forest types, various natural disturbances such as fires and pests, and human activities of afforestation, reforestation, and deforestation. The biomass carbon increase rate is expected to slow down as planted or restoration forests mature in Japan and the Republic of Korea. In China, the rise of biomass carbon is expected to continue due to the current high proportion (i.e., 64.7%) of young forests.

A steady increase in biomass carbon is expected in the United States of America, owing mainly to increased forest stocking volumes on existing forest stands, but its future direction is unclear. In Australia, forest carbon stocks will remain at the present level, except for commercial plantation forests on previously cleared agricultural land. Based on the current trends in Canada, carbon stocks in the biomass and litter pools are expected to continue to decline, while soil carbon stocks are expected to continue to increase. Carbon stocks in Canada's deadwood pool have been mostly decreasing since 2007, but recent significant natural disturbance events suggest that these stocks may start rising again. Climate change would also affect changes in potential forest growth and distribution.

Key findings:

- Carbon stock densities in above- and below-ground biomass have increased in nine of the twelve Montréal Process countries, particularly in East Asia (Republic of Korea, Japan, and China) and the United States of America.
- Carbon stock density in the soil is high, particularly in high latitudes, cool temperate regions, such as Australia, Canada, New Zealand, the Russian Federation, and the United States of America.
- Expected change in carbon stock density varies among Montréal Process countries, depending on their situation, e.g., forest age distribution, forest types, forestry activities, and various natural disturbances such as fires and pests.

Photo: Forestry Agency of Japan – Japan

Criterion 6 – Maintenance and enhancement of long-term multiple socio-economic benefits

6.1.a Value and volume of wood and wood products production

Industrial roundwood production, 2000 – 2019 (thousand m³)

Note: Data source: FAOSTAT
Figure displays Industrial Roundwood Production in Montréal Process countries on the y-axis from 2000 to 2020.

Why is this indicator important?

This indicator provides information on the volume of industrial roundwood, which includes all industrial wood in the rough (saw-logs and veneer logs, pulpwood and other industrial roundwood). In some Montréal Process countries it also includes chips, particles and wood residues. It comprises all wood obtained from removals, i.e., the quantities removed from forests and from trees outside the forest, including wood recovered from natural, felling and harvesting losses during the period.

This indicator contributes to all three pillars of sustainable development in that it is critical in understanding socio-economic benefits (i.e., employment per unit of wood harvested) and environmental benefits (i.e., quantity of wood harvested and the harvesting rate to demonstrate sustainability), as well as the economic contribution of roundwood. The values presented in this section derive from a combination of availability and demand for industrial roundwood.

What do the data show?*

In most Montréal Process countries, roundwood volume increased slightly between 2000 and 2019, with a peak occurring in 2006/7 followed by a low in 2009 driven mostly by the global financial crisis. The peak volume occurred in 2018 at 1.1 million cubic meters, representing 55% of global production. Over the last decade, most Montréal Process countries have reported stable growth and production with the exception of a few. The United States of America has consistently dominated roundwood production. Canada and the United States of America experienced a downward trend in roundwood production in the late– 2000s, driven both by the collapse of the United States of America housing market and, in Canada, by changes in roundwood availability due to mountain pine beetle infestation.

Following the global economic crisis, the upward trend in roundwood production has been driven by strong demand for solid wood products (timber and structural panels), as the United States of America housing market recovered. Nevertheless, fibre supply issues due to wildfires and insect outbreaks have influenced softwood lumber production in Canada in recent years (falling 15% from 2018 to 2020).

** Note that the data collection methodology and content vary somewhat between countries.*

Photo: Korea Forest Service – Republic of Korea

Australia, China and the Republic of Korea have experienced overall increases in roundwood production. In Australia, this was due to manufacturing, new home builds, sawn wood, panel production, paper and paper-board, and wood product exports peaking in 2015–16. In the Republic of Korea, domestic wood production increased partly due to rising demand for wood at the national level following the financial crisis in 1997, affecting the capacity to import wood. In that country, producers preferred steady domestic supplies over imported alternatives. In China, the annual volume of roundwood production showed an overall increase of 47% between 2000 and 2019 due to rapid development of plantations in southern China, contributing to sustainable growth of roundwood products.

