STATE OF THE FOREST REPORT 2020

Environment, Energy, and Climate Action

Forests, Fish & Wildlife Division

Contents

List of Figures

List of Tables

Executive Summary

Prince Edward Island (PEI) is known for its patchwork of farm fields, sand dunes and red sandstone cliffs, but in fact has more forest than anything else. Unlike the rest of Canada, most of PEI's forests (more than 85%) are privately rather than publicly owned.

Once each decade, the Government of Prince Edward Island completes a Corporate Land Use Inventory and State of the Forest Report. Using a combination of high-resolution aerial photography and the collection of forest metrics at 822 ground plots, the Forests, Fish and Wildlife Division prepares information on land use change over time, as well as key attributes of Island forests.

The 2020 State of the Forest Report works to expand on the three previous reports (1990, 2000, and 2010) published by the province. Significant new technological improvements and innovative products were used to help measure the forest in new ways, allowing provincial staff and landowners to know more about their forests than ever before.

In 2020, PEI's forest area stood at 245,919 hectares (ha), representing 43.2% of the landscape. Agricultural land was the next largest category, totaling 213,908 ha, or 37.6% of PEI. The remainder of the Island is comprised of wetland and sand dunes (28,788 ha, 5.1%), non-evident / abandoned land (21,943 ha, 3.9%), wet forest (12,492 ha, 2.2%) and developed lands (45,969 ha, 8%).

Between 2010 and 2020, there were 5,350 ha of forest created and 9,350 ha lost, for a net decrease of 4,000 ha. Reasons for forest loss include conversion to agriculture, development, and other land uses as well as some reclassification to wetland or wet forest. This continues a trend of forest loss seen since 1990. Efforts are underway to increase forest area in the province by planting abandoned or marginal agricultural lands and trying to limit land use conversion.

As of 2020, PEI's forests are 60% hardwood dominated and 40% softwood dominated; intolerant hardwood is the single most common forest community on PEI, comprising just over one-third of the forest. Most stands are of natural origin and the most abundant species in terms of volume and area is red maple. Due to the Island's long history of land use, the forests are rather young on average, with roughly one-quarter being in age classes of 61 years or older and three-quarters being younger than this.

The estimated volume of wood harvested annually on PEI between 2010 and 2020 ranged from a low of 342,000 m^3 to a high of 449,000 m^3. Overall live wood volume increased slightly during this period, from 135 m^3/ha to 137 m^3/ha. The Provincially owned J. Frank Gaudet Tree Nursery produced more than 8 million native trees and shrubs for reforestation and enhancement efforts during the reporting period and is on track to increase annual production in the coming decade.

Forests play a role in the mitigation of climate change through the reduction of atmospheric greenhouse gases. For the first time, this State of the Forest Report includes information on forest carbon storage and sequestration, using the Carbon Budget Model of the Canadian Forest Service (CBM-CFS3). This modelling suggests that PEI's forests contain 59 megatonnes (millions of tonnes) of carbon, equivalent to 217 megatonnes of carbon dioxide in its soil, live plants, and dead matter. This is projected to increase by 0.04-0.08 Mt CO_2e per year in the coming decades. If the full lifecycle of harvested wood products and their end use are incorporated, this carbon sink could increase further.

Résumé

L’Île-du-Prince-Édouard est surtout connue pour sa mosaïque de champs agricoles, de dunes et de falaises de grès rouge – il peut donc être surprenant de constater que les terres forestières y sont plus nombreuses que toute autre chose. Contrairement au reste du Canada, la plupart des forêts de l’Île-du-Prince-Édouard (plus de 85 %) sont des terres privées plutôt que publiques.

Tous les dix ans, le gouvernement de l’Île-du-Prince-Édouard réalise un recensement des utilisations commerciales des terres ainsi qu’un rapport sur l’état des forêts. En s’appuyant sur des photographies aériennes à haute résolution et la collecte de mesures forestières sur 822 parcelles, la Division des forêts, de la pêche et de la faune prépare des informations sur l’évolution de l’utilisation des terres au fil du temps, ainsi que sur les principaux attributs des forêts de l’Île.

En 2020, l’Île-du-Prince-Édouard enregistrait une superficie forestière de 245 919 hectares (ha), soit 43,2 % de son territoire. Les terres agricoles constituaient la deuxième catégorie en importance, totalisant 213 908 ha, soit 37,6 % de la province. Le reste de l’Île est composé de terres humides et de dunes (28 788 ha, 5,1 %), de terres non évidentes ou abandonnées (21 943 ha, 3,9 %), de forêts humides (12 492, 2,2 %) et de terrains aménagés (45 969 ha, 8 %).

Entre 2010 et 2020, on a créé 5 350 ha de forêts, mais aussi perdu 9 350 ha, soit une diminution nette de 4 000 ha. La perte de forêts s’explique notamment par l’affectation de zones forestières à l’agriculture, au développement et à d’autres utilisations des terres, ainsi que certains reclassements en zones humides ou en forêts humides. Cette évolution s’inscrit dans la tendance à la perte de forêts observée depuis 1990. Des efforts sont en cours pour augmenter la superficie forestière de la province en plantant des arbres sur des terres agricoles abandonnées ou marginales et en essayant de limiter la transformation de l’utilisation des terres.

En 2020, les forêts de l’Île-du-Prince-Édouard étaient dominées à 60 % par les feuillus et à 40 % par les résineux. Les feuillus intolérants constituent la communauté forestière la plus répandue à l’Île, représentant un peu plus d’un tiers des forêts. La plupart des peuplements sont d’origine naturelle. En termes de volume et de superficie, l’érable rouge est l’espèce la plus abondante. En raison de sa longue histoire en matière d’utilisation des terres, l’Île compte des forêts plutôt jeunes en moyenne : environ un quart appartiennent à des classes d’âge de 61 ans ou plus, et les trois quarts restants sont plus jeunes.

Entre 2010 et 2020, le volume estimé de bois récolté annuellement dans la province a varié entre 342 000 m³ et 449 000 m³. Le volume global de bois vivant a légèrement augmenté pendant cette période, passant de 135 m³/ha à 137 m³/ha. Au cours de la période visée par le présent rapport, la pépinière provinciale J. Frank Gaudet a produit plus de 8 millions d'arbres et d'arbustes indigènes pour appuyer les efforts de reboisement et d'amélioration. La pépinière est en passe d'augmenter sa production annuelle au cours de la prochaine décennie.

Il faut aussi souligner que les forêts jouent un rôle dans l'atténuation du changement climatique en réduisant les gaz à effet de serre dans l'atmosphère. Pour la première fois, le rapport sur l'état des forêts comprend des informations sur le stockage et la séquestration du carbone forestier en se basant sur le Modèle du bilan du carbone du secteur forestier canadien (MBC-SFC3). Cette modélisation suggère que les forêts de l'Île-du-Prince-Édouard contiennent 59 mégatonnes (millions de tonnes) de carbone, soit l'équivalent de 217 mégatonnes de dioxyde de carbone dans le sol, les plantes vivantes et la matière morte. Ce chiffre devrait augmenter de 0,04 à 0,08 Mt CO_2e par an au cours des prochaines décennies. Si l'on tient compte du cycle de vie complet des produits du bois récoltés et de leur utilisation finale, ce puits de carbone pourrait grossir encore plus.

Introduction

The forests of Prince Edward Island (PEI) are a mix of northern boreal species and temperate hardwood trees of the south. This type is known as the Acadian forest, and can be found in New Brunswick, Nova Scotia, and Prince Edward Island, as well as southern Quebec and the northern United States. This transition between coniferous-dominated boreal forest to the north, and deciduous dominated temperate forest to the south, is the defining feature of this eco-region.

Historically, nearly all of PEI was covered in forests, up to 98% by some estimates. Massive red spruce, white pine, yellow birch, sugar maple, and American beech would have dominated the dryer upland areas, while large examples of eastern hemlock, eastern white cedar, eastern larch, red maple, American elm, and white ash would have existed in wetter low-lying areas. The coast was covered in thick white spruce. Almost four centuries of human settlement have greatly altered this landscape into the patchwork that is so familiar and part of the Island's identity. While once seen as a barrier to settlement, PEI's forests long provided much needed resources to its residents. Fuelwood continues to be the most harvested wood product in the province, with amounts varying in accordance to market trends and homeowner needs.

The Forest Management Act of 1988 dictates that the department will produce a document reporting on the State of the Forest every ten years. Clause 6 of the act is as follows:

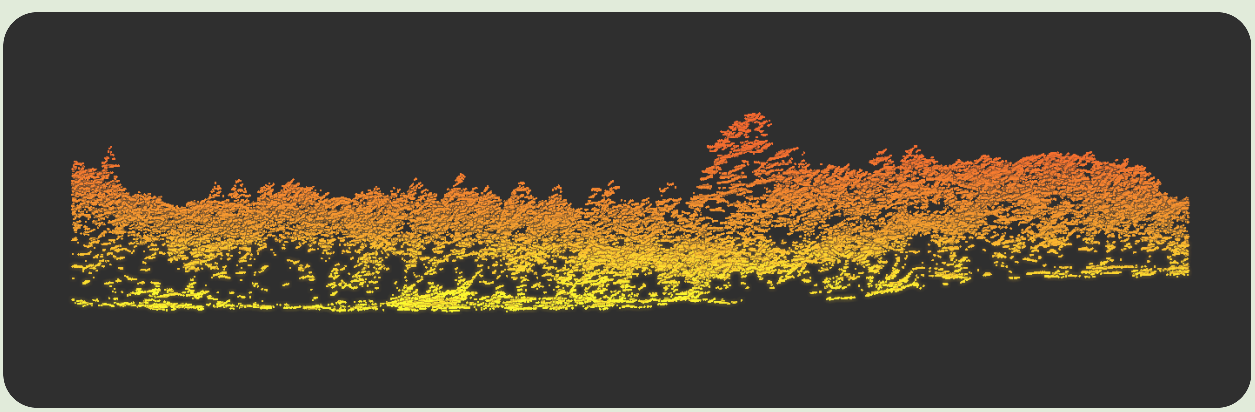
The Minister shall monitor forest growth in and, in 1992 and every ten years thereafter, shall provide to the Lieutenant Governor in Council a State of the Forest Report which includes:

- a) *an inventory of the forest in the province identifying the area of the forest by covertype, the volume of the forest products available in the forest, the age distribution of the forest, and an estimate of the growth by product type that the forest can sustain with and without management:*
- b) *a summary of the forest management activities for both Crown forest lands and private land implemented during each year of the ten-year reporting period:*
- c) *an estimate of the wood supply shortfalls or surpluses based on the projections of forest growth and demand for forest products:*
- d) *an outline of programs proposed to manage the forest in the next reporting period:*
- e) *such other information as may be prescribed by regulations.*

This is the Island's fourth report, and each iteration attempts to incorporate the latest technologies for forest inventory. Manual aerial photo interpretation continues to be the most efficient and accurate method for conducting land use inventories for Prince Edward Island; for 2020, aerial photography resolution was increased to 30 centimeters (from 40cm in 2010) in both True Colour and Infrared. Infrared photography is used on PEI because it emphasizes differences between tree species, improves the detection of wetlands, and highlights vegetation stress such as insects and disease.

The other main source of data for this report was collection of forest measurements at permanent sample plots distributed across the province; 822 plots were visited between 2020 and 2021 where trees, shrubs, herbs, and woody debris were sampled. Results were used to provide statistical estimates on forest age, wood volume, wood quality, and species distributions, as well as how each of these is changing over time.

LiDAR (**Li**ght **D**etection **a**nd **R**anging) technology is a form of remotely sensed laser scan data and was incorporated as part of the 2020 Corporate Land Use Inventory (CLUI). Highly accurate elevation data provide the province with a 3D point cloud, which is used to create a Digital Elevation Model, Digital Surface Model, and Canopy Height Model. An Enhanced Forest Inventory (EFI) was also produced which combined the permanent inventory plots with LiDAR to derive forest metrics for the entire province.



History 2010 – 2020

Some changes since 2010 include new or updated programs, changing product markets, new carbon initiatives, extreme weather events, and a worldwide pandemic. The following changes are worth noting:

Eco-manual Updates: In 2018, a committee of Forests, Fish and Wildlife staff updated the Ecosystem-based Forest Management Manual (or eco-manual) to incorporate additional values that serve to improve the quality of Island forests, as well as to assist forest professionals and woodlot owners in forest management.

FEP Changes: The Forest Enhancement Program (FEP) provides woodland owners with forestry-related advice and financial assistance in the management of their forest properties. The FEP is continuously updated as markets and forestry practices change. These changes include periodic rate increases as well as adoption of updated best management practices.

Carbon Capture Tree Planting Program (CCTPP): Launched in 2019, this is the first Island program focused solely on afforestation. Through the National Low Carbon Economy Fund, landowners received a one-time land use payment for converting their unforested land to forest. All seedling and planting costs were also covered through the program.

Biomass Heating: Harvesting for biomass heat production increased in the past decade, with multiple companies using local wood chips for energy. Heat energy is supplied to schools, hospitals, and other public and private buildings. This has opened new opportunities for a previously low value pulp product while reducing reliance on fossil fuels, thus assisting a movement towards Net-Zero emission targets.

Forest-Related Climate Change Research: Research regarding the impacts of climate change on PEI's forests is ongoing. Some reports have used climate predictions to model potential species habitat distribution into the future, as well as which species may outcompete others. General climate change research continues at the provincial and national level, with adaptation plans being created and greenhouse gas inventories being refined.

Watershed Groups: There has been increased engagement of watershed groups in forest management, higher capacity among groups, and new government funding to support these initiatives. It is recognized that these groups play an important role in fostering forest and land stewardship.

Land Use

The 2020 land use inventory was conducted through interpretation of high-resolution aerial photography. Captured in the summer of 2020, these photos were processed and analyzed by professional photo interpreters consistent with the 2010 inventory. Areas with different uses are delineated and described with a set of attributes. All forest stands are given estimated species breakdowns, heights, crown closures, and developmental stages; wetlands are assigned a type based on components of water and vegetation. Using a Geographic Information System (GIS), area-based results can be used to track how the various land uses on PEI are changing.

Table 1 shows the land use categories for Prince Edward Island in 2020. As in previous reports, forest is the leading land use at 43%, with agriculture following closely at 38% of total land area.

- ↑ Developed areas have increased by 0.6% since 2010, to almost 6% of the total area
- ↓ Forest area was reduced the most, from 43.9 to 43.2% of the total area
- ↓ Agriculture changed slightly from 37.8 to 37.6%

Table 1. Land use areas for 2020.

