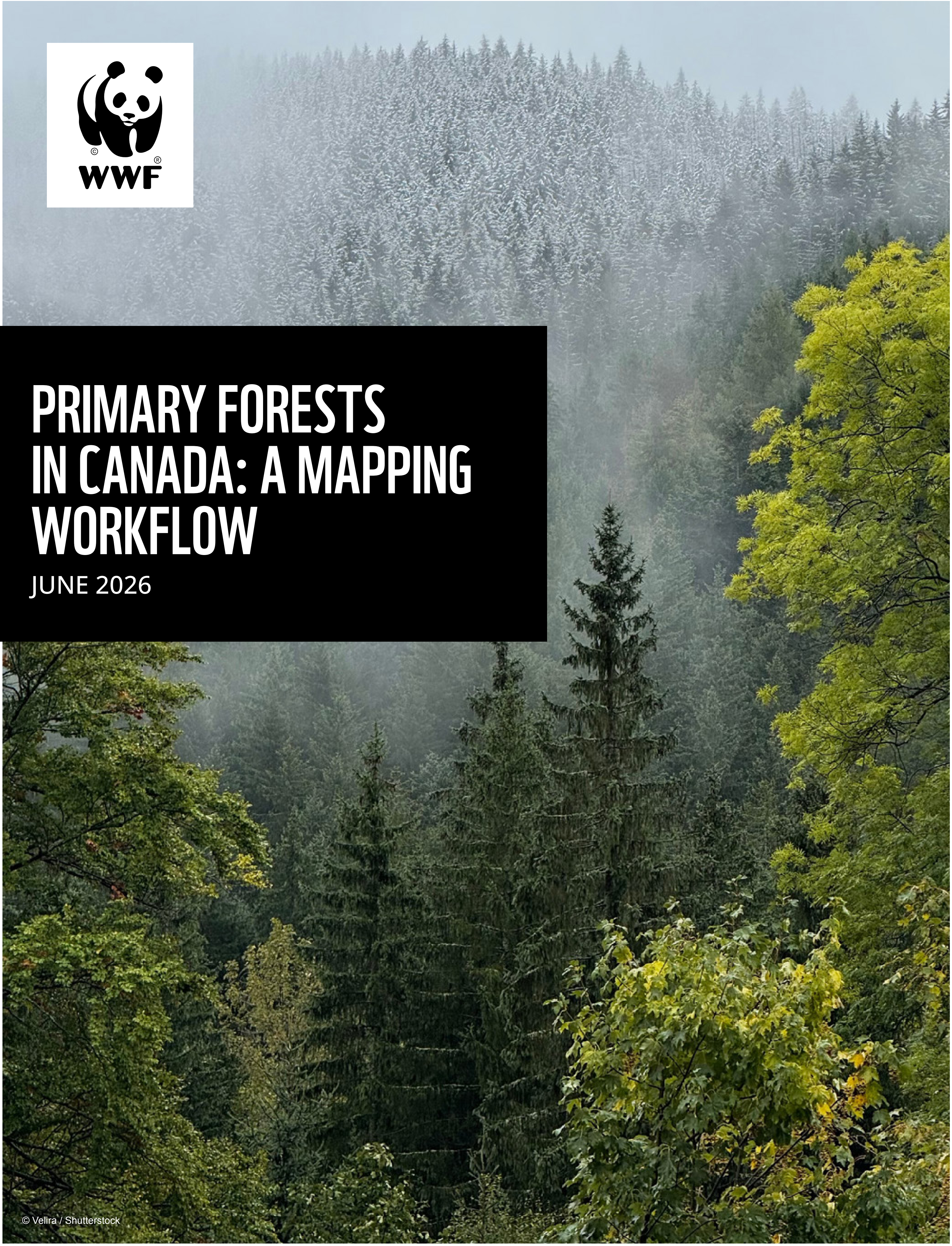

PRIMARY FORESTS IN CANADA: A MAPPING WORKFLOW

JUNE 2026

CONTENTS

INTRODUCTION

Forests in Canada play critical roles in environment, history, culture and economy, and are deeply interconnected with the lands, cultures, languages, and knowledge systems of Indigenous Peoples. These ecosystems support biodiversity, store globally significant amounts of carbon, regulate water systems, and sustain cultural practices and traditional livelihoods. However, as industrial development expands across the country, the integrity of these forests is threatened. Human activities and development have impacted nearly half of Canada's forests (FAO 2025a), making areas that remain largely undisturbed increasingly valuable.

The term "primary forest" is used in and beyond Canada to describe forests that merit special management approaches because they remain outside of the influence of human activities, and therefore retain ecological and social value. Primary forests are believed to preserve ecosystem services that are less well-maintained in disturbed forests such as biodiversity, wildlife habitat and water resources. Boreal and temperate primary forests often contain structural features such as coarse woody debris and large old trees that support biodiversity (Lindbladh et al. 2013). The absence of anthropogenic features, like roads and other linear disturbances, in primary forests is also important for the conservation of certain wildlife species such as the at-risk woodland caribou. Water resources in boreal forests in Canada are impacted by industrial development (Webster et al. 2015), and therefore intact forest watersheds such as those with a high proportion of primary forest, are likely to support high water quality (DellaSala et al. 2011). As such, primary forests may be used as a proxy for forests with high ecological integrity that provide valuable ecosystem services. Primary forests may also be important to maintain as a scientific reference for understanding natural ecosystem processes, given that ecosystems outside of human influence are becoming increasingly rare (Volle et al. 2026).

Although the Food and Agriculture Organization (FAO), an agency of the United Nations, reports national-scale estimates of primary forest area, methods vary across countries. Canada does not have a nationally accepted definition of primary forest, nor a method for directly measuring it. Instead, proxy indicators are used to estimate the area of primary forest, without identifying where primary forests are located. Cautioning that data and methodologies have changed over time, Canada's 2025 country report to the FAO estimates that 10 per cent of Canada's primary forests have been lost since 1990 (FAO 2025b), highlighting the need to understand where remaining primary forests are, so that they can be effectively stewarded. Researchers have used satellite-based approaches to map primary forests in humid tropical regions, where structural attributes can

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indicate forest disturbance (Turubanova et al. 2018). However, these methods are not as effective in boreal and temperate forests in Canada, which are naturally shaped by large-scale disturbances such as fire and insect outbreaks (Brandt et al. 2013). Satellite imagery alone is insufficient for distinguishing natural and anthropogenic disturbance drivers (Schroeder et al. 2011) and does not allow for the identification of historical disturbance drivers if the forest has regenerated.