Chile, New Zealand, Argentina and Uruguay's roundwood production increased consistently over the last two decades. Uruguay produced nearly 14 million cubic meters of roundwood in 2018 and this trend has been increasing since 2012. This increase in production is a result of wide spread afforestation efforts in the country and opening of new mills. In Argentina, the increase is a result of traditional products demand (sawn-wood, board, cellulose, certain papers, furniture) and in new applications in wooden construction and biomaterials.

Photo: Rohan Jacobsen – Australia

What could change in the future?

Australia, China, Argentina and Uruguay are forecasting continued growth and profitable log volumes. In Australia, this will depend on demands from the residential building sector. There are also supply limitations in Australia both in native forests and in plantations following recent bushfires. In China, forestry investments and promotional policies should have a positive impact as it is implementing and continuing its holistic approach to the conservation of mountain, river, forest, farmland, lake, grassland, and desert ecosystems. Japan has a target of an increased production volume for 2030 and Uruguay expects recent trends to continue. In the Republic of Korea, future domestic wood production is expected to decrease due to a slowdown in the construction industry and economic growth; competition from imported wood products will also contribute.

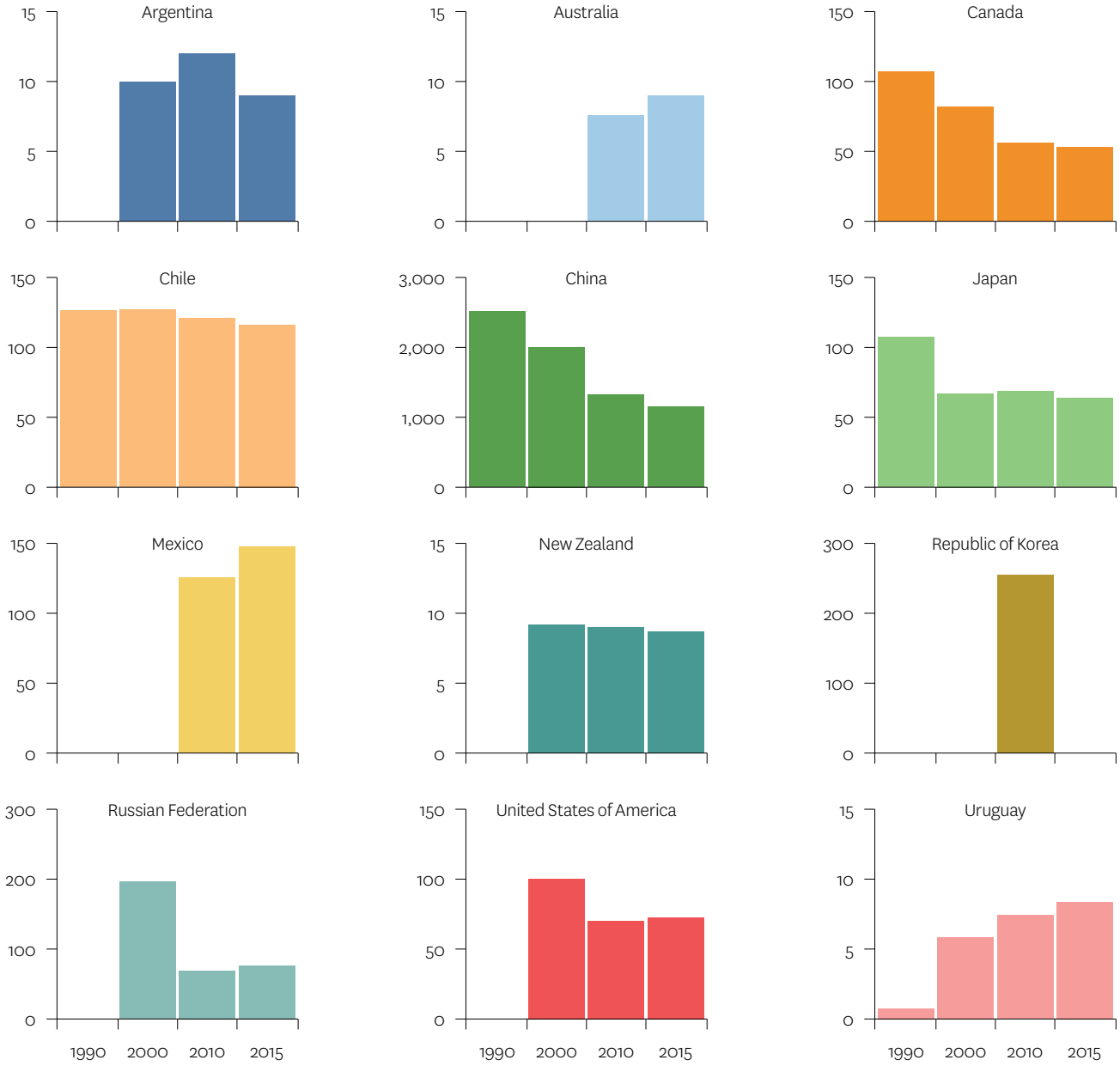
In North America, the demand for roundwood is expected to rise in large part due to the growing demand for solid wood products, particularly in the housing sector. As new residential construction grows in the United States of America, the demand for softwood lumber and structural panels from Canada will follow, increasing the demand for roundwood from Canadian mills.