Land Use	2020 Area (ha)	2020 Area (%)	Change from 2010 (2020 % – 2010 %)
Forest	245,919	43.2	-0.71
Agriculture	213,908	37.6	-0.18
Non-evident / Abandoned	21,943	3.9	-0.06
Wetland and Sand Dunes	28,788	5.1	0.36
Wet Forest	12,492	2.2	-0.02
Transportation	12,991	2.3	0.03
Other	32,978	5.8	0.58
Total	**569,019**		

On the provincial scale, the land use inventory has changed little since 2010. Forest was the largest change, with a net decrease of 4000 hectares (ha). That is a 0.7% decrease as a proportion of the entire inventory, while the 4000 hectare loss is close to 1.7% reduction in area since 2010. Agricultural area saw a slight decrease in total area, down just over 1000 hectares. These losses are reflected in corresponding gains in the wetland inventory and developed areas (recorded as other land use and transportation). The area of developed land (commercial, industrial, institutional, recreational, residential, transportation, and urban land uses) has increased by 0.6% (net 3400 ha) with 65% of that going to single dwelling residential land use. New developments have converted approximately 650 ha of forest, 1,950 ha of agriculture, 735 ha of abandoned land, and 30 ha of wetlands.

While over 10,400 ha of agricultural land has been lost, 9,400 ha has been created. This accounts for a net loss of 0.2% or just over 1000 ha. Much of the loss comes from the abandoning of fields, which will eventually regenerate to forest if it is not fully converted back to agriculture or other land use. Other agricultural losses include conversion to residential lots, as well as a small amount of forest reclamation. Converted forest and abandoned land were the main contributors to the 9,400-ha increase in agriculture.

Wetland areas can fluctuate from anthropogenic activities (alteration permits require a 3:1 replacement factor), wildlife activity (beaver ponds and meadows), and weather events. Many wetlands on PEI support tree growth and provide services of both forests and wetlands. Previous reports included wetland forests in the wetland category, but it has been separated here to draw distinction. The primary land use of these areas is determined by the context; when speaking on forest resources or timber they are considered forests, but when speaking from a water cycle and habitat services perspective, wetland is a more appropriate classification. Titles aside, on PEI these areas are black spruce bogs, wooded swamps, shrub swamps, and alder swales.

Strict comparison of current data to what is included in past reports is always challenging. For example, new wetlands are continually being added to the land use inventory between State of the Forest Reports, based on site inspections and field work. Some land uses – recent clearcuts, abandoned agriculture, and temporarily fallow lands – can be difficult to distinguish from each other on air photos. This explains discrepancies from one report to another, such as some forest land in 2010 being classed as wetland or abandoned agricultural land in 2020 and vice versa.

Forest Area Changes

Since 2010, 5,350 hectares of forest have been created, and 9,350 have been lost. Figure 1 depicts the main forest land use changes. The largest gain comes from areas that appeared to be abandoned during the last inventory, but their tree cover has increased, and regenerating trees species can now be identified.

There is also a loss of forest area to this same non-evident land use. Most of these areas were labelled as clearcuts in 2010, and regenerated trees are still too small to allow identification to species from aerial photography. The next inventory should see these areas with more evident primary land use. Forest gains from converted agriculture is the second largest increase, followed by reclassified wetlands, and finally developed areas that are reverting to forest (mainly rural residential areas with encroaching edges). Conversion to agriculture accounts for 45% of the deforestation that occurred since 2010. These are permanent conversions, unlike the loss due to wetlands or non-evident types, which could be interpreted differently in future inventories. Development is also considered permanent and is counted as "Other" in Figure 1.

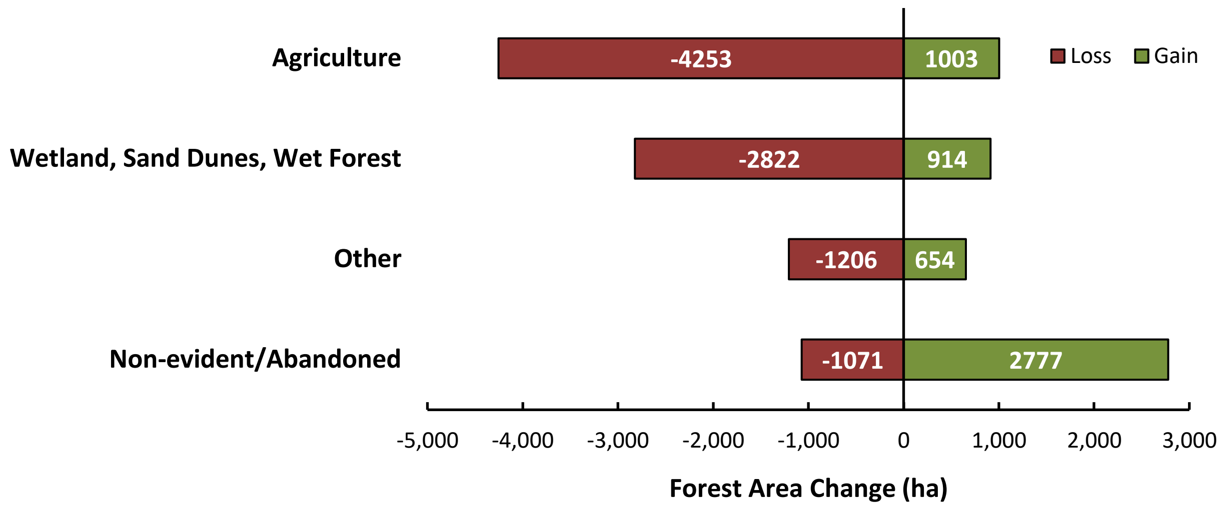


Figure 1. Change in forest area since 2010.

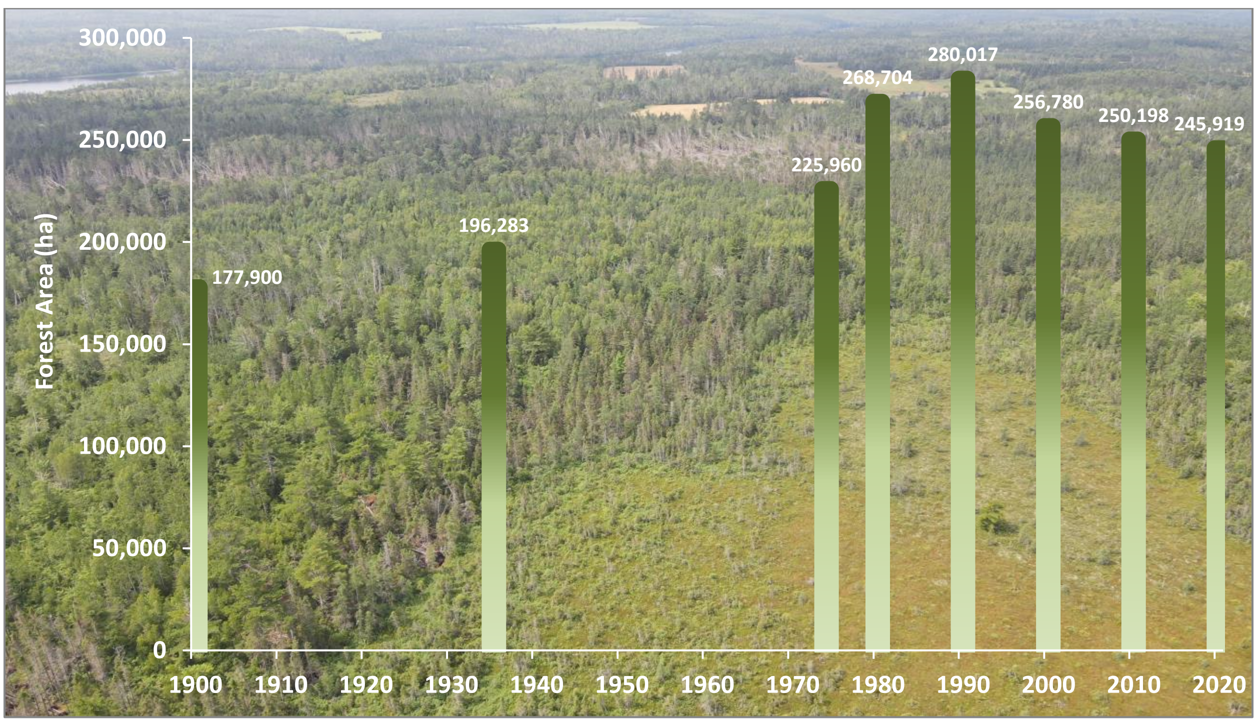


Figure 2. Forest area 1900-2020.

Figure 2 shows the variation in forest area since 1900. Since the peak in 1990, the following three reporting periods have all seen a declining trend. Forest area is at its lowest since at least 1974, with agriculture area increasing by more than 40,000 hectares in this same time frame.

Most of the forest area (85%) is considered natural forest, which is dominated by naturally regenerated tree species. The remaining forest is classified as plantations (10%) or recently harvested and naturally regenerating (5%), Table 2. Approximately 2600 ha of those plantations are younger than 10 years old. Wet forests are over 95% natural and contain very few plantations or harvest sites.

Table 2. Stand origins - Amount of current forest area that is natural, a plantation, or regenerating.

Forest Type	2020 Forest Area (ha)	2020 Forest Area (%)	2010 Forest Area (%)
Natural	209,126	85.0	80.8
Plantation	23,488	9.6	9.0
Regenerating	13,305	5.4	10.2
Total	**245,919**	**100.0**	**100.0**

Plantations include recently harvested areas that have been planted. Regenerating areas have been harvested since the previous inventory and new growth is too young to be identified from aerial photos.

It should be noted that what is classified as forest for the purposes of the provincial Land Use Inventory, and what is recognized as forest by the public, can be two different things. Although a newly harvested site or planted field may not be perceived as forest, from an inventory point of view this is land dedicated to growing trees. The collective area of forest converted to other uses, harvested forest, and newly planted land is 25,320 ha; this is considerably higher than the area of actual deforestation reported using standard inventory methodology and may lead to a public perception of increased forest loss over the past decade.

PEI uses the same definition of forest as Canada and the Food and Agriculture Organization of the United Nations:

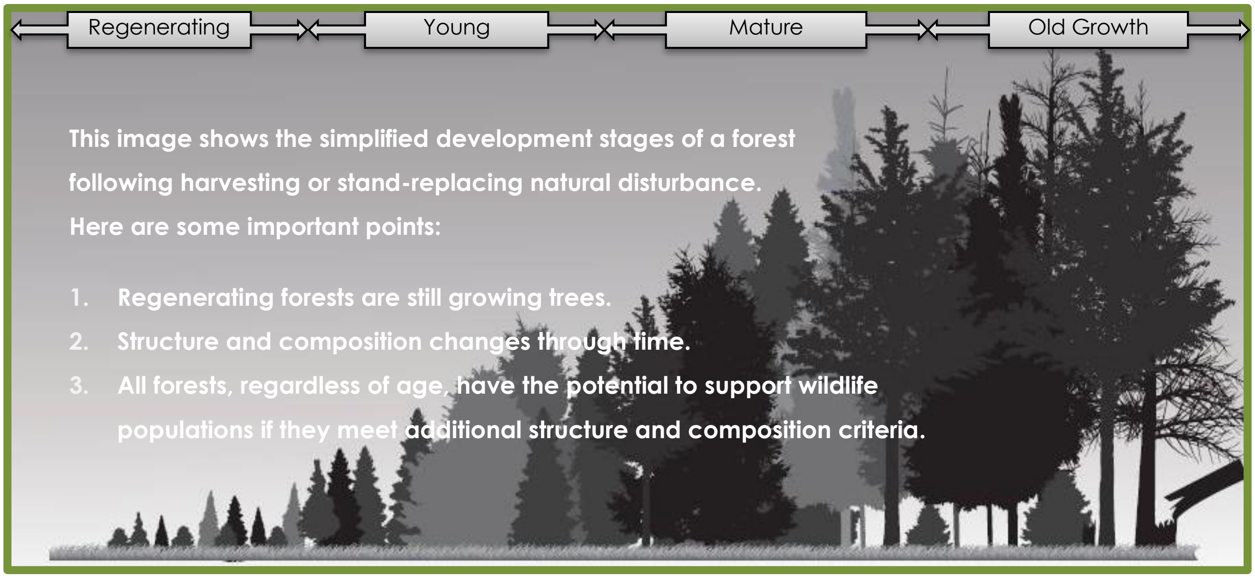
- *Land not predominantly under agriculture or urban land-use (non-developed)*
- *Stand size greater than 0.5 hectares*
- *With trees taller than 5 meters*
- *Tree canopy cover greater than 10%*

OR

- *Site has the capability to meet these criteria in the natural environment*

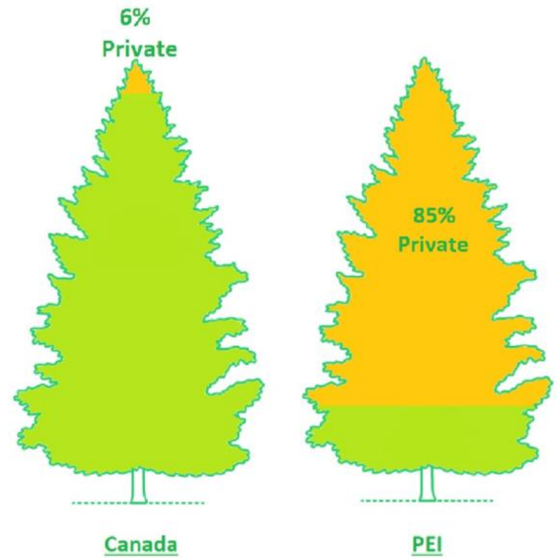
Forest is classified as forest land use after a temporary loss of tree cover, such as after harvesting or wind disturbance. Changes in forest area result from:

- *Afforestation – creation of new forests where they weren't before*
- *Deforestation – permanent removal of trees for the purpose of development into a different land use*
- *Natural forest expansion and dieback*



Forests can be natural or planted, young or old, wet or dry, hardwood or softwood, even or uneven-aged, and much more. The pictures below are just a few examples of what Island forests look like.

Forest Ownership



Proportion of Crown and private forest in Canada and PEI

PEI's forest ownership is unique in Canada. Only 6% of the nation's forests are privately owned, whereas more than 85% of the Island's forests are under private ownership (Table 3). Of this amount, 46% is on small (<=25ha) parcels. The largest single landowner is the Province of PEI, owning 14% of the forest (35,716 ha). Provincial forests on PEI are managed under long-term management plans which focus on ecosystem utility, biodiversity, and improving forest quality. Just over 1% of the forest is owned by federal (1,776 ha), municipal (413 ha) or Indigenous governments (471 ha). The Abegweit Conservation Society now manages 267 ha of provincial forest in northeast Queen's County, and the Environmental Coalition of PEI (via the MacPhail Woods Ecological Forestry Project) manages 817 ha in the Orwell/Caledonia area. Since the last report in 2010, the ownership of PEI's forests has shifted slightly towards the public due, in part, to provincial and national initiatives to acquire and protect 7% of PEI's land area.

Table 3. Forest land ownership categories for PEI in 2020. This includes wet forests.

Ownership	Forest Area (ha)	(%)
Private Small	118,956	46.0
Private Large	101,029	39.1
Provincial	35,716	13.8
Federal	1,776	0.7
Indigenous	471	0.2
Municipal	413	0.2
Total	**258,361**	**100**

Parks, Protected Natural Areas, and Wildlife Management Areas

Prince Edward Island has committed to protecting 7% of the Island. As of 2020, more than 26,600 ha (4.7%) is counted in the Island's Protected and Conserved Areas Network, an increase of 8,200 ha from the 2010 report. In recent years, PEI has adopted national standards to include Other Effective area-based Conservation Measure (OECMs) and Interim lands (areas planned for protection or conservation in the short term) when reporting on progress to the Canadian Protected and Conserved Areas Network.