Since it can be difficult to distinguish natural stand-replacing disturbances from human-caused ones using remote sensing data, efforts to map primary forests in Canada may be more successful using other accurate, current and historic human disturbance data sources. Unfortunately, there is no consistent dataset at a national scale, largely because provinces have jurisdiction over land use and natural resource management. This means that the accuracy and temporal scale of human disturbance data differ on a province-to-province basis and are not always publicly available. While each provincial government has some forest harvest area data, historic data is often missing.

Proposed definition of primary forest: "Forest of any age class, composed of naturally regenerated native species, undergoing natural ecological processes and subjected to natural forest disturbance dynamics, that have not been impacted by recent or major anthropogenic disturbances or usage other than traditional land use"

WWF-Canada has been working towards a reliable methodology to map primary forests in Canada. First, we commissioned Habitat, an environmental solutions company, in conducting a literature review on the criteria used to define primary forests. The recommended definition that resulted from the literature review (see text on the left) was accompanied by a proposed geospatial workflow that translates the definition into six mappable criteria. We also supported a prototype mapping methodology for structurally stable natural forests in Canada, developed by the University of Maryland Global Land Analysis & Discovery Laboratory, using satellite data (Turubanova et al. 2026). The proposed definition and prototype mapping methodology were presented at two in-person workshops hosted by WWF-Canada in January 2025, where feedback on the criteria used to define primary forests and the utility of a primary forest map was collected. Based on this feedback, and best publicly available data, WWF-Canada adapted and refined the proposed mapping workflow (Habitat 2024) as a next step towards a reliable delineation of primary forests in Canada, which could be used to advance forest conservation and stewardship. This technical report presents the updated mapping workflow, and discusses the limitations and considerations for adapting the workflow in accordance with particular use cases.

MAPPING WORKFLOW

Here, we suggest an approach to mapping primary forests in Canada, based on a set of six criteria that are aligned with the recommended definition (Habitat 2024, see page 4): 1) forest cover, 2) natural disturbance from fire, 3) anthropogenic disturbance from harvesting, 4) regeneration, 5) human pressure, and 6) other anthropogenic disturbance (Figure 1). Through this approach, all forests can be classified into the following three categories:

1. **Primary forests:** Forests meeting all criteria.
2. **Potential primary forests:** Forests that have undergone stand-replacing disturbances of unknown origin. This category aims to capture uncertainty resulting from incomplete forest disturbance data.
3. **Non-primary forests:** Forests that do not meet all criteria.

This approach also points to the best publicly available national and regional datasets for each criterion at the time of publication (Tables 1-7), and provides guidance on their use. The datasets and criteria presented in this workflow represent a starting point for identifying primary forests. Users are encouraged to augment the suggested datasets with their own best available data sources to further refine the mapping for regional and/or specific conservation applications.

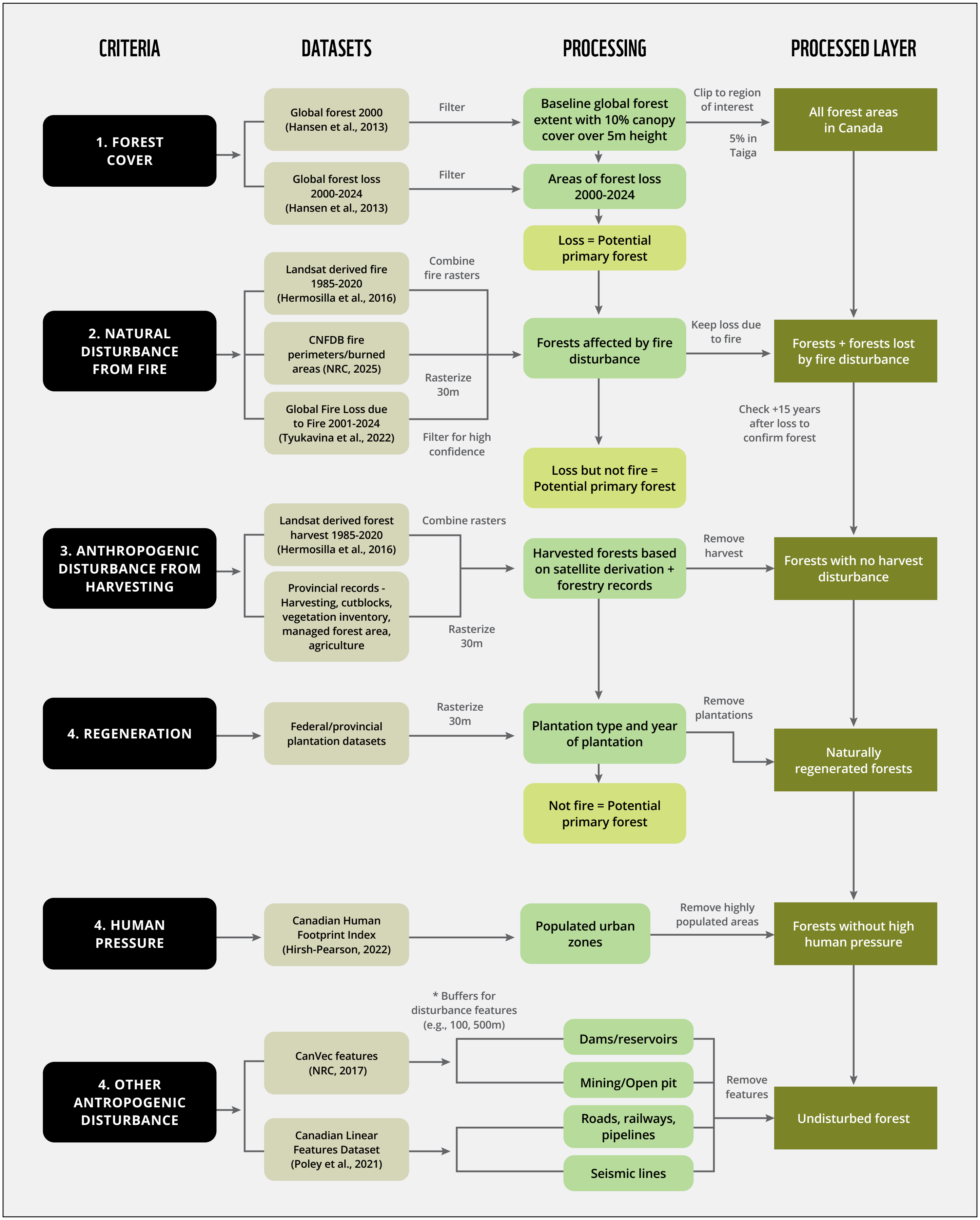

Figure 1. Primary forest mapping workflow.

