MAPPING OLD-GROWTH FORESTS IN NORTHERN PETERBOROUGH COUNTY, ONTARIO

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Powassan, Ontario

The Catchacoma Eastern Hemlock Old-growth Forest, the Largest of its Kind in Canada

by P. A. Quinby

"*In the short-term, individual groups and societies might profit from forest destruction. However,* ***with old-growth forest vanishing at an unprecedented pace, mankind as a whole loses the ecosystem services provided by these forests****… [including their] spiritual and/or aesthetic nature, genetic resources, non-timber products, habitat for wildlife, the sequestration of carbon, the prevention of floods and erosion, to name only a few... Data on old-growth forests are generally scarce… NGOs involved in the protection of old growth or primary forests need fast and efficient survey methods and, given the land-use pressure on the remaining areas, they cannot afford to waste time."* (Old-Growth Forests, Wirth et al. 2009)

March 2020

Executive Summary

It is now generally accepted that old-growth forests (OGF) in Ontario, south of the Boreal Forest region, are rare ecosystems at minimum. More likely they are endangered, as has been documented for North America's red and eastern white pine OGFs. Experts agree that the loss of OGFs and large old trees throughout the world represents a serious threat to global ecological integrity since OGFs provide regulating services that help to maintain natural levels for climate, floods, disease, wastes, and water quality; cultural services that provide scientific, educational, recreational, aesthetic, and spiritual benefits; supporting services such as soil formation, photosynthesis, and nutrient cycling; and provisioning services such as food and water.

The effective stewardship of OGFs and large old trees depends on an understanding of the composition and amount of what remains, where it is located, and how much is protected. Since the location, composition, and other features of the OGFs in northern Peterborough County (NPC; the study area) are currently unknown, OGF mapping is necessary in order to facilitate OGF conservation through the various provincial land protection processes. The only past assessment for OGFs in NPC was completed eight years ago as part of the local forest management planning process. However, this mapping did not differentiate OGFs by tree species composition, landscape-level features, population-level features, land ownership, or protection.

This lack of detailed OGF analysis using digital mapping data has resulted in ignoring OGFs with local, provincial and even national natural heritage significance. For example, the 1,655 ac (662 ha) eastern hemlock OGF located at the north end of Catchacoma Lake was found to be the largest of its kind in Canada, and natural (unlogged) eastern hemlock forests have been found to be very rare in Ontario. If this nationally-significant OGF had been assessed and evaluated prior to approval of the last ten-year forest management plan, it is highly likely that it would have been set aside as a protected area. Instead, this rare and unique OGF is currently being logged, with no current plans for protection.

Thus, the purpose of this project was to utilize data and OGF policy guidance provided by the Ontario government to locate, map, and describe the variety of OGF types in NPC in terms of features such as age, stand metrics, population metrics and landscape metrics. The southern portion of the County was excluded from this analysis due to the lack of useful digital forest resource inventory data for that area. Our results can be applied to forest conservation issues in NPC including consideration of OGF protection to meet the 30% land protection by 2030 target set by the federal government. Since only 12% of Ontario's terrestrial landscapes is currently protected, another 18% needs protection.

Future ground-truthing will likely determine that many of the OGFs shown on maps in this report are not "old growth" when evaluated using the five primary features of OGFs including age, old tree density, snags, logs, and integrity (stump density). However, these mapped OGFs are some of the most high-integrity forests remaining in the study area and therefore represent landscapes with the greatest potential for OGF restoration.

A total of 14 OGF types across 18.1% (34,333 ha) of the study area were found. Total OGF stand area was 34,333 ha (2+ ha), mean total OGF stand area was 2,452 ha, ranging from 116 ha (black ash) to 11,033 ha (poplar). Poplar and white cedar OGFs made up 53% of the total OGF area, the other 12 OGF types made up 47% of the OGFs in NPC. The top 50% of the OGF types with the most area (ha) made up 91% of the OGF area in NPC, the other half made up only 9%. Eight of the OGF types made up less than 3.5% of the total OGF area including those with the following lead species: white spruce, white birch, red oak, sugar maple, tamarack, black spruce, red pine and black ash (in decreasing order).

OGFs on public land occupied 18,247 ha (53%) and OGFs on private land occupied 16,086 ha (47%). The top five OGFs in total area (ha) on public land included poplar, white pine, red maple, white cedar, and eastern hemlock (in decreasing order). The top five OGFs in total area (ha) on private land included white cedar, poplar, red maple, balsam fir, and eastern hemlock (in decreasing order). Three of the most rare OGF types in Ontario's Temperate Forest Region are also rare on both public and private lands in NPC including black ash, red pine, and red oak.

Twenty-six percent of the OGF area in NPC was protected (8,817 ha) and a total of 74% was unprotected. The majority (>50%) of the area of each of 12 OGF types remains unprotected in NPC. Four of the rarest OGF types in Ontario have less that a third of their areas protected in NPC including black ash, red pine, red oak, and eastern hemlock (increasing order).

The total area logged in northern Peterborough County since 1987 was 5,201 ha composing 3% of the study area and 4% of the forested area, mean stand size was 35 ha, and 14 different forest types were logged. The three most abundant forest types made up 87% (4,522 ha) of the logged area including those dominated by sugar maple, white pine and red maple (decreasing order). Four types make up from 1.5 to 3% of the area logged including those dominated by red oak, red pine, poplar, and trembling aspen (decreasing order). Below 1.5% there were seven forest types including those dominated by hemlock, white spruce, beech, white ash, white cedar, white birch and balsam fir (decreasing order).

Using our (or similar) mapping, OGFs of rare provincial forest types (Quinby 2019a) in NPC should be targeted for ground truthing including red pine, red oak, black ash, red maple and eastern hemlock forests. The spatial logging data should be used to further refine potential boundaries for these stands. Ground truthing of all other OGF types in NPC should be considered lower priority, however, within this group eastern white pine and white cedar OGFs should be prioritized. Ground truthing should include assessment of the five primary features of OGF including stand/tree age, density of old-growth trees, snags, logs and integrity (stump density).

Stands that are verified in the field as OGF based on the five primary OGF features should be proposed for protection at the most appropriate level including local, provincial and federal. Those OGF stands that are in close proximity to existing protected areas and/or may contribute to ecological connectivity at the landscape or regional levels should also be prioritized for protection.

The assessment method presented in this report can be applied to other forested regions as the first step in identifying, describing and conserving OGFs. However, some mapped OGFs with no FRI record of logging will have cut stumps in them, which will not be discovered until field data are collected. One way to potentially avoid losing time discovering that an OGF has been logged would be to find an OGF feature other than age, such as above-ground biomass or total tree biomass, that has been or can be remotely sensed and converted to use in GIS analyses. Research is required to identify this/these additional OGF indicator(s), assuming that one or more exist.

Introduction

Globally, 1.5 million square kilometers of forests were lost to human activity between 2000 and 2012. In fact, the excessive exploitation of timber throughout the world has resulted in the rarity and even the extinction of some forest types (Franklin 1988, Maser 1990, Norse 1990). Noss et al. (1995) reported that old-growth and other natural forests of all types throughout the eastern USA have declined by 98% or more. Of all countries, Canada lost the greatest amount of primary, natural (old-growth) forest between 2000 and 2014 representing 20% of global