Table 4 and Figure 3 summarize the various classes of protected lands on PEI. The protection of private land continues to be a key factor in increasing the size of PEI's protected areas network. Partners such as Island Nature Trust, the Nature Conservancy of Canada, and the PEI Wildlife Federation acquire and protect lands, and facilitate designations with private landowners.

Table 4. Summary of protected areas on Prince Edward Island.

2020 Protected Area Class	Area (ha)	Total Area (%)	Protected Area (%)
Federal Parks	3512	0.6	13.2
National Bird Sanctuary	*130*	<0.1	0.5
Provincial Parks	*415*	0.1	1.6
Private Natural Areas	*3655*	0.6	13.7
Public Natural Areas	*6541*	1.1	24.6
Private Wildlife Management Areas	*37*	<0.1	0.1
Public Wildlife Management Areas	*8738*	1.5	32.8
Other Effective Conservation Measures (OECM):			
Ducks Unlimited Canada Conservation Agreements	*2219*	0.4	8.3
Private Conservation Agreements	*5*	<0.1	<0.1
Morell River Conservation Zone	*273*	<0.1	1.0
Environmental Coalition Of PEI	*825*	0.1	3.1
Abegweit Conservation Society	*282*	<0.1	1.1
Total Area	*26632*	4.7	100.0

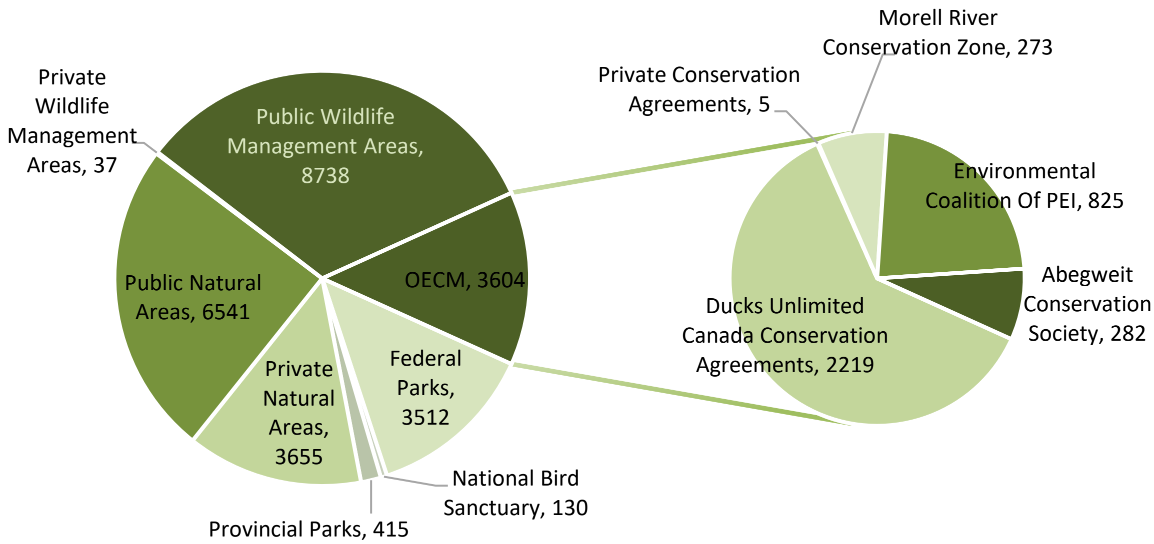


Figure 3. PEI Protected Areas Network; total protected areas on the left (26,632 hectares) with a breakdown of Other Effective Conservation Measures (OECM) on the right (3,604 hectares).

Consistent signage for Public Forests, Natural Areas, Wildlife Management Areas, and Wetlands

Forest Cover

A fundamental method of describing a forest is by the composition of hardwood and softwood species (Figure 4). Pure stands contain 75% or greater of one type (as determined by photo interpretation) and make up more than 162,000 ha or 64% of PEI's forest area. Of this, 60% are hardwood dominated and 40% are softwood dominated. The remaining forest (36%) is made up of mixed wood stands, with most being led by hardwoods.

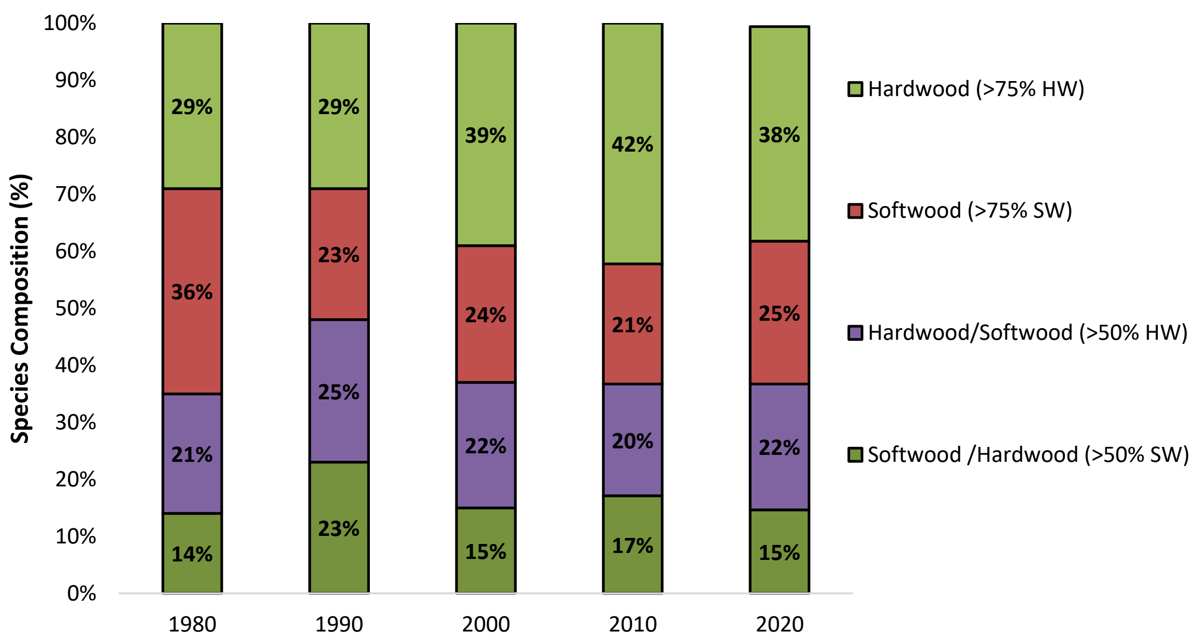


Figure 4. Change in cover type over time.

Taking this further, hardwood stands can be described by their performance in different light conditions: shade tolerant species compete well in low light, while intolerant species are more successful in conditions closer to full sunlight. Conifers also display shade tolerances, but to a lesser degree than their deciduous counterparts. Natural forest succession typically progresses from being dominated by intolerant species after a disturbance, to a mixed system, and finally coming to an equilibrium state of high shade tolerance. Photo interpretation identified the top five tree species in each stand with their relative percentage and specific species combinations can be defined as various forest community types. Figure 5 shows the proportion of Island forests in each defined community.

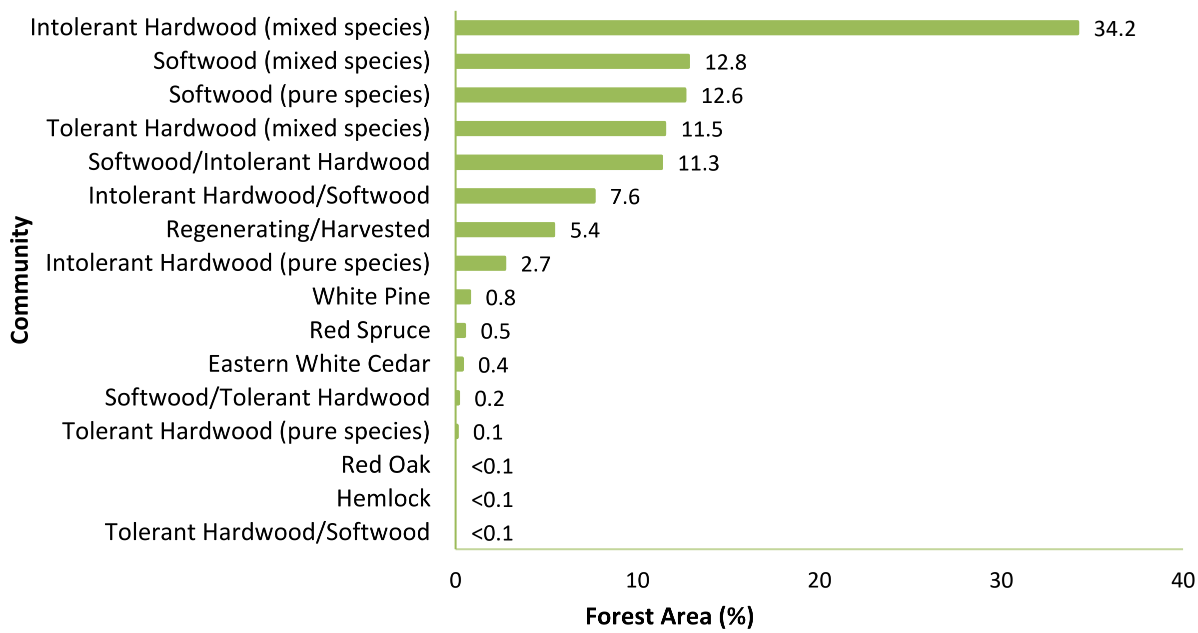


Figure 5. Community type and percent distribution of the forest on Prince Edward Island in 2020.

In 2020, the intolerant hardwood mix type accounted for over a third of PEI's forest area. Red maple is the most common leading species in this forest type and can show a wide range of shade tolerances. When present with other pioneer species such as poplar and white birch, red maple is considered shade intolerant; however, when it exists with more tolerant species like yellow birch and sugar maple, red maple is treated as tolerant. Regenerating or recently harvested stands (currently ~5% of forest area) will likely become dominated by intolerant hardwood species unless managed for a different outcome.

Stands composed of greater than 70% shade tolerant hardwood species only make up 12% of the forest area, when this would have historically been the most dominant type. Less common community types with significant components of white pine, red spruce, Eastern white cedar, Eastern hemlock, or red oak were also identified. These areas make up very little (<2%) of the overall forest area.

Curious about how each of the forest communities are defined?

Here's some extra info:

- *White pine and red spruce stands have greater than 40% composition of those species.*
- *Eastern white cedar, eastern hemlock, and red oak forest communities have greater than 30% of these less common species.*
- ***Pure species** stands have greater than 70% of one species and are defined by their species type (softwood, intolerant hardwood, tolerant hardwood).*
- ***Mixed species** stands have less than 70% of one species but greater than 70% of one species type (softwood, intolerant hardwood, tolerant hardwood).*
- *The community types of tolerant hardwood/softwood, intolerant hardwood/softwood, softwood/tolerant hardwood, or softwood/intolerant hardwood have 50-70% of the first type and 30-50% of the second type.*
- ***Intolerant hardwood species** include alder, apple, ash, grey birch, poplar, pin cherry, willow, white birch, and occasionally red maple.*
- ***Tolerant hardwood species** include beech, elm, ironwood, sugar maple, yellow birch, and occasionally red maple.*
- ***Intolerant softwood species** include red pine and Eastern larch.*
- ***Tolerant softwood species** include black spruce, Eastern white cedar, and Eastern hemlock.*

Age Class Distribution

Forests with diverse age class distributions are healthier and better adapted to change, including climate change. Wildlife habitat requirements change over time, requiring forests of different ages and composition. Risks that may negatively affect one age class may not have as much of an overall impact when there are many age classes present; diverse species composition can help limit pests, disease, and fire damage. Humans also make use of forests of all ages: older forests usually have larger timber, which makes long lasting building materials and is preferred for recreational areas, while younger forests provide fuelwood as well as pulp for paper and other products.

Tree ages are measured in inventory plots, and the results by 20-year age class can be seen in Figure 6. Age class distributions from the last two measuring cycles are included for comparison.

Figure 6. Age class distribution of forests on PEI in 2000, 2010, and 2020.

The Island's total area in the youngest age class continues to decrease, down a further 3.6% from 2010 (which was down 5.7% from 2000). Stands under 20 years old are not ideal candidates for harvest, and these stands are aging into the next class, with the corresponding increase seen in the 21 to 40-year group. There are no other significant differences in the remaining age classes, with only a minor decrease in the 61 to 80-year range; a continued decline of aging spruce stands is contributing to this.

If harvest levels remain low in the upcoming decade, similar changes can be expected for the next reporting period. An increase in older age classes (to achieve more even distribution) is desired and could be achieved through protecting forests; this can be done in conjunction with increased forest management to promote health and to prevent early mortality. Reclaiming abandoned land through afforestation will continue through the 2020s, resulting in more freshly regenerated areas. This, combined with potential increases in climate related disturbances, could produce younger stands in the future even without the pressure of increased harvesting.

Stands are classified as even or uneven aged. Plantations and early successional forests are commonly even aged, while older forests contain a range of trees of different ages. The old-field white spruce stands on PEI are almost all evenly aged, as are any other new forests on former agricultural land. PEI's history of land use is one of the reasons why the forest ages are not evenly distributed, and why there are so few stands of older age classes.

Wood Volume

Total tree volume refers to the full bole or stem of a living tree, while merchantable volume is just the stem from the stump up to a diameter of 8 cm. Specific equations have been developed for our native tree species in local habitats and were applied to all trees measured in the permanent forest inventory plots. Plot values were processed and extrapolated to represent the entire forest. Table 5 shows the total aboveground volume (alive and dead), total live stem volume, and merchantable volume as measured in 2020. Since 2010, live wood volume per hectare has increased from 135 to 137 m^3/ha (1.6%), merchantable volume has increased from 113 to 120 m^3/ha (6.4%), and standing dead volume increased from 19 to 23 m^3/ha. Higher volumes indicate that annual growth is outpacing the level of harvest and mortality.

Table 5. Per hectare and total volumes of the forest on Prince Edward Island in 2020.

Class	Average Volume (m^3/ha)	Total Volume (m^3)
Aboveground	159.8	41,294,078
Live	136.9	35,376,466
Merchantable	120.2	31,061,992
Standing Dead	22.9	5,917,612

The distribution of merchantable volume by species is displayed in Table 6. The trend towards more hardwood volume continues from 2000 and 2010. These data indicate that red maple volume is filling in where white spruce is declining, and could also be a remnant of higher harvest levels in the past; natural regeneration favours hardwood stands in the short to mid-term. Merchantable volume in this context is based on size only, not considering age, quality, or accessibility.

Table 6. Percent of merchantable volume by tree species from 1990 to 2020.