CRITERION ONE: FOREST COVER

Mapping primary forests in Canada begins with a map of all forests: "Forests of all age classes" (Habitat 2024). Total forest cover can be mapped using a global forest layer for the year 2000, which classifies all areas with trees taller than five metres as forest (Hansen et al. 2013; Table 1). Many accepted definitions of "forest" use a canopy cover threshold to eliminate areas with very few trees from being counted as forest (FAO 2023). To account for variations in canopy cover across the Canadian landscape, we suggest applying a five per cent canopy cover threshold to the naturally sparser forests in the northern taiga ecozones and the Hudson James Bay lowlands, and applying a 10 per cent canopy cover threshold in other ecozones (Figure 2). After this first step, all areas that have forest cover are initially classified as primary forest. In the subsequent steps, forests that do not meet each criterion are reclassified as potential primary forest or non-primary forest.

Table 1. Forest cover dataset details.

Dataset	Spatial Data Description	Source
Global Forest Change v1.11 (2000-2023)	Global 30-metre raster containing forest cover and change data at a minimum height of five metres since 2000.	(Hansen et al. 2013)

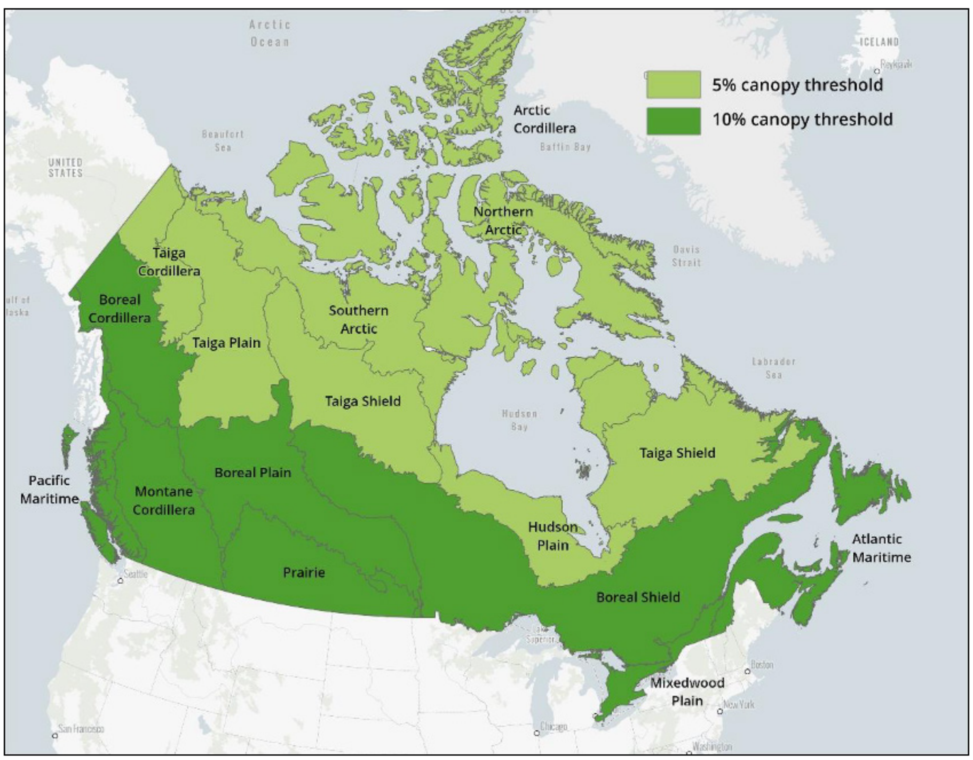

Figure 2. Northern (light green) and southern (green) forests with 5% and 10% canopy cover thresholds applied, respectively.

An important element of identifying primary forests is distinguishing drivers of forest loss. To attribute forest loss in criteria two and three, the global forest change layer (Hansen et al. 2013) is first used to identify forest areas that were lost from 2000 to 2023, due to various natural and anthropogenic causes. Since this layer does not identify whether the forest was lost because of natural disturbance or human disturbance, these areas are temporarily classified as 'potential primary forest'. If it is determined (after criterion two) that the disturbance driver was natural and (after criterion four) that they regenerated naturally, these areas are reclassified as primary forest.

CRITERION TWO: NATURAL DISTURBANCE FROM FIRE

The definition of primary forest includes forests that are "undergoing natural ecological processes and subjected to natural forest disturbance dynamics" (Habitat 2024). This means that forests that have burned should still be classified as primary. Disturbance from forest fire can be mapped using a combination of satellite and record-based fire datasets (Table 2). Polygon datasets are rasterized to 30-metre resolution and aligned for further processing. One of the datasets, the global forest loss due to fire (GLAD) dataset (Tyukavina et al. 2022), contains a measure of uncertainty that can be used as a filter to isolate areas where there is high confidence that the loss is from fire. From this dataset, all forest loss areas with values of four (considered high confidence for fire-driven loss) are reclassified from potential primary forest to primary forest.

All of the areas identified as forest loss due to fire from all available datasets are classified as primary forest in alignment with the definition. This includes any areas that overlap with areas identified as forest loss between 2000 and 2023 that were categorized as potential primary forest in criterion one. Any areas of loss that are not within the fire disturbance datasets remain in the potential primary forest category.

Table 2. Natural disturbance from fire dataset details.