Key findings:

- In most Montréal Process countries, volume of industrial roundwood production increased slightly between 2000 and 2019, with a peak occurring in 2006/2007 followed by a low in 2009 driven mostly by the global financial crisis.
- Following the global economic crisis of 2008/2009, the upward trend in roundwood production has been driven by strong demand for solid wood products.
- Most Montréal Process countries have reported stable growth and production with the exception of a few; expectations for this indicator are to increase or remain stable in most Montréal Process countries.

6.3.a Employment in forestry and logging

Employment in forestry and logging, 1990, 2000, 2010, 2015 (thousand full time equivalents)



Why is this indicator Important?

Employment in the forest sector is an important economic driver, especially in rural and Indigenous communities where other economic opportunities may be limited. It is a measure of economic, social and community well-being.

What do the data show?

The primary data source is the FRA 2020, which for this indicator includes employment in logging, silviculture and other forestry activities, support services to forestry, and the gathering of non-wood forest products. This data does not capture the full spectrum of forest-based employment and its contributions to communities and economies along the extended supply chain. The data collection methodology, coverage and content vary somewhat between countries, and for some years data were not available. As such, comparisons between these datasets should be made with caution.

When taken as a whole, the total employment across Montréal Process countries has been steadily declining throughout the reporting period, decreasing by 40% between 1990 and 2015. In some cases, country-level data external to what was submitted to the FRA was consulted and referred to in order to fill gaps in certain years' data, and to provide additional context for the trends (such as for Australia and the Republic of Korea).

Photo: Scion – New Zealand

In China and the Republic of Korea, there were reductions in forest employment numbers resulting from environmentally motivated decisions (e.g., the promotion of tourism and regeneration instead of production forestry). In the Republic of Korea, these trends varied between the national and private forest working groups. In national forests of the Republic of Korea, jobs are being created with the input of the national budget, while jobs in private forests are gradually decreasing due to the lack of investment in the forest industry. China has increasingly invested in ecological restoration programs to better protect its existing national forests and restore lands which have been degraded in the last decades. The reduction in commercial logging has resulted in a loss of employment in the conventional forest sector. Conversely, the total number and share of employees in forest cultivation (state-owned forest farms, seedling nurseries, planting stations, stations of controlling disease and pest infestation and combating desertification) have Increased during this time period.