Species	1990	2000	2010	2020	Difference (2020-2010)
White spruce	21.5	21.1	18.4	14.4	-4.0
Balsam Fir	14.1	15.6	14.3	15.0	0.7
Red/Black Spruce	8.5	10.3	10.2	9.1	-1.1
Larch	5.5	5.0	5.6	3.2	1.2
Other Softwood				3.6	
Total Softwood	**49.6**	**52.0**	**48.5**	**45.3**	**-3.2**
Red Maple	24.2	22.9	23.8	28.0	4.2
Sugar Maple	4.7	3.5	3.8	3.4	-0.4
Yellow Birch	3.2	2.6	3.3	3.5	0.2
Poplar	8.0	9.9	8.4	8.7	0.3
White Birch	7.8	6.1	7.3	6.3	-1.0
Beech	1.4	2.0	1.6	1.5	-0.1
Other Hardwood	1.1	1.0	3.3	3.4	0.1
Total Hardwood	**50.4**	**48.0**	**51.5**	**54.7**	**3.2**

Estimates of wood quality are used to classify standing timber by potential end-user product. Piece size can determine if a log is suitable for a high-quality veneer product, a sawlog to make dimensional lumber, or a lower value pulp product. Defects like branching, forking, scars, and rot can further limit a tree's possible use. Firewood (residential use) and fuelwood (industrial use) are the most harvested products on PEI. They have been recorded here in the pulpwood category but technically any biomass can be used as fuel. Table 7 shows the standing volume of wood by type and by potential product. Biomass volume displayed below is the difference between total volume and merchantable volume, plus the volume of dead standing trees.

Table 7. Product potential of hardwood and softwood described in volume and percent of volume in 2020.

Product Type	Volume (m^3)	Volume (%)
Softwood Biomass	5,872,493	14.2
Softwood Pulp	7,734,112	18.7
Softwood Sawlogs	6,594,996	16.0
Total Softwood	**20,201,601**	**48.9**
Hardwood Biomass	4,360,582	10.6
Hardwood Pulp	13,503,257	32.7
Hardwood Sawlogs	2,916,779	7.1
Hardwood Veneer	311,858	0.8
Total Hardwood	**21,092,477**	**51.1**


High quality hardwood logs destined for a furniture manufacturer

Coarse Woody Debris

Coarse woody debris *(CWD) or* ***coarse woody habitat*** *(CWH) is a vital component of the forest ecosystem. Dead and fallen trees and branches accumulate on the forest floor to play a key role in nutrient cycling and provide habitat for hundreds of organisms. Pieces greater than 7.5 cm in diameter that are not rooted or self-supporting were measured and their level of decay assessed on the following scale:*

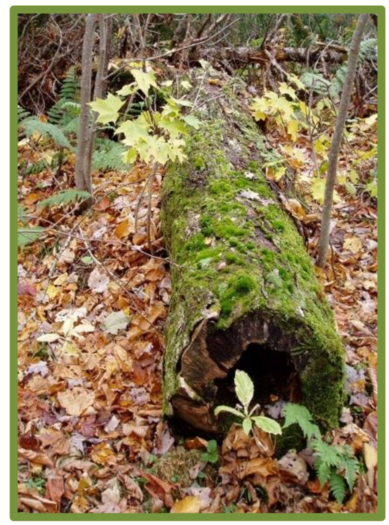
1. *Intact and hard wood, still has bark and twigs, barely touching the ground.*
2. *Intact with wood starting to soften, still has bark but loses twigs and sags closer to the ground.*
3. *Broken in pieces, noticeable rot begins with only minimal bark remaining, adjacent roots start to invade.*
4. *Crumbling into small pieces which still have integrity, completely on the ground and sinking.*
5. *Last stages of decomposition where species identification is difficult, whole piece is falling apart and becoming soil.*

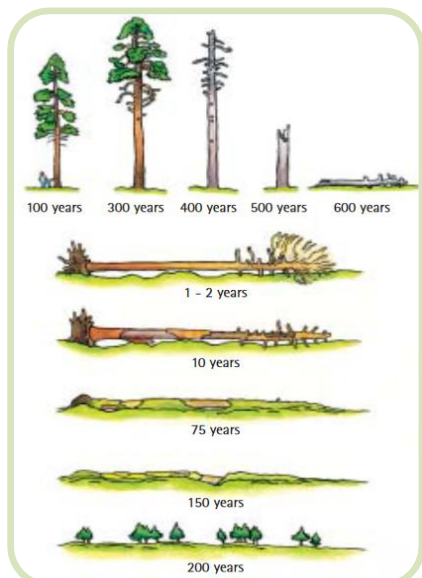
Different sizes and levels of decay offer different microhabitats for fungi, lichen, mosses, insects, reptiles, birds, and mammals. A rich coarse woody habitat layer can help support, improve, or maintain levels of biodiversity under disturbance. Table 8 shows how the total volume of coarse woody debris is distributed by decay class. The inventory plots show an average of ~30 m³/ha of CWD. Interestingly, 30 m³/ha has been found to be an indicator level of debris for old forest communities in New Brunswick; over a third of the plots met this threshold. [1]

(NB DNR. (2013). Old Forest Community and Old-Forest Wildlife Habitat Definitions for New Brunswick 2012. Retrieved from: www2.gnb.ca/content/dam/gnb/Departments/nr-rn/pdf/en/Forests CrownLands/OldForestCommunityWildlifeHabitatDefinitions.pdf)

Table 8. Proportion of CWD (count) in each decay class.

Decay Class	Proportion (%)
1	12.5
2	30.6
3	36.8
4	15.6
5	4.5
Total	**100.0**





Forest Harvest

Since 2010, the estimated volume of wood harvested across PEI has been relatively stable, ranging from a maximum of 449,000 m³ in 2012 down to a minimum of 342,000 m³ in 2018. There were no major spikes or troughs as those seen in the late 2000s. In fact, harvest levels have varied little since the major downturn in 2008, demonstrated in the 20-year graph below (Figure 7). Residential firewood and fuelwood are still the most common products extracted from PEI's forests. Since 2010, an average of 299,000 m³ of fire and fuel wood were harvested per year. This is a 20% increase from the last reporting period when the average was 248,000 m³ annually. As of 2020, 43 provincial buildings are fitted with biofuel furnaces; these facilities are heated with locally sourced wood chips and have contributed to fuelwood consumption. As residents continue to move away from wood burning heat sources and rely more on electricity, consumption of firewood is expected to decrease in the coming decade.

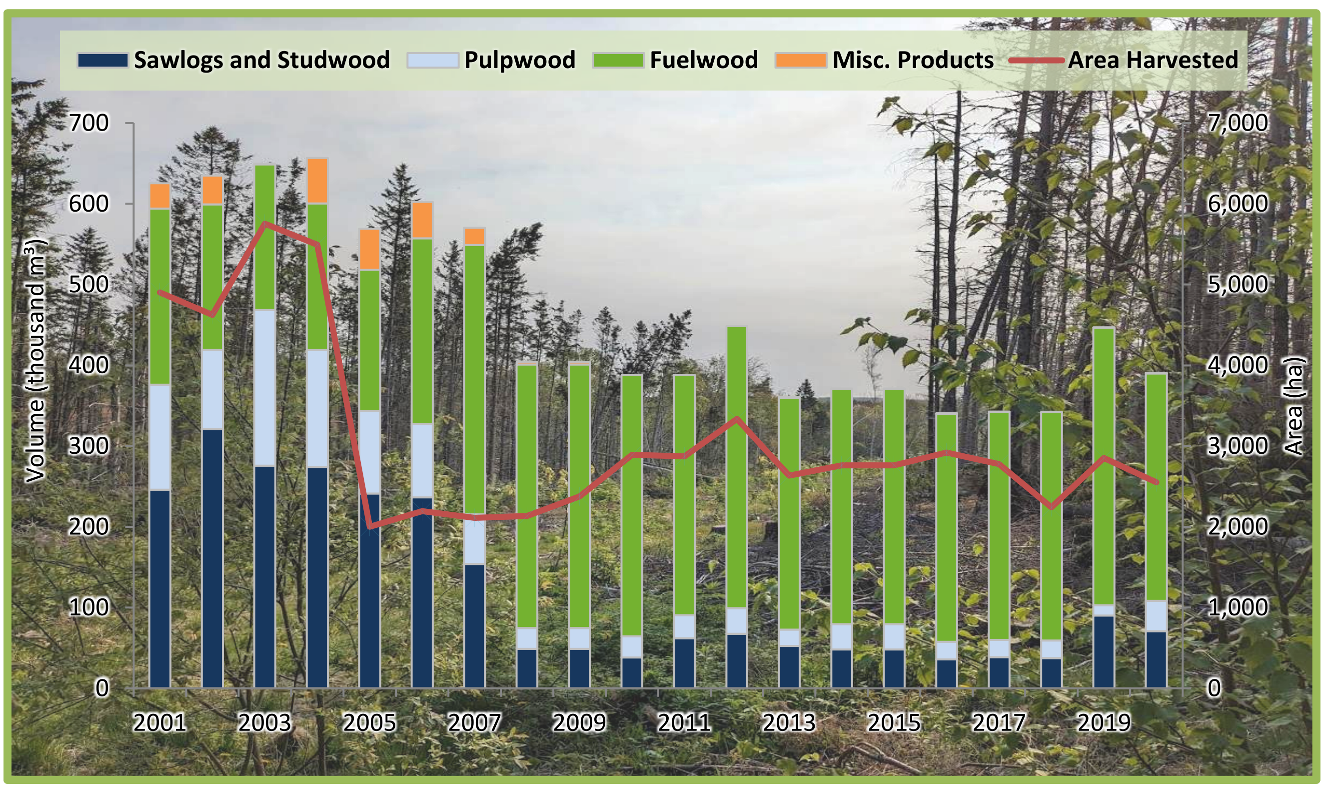


Figure 7. Harvest volumes and areas from 2001-2020. Photo of a recent strip cut harvest.

Nursery Production

Tree and shrub seedlings used for reforestation and forest enhancement across PEI are produced at the provincial J. Frank Gaudet Tree Nursery, located in Charlottetown. Private and public planting crews, watershed groups, and private-sector nurseries receive trees and shrubs, with more than 30 species available. Private landowners who are part of the Forest Enhancement Program (FEP) may be eligible to have their harvested woodlots reforested with trees from the nursery while others rely on seedlings from other sources or let their sites regenerate naturally. The nursery supplies the plant needs of all Division programs, so production is driven by the needs of those programs.

Table 9 shows the total nursery production by decade, as well as the proportion of hardwood and softwood; Table 10 outlines the proportion of various species. Species included in the "Other" category are sold exclusively to garden centers, and include Austrian pine, Colorado spruce, Norway spruce, American elm, and lindens (among others). Shrubs include hollies, willows, dogwoods, sumacs, and more.

Table 9. Change in the proportion of hardwood and softwood nursery production through time.

Report Period	Hardwood (%)	Softwood (%)	Total # of Trees
1981-1990	<0.1	100.0	18,098,000
1991-2000	0.9	99.1	25,435,000
2001-2010	3.9	96.1	20,787,000
2011-2020	8.7	91.3	8,013,000

While the annual production of both hardwood and softwood trees has decreased since 2010, there has been an increase in the proportion of hardwood since the 1990 report (Table 9/10). Hardwoods accounted for less than 1% of total nursery production in the 1980s and 90s, then went up to 4% in 2000s; reaching 9% over the last decade. This increase reflects the strategies for private and public land management as seen in the Ecosystem Based Forest Management Standards. White spruce is the most produced and planted species on PEI, used in many reforestation and afforestation activities, hedgerow plantings, and horticulturally. This species competes very well in old-field sites, is tolerant to drought and salt, and is not a preferred food source for foraging rodents and hares.

Table 10. Proportion of nursery production of various species.

Softwood Species	2010 (%)	2020 (%)
White spruce	47.6	58.6
Eastern larch	6.5	10.4
Eastern white pine	8.6	8.6
Black spruce	19.9	7.8
Balsam fir	3.5	7.5
Red pine	5.3	1.8
Eastern white Cedar	1.1	1.4
Eastern hemlock	0.4	1.0
Red spruce	2.4	0.5
Other	4.7	2.4

Hardwood Species	2010 (%)	2020 (%)
Shrubs	10.0	27.0
Red Oak	20.7	21.8
Sugar Maple	5.6	13.6
White Ash	10.4	13.4
Yellow Birch	30.6	10.4
Red Maple	7.1	6.4
White Birch	9.3	3.4
Mountain Ash	1.3	1.3
Other	5.0	2.6

Afforestation: *When a site has been non-forested for at least 50 years and is then converted to forest through planting or seeding.*

Reforestation: *Regenerating the tree growth on a site with a more recent loss of trees, typically due to some natural or anthropogenic disturbance. Does not involve land use change.*

Private Land Silviculture

The Forest Enhancement Program (FEP) was established in 2002 to encourage and support sustainable forest management on private land. Activities under the program are outlined in the Ecosystem-based Forest Management Manual and are eligible for financial support from the province. The eight most used incentives under the FEP are shown in Table 11. Total support for private land silviculture from 2011-2020 was just over $8 million, with new plantation and plantation maintenance accounting for the highest investment. 1,060 forest management plans were written, prescribing sustainable management activities for a portion of the Island's privately owned forest. It is important to note that the values reported in Table 11 do not reflect the full scope of private land silviculture, only what has been done under the provincial program; private landowners are not obligated to participate in the FEP or to report on their own forest management activities. More than 10,000 ha of forest was treated during the 2011-2020 period. Public investment and treatment areas remained relatively stable compared to the previous decade (Figure 8) while per hectare investment continues to increase.

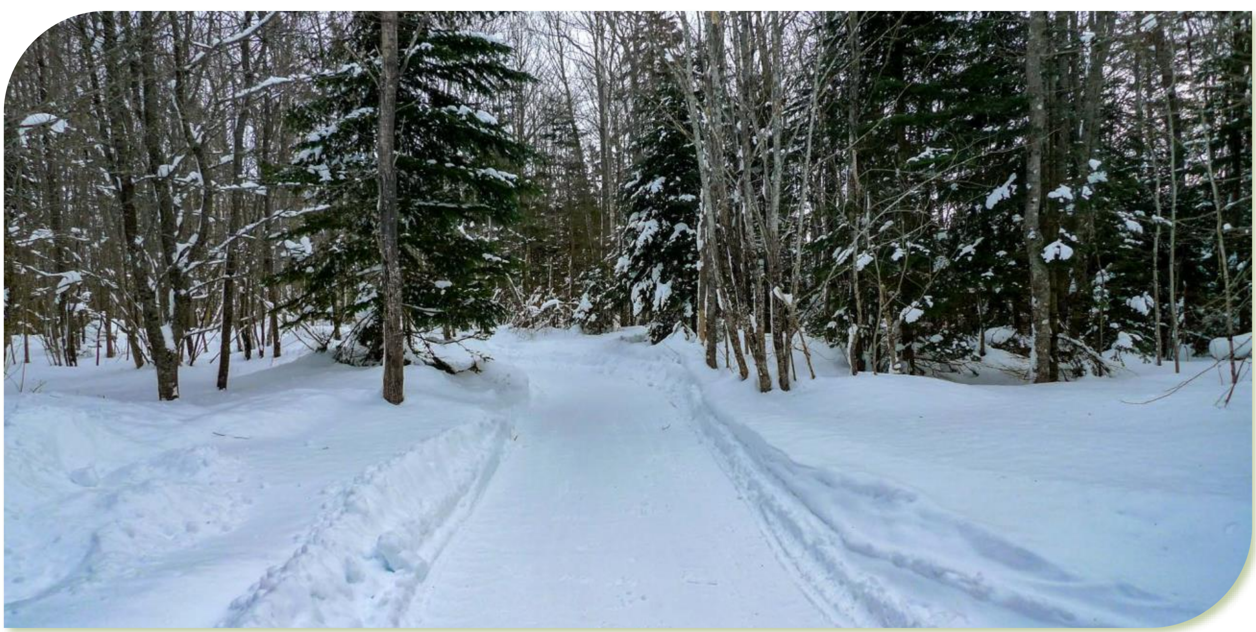


Table 11. Activity summary of silviculture investment on private land from 2011-2020.