Dataset	Spatial Data Description	Source
Global forest loss due to fire (2001-2024)	Global 30-metre forest cover loss due to fire map, distinguishing between fire and non-fire forest loss drivers. Includes a measure of uncertainty.	(Tyukavina et al. 2022)
Canadian National Fire Database (1980-2024)	Records of fire perimeters in polygon format collected from Canadian fire management agencies (provinces, territories and Parks Canada).	(Canadian Forest Service 2024a)
National Burned Areas Composite (1972-2024)	Canada-wide 30-metre composite raster with burned areas by year since 1972, evaluated from best available sources.	(Canadian Forest Service 2024b)
Canada Landsat Derived Wildfire (1985-2022)	Landsat-derived 30-metre raster containing stand-replacing wildfire disturbances that occurred from 1985 to 2022.	(Hermosilla et al. 2016)

Forests affected by fire are assumed to return naturally to a forested state within 15 years (Bartels et al. 2016). Exceptions include if the forest has been disturbed to the point that natural regeneration is unlikely, or if another disturbance has removed the forest again. Areas burned in the years leading up to 2000 may not appear as forest in the forest baseline since they may not be tall enough (i.e. five metres) or dense enough (10 per cent canopy cover, or five per cent in northern ecozones), but it is still important to capture them as forests. These forests should be re-included in the baseline forest layer if they have returned to a forested condition in later years. Similarly, areas that have burned but have not regenerated within the expected time frame should be removed from the baseline forest. To capture these areas, we apply a check for each fire dataset using a global tree canopy height dataset for 2019 (Potapov et al., 2021; Table 3) while applying the following logic of 15–20-year recovery to a minimum canopy height of five metres:

- **Fires 1985 - 1999** — should be recovered in the 2019 tree canopy cover > five metres; if tree canopy has recovered it will be added to the forest baseline and considered as primary forest, if not it will be removed.

- **Fires 2000 – 2004** — if not recovered in the 2019 tree canopy cover dataset, will be removed from the baseline forest layer.

Table 3. Dataset details to check forest regeneration after fire.

Dataset	Spatial Data Description	Source
Global Forest Canopy Height (2019)	Global 30-metre forest canopy height raster derived from GEDI (LiDAR) and Landsat data for 2019	(Potapov et al. 2021)


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CRITERION THREE: ANTHROPOGENIC DISTURBANCE FROM HARVESTING

In accordance with the definition, primary forest should not include forest that has "been impacted by recent or major anthropogenic disturbances, or usage other than traditional land use" (Habitat 2024). As such, this step identifies forest that is not primary forest because it has been commercially harvested. A variety of satellite and record-based harvest datasets support this criterion (Table 4). Polygon datasets are rasterized and aligned for further processing. National and provincial datasets can include clear-cut and partial harvesting activities, with historical records going as far back in time as possible.

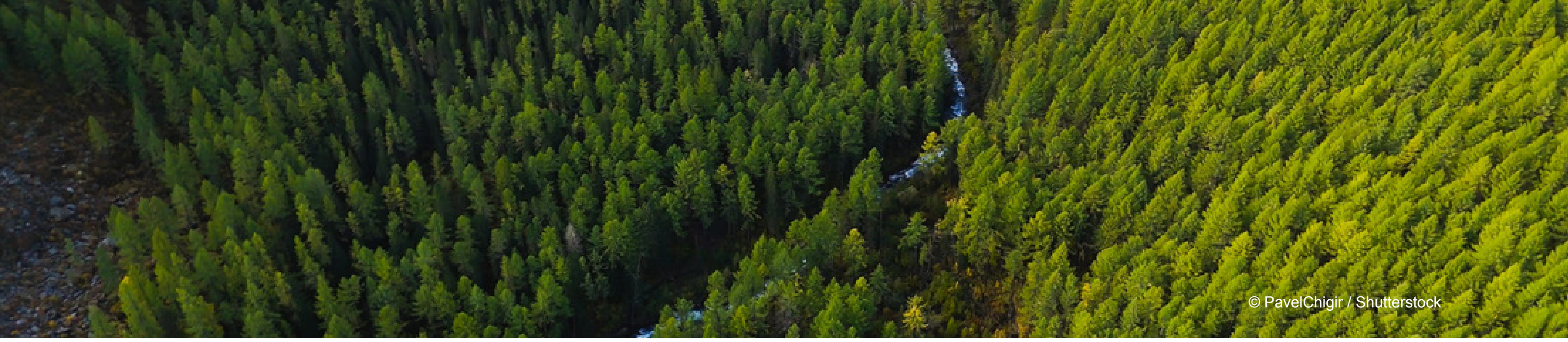
Although harvest records have higher accuracy than satellite-derived datasets, provincial harvest datasets differ across provinces in terms of temporal coverage, completeness and public availability. The best available data are gathered and merged to support this methodology. Harvest record datasets from Alberta, B.C., Ontario, Quebec, New Brunswick, Newfoundland and Labrador, and Yukon were identified. To our knowledge, no data is available from Saskatchewan, Manitoba, Nova Scotia, Prince Edward Island, Nunavut and Northwest Territories.

A national satellite-derived harvest dataset (Hermosilla et al. 2016) can be used to make up for incomplete records. This dataset uses the Composite2Change (C2C) approach to distinguish between drivers of forest loss (e.g., differentiate harvest, fire, and so forth) using an object-based random forest classifier rooted in spectral, temporal and geometric properties. This model accurately detected disturbance 89 per cent of the time, and when it detected disturbance, it was able to accurately identify the cause 92 per cent of the time.

All identified harvest areas (satellite and record-based) are reclassified as non-primary forest.

Table 4. Anthropogenic disturbance due to harvesting dataset details.