Canada, the United States of America, and Australia, saw reduced employment because of increased mechanization, as well as sector restructuring in response to changing market conditions (e.g., decline in global paper demand, especially newsprint and printing and writing paper). Overall production has been increasing, while employment is reducing. For example, in the state of Tasmania in Australia, forest sector employment fell by almost half between 2006 and 2011; in Canada, forest sector employment decreased by 50% from 1990 to 2015, though the rate of decrease slowed between 2010 and 2015.

In Uruguay, forestry employment increased due to the development of a new pulp mill. In Argentina, though most forest sector employment is concentrated in the sawmill, boards, pulp, paper and cardboard industries, employment increased to fulfil greater management and planning needs enforced by the new forest sector legal framework (2007).

What could change in the future?

In China and the Republic of Korea, a continued decline In forestry employment is expected due to decreasing traditional wood-based forest product manufacturing. However, potential increases may occur in relation to the promotion of tourism and conservation.

In Canada, the United States of America and Australia, a continued overall reduction in employment is expected due to continued mechanization (which presumably will affect all Montréal Process countries to varying extents) and market restructuring. However, potentially significant fluctuations in forestry employment can be expected in some production sectors due to new product development and demand, modernization, and shifting market conditions. For example, in Canada, though employment in the pulp and paper product manufacturing sub-sector continued to decrease after 2015, the wood product manufacturing sub-sector grew in importance, accounting for nearly 50% of total forest sector employment in 2018.

In Uruguay, employment is expected to continue to increase due to the new pulp mill. In Argentina the hope is that the recent legal framework changes will continue to promote forest sector employment.

Key findings:

- Employment totals across all Montréal Process countries combined have been steadily declining throughout the reporting period, decreasing, on average, by 40% between 1990 and 2015. Reasons for this include increased mechanization, prioritization of environmental values over conventional forest sector resources, changing market demands and consumer preferences.
- China and the Russian Federation saw the greatest decrease in forest sector employment between 2000 and 2015, with reductions of 43% and 61%, respectively.
- In the Russian Federation, this decrease is due to a lack of qualified employees as well as forest sector reforms.
- In China, this decline was largely due to the implementation of projects aimed at protecting natural forests, industrialization and the transfer of employment from formal to non-formal forestry sectors.
- Uruguay saw the greatest rise in forest sector employment between 2000 and 2015, with an increase of 43%.
- These historical trends in both increased and decreased employment are expected to continue. However, sub-sector development and increased capacity in some countries or regions may lead to new employment opportunities in the future.

Photo: Korea Forest Service – Republic of Korea

Criterion 7 – Legal, institutional, and economic framework for forest conservation and sustainable management

7.1.a Legislation and policies supporting sustainable forest management

Why is this indicator important?

A country's legislation and policies determine its ability to effectively conserve forest ecosystems, and to ensure the sustainable management of forests to meet the needs of dependent communities and society. Legislation and policies designed to conserve and improve forest functions and values are prerequisites to achieving the sustainable management of forests.

This indicator provides information on legislation and policies, including regulations and programmes, which govern and guide forest management, operations and use.

Reporting against this indicator aims to demonstrate the strength and scope of each country's forest-related legislation and policies.

Laws, regulations and policies in Montréal Process countries cover:

- conservation of forest habitats and species;
- management of forests for cultural, social and scientific values;
- maintenance and management of ecosystem services
- the harvesting of wood and non-wood products;
- governance of management systems; and
- prohibition of illegal logging.

In some countries, legislation also ensures the ongoing public financing of the conservation and sustainable management of forests.

Photo: Korea Forest Service – Republic of Korea

What do the data show?

Montréal Process member countries vary in their approaches to applying legislation, regulation and polices towards the sustainable management of forests. All countries have national arrangements, while some countries with sub-national jurisdictions also have varying degrees of sub-national arrangements.