Activity		Amount	Investment
	(#)	(ha)	($)
Management Plan Preparation	1,060		346,045
Plantation Site Preparation		2,433	1,326,526
Full and Enrichment Planting		2,433	1,261,019
Fill Planting		658	245,567
Plantation Maintenance		4,862	3,125,537
Tree Pruning	568,677		750,328
Precommercial Thinning		352	292,454
Commercial Thinning		324	231,565
Other			477,061
Total Investment			**8,056,102**

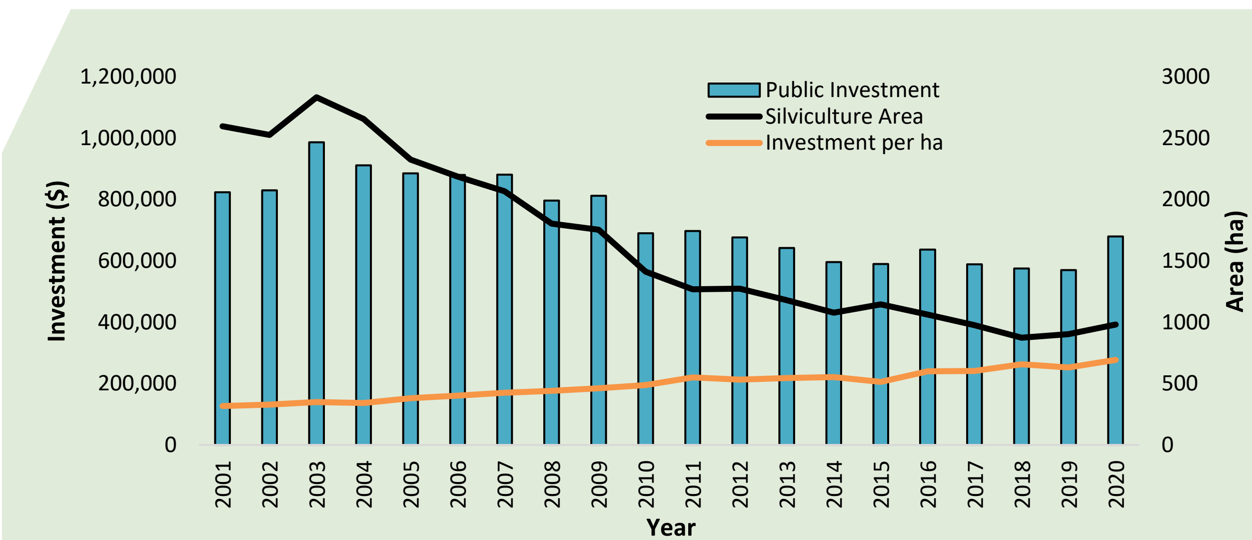


Figure 8. Area treated and total public investment in private land silviculture from 2001-2020.

Public Land Management

The Government of PEI is the largest single forest landowner, with 36,000 ha under its management. Provincial forest technicians prescribe various activities to produce quality timber for a range of wood products, while maintaining public access and all other non-timber forest values. Figure 9 and Table 12 outline the revenue, harvest area, and area of silviculture activities associated with public forests. All work on public lands is conducted by provincial employees or private contractors and must be in accordance with the Ecosystem-based Forest Management Manual.

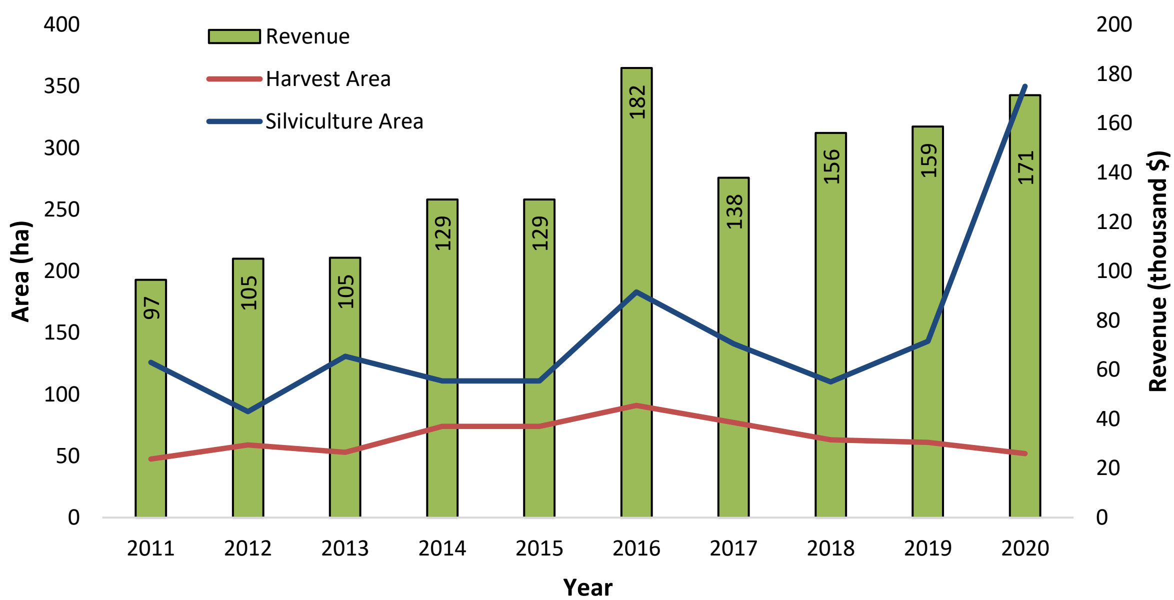


Figure 9. Revenue, harvest area, and silviculture area on public land from 2011-2020.

Table 12. Public forest silviculture and harvesting activities.

Year	Silviculture (ha)	Site Prep (%)	Planting (%)	Maintenance (%)	Other (%)	Harvest (ha)	Clearcut (%)	Commercial Thin (%)
2011	**126**	21.4	20.6	56.3	1.6	**48**	45.3	54.7
2012	**86**	22.1	22.1	44.2	11.6	**59**	16.9	83.1
2013	**131**	17.6	18.3	46.6	17.6	**53**	28.3	71.7
2014	**111**	26.1	27.0	44.1	2.7	**74**	43.2	56.8
2015	**111**	26.1	27.0	44.1	2.7	**74**	43.2	56.8
2016	**183**	22.4	24.0	37.2	16.4	**91**	96.7	3.3
2017	**141**	29.1	36.9	28.4	5.7	**77**	83.1	16.9
2018	**110**	29.1	41.8	29.1	0.0	**63**	73.0	27.0
2019	**143**	33.6	38.5	28.0	0.0	**61**	95.1	4.9
2020	**350**	37.1	33.1	29.4	0.3	**52**	71.2	28.8

Site Preparation *activities increase the number of suitable microsites for planting or create more suitable seedbeds for natural regeneration.*

Planting *includes the initial planting of a site either after harvest or as part of an afforestation program, as well as enrichment plantings to increase species/age diversity and wildlife habitat.*

Maintenance work *removes undesirable plants around crop trees to increase growing space. Public Forests receive only manual treatments with hand tools, while some herbicide application is still used on private woodlots. Some plantations may require more than one maintenance treatment before they are considered free to grow.*

The harvest area remained relatively constant throughout the 10-year period, with 2016 being the highest and 2011 the lowest. Over the last five years of the reporting period, the area harvested trended downward, while revenue from those harvests trended upwards. Wood harvested from public forests in the 2010s earned almost $400 more per hectare than in the 2000s, due in part to recovery of national and international markets. The proportion of the annual harvest from block harvest and commercial thinning sources remained the same since the last report.

Silviculture treatment area shows more variance, from a low of 86 ha in 2012 up to 350 ha by the end of the decade. Most of the planting sites require some level of site preparation, and these sites are maintained until approximately 8-10 years after establishment. Higher site preparation and planting levels in 2020 include work through the Carbon Capture Tree Planting Program on public land. The increasing trend of silviculture activity is likely to continue into the 2020s; new sites will continue to be established for carbon capture and forest regeneration or enhancement purposes, all of which will be prepared and maintained.

Renewing of Forestry's Demonstration Woodlots

The Forests, Fish, and Wildlife Division has focused on renewal of two provincial woodlots, Brookvale and Auburn, which are highly used by the public for recreation and forest education. These updates are ongoing, but some highlights include:

Brookvale:

- *New parking lot installed to improve visitor safety*
- *Existing trail rerouted to avoid sensitive areas*
- *New interpretive signage developed to highlight historical and ecological values, and sustainable forest management techniques*

Auburn:

- *40 meters of boardwalk installed through sensitive forested wetland habitat and low-lying areas adjacent to wetlands*
- *New interpretive signage developed*

Forest Management Plans

What are they?

Detailed strategies that outline a set of activities aimed at improving overall quality of public forests. Objectives could relate to timber quality, wildlife habitat, biodiversity, recreation, or other values.

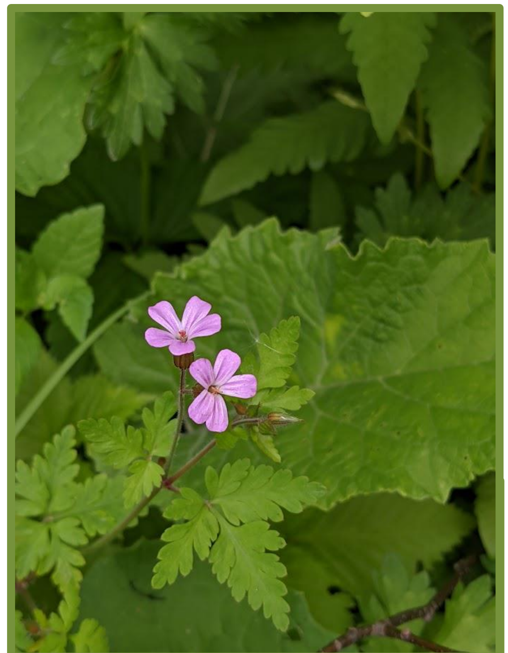
What info do they contain?

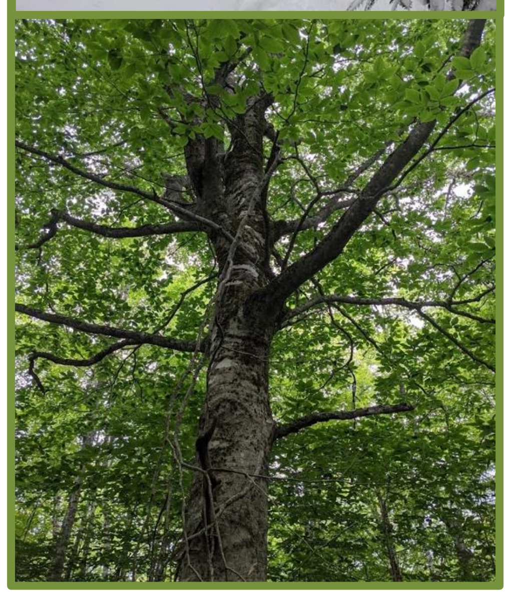
Full descriptions and histories of the areas in question, aerial photography and maps of forest stands, comprehensive prescriptions of forest management activities and their associated schedules.

Why are they important?

To keep Islanders informed on the work being done on the shared public resource and allow for community input on these activities.

Plans are available for public input for 30 days and can be found on the provincial Public Lands Forest Management Plans Comment Page website.





Wood Supply

Future forest conditions under different scenarios can be projected by building a simulation model of our forest and progressing it through time. This was carried out with Remsoft's Woodstock Optimization Studio, an industry standard for wood supply analyses since 1992. Different actions and transitions can be modeled, and the impacts on the forest analyzed. Summarizing the diverse forests of PEI into a manageable model is complex, and major simplifications must be made. The species composition codes described in Figure 5 (page 18) are the basis of stand classification, while the origin (natural or plantation), ownership, and provincial county further define them. All protected forests, offshore islands, and riparian zones were included in the inventory, but were not available to be harvested.

Beyond the full forest inventory data used as model inputs, growth and yield information allows the model to simulate forest change into the future. Merchantable volume of the different forest stands in relation to their age is included for every stand, separated into hardwood and softwood pulp and stud volumes. These volume curves are derived from the provincial permanent sample plot program which measures specific trees over time to calculate their growth. Thousands of measurements taken over the last four decades are combined to create the curves, which follow a similar trend of growth and then decline, followed by the regrowth of forest succession. The age distribution data seen in Figure 6 were used to apply ages to each stand, giving them a starting point on the yield curve.

"All models are wrong, but some are useful." – George E.P. Box

PEI's forests are predominantly privately owned and are therefore under no expectation to be managed or used. A randomized method was used that prescribes harvest (and other silvicultural activities) from eligible stands based on age or merchantable volume. Private landowners each have unique goals and objectives for their forests, all of which can change quickly; the random harvest simulation is the best way to capture the diverse value systems represented. The simulation looks to achieve the harvest target by selecting from the large inventory of forest stands; if selected, a merchantable stand has a 70% chance of being harvested. This sequence of random selection, discard or action, and select again, is continued until the full harvest volume is reached. As with most simulation models, results should not be interpreted as strict instructions, but as an evidence base for decision-making; these are projections rather than predictions.

Three forest management scenarios were selected for modelling. Annual harvests typically vary from year to year but were modelled here as constants to allow for interpolation.

1. **250,000 m^3** annual harvest – a low harvest level representing a future where commercial pressure on the forest is very low, similar in volume to just the average fuelwood harvest.
2. **400,000 m^3** annual harvest – the past 15-year average harvest level.
3. **750,000 m^3** annual harvest – a slight increase on the highest harvest recorded, representing an increased push for forest resources.

Historically relevant levels of silviculture activity since 2010 were used in each of the modelling scenarios. These activities are minor on the provincial scale but are included for completeness and to allow for sensitivity analysis on forest management prescriptions. All three scenarios assumed similar levels of silviculture activity (500 hectares of planting, 50 hectares of precommercial thinning, 50 hectares of commercial thinning, and 100 hectares of selective cutting annually).

Figure 10 shows the standing merchantable inventory of PEI's forests over a 100-year timespan under the three different harvest scenarios. As this is a random simulation, dozens of runs of each scenario were synthesized to create this graph.