Data Scale	Dataset	Spatial Data Description	Source
National	Canada Landsat Derived Forest Harvest Disturbance (1985-2022)	Landsat-derived 30-metre raster containing stand-replacing harvest disturbances from 1985 to 2022.	(Hermosilla et al. 2016)
Provincial	Alberta Vegetation Inventory (AVI) Crown (1968-2021)	Aerial imagery-based inventory containing type and condition of vegetation in Alberta, includes harvesting records since 1968.	(Government of Alberta 2022)
Provincial	BC Forest Tenure Harvest (Cutblock) Polygons (FTA 4.0) 2025	Operational harvest activities for cutblocks within harvesting authorities in British Columbia, records as early as 1900.	(Government of British Columbia 2025)
Provincial	NB Crown Forest Management Plan Harvest Blocks (2022)	Harvesting from Crown timber licenses in New Brunswick since 2012.	(Government of New Brunswick 2022)
Provincial	NB Stand Improvements (2005 – 2025)	Silviculture records of stand improvement treatments (precommercial thinning, plantation cleaning) on private woodlots and Crown land since 2005.	(Government of New Brunswick 2023a)
Provincial	NB Vegetation Management (1969 – 2024)	Historical silviculture records of herbicide treatment on private woodlots and Crown land since 1969.	(Government of New Brunswick 2023b)
Provincial	Newfoundland Harvest (1976-2006, 2020-2024)	Harvest records in Newfoundland.	(Government of Newfoundland and Labrador 2024a)
Provincial	Labrador Harvest (1976-2006, 2020-2024)	Harvest records in Labrador.	(Government of Newfoundland and Labrador 2024b)
Provincial	Ontario Harvest (2002-2023)	Harvest records in Ontario including clear cut, shelterwood and selection cutting.	(Ontario Ministry of Natural Resources and Forestry 2024)
Provincial	Quebec Harvest (1855 – 2025)	Harvesting and other forestry operations (thinning, reforestation) since 1855. Dataset is split into activity before and since 1976.	(Government of Quebec 2017a)
Provincial	Quebec Infrastructure clearings (2003-2022)	Infrastructure in forest areas since 2003; where trees were removed for infrastructure development and purposes other than logging.	(Government of Quebec 2017b)
Provincial	Yukon Historic Silviculture Inventory - 50k (1970-2022)	Forest clearing boundaries for harvest in Yukon.	(Government of Yukon 2022)



CRITERION FOUR: REGENERATION

In accordance with the definition, primary forests are "composed of naturally regenerated native species," which exclude forests that were artificially regenerated such as tree plantations and artificially-seeded areas. Available plantation datasets from provincial sources (Table 5) are rasterized and these areas are reclassified as non-primary forest.

Table 5. Regeneration dataset details.

Dataset	Spatial Data Description	Source
Reforestation in New Brunswick (2005-2023)	Location of reforestation (plantation) treatments on private woodlots and provincial Crown Lands in New Brunswick.	(New Brunswick Department of Natural Resources 2023)
Reforestation/plantation in Ontario (2002-2022)	Renewal (planting, seed and natural declaration) areas from Ontario forest management information records.	(Ontario Ministry of Natural Resources and Forestry 2024)
Ecoforestry inventory of Southern Quebec (1970 – 2024)	Forest inventory map derived from aerial photography containing ecological characteristics and disturbances. Includes plantation records.	(Government of Quebec 2026)

CRITERION FIVE: HUMAN PRESSURE

In addition to areas that have been commercially harvested, other areas that have experienced "recent or major anthropogenic disturbances or usage other than traditional land use" should not be classified as primary forest. The Canadian Human Footprint dataset (Hirsh-Pearson et al. 2022a) includes a population density raster. By selecting areas with the population density sub-index value of one, all areas with a population density of around one person per square kilometre or higher are reclassified as non-primary forest.

Table 6. Human pressure dataset details.

Dataset	Spatial Data Description	Source
Canadian Human Footprint Index	300-metre raster including a cumulative measure of human pressure and 12 sub-indices of anthropogenic pressure. The population density sub-index was used in this workflow.	(Hirsh-Pearson et al. 2022b)

CRITERION SIX: OTHER ANTHROPOGENIC DISTURBANCE

Using the same logic as with criterion five, to eliminate other areas that have experienced "recent or major anthropogenic disturbances or usage other than traditional land use," a variety of other anthropogenic disturbance features (Table 7) are reclassified as non-primary forest. This includes point features like mines, dams, cities and towns; linear features like roads, railroads, and seismic lines; and other polygon infrastructure features. These features are buffered and reclassified as non-primary forest. See below for a discussion about buffer considerations.

Table 7. Other anthropogenic disturbance dataset details.

Dataset	Spatial Data Description	Source
Canadian Linear Features Dataset	Compilation dataset of global, national and regional road datasets in Canada, and seismic lines.	(Poley et al. 2022)
Canadian Pipelines	Canada's oil and gas pipeline network.	(Canada Energy Regulator 2022)
CanVec – Manmade Features	Manmade features from the CanVec data series, including dams.	(Natural Resources Canada 2025a)
CanVec – Resource Management Features	Resource management features from the CanVec data series, including powerlines, pipelines, and oil and gas sites.	(Natural Resources Canada 2025b)
CanVec – Transport Features	Transport features from the CanVec data series, including rail stations and railway tracks from the National Railway Network (NRWN).	(Natural Resources Canada 2025c)
Principal Mineral Areas, Producing Mines and Oil and Gas Fields (900A)	Locations of significant metallic, nonmetallic and coal mines, oil sands mines, selected metallurgical works, helium facilities, and oil and gas fields.	(Natural Resources Canada 2025d)

DISCUSSION

This report introduces an adaptable geospatial methodology for identifying primary forest in Canada, designed for use with best available national and regional datasets. The effectiveness of the workflow depends on the quality, completeness and temporal distribution of the disturbance data used. In particular, the absence of comprehensive national-scale harvest datasets, as well as incomplete information on non-fire natural disturbances (e.g. insects, disease, windthrow) limits the ability to confidently classify all forest areas. Until improved national datasets become available, the workflow is most appropriately applied at sub-national scales, where higher-resolution provincial, territorial, or Indigenous data can improve accuracy.

NATURAL VERSUS ANTHROPOGENIC DISTURBANCE

In this workflow, fire is considered a natural disturbance regardless of ignition source, reflecting its ecological role in boreal and temperate forest dynamics, and aligning with established methods to map intact forest landscapes in Canada (Conservation Biology Institute 2018). Burned areas are therefore categorized as primary forests if forests regenerate 15-20 years after the fire. Climate change is altering fire regimes and increasing the likelihood of frequent and severe fires, making it challenging to distinguish climate-amplified events from natural variation. Future refinements may be needed as attribution science advances.

Classifying forests as naturally or anthropogenically disturbed remains a major challenge. Although Landsat-derived harvest datasets and provincial harvest records substantially improve disturbance attribution, satellite imagery alone cannot consistently distinguish between logging, wildfire, insect outbreaks, or overlapping disturbance events, especially before 1985. This limitation reinforces the value of incorporating multiple data sources and field validation where possible.

Even where high-quality datasets exist, historical anthropogenic disturbances predating satellite monitoring may remain undetected. Early logging, for example, has had persistent effects on forest structure and composition, shifting forests towards younger, early-successional stands and reducing old-growth representation (Grondin et al. 2018). These legacy effects highlight the importance of recognizing that forests appearing undisturbed in contemporary imagery may still reflect long-term human influence, particularly in areas with centuries of forest use.