All Montréal Process countries reported to FRA 2020 information regarding national environmental and forest-specific policies supporting the conservation and sustainable forest management in native and plantation forests (see Figure C on following page). Ten of the twelve member countries also have similar policies at the sub-national level. The participation of stakeholders in forest policy development is also generally promoted and allowed for by Montréal Process countries.

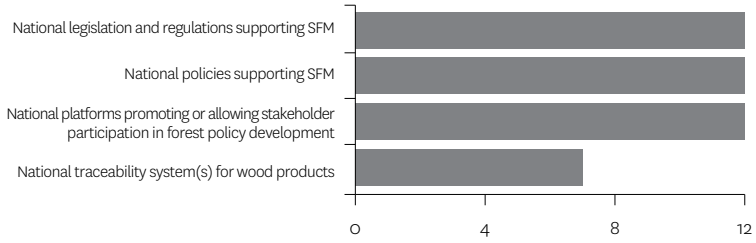
All Montréal Process member countries have national environmental and forest-specific legislation and regulations based on principles of conservation and sustainable forest management, applying to native and plantation forests (see Figure). The enforcement of these laws and regulations, and their periodic review, also form part of the legislative framework in each country. Eight of the twelve member countries also have legislation and regulations supporting sustainable forest management at the sub-national level.

Seven countries report national wood product traceability systems, and four of these also have sub-national wood product traceability systems. An eighth country operates its wood product traceability system at the sub-national level.

Codes of best practice and compliance systems relating to operations in wood production forests generally form part of the regulatory framework in Montréal Process countries. These codes and compliance systems aim to minimize impacts on ecosystems and maintain forest health and productivity. The strongest regulatory frameworks specify independent officers with powers to investigate, report findings and make recommendations to governing bodies, and address the effectiveness of environmental planning and management.

Figure C.

Number of countries having national legislation, policies, stakeholder participation mechanisms and wood product traceability systems



The member countries of the Montréal Process are participants in international agreements and processes such as the United Nations Forum on Forests, the World Trade Organisation, the Convention on International Trade in Endangered Species, the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change, and the Intergovernmental Panel on Climate Change. This participation demonstrates the commitment of Montréal Process countries to being responsible participants in matters of significance, including the sustainable management of forests.

International engagement, such as the participation by Montréal Process countries in the FAO Global Forest Resources Assessment, also assists in the creation of an enabling environment for the sustainable management of forests within member countries.

Some Montréal Process countries participate in the International Model Forest Network, by endorsing and maintaining the Principles and Attributes of Model Forests. These principles are based on flexible landscape and ecosystem management that combines the social, environmental and economic needs of local communities with the long-term sustainability of large landscapes. This involves planning and managing sustainable development of forest ecosystems in ways that also aims to improve the quality of life in marginalised or poor communities.

What could change in the future?

Legislation and policy changes may result from the increased pressures on forests from their use to generate products and services, the effects of climate change, and social drivers for greater conservation. The twelve member countries of the Montréal Process collectively manage 60% of the world's forests, including 90% of the world's temperate and boreal forests. The legislation and policies of these countries support the sustainable management of forests, and serve as a positive influence on global management practices and progress regarding the conservation and sustainable management of forests.

Key findings:

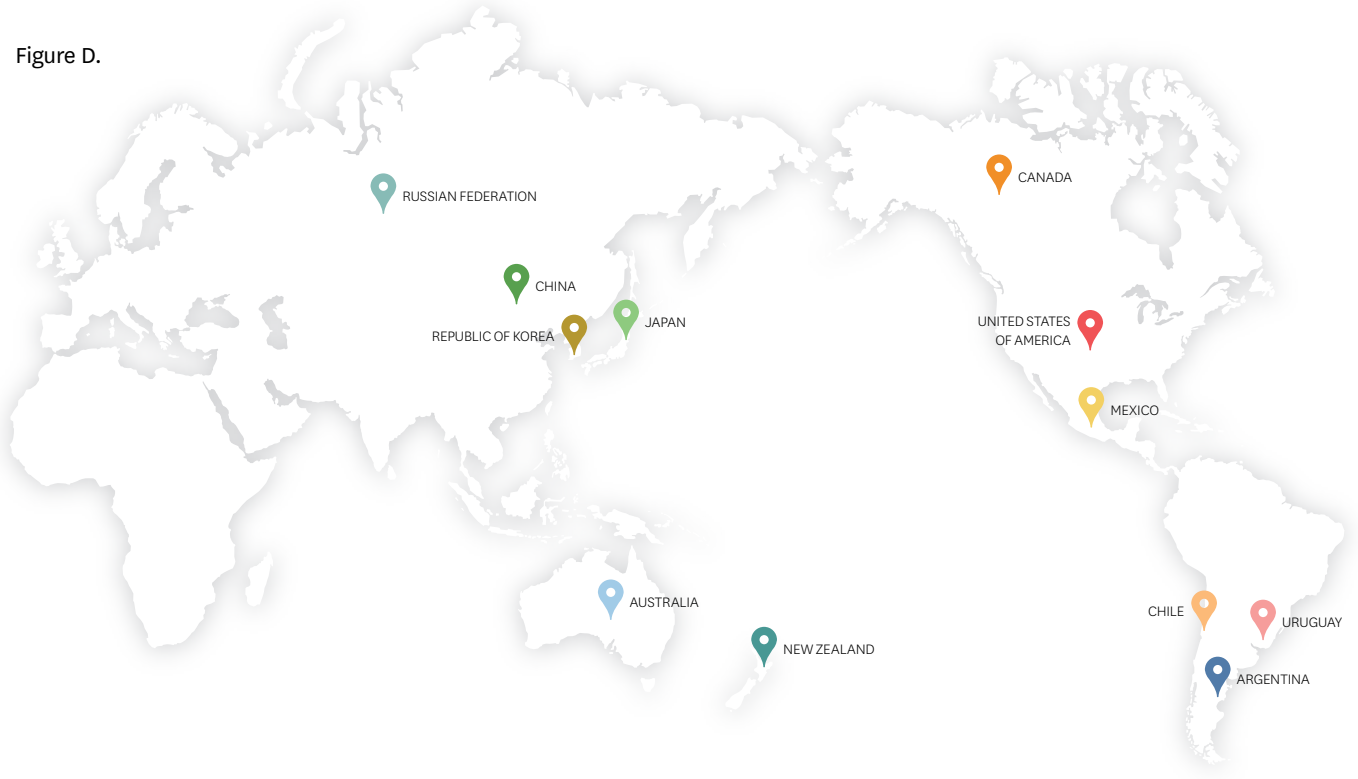
- All Montréal Process countries report national environmental and forest-specific policies supporting the conservation and sustainable management of forests.
- All Montréal Process member countries have national environmental and forest-specific legislation and regulations based on principles of conservation and sustainable forest management.
- National platforms that promote or allow for stakeholder participation in forest policy development are available in all Montréal Process countries.
- Seven countries report national wood product traceability systems, and four of these also have sub-national wood product traceability systems.

Appendix 1: The Montréal Process Working Group Criteria and Indicators framework

The Montréal Process Working Group has 12 member countries: Argentina, Australia, Canada, Chile, China, Japan, the Republic of Korea, Mexico, New Zealand, the Russian Federation, Uruguay and the United States of America (see map). Since it was established in 1995 the Working Group has developed a framework of Criteria and Indicators of Sustainable Forest Management. These have been revised over the years to culminate in the current set of seven criteria and 54 indicators (Figure D).

The criteria and indicators span all aspects of sustainable forest management and enable a comprehensive description of the state of a country's forests to be made and presented. Countries periodically publish 'Country Reports' outlining the state of their forests, generally on a 5-year cycle. The criteria and indicator set is also applied at the sub-national level.

Figure D.