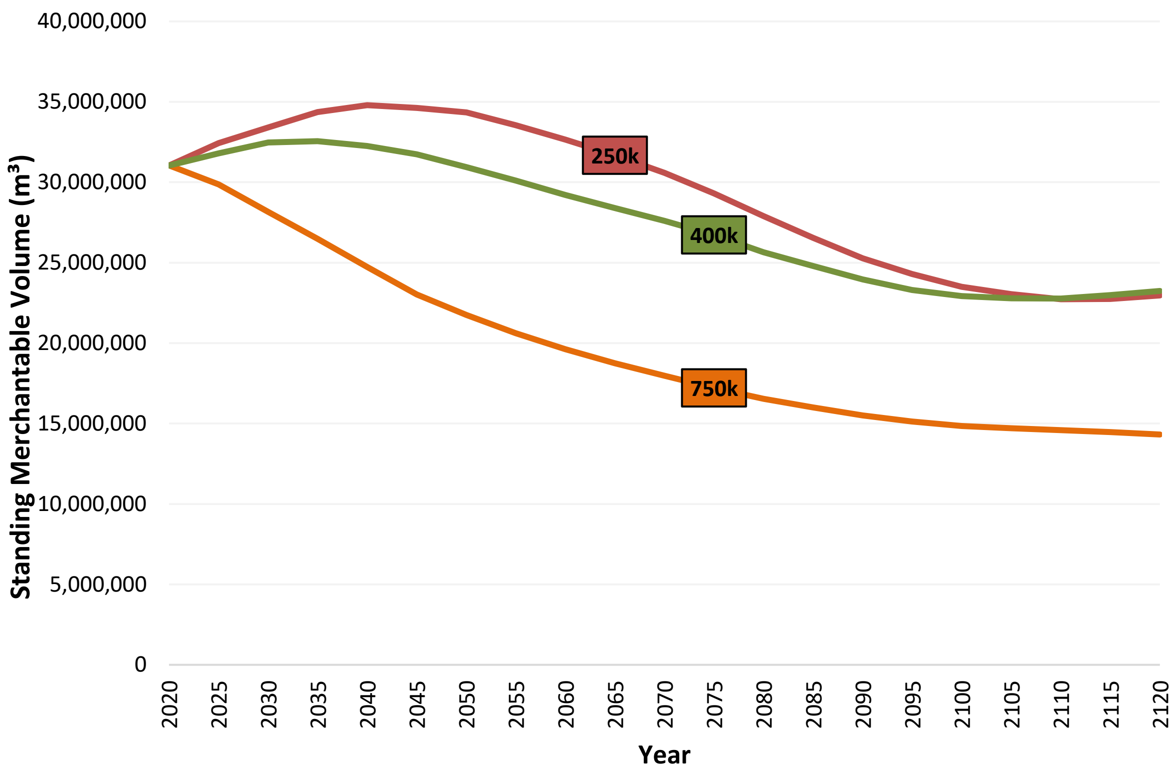


Figure 10. Inventory volume comparison over time between three harvest level scenarios.

Both the lower (250k) and middle (400k) harvest levels indicate a slight increase in standing merchantable inventory over the short term (12% and 5% increases respectively), followed by a decline of almost 30% out to about 75 years, before slowly rebuilding. Actual forest progression in the last decade (including harvest and other disturbance) has increased merchantable and total forest volume, as seen in the Wood Volume section. The projection above shows a continuation of that growth in the early portions (up to 2040 or so). The high (750k) harvest scenario loses volume every year until the 75^{th} year, dipping below half the initial level. With the current age class distribution and a randomly applied harvest regime, natural succession and stand replacement are major mechanics at play in all these scenarios.

The three different harvest targets yield very different future age structures (Figure 11). At the end of the 100-year simulation, the high harvest scenario results in a very young forest where 90% is less than 50 years old. The two lower harvests give a more distributed structure, and the random selection of harvest sites leaves even more area to grow into older classes. Conserved and protected lands are also left to age naturally.

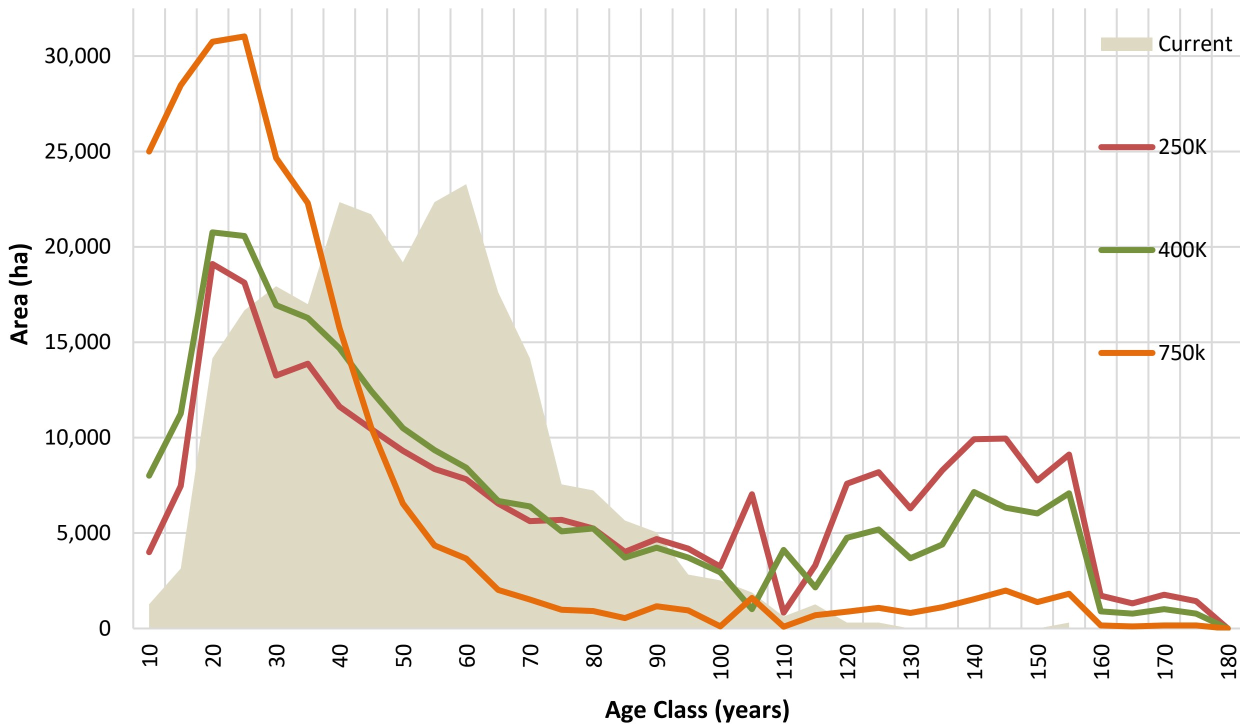


Figure 11. Comparison of age-class structures at the end of the 100-year simulation.

Main Takeaways Under Random Harvesting:

1. **High harvest scenario results in much lower forest inventory through time**
2. **Lower harvest levels result in a more evenly distributed age class structure**
3. **All random harvest scenarios decrease forest inventory at the end of 100 years**
4. **Random harvesting can allow for the development of older age classes**

To illustrate the potential productivity of PEI's forests, a suite of optimized models was also created. Optimization involves iteratively solving an objective function, typically trying to maximize or minimize certain outputs under various levels of constraint. The goal is to create a tool that shows what short, mid, and long-term strategies might be helpful in achieving various outcomes, and to illustrate what values the forest can provide when managed with intent. Three optimization scenarios are presented here, as well as one example from the previous section.

Scenario	Description
S1	Eligible harvest stands are selected at random to supply 400,000 m^3 annually. Historic levels of silviculture activity (500 ha planting, 50 ha PCT, 50 ha CT, 100 ha Selective Cut). These are all hard constraints for the full 100-year simulation.
S2	Optimized result to Maximize the Annual Harvest while never decreasing the standing inventory. Other constraints are harvest and silviculture levels cannot vary wildly from year to year (maximum 15% variance between highest and lowest years), and standing hardwood and softwood volumes are not allowed to diverge to more than 50% separation.
S3	Optimized result to Maximize the Standing Inventory rather than harvest level. This scenario used the same even flow and species composition constraints as S2.
S4	Optimized result to Maximize the Annual Harvest while never decreasing the standing inventory. In this case, no other constraints were used. The model was open to harvest, plant, and thin any amount to achieve the target.

A basic objective could be to maximize the level of harvest, while maintaining the same level of standing inventory. When a non-declining inventory is the only constraint, the harvest schedule output looks like S4 in Figure 12. Annual harvest volume starts at approximately 740,000 m^3 and steadily increases to a maximum of 2.5 million m^3 (six times greater than the 15-year average), all while maintaining and even increasing the standing inventory. Achieving this requires planting about 3,750 hectares after harvest (roughly 7.5 million seedlings), about ten times what is currently planted. These are significantly high values but demonstrate that with a concerted effort on targeting the right stands for harvest and letting far fewer sites regenerate naturally, PEI could supply global resource markets with much more volume than it has historically. Forest conditions under this scenario are very softwood dominated with even aged plantations across the landscape, heavily skewed to the younger age classes.

An unconstrained model is valuable in showing the high capacity for production the forest has, but strays from reality in such a way to make it purely academic. Putting limits on silviculture activities that align with provincial capacity and responsible resource flow, while maintaining certain key features of the forest gives a more reasonable solution. When the maximum harvest volume model above was constrained so that no silviculture activity could vary by more than 15% between its highest and lowest prescribed levels, the ratio between standing softwood and hardwood volumes is preserved and total inventory volume does not decline; the harvest program S2 in Figure 12 is created. Approximately 780,000 m^3 could be cut each year if 1,250 hectares are planted (higher harvest than since at least 1990 and planting levels close to the early 2000's).

The last result to present is S3, where the objective function was set to maximize the standing inventory over time instead of the harvest level, with the same even flow and inventory ratio constraints as S2. This scenario shows an increasing standing inventory with a split annual harvest of 430,000 m^3 for the first 60 years, and then down to 370,000 m^3 for the last 40 years. This 15% reduction is a key element to the increasing inventory level occurring at the same time. This shows that activities carried out today have long-lasting impacts on the forest resource; to maintain this resource indefinitely, management strategies need to be flexible and allowed to adapt over time. To maintain this level of harvest while increasing the inventory, an average of 750 hectares of annual planting was output by the model, requiring roughly 1,500,000 seedlings per year. These are similar harvest and planting levels as in the 400,000 m^3 random scenario presented above but shows how different strategies can create very different future conditions.

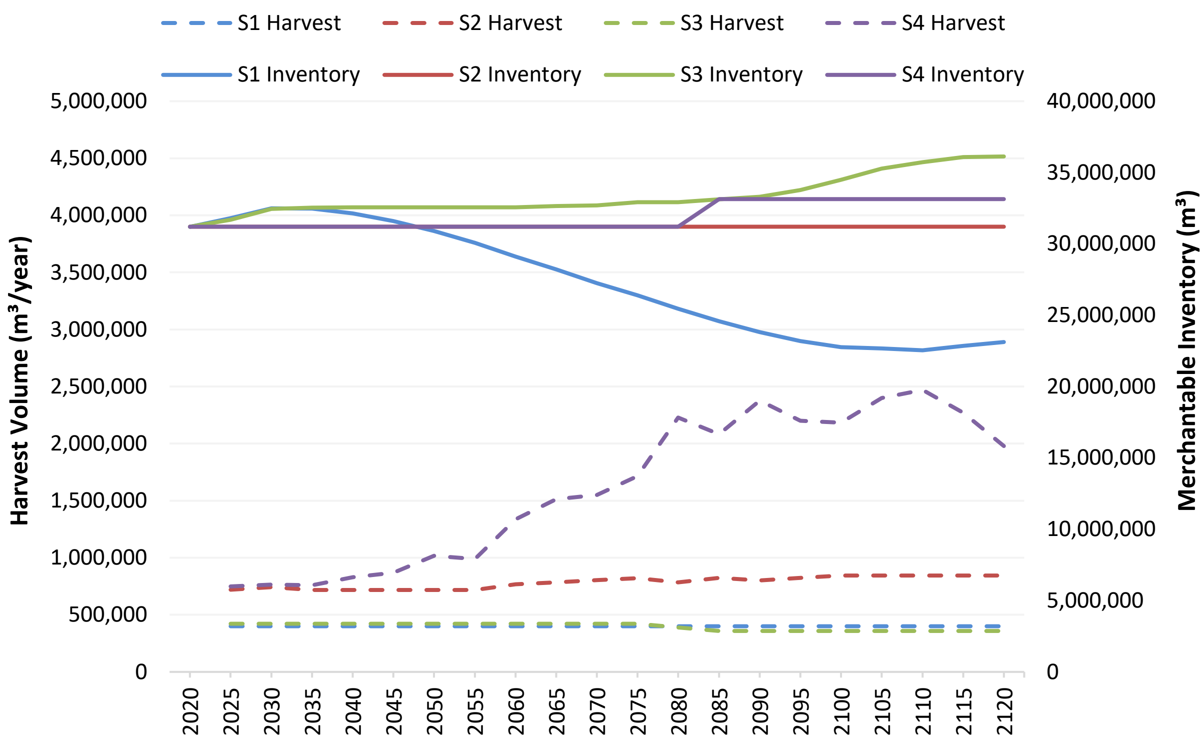


Figure 12. Harvest levels and merchantable inventory through time among four simulation scenarios.

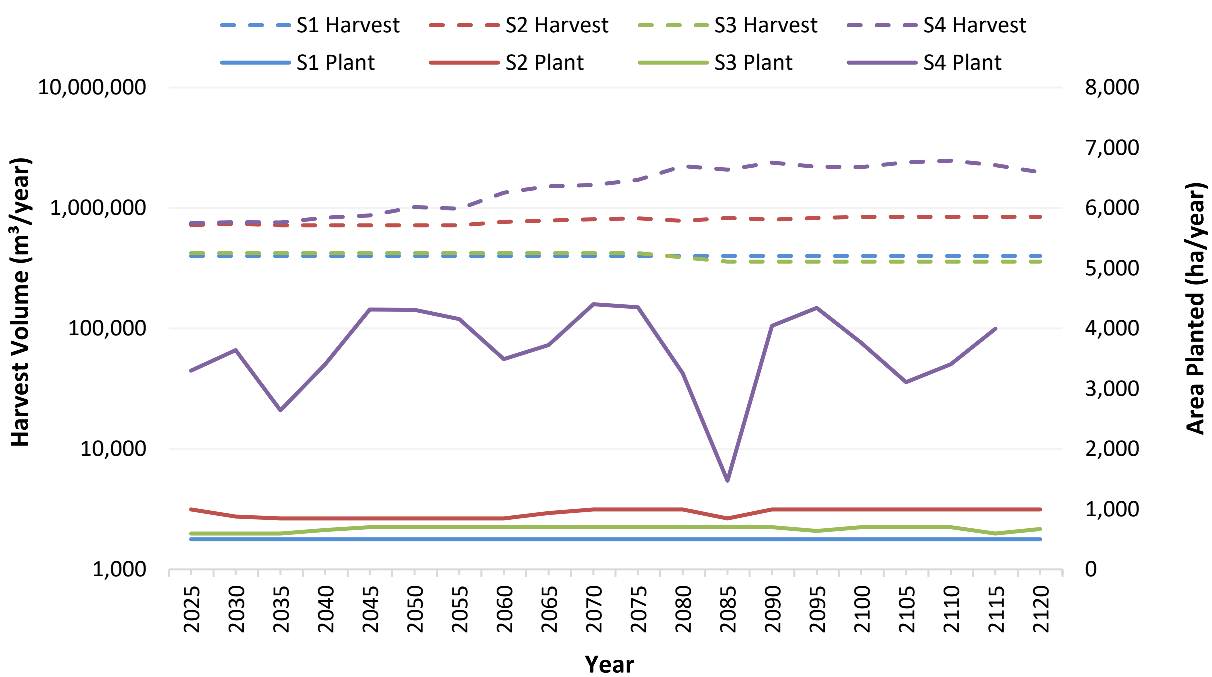


Figure 13. Harvest levels in m³ and planting area in hectares through time among four simulation scenarios.