In addition to harvest and other direct anthropogenic disturbances, varying levels of human pressure can influence the ecological integrity of forests and therefore shape how primary forests should be identified and interpreted. The Canadian Human Footprint Index provides a measure of cumulative human influence, but for the purposes of this workflow, only the population sub-index is used, given the availability of higher-resolution datasets for roads and infrastructure. Selecting the population sub-index value of one removes all census blocks that have a population density of around one person per square kilometre or higher. Users may adjust the population density threshold depending on their objectives. More restrictive thresholds (lower number, lower density of people per square kilometre) may help exclude areas where low-density human presence affects wildlife behaviour or ecological integrity, while more inclusive approaches (higher number, higher density of people per square kilometre) may be suitable for identifying near-primary forests in otherwise disturbed and fragmented landscapes.

Importantly, Human Footprint Index values should be interpreted with care in regions where Indigenous communities reside, as population-based exclusion risks misclassifying Indigenous cultural landscapes surrounding communities as non-primary despite the absence of industrial disturbance. This issue highlights the importance of incorporating Indigenous knowledge, data, and perspectives into primary forest mapping approaches.

INDIGENOUS STEWARDSHIP

Indigenous stewardship and traditional land use form an essential part of forest history and condition. These activities do not disqualify an area from being primary forest under the adopted definition. Consequently, forests traditionally used by Indigenous communities are retained in the primary forest category, unless they overlap with other anthropogenic disturbances, such as industrial infrastructure. Incorporating Indigenous knowledge and data, particularly at sub-national scales, would substantially strengthen the delineation of primary forests and contribute to more culturally grounded outputs.

NATURAL VERSUS ARTIFICIAL REGENERATION

Datasets delineating plantations and artificially regenerated areas remain incomplete. A global natural and planted forest dataset is available (Xiao 2024), but we chose not to incorporate it given its reliance on predictive AI rather than government records (Xiao et al. 2024). As more provincial datasets on forest regeneration become publicly available, the accuracy of this component of the workflow will continue to improve.

POTENTIAL PRIMARY FORESTS – ADDRESSING UNCERTAINTY

A significant contribution of this methodology is the explicit separation of primary, non-primary and potential primary forests. This approach provides transparency around the limitations of current data, particularly for disturbances such as insect outbreaks, disease and windthrow, that are rarely captured in provincial inventories. Insects alone affected 11.6 million hectares of forests in 2023 (Natural Resources Canada 2026). Without these data, certain instances of forest cover loss cannot confidently be attributed to either anthropogenic or non-anthropogenic causes, and therefore cannot be categorized within the binary of primary forest or non-primary forest. The potential primary forest category ensures that areas of unclassified forest loss are not prematurely excluded and can be prioritized for further assessment or field validation.

BUFFER AND PATCH SIZE CONSIDERATIONS

Buffers around anthropogenic features are needed to account for ecological impacts of human disturbances that extend beyond their direct physical footprint. Appropriate buffer distances can vary depending on the purpose of the mapping exercise and/or regional considerations, such as species of concern. While chemical and nutrient pollution and edge effects can extend up to 100 metres from roads (Laurance et al. 2009), larger buffers may be necessary for wildlife sensitive applications and around other disturbance types. For example, a study on grizzly bear demography in Alberta found that most grizzly bear mortalities occurred within 500 metres of a road (Boulanger and Stenhouse 2014). A 500-metre buffer is also applied on anthropogenic features when mapping caribou habitat disturbance, accounting for increased predation and avoidance (Environment and Climate Change Canada 2020). It has been suggested that caribou may avoid industrial disturbances, such as mines and well sites, by several kilometers (Venier et al. 2014). These examples illustrate that no single buffer distance is universally appropriate. See Habitat (2024) for proposed buffers around various anthropogenic features supported by scientific literature.

The appropriateness of different buffer sizes depends on the intended use of the primary forest map. More inclusive approaches that use narrower buffers may be useful for identifying potentially high-value forest remnants in heavily disturbed landscapes, while more exclusive approaches that apply wider buffers may be preferable when assessing the proportion of forests outside human influence for purposes like international reporting. As a baseline, we recommend applying at least a 100-metre buffer, given the well-documented edge effects in boreal and temperate forests. However, because anthropogenic disturbances often exert ecological impacts far beyond 100

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metres, further work is needed to determine context-appropriate buffer distances, particularly for standardizing reporting and ensuring comparability across regions and applications.

An additional optional, but recommended, step is to apply minimum size, width and corridor criteria to the primary forest patch areas. Criteria for mapping Intact Forest Landscapes include a 50,000-hectare minimum patch size, 10-square kilometre width, and two-kilometre corridor width (Potapov et al. 2017). These thresholds for intact forest landscapes are likely larger than what would be needed for a primary forest mapping approach. As with buffers, defining thresholds involves trade-offs between recognizing small but ecologically important remnants and emphasizing larger, contiguous tracts of primary forest. These decisions inevitably influence the amount and distribution of primary forest identified and the credibility of the resulting layer.

While the primary forest definition underpinning this workflow does not specify patch size criteria, primary forests must be large enough to allow natural ecological processes to occur (Habitat 2024). A minimum patch size of at least 0.5 hectares would be consistent with the FAO's definition of a forest (FAO 2023). Larger patches may support more complete ecological processes and interior habitat conditions. For example, forest patches larger than five hectares may be required to support communities of old-forest birds (Venier et al. 2014), and larger connected patches are often required to conserve umbrella species (Roberge and Angelstam 2004). However, small patches within otherwise disturbed landscapes can function as important refugia, and therefore play an important role in supporting biodiversity, especially if efforts are made to reconnect isolated patches (Wintle et al. 2019). Adding minimum width criteria ensures that long, narrow forests are not classified as primary, because these shapes cannot sustain intact ecological processes. Corridor width criteria ensure that very narrow corridors, which are vulnerable to edge effects, are excluded. Without universally accepted standard minimum size, width and corridor criteria for primary forests, the appropriate thresholds depend on regional ecological conditions and the intended use of the primary forest map.