Montréal Process Criteria and Indicator framework, Fourth Edition (2015)

Criterion 1: Conservation of Biological Diversity

1.1. Ecosystem Diversity

1.1.a Area and percent of forest by forest ecosystem type, successional stage, age class, and forest ownership or tenure

1.1.b Area and percent of forest in protected areas by forest ecosystem type, and by age class or successional stage

1.1.c Fragmentation of forests

1.2. Species Diversity

1.2.a Number of native forest-associated species

1.2.b Number and status of native forest-associated species at risk, as determined by legislation or scientific assessment

1.2.c Status of on site and off site efforts focused on conservation of species diversity

1.3. Genetic Diversity

1.3.a Number and geographic distribution of forest-associated species at risk of losing genetic variation and locally adapted genotypes

1.3.b Population levels of selected representative forest-associated species to describe genetic diversity

1.3.c Status of on site and off site efforts focused on conservation of genetic diversity

Criterion 2: Maintenance of Productive Capacity of Forest Ecosystems

2.a Area and percent of forest land and net area of forest land available for wood production

2.b Total growing stock and annual increment of both merchantable and non-merchantable tree species in forests available for wood production

2.c Area, percent, and growing stock of plantations of native and exotic species

2.d Annual harvest of wood products by volume and as a percentage of net growth or sustained yield

2.e Annual harvest of non-wood forest products

Criterion 3: Maintenance of Forest Ecosystem Health and Vitality

3.a Area and percent of forests affected by biotic processes and agents (e.g., disease, insects, invasive alien species) beyond reference conditions.

3.b Area and percent of forest affected by abiotic agents (e.g., fire, storm, land clearance) beyond reference conditions

Criterion 4: Conservation and Maintenance of Soil and Water Resources

4.1. Protective Function

4.1.a Area and percent of forest whose designation or land management focus is the protection of soil or water resources

4.2. Soil

4.2.a Proportion of forest management activities that meet best management practices or other relevant legislation to protect soil resources

4.2.b Area and percent of forest land with significant soil degradation

4.3. Water

4.3.a Proportion of forest management activities that meet best management practices, or other relevant legislation, to protect water related resources

4.3.b Area and percent of water bodies, or stream length, in forest areas with significant change in physical, chemical, or biological properties from reference conditions

Criterion 5: Maintenance of Forest Contribution to Global Carbon Cycles

5.a Total forest ecosystem carbon pools and fluxes

5.b Total forest product carbon pools and fluxes

5.c Avoided fossil fuel carbon emissions by using forest biomass for energy

Criterion 6: Maintenance and Enhancement of Long-term Multiple Socio-economic Benefits

6.1. Production and Consumption

6.1.a Value and volume of wood and wood products production, including primary and secondary processing

6.1.b Value of non-wood forest products produced or collected

6.1.c Revenue from forest based ecosystem services

6.1.d Total and per capita consumption of wood and wood products in round wood equivalents

6.1.e Total and per capita consumption of non-wood forest products

6.1.f Value and volume in round wood equivalents of exports and imports of wood products

6.1.g Value of exports and imports of non-wood forest products

6.1.h Exports as a share of wood and wood products production, and imports as a share of wood and wood products consumption

6.1.i Recovery or recycling of forest products as a percent of total forest products consumption

6.2. Investment in the Forest Sector

6.2.a Value of capital investment and annual expenditure in forest management, wood and non-wood forest product industries, forest-based environmental services, recreation, and tourism

6.2.b Annual investment and expenditure in forest-related research, extension and development, and education

6.3. Employment and Community Needs

6.3.a Employment in the forest sector

6.3.b Average wage rates, annual average income and annual injury rates in major forest employment categories

6.3.c Resilience of forest-dependent communities

6.3.d Area and percent of forests used for subsistence purposes

6.3.e Distribution of revenues derived from forest management

6.4. Recreation and Tourism

6.4.a Area and percent of forests available and/or managed for public recreation and tourism

6.4.b Number, type, and geographic distribution of visits attributed to recreation and tourism and related to facilities available