Forest Carbon

New to this report is the inclusion of results from a carbon budget model, which tracks the forest in terms of greenhouse gases. Forests pull carbon dioxide from the environment and store the carbon in their wood, leaves, and roots via photosynthesis; forests also continuously release carbon to the atmosphere through respiration and decomposition. The accounting of each source and sink is the basis of this section. A pair of scenarios, described in the Wood Supply section (page 39), were also processed through the Carbon Budget Model of the Canadian Forest Sector or CBM-CFS3. This model tracks the transfer of carbon pools in the forest ecosystem, including live biomass (stems, branches, leaves), dead biomass (snags, litter, CWD), and various types of soil carbon. How the carbon in each pool fluctuates and transfers is simulated based on decades of testing and research and is specific to our local species and climate. The CBM-CFS3 is used for Canada's national Greenhouse Gas (GHG) inventory reporting and meets all UN Intergovernmental Panel on Climate Change (IPCC) reporting guidelines.

Carbon Storage Fluxes:

- *NPP = Net Primary Productivity = gases sequestered through photosynthesis minus the gases respired*
- *NEP = Net Ecosystem Productivity = NPP minus the gases released through decomposition*
- *NBP = Net Biome Productivity = NEP minus the carbon moved to the forest product sector or lost from disturbance = net annual change in total stored carbon/carbon dioxide equivalent (Figure 14 – solid lines)*

Figure 14 displays **annual** greenhouse gas emissions for 50-year simulations through the Carbon Budget Model (solid lines) as well as the total amount of carbon stored (dashed lines), presented in carbon dioxide equivalent. The two scenarios presented here had similar harvest and silvicultural activity that were applied very differently. The randomly applied 15-year average harvest volume (S1 as described above) treats every stand separately without a long-term objective for the forest, while the optimized schedule maximizes merchantable volume by focusing all interventions to achieve the objective. Different management methods, and the general trend in forest volume seen above, are clearly reflected in the CBM results. When only random stands are selected for harvest, the forest starts emitting carbon around year 29, and continues to do so for the remainder of the simulation. Overall, the net CO_2 equivalent is still a cumulative sink of 2 megatonnes (Mt) or 0.04Mt CO_2e per year. Alternatively, the harvest regime where focus is on growing the overall forest resource while still extracting historically reasonable volumes, displays a carbon sink every year of the 50-year simulation. The cumulative greenhouse gas sequestration is almost twice that of the first scenario at 3.9 Mt CO_2e, for an average of 0.08 Mt CO_2e/year; this is about the same amount emitted from 17,000 cars per year.

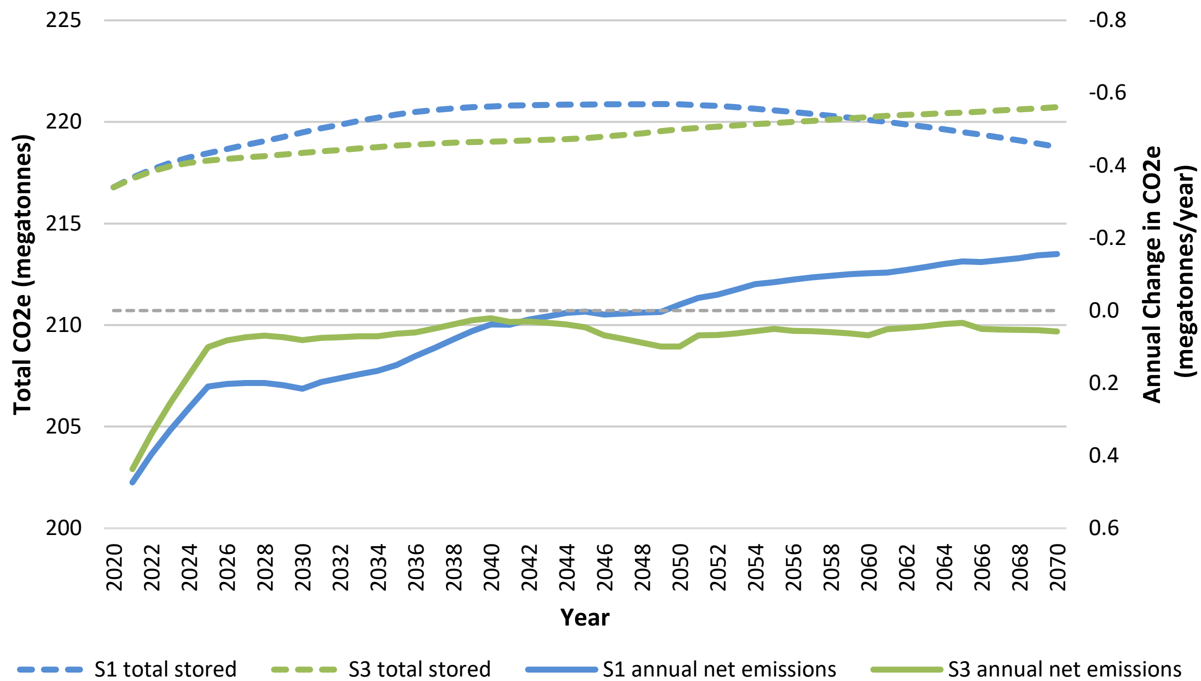


Figure 14. Total stored CO_2e and annual change in CO_2e storage through time. Positive change values indicate an increase in carbon storage between timesteps while negative change values indicate a decrease in stored carbon.

The carbon implications of harvested wood products were not analyzed for this project. Different products release their carbon back to the environment at different rates; paper products decompose almost immediately upon use, while dimensional lumber can last centuries. These emissions are important for greenhouse gas inventories and highlight the value of creating longer lasting products. Building materials, including engineered wood products, can sometimes retain their carbon indefinitely. Furthermore, the use of wood as a building material has secondary GHG impacts by offsetting the emissions from other sectors; this is known as additionality. Steel and concrete have higher per unit emissions, so replacing them with wood has a further positive CO_2 impact. The CBM-CFS3 is currently programmed to emit all the carbon associated with harvested wood as soon as it is cut, the actual timing of these releases would depend on the end use, like the product breakdowns seen in Figure 7. Further research into new tools and methodologies to help quantify and distribute these emissions is underway, and it is anticipated that greater mitigation results could be realized.

Main Takeaways from Carbon Budget Modelling:

1. **Total stored carbon is very stable throughout the simulation, varying by <2%.**
2. **Managing with focus and intent can create a carbon sink which continually builds stored carbon.**
3. **Random harvest regime is a carbon sink in the short term but soon flips to become a carbon source.**
4. **Younger age classes typically have lower sequestration capacity than older ones, but oldest stands are often sources of carbon instead of sinks.**
5. **When the end use of harvested wood products is incorporated, PEI's forests are expected to remove and displace higher GHG levels.**
6. **All modelling projects are undergoing continuous improvement and will continue to be refined throughout this new reporting period.**

Both the Wood Supply Model and the Carbon Budget Model are simplified representations of complex systems. They are only intended to inform on the possible outcomes of forest management decisions.

Wildfire Management

The number and size of wildfires vary from year to year and is predominantly based on weather conditions and human activity. Figure 15 shows the annual wildfire statistics from 2011-2020. There was an average of seven fires per year, burning about 24 hectares annually with an average size of 3.8 hectares. Compared to the previous reporting period (2001-2010), that is a drop of 11 fires and eight hectares per year, but with an increase of two hectares average size. Fewer fires are burning less area, in part due to improved response procedures and ease of reporting through smartphone use. During the reporting period, the pager method of wildfire callouts was phased out and replaced with an automated smart phone app, bringing local teams in line with many other volunteer fire departments. With the continued public investment made in equipment and training for wildland fire staff, response times and burned area have decreased significantly in the last decade. Wildfire crews are refreshed on safety, tactics, and fire behavior every year and provincial wildfire staff are on call 24/7 across the Island from March 31 until December 1 annually.

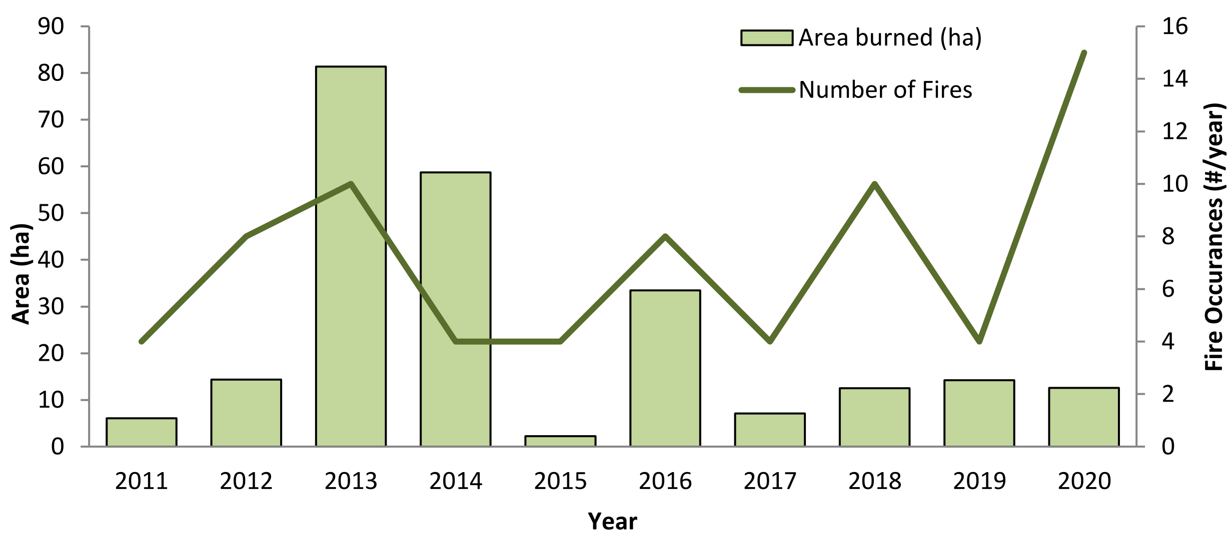


Figure 15. Annual fire statistics 2011-2020.

2020 had the most fires reported since 2006, with 15 separate fires, but the total area was very low. These fires were reported quickly and actioned before they could spread or get out of control. 2013 had the highest area burned, with more than 81 hectares disturbed by 10 reported fires. One particularly large fire occurred in May of that year and burned more than 50 hectares near Friston Road in Covehead. Resources from five volunteer fire departments (Covehead, Charlottetown, Mount Stewart, New Glasgow, North River), PEI National Park, independent heavy equipment operators, a spotter plane, and provincial crews spent more than three days suppressing and mopping up this fire with support from local residents.

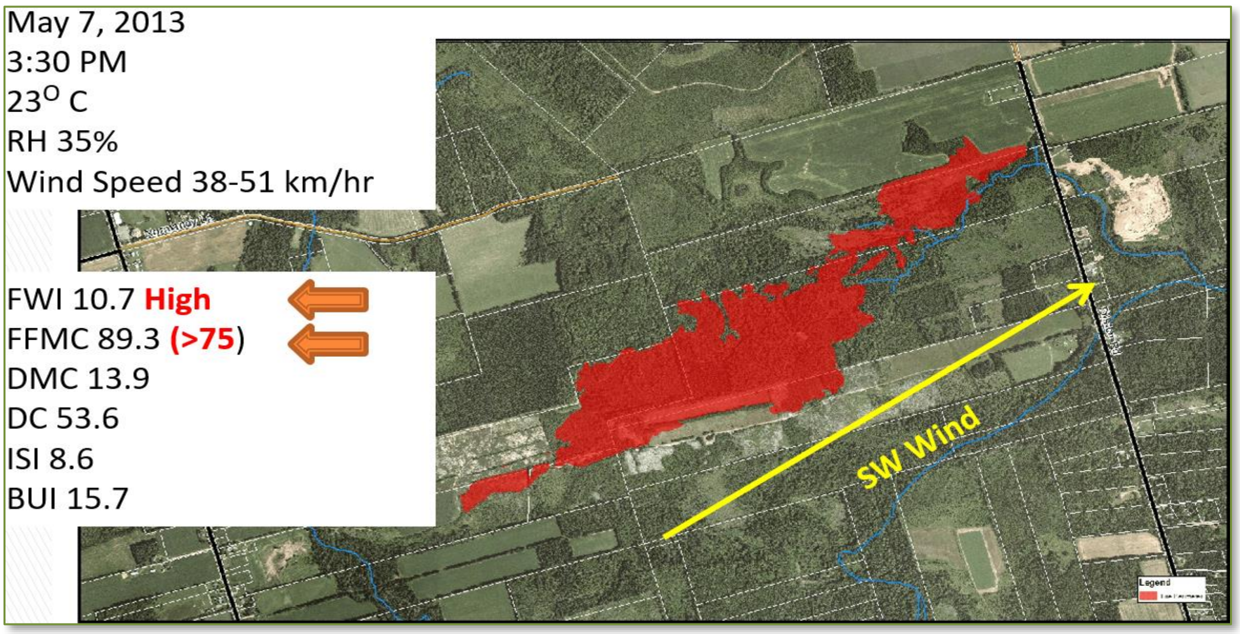


Figure 16. Map showing the burn area and the fire weather indices for Friston Road fire, 7 May 2013.

Government has made significant investments in renewal of the provincial forest fire fleet during the reporting period. Between 2017 and 2020, one three-ton float truck was replaced, and three one-ton 4x4s each with 2000 liter water capacity were required to replace aging trucks, some of which were decades old. It is expected this investment will continue beyond 2020

Significant effort has been made to renew provincial wildfire equipment and fleet vehicles.

Recent investments include three 4x4 trucks with 2000L water and pumping capacity, as well as a three-ton float truck

A new 4X4 Forestry Fire Truck has off-road capability, 2000-liter water storage and pumping capacity.

While fires in the province are infrequent and low intensity, other jurisdictions across the country and around the world are not as fortunate. Provincial wildfire response crews were exported to assist in 25 fires in eight separate jurisdictions, with 60 crew members working a total of 951 days between 2011 and 2020 (Table 13).