ACCOUNTING FOR NON-FOREST FEATURES

Finally, the workflow described here does not account for natural non-forest features, such as lakes, non-treed wetlands, rivers and rocky outcrops, that inherently fragment Canadian forest landscapes. Incorporating these features into the initial forest mask is essential if the goal is to map primary forest landscapes rather than individual forest polygons. In this context, the concept aligns closely with intact forest landscape mapping, which explicitly incorporates environmental heterogeneity of forested ecosystems (Potapov et al. 2017). Including natural non-forest features in the primary forest layer is also important to consider in the context of applying a minimum patch size criterion, because the user must determine what proportion of primary forest can be made up of these features. For example, the user may want most lakes to be included within primary forest patches but may not want a large lake adjacent to a relatively small area of forest cover to be identified as a primary forest patch.

CONCLUSION

This report presents an adaptable and transparent workflow to delineate primary, non-primary and potential primary forests in Canada using best available national and regional datasets. Any primary forest map can only be as accurate as the data underpinning it. Because no national-scale dataset currently provides reliable, temporally consistent information on key disturbance drivers — such as forest harvesting, windthrow and insect damage — the final product will always be subject to a level of uncertainty.

The workflow presented in this report should be interpreted as a practical and flexible framework rather than a definitive solution. By integrating best available national datasets with finer-resolution provincial and regional information, the methodology offers a credible approach to delineate primary forests at sub-national scales, while accounting for areas where the drivers of forest loss are uncertain.

Finally, while primary forest area remains an important indicator for conservation planning and stewardship, it doesn't capture the full spectrum of degradation or ecological integrity on its own, especially given national-scale data constraints. We therefore recommend pairing primary forest maps with ecological integrity metrics and Indigenous indicators of forest condition to accurately inform conservation planning and stewardship activities.

LITERATURE CITED

Bartels, S. F., H. Y. H. Chen, M. A. Wulder, and J. C. White. 2016. Trends in post-disturbance recovery rates of Canada's forests following wildfire and harvest. Forest Ecology and Management 361:194–207.

Boulanger, J., and G. B. Stenhouse. 2014. The Impact of Roads on the Demography of Grizzly Bears in Alberta. PLOS ONE 9:e115535.

Brandt, J. P., M. D. Flannigan, D. G. Maynard, I. D. Thompson, and W. J. A. Volney. 2013. An introduction to Canada's boreal zone: ecosystem processes, health, sustainability, and environmental issues. Environmental Reviews 21:207–226.

Canada Energy Regulator. 2022. Canadian Pipelines. Dataset, ArcGIS Online, https://www.arcgis.com/home/item.html?id=4e036b4f61a142a49e402bd781087876.

Canadian Forest Service. 2024a. Canadian Wildland Fire Information System. Canadian National Fire Database – Agency Fire Data, Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, Canada. https://cwfis.cfs.nrcan.gc.ca/datamart/metadata/nfdbpoly.

Canadian Forest Service. 2024b. Canadian Wildland Fire Information System. National Burned Area Composite (NBAC), Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, Canada. https://cwfis.cfs.nrcan.gc.ca.

Conservation Biology Institute. 2018, January 5. Canada's Intact Forest Landscapes. Data Basin.

DellaSala, D. A., J. R. Karr, and D. M. Olson. 2011. Roadless areas and clean water. Journal of Soil and Water Conservation 66:78A-84A.

Environment and Climate Change Canada. 2020. Amended recovery strategy for the Woodland Caribou (Rangifer tarandus caribou), Boreal population, in Canada. Government of Canada, Ottawa, Canada.

FAO. 2023. Terms and Definitions FRA 2025. Rome, Italy.

FAO. 2025a. Global Forest Resources Assessment 2025. FAO , Rome, Italy.

FAO. 2025b. Global Forest Resources Assessment 2025 – Canada Country Report. Rome, Italy.

Government of Alberta. 2022. Alberta Vegetation Inventory (AVI) Crown. Dataset, https://geodiscover.alberta.ca/geoportal/rest/metadata/item/100b275712b442acbda4a0358d8a4951/html.

Government of British Columbia. 2025. Forest Tenure Cutblock Polygons (FTA 4.0). https://catalogue.data.gov.bc.ca/dataset/forest-tenure-cutblock-polygons-fta-4-0.

Government of New Brunswick. 2022. Crown Forest Management Plan Harvest Blocks. Dataset, https://gnb.socrata.com/Lands-Forests-and-Wildlife/Crown-Forest-Management-Plan-Harvest-Blocks-Plan-d/7b72-tudg.

Government of New Brunswick. 2023a. Stand Improvement. Dataset, https://hub.arcgis.com/datasets/NBDNR::stand-improvement-am%C3%A9lioration-des-peuplements.

Government of New Brunswick. 2023b. Vegetation Management. Dataset, https://hub.arcgis.com/datasets/NBDNR::vegetation-management-gestion-de-la-vegetation.

Government of Newfoundland and Labrador. 2024a. Harvest - Newfoundland. Dataset, https://geohub-gnl.hub.arcgis.com/datasets/GNL::harvest-newfoundland.

Government of Newfoundland and Labrador. 2024b. Harvest - Labrador. https://geohub-gnl.hub.arcgis.com/datasets/GNL::harvest-labrador.

Government of Quebec. 2017a. Harvesting and other forestry operations. Dataset, Données Québec, https://www.donneesquebec.ca/recherche/fr/dataset/recolte-et-reboisement.

Government of Quebec. 2017b. Infrastructure in forest environments. Dataset, Données Québec, https://www.donneesquebec.ca/recherche/dataset/infrastructures-en-milieu-forestier.

Government of Quebec. 2026. Updated Ecoforestry Map. Dataset, Données Québec, https://www.donneesquebec.ca/recherche/dataset/carte-ecoforestiere-avec-perturbations.

Government of Yukon. 2022. Historic silviculture inventory - 50k. Dataset, GeoYukon, https://open.yukon.ca/data/historic-silviculture-inventory-50k.

Grondin, P., S. Gauthier, V. Poirier, P. Tardif, Y. Boucher, and Y. Bergeron. 2018. Have some landscapes in the eastern Canadian boreal forest moved beyond their natural range of variability? Forest Ecosystems 5:30.

Habitat. 2024. Review of the current state of knowledge for defining, identifying and classifying primary forest in Canada. For World Wildlife Fund Canada.

Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. Science 342:850–853.