6.5. Cultural, Social, and Spiritual Needs and Values

6.5.a Area and percent of forests managed primarily to protect the range of cultural, social, and spiritual needs and values

6.5.b The importance of forests to people

Criterion 7: Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

7.1.a Legislation and policies supporting the sustainable management of forests

7.1.b Cross sectoral policy and programme coordination

7.2.a Taxation and other economic strategies that affect sustainable management of forests

7.3.a Clarity and security of land and resource tenure and property rights

7.3.b Enforcement of laws related to forests

7.4.a Programmes, services and other resources supporting the sustainable management of forests

7.4.b Development and application of research and technologies for the sustainable management of forests

7.5.a Partnerships to promote the sustainable management of forests

7.5.b Public participation and conflict resolution in forest-related decision making

7.5.c Monitoring, assessment, and reporting on progress towards sustainable management of forests

Appendix 2: Data and information

Table 1: Montréal Process Indicators analysed within this report with equivalent FRA 2020 and FAOSTAT variables.

Montréal Process Indicator	Equivalent FRA2020 variables
1.1.a Area of Forest	1a Extent of forest and other wooded land - forest
1.1.b Area of forest in protected areas	3b Area of forest within legally established protected areas
2.a Area of forest available for wood production	3a Designated Management Objective - production
2.c Area and growing stock of plantations	1b Forest Characteristics - plantation forest
	2a Total Growing stock - plantation forest
3.a Area affected by biotic processes	5a Disturbances by insects
3.b Area affected by abiotic processes	5b Forest area affected by fire
4.1.a Area of forest designated for protection of soil and water	3a Designated Management Objective: protection of soil and water
5.a Carbon pools and fluxes	2d Carbon stock – carbon in above ground biomass
	2d Carbon stock – carbon in below ground biomass
	2d Carbon stock – carbon in dead wood
	2d Carbon stock – carbon in litter
	2d Carbon stock – soil carbon
6.1.a Value and volume of wood and wood products production	FAOSTAT – Industrial roundwood production
6.3.a Employment	7a Employment in forestry and logging – silviculture
	7a Employment in forestry and logging – logging
	7a Employment in forestry and logging – gathering of non–wood forest products
	7a Employment in forestry and logging – support services
7.1.a Legislation supporting sustainable forest management	6a Policies legislation and national platform for stakeholder participation in sustainable forest management – policies supporting sustainable forest management (Y/N)
	6a Policies legislation and national platform for stakeholder participation in sustainable forest management – legislation &/or regulation supporting sustainable forest management (Y/N)
	6a Policies legislation and national platform for stakeholder participation in sustainable forest management – stakeholder participation platform
	6a Policies legislation and national platform for stakeholder participation in sustainable forest management – traceability system

Data

Table 1 shows the Montréal Process Indicators described in this report, and the equivalent variables captured by the Global Forest Resources Assessment. The Montréal Process has been involved with the FRA and other criteria and indicator processes in past years to develop the Collaborative Forests Resources Questionnaire designed to improve alignment between indicator processes and the FRA. This enabled this project to utilize a mix of FRA 2020 data and member country data where the report developers and country contributors deemed appropriate. The Montréal Process was closely involved with the FAO Forestry Department as part of the FRA 2020 process, and this has led to easy accessibility to combined data for the Montréal Process countries and we acknowledge the great support of the FRA team in assisting us with this access.

One major outcome of the interaction has been the development of 'custom regions' within the online FRA data portal. We were fortunate to have a specific Montréal Process region created where data from the combined group or individual countries can be displayed or downloaded for all FRA variables.

https://fra-data.fao.org/MP/fra2020/home

Other data sources were also used. For indicator 6.1.a, which focused on round wood production, we accessed data from the United Nations Department of Statistics (FAOSTAT).

https://www.fao.org/faostat/en/#home

Other data was provided by individual countries for some indicators where they felt it fitted better with the purpose of the report.

Montréal Process

September, 2023
www.montreal-process.org