*Table 13. Fire crew exports from 2014 to 2020 from PEI. *2020 was impacted by Covid-19.*

Year	Exports	Crew (# of people)	Crew Days (# of days)
2014	1	2	36
2015	4	9	149
2016	4	13	157
2017	6	19	331
2018	5	11	183
2019	5	6	95
***2020**	0	0	0

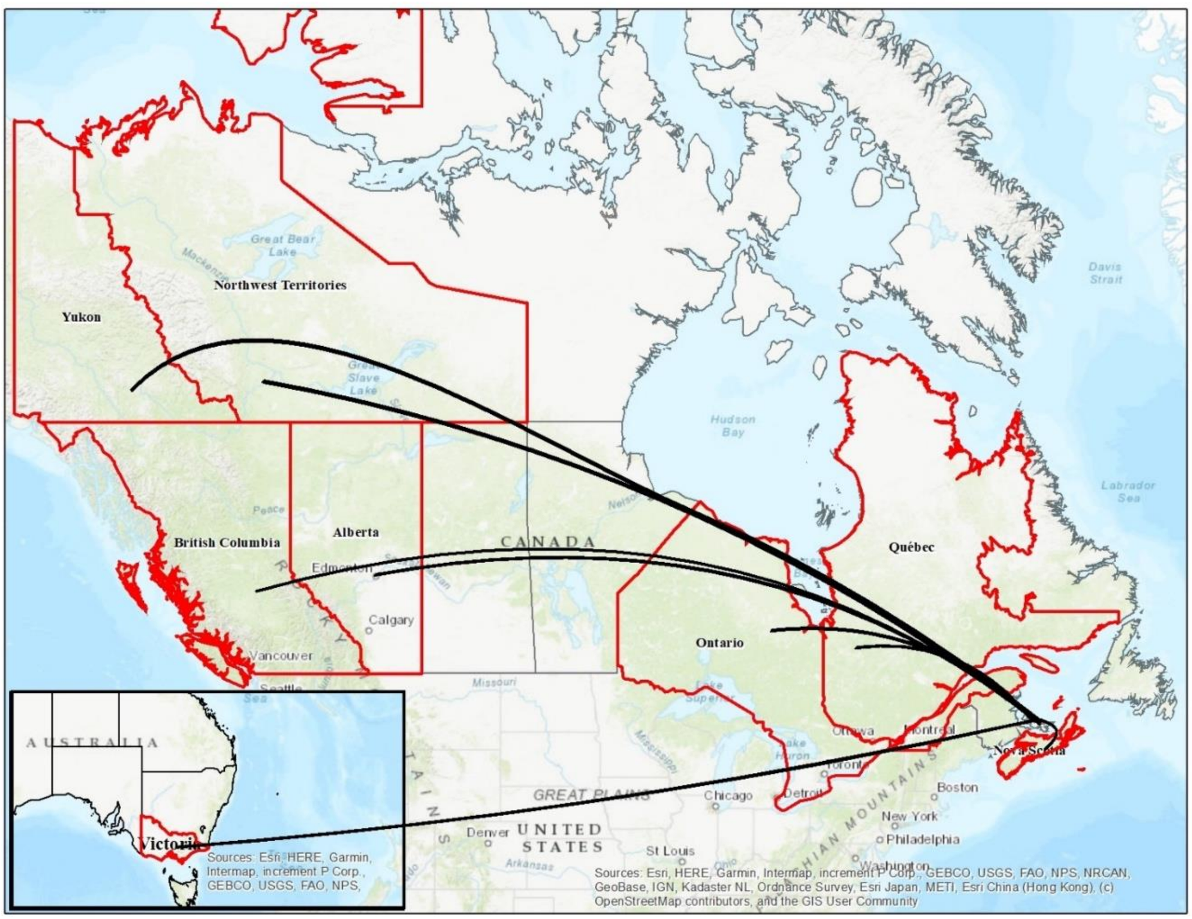


Figure 17: Jurisdictions where PEI Wildland Fire Fighters have aided with wildfire suppression (2011 – 2020).

Looking ahead, there is a risk of increased wildfire activity on PEI. Climate change will play a role in the shifting likelihood and severity of fires, with more sporadic summer precipitation, increasing temperatures, and an overall extended fire season. A changing climate also provides opportunities for new pests to survive or invade, and potentially impact our forests; insects and disease can kill more trees, and further increase overall fuel loading. Lastly, climate change is expected to increase the probability and intensity of storms, with high wind and increased blowdown likely to contribute to increased fire risk in some areas. This combination of elements, along with the ever- lengthening urban/wildland interface, could mean more active fire seasons in the coming decade. Provincial wildfire protection teams are working to prepare for these changes by improving public awareness, implementing FireSmart Canada guidelines, and continuing to invest in equipment and human resources, while learning from and assisting national and international firefighting efforts.

Planned Programs

Prince Edward Island's Forest Policy illustrates a vision of healthy, diverse Acadian forests. Such forests host a range of plants and animals that deliver economic benefits, as well as ecological goods and services essential to our well-being. Future programs are focusing on positively benefiting the forest resource through sustainable management efforts and educational outreach:

- Forest Management
  - Updated Forest Policy
  - Updated Forest Management Act
  - Public Forest Landscape-Level Management Planning
  - Increased Protected Areas Network
- Education
  - Fire Prevention and Mitigation
  - Atlantic Teachers Tour
  - PEI Envirothon
- Climate Change Adaptation & Mitigation
  - Climate Action Fund
  - 2-Billion Tree Program
  - New Fire Act
  - AtlanTIC Partnership
- Technology Advances
  - Enhanced Forest Inventory

Forest Management

The Forest Management Act was adopted in 1988, and there have been significant changes to our collective understanding of forests and management over the past three decades. PEI's Forest Policy was adopted in 2006 and has not been reviewed since that time. Updates to the provincial Forest Management Act, Forest Policy, and Public Forest Management Plans are all expected to be made before the next State of the Forest Report.

Public Forest Landscape-Level Management Planning: Long-term plans for the Provincial forest require updating to incorporate shifting priorities and best management practices. Updated inventory information is crucial to this effort, and the results presented in this report will be used to produce these plans. The next stage is to expand our view to the landscape level and begin planning management of our public forests at this larger scale.

Increased Protected Areas Network: Formally adopting and protecting the areas on the Other Effective Conservation Measures list, as well as continuing to expand the area of protected land, will be priorities moving forward.

Education and Training

Informing all members of the public on forest-related issues and topics will be a continued priority for the Division. While the number of publications, brochures and information sheets has declined in recent years, more information is being made available digitally. Private woodlot owners have historically been the main audience for many of these publications, but this is being expanded to reach wider society.

Fire Prevention and Mitigation: Increasing awareness and reducing risks from wildfire are significant priorities for the upcoming decade. National FireSmart guidelines will be expanded upon and made readily accessible to homeowners, municipalities, and local communities. The Division will continue efforts to expand its capacity to respond to wildland fire both here on PEI and across Canada. This includes training of staff and others, investment in fleet replacement and equipment upgrades, and staying up to date on technology and tools that can enhance fire prevention and mitigation.

Atlantic Teachers Tour: Founded in New Brunswick in 1998, this program now includes all Atlantic provinces and has become recognized as one of the best professional development programs in the region. Forests, Fish and Wildlife staff have been actively involved in this tour since its inception, and PEI teachers (across all grades and subject matters) are invited to attend this all-inclusive, experiential tour to learn about the region's forests and subsequent industries. Each year, PEI teachers attend through sponsorship from Forests, Fish and Wildlife, and bring new knowledge back to their classrooms to help increase the students' understanding of the various aspects of forest management and sustainability.

PEI Envirothon: Formally known as the Provincial Forest Envirothon, the PEI Envirothon has become a fundamental program in high schools across PEI. Part of the international competition known as the NCF-Envirothon, PEI has taken part since 1994, and has seen hundreds of Island students participating in this annual event. Forestry is one of the core topics of this program, along with aquatics, wildlife, and soils & land-use, and provincial employees play a pivotal role in providing education to students each year.

Climate Change Adaptation & Mitigation

In this region, a changing climate is expected to bring increased precipitation, but also more droughts. There is likely to be a rise in frequency and severity of weather events, which means increased disturbance patterns both in and out of the forest.

Accelerated disturbance regimes will be a significant aspect of climate change as it impacts PEI's forests. Wind events will be more severe and occur more regularly, extended summer conditions will increase risk of drought and fire, and changing winter conditions may not provide the insect population suppression of the past. Future planting programs must strongly consider in what environments these trees will eventually live. While some tree species ranges may tighten or expand slightly, major shifts are not expected in the short to mid-term, thus more focus is being put on provenance trials rather than species migration modelling. This involves sourcing seed from different locations, locations with climates like what may be expected locally in the future. Planting the same species with more climate appropriate origins is one way to adapt the forest to climate change. Research into the impacts of climate on forest growth and yield is ongoing at the national level through the Climate Change Working Group under the Canadian Council of Forest Ministers. Lengthened growing seasons and improved conditions could enhance forest growth rates in the mid to long-term but changing disturbance patterns may offset that.

PEI Climate Challenge Fund: this is a $1 million annual fund designed to support innovative projects that address climate-related stressors to the province. Launching in 2020, First Nations, not-for-profit organizations, private businesses, municipalities, and academic institutions are encouraged to submit project proposals through this fund. Funded projects should align with the upcoming Net Zero Framework and Provincial Climate Adaptation Plan and can be related to greenhouse gas mitigation or adapting to new climate realities.

2-Billion Tree Program: The federal government has set a goal to plant two billion trees in Canada over 10 years. These trees will help restore nature, create healthy forest ecosystems, and increase carbon capture across the country. Prince Edward Island is supporting this work and a provincial version of the program – PEI 2 Billion Trees Program – will operate to:

1. Plant native tree species on marginal agricultural land and in riparian zones;
2. Assist municipalities with urban and suburban tree planting; and
3. Replant forested sites damaged through natural disturbance.

The program will support the creation of new permanent forest cover on currently unforested lands, in low-forest-cover watersheds and riparian zones, and in urban areas across the province. Planting a mix of climate-adaptive species with a range of habitat requirements will enhance biodiversity and offer additional resiliency to the impacts of climate change. Six native species are selected for their suitability to the planting sites and reliability of nursery production: red maple, white pine, yellow birch, white spruce, white birch and Eastern hemlock.

New Forest Fire Prevention Act: The intent of this Act is to create legislation that will allow the public to carry out open burning of small quantities of natural brush and cut vegetation without having to acquire a domestic burning permit. The current legislation requires landowners to visit a Forests, Fish and Wildlife office to physically obtain a permit, possibly requiring lengthy travel. The proposed changes in this new Act allow for general burning rules to apply based on weather conditions with no permit required. Residents wishing to burn larger quantities of brush and vegetation, grass for agricultural clearing, or blueberry fields will still require a permit with stricter guidelines on appropriate weather and suppression tools. The intent of these changes is to improve client service while minimizing the risk of wildfires and subsequent impacts on forests and climate.

AtlanTIC Partnership: PEI continues to be a contributing member of the Atlantic Tree Improvement Council, which operates as a space for industry, government, and research institutes to collaborate on tree improvement projects. Selective breeding and increasing genetic gain are key components of PEI's tree improvement program; the AtlanTIC partnership enhances these by opening research opportunities and making previous research more accessible.

Technology Advances

Enhanced Forest Inventory (EFI): A new advancement since the 2010 report is the inclusion of an Enhanced Forest Inventory. This product uses ground plot inventory data to help train a model to predict forest statistics from LiDAR points. The entire forest is split into separate 20-metre by 20-metre cells, and attributes are assigned to each one, including diameters, heights, volumes, stem densities, etc. Potential uses include prioritizing stands for harvest based on predicted size and value, verifying contractor reported wood volumes after harvest, and estimating losses due to storm events. This new product can aid in the identification of specific forest information, but also helps in biodiversity conservation, managing wildfires, and adapting to climate change, in addition to the identification of other features such as sensitive areas, wildlife habitat and wetlands.

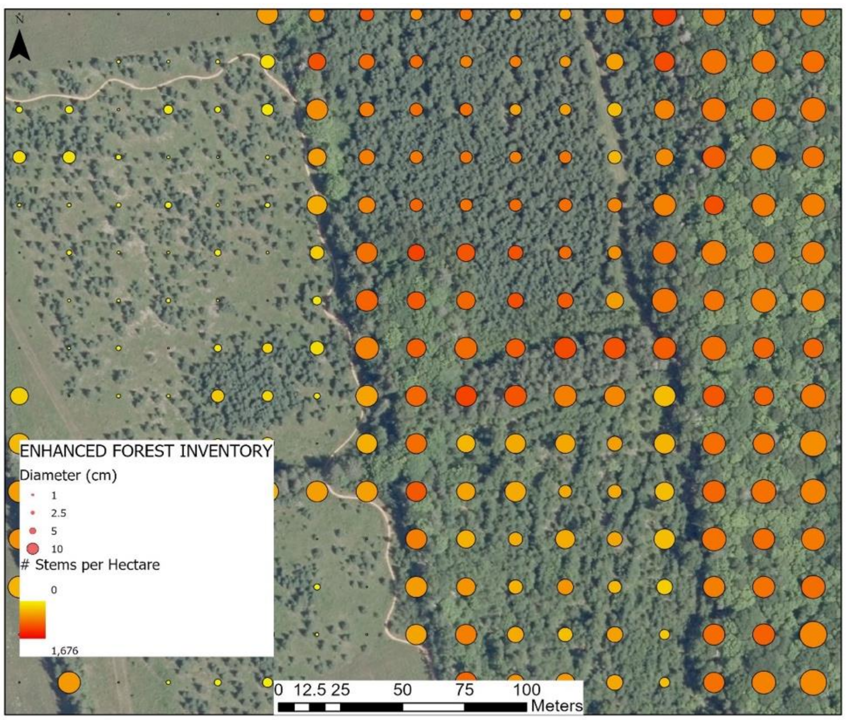


Figure 18. One way to map EFI data. The colour of each point relates to the stem density in each 400m² cell while the size represents average tree diameter. The regenerating field in the West shows very low density with only small trees while the mature hardwood stand in the East has large tree diameter and a moderate number of stems per hectare. The plantation in the central part of the map is a combination of both.

A Look-Back at Dorian

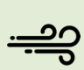
- On **September 7th, 2019,** and into the early morning of **September 8th**, Post Tropical Storm Dorian made landfall on Prince Edward Island, causing localized flooding, downed power lines, damage to infrastructure, widespread power and communication outages, and extensive damage to forests, aquaculture and agriculture.

Approximate storm path as provided by US National Hurricane Center

- On **September 9th**, Samaritan's Purse joined Provincial Forestry, Transportation and Parks Canada to assist with debris removal and clearing.
- The Forests, Fish & Wildlife Division's Field Services section was involved in providing chainsaw crews to aid in the clean-up efforts for downed trees and helping Maritime Electric access power lines.

A planted larch stand completely blown down by Dorian

- The Insurance Bureau of Canada estimated the insured damage to PEI from the storm was $17.5 million, and more than $100 million across Atlantic Canada, not including damage to government- owned infrastructure.

- **Charlottetown:** 102 Km/h, 48mm
- **Summerside:** 115km/h, 90mm
- **North Cape**: 122km/h, 135mm
- **St. Peters:** 98Km/h, 30mm

Figure 19. Brookvale Nordic Ski Park before Dorian (Aug. 2010) and after clean-up (July 2020).