Hermosilla, T., M. A. Wulder, J. C. White, N. C. Coops, G. W. Hobart, and L. B. Campbell. 2016. Mass data processing of time series Landsat imagery: pixels to data products for forest monitoring. International Journal of Digital Earth 9:1035–1054.

Hirsh-Pearson, K., C. J. Johnson, R. Schuster, R. D. Wheate, and O. Venter. 2022a. Canada's human footprint reveals large intact areas juxtaposed against areas under immense anthropogenic pressure. FACETS 7:398–419.

Hirsh-Pearson, K., C. Johnson, R. Schuster, R. Wheate, and O. Venter. 2022b, April 8. The Canadian Human Footprint. Dataset, Borealis, https://borealisdata.ca/dataset.xhtml?persistentId=doi:10.5683/SP2/EVKAVL.

Laurance, W. F., M. Goosem, and S. G. W. Laurance. 2009. Impacts of roads and linear clearings on tropical forests. Trends in Ecology & Evolution 24:659–669.

Lindbladh, M., S. Fraver, J. Edvardsson, and A. Felton. 2013. Past forest composition, structures and processes – How paleoecology can contribute to forest conservation. Biological Conservation 168:116–127.

Natural Resources Canada. 2025a. Constructions and Land Use in Canada - CanVec Series - Manmade Features. Dataset, Open Government Canada, https://open.canada.ca/data/en/dataset/fd4369a4-21fe-4070-914a-067474da0fd6.

Natural Resources Canada. 2025b. Mines, Energy and Communication Networks in Canada - CanVec Series - Resources Management Features. Dataset, Open Government Canada, https://open.canada.ca/data/en/dataset/92dbea79-f644-4a62-b25e-8eb993ca0264.

Natural Resources Canada. 2025c. Transport Networks in Canada - CanVec Series - Transport Features. Dataset, https://open.canada.ca/data/en/dataset/2dac78ba-8543-48a6-8f07-faeef56f9895.

Natural Resources Canada. 2025d. Principal Mineral Areas, Producing Mines, and Oil and Gas Fields (900A). Open Government Canada, https://open.canada.ca/data/en/dataset/000183ed-8864-42f0-ae43-c4313a860720.

Natural Resources Canada. 2026. The State of Canada's Forests: Annual Report 2025. Canadian Forest Service, Ottawa, Ontario, Canada.

New Brunswick Department of Natural Resources. 2023. Reforestation. Dataset, https://hub.arcgis.com/datasets/NBDNR::reforestation-reforestation.

Ontario Ministry of Natural Resources and Forestry. 2024. Ontario Harvest. Dataset, Government of Ontario.

Poley, L. G., R. Schuster, W. Smith, and J. C. Ray. 2022. Identifying differences in roadless areas in Canada based on global, national, and regional road datasets. Conservation Science and Practice 4:e12656.

Potapov, P., M. C. Hansen, L. Laestadius, S. Turubanova, A. Yaroshenko, C. Thies, W. Smith, I. Zhuravleva, A. Komarova, S. Minnemeyer, and E. Esipova. 2017. The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013. Science Advances 3:e1600821.

Potapov, P., X. Li, A. Hernandez-Serna, A. Tyukavina, M. C. Hansen, A. Kommareddy, A. Pickens, S. Turubanova, H. Tang, C. E. Silva, J. Armston, R. Dubayah, J. B. Blair, and M. Hofton. 2021. Mapping global forest canopy height through integration of GEDI and Landsat data. Remote Sensing of Environment 253:112165.

Roberge, J.-M., and P. Angelstam. 2004. Usefulness of the Umbrella Species Concept as a Conservation Tool. Conservation Biology 18:76–85.

Schroeder, T., M. A. Wulder, S. P. Healey, and G. G. Moisen. 2011. Mapping wildfire and clearcut harvest disturbances in boreal forests with Landsat time series data. Remote Sensing of Environment. 115: 1421-1433.

Turubanova, S., P. Potapov, and A. Tyukavina. 2026. Mapping structurally stable natural forests in Canada. University of Maryland Global Land Analysis & Discovery Laboratory, Maryland, USA.

Turubanova, S., P. V. Potapov, A. Tyukavina, and M. C. Hansen. 2018. Ongoing primary forest loss in Brazil, Democratic Republic of the Congo, and Indonesia. Environmental Research Letters 13:074028.

Tyukavina, A., P. Potapov, M. C. Hansen, A. H. Pickens, S. V. Stehman, S. Turubanova, D. Parker, V. Zalles, A. Lima, I. Kommareddy, X.-P. Song, L. Wang, and N. Harris. 2022. Global Trends of Forest Loss Due to Fire From 2001 to 2019. Frontiers in Remote Sensing 3.

Venier, L. A., I. D. Thompson, R. Fleming, J. Malcolm, I. Aubin, J. A. Trofymow, D. Langor, R. Sturrock, C. Patry, R. O. Outerbridge, S. B. Holmes, S. Haeussler, L. De Grandpré, H. Y. H. Chen, E. Bayne, A. Arsenault, and J. P. Brandt. 2014. Effects of natural resource development on the terrestrial biodiversity of Canadian boreal forests. Environmental Reviews 22:457–490.

Volle, C., G. Fälthammar de Jong, M. Karström, and A. Ahlström. 2026. Swedish primary forests: factors behind their persistence and potential suitability as natural baselines. Landscape Ecology 41:39.

Webster, K. L., F. D. Beall, I. F. Creed, and D. P. Kreutzweiser. 2015. Impacts and prognosis of natural resource development on water and wetlands in Canada's boreal zone. Environmental Reviews 23:78–131.

Wintle, B. A., H. Kujala, A. Whitehead, A. Cameron, S. Veloz, A. Kukkala, A. Moilanen, A. Gordon, P. E. Lentini, N. C. R. Cadenhead, and S. A. Bekessy. 2019. Global synthesis of conservation studies reveals the importance of small habitat patches for biodiversity. Proceedings of the National Academy of Sciences 116:909–914.

Xiao, Y. 2024, February 24. Global Natural and Planted Forests Mapping at Fine Spatial Resolution of 30 m. Zenodo.

Xiao, Y., Q. Wang, and H. K. Zhang. 2024. Global Natural and Planted Forests Mapping at Fine Spatial Resolution of 30 m. Journal of Remote Sensing 4:0204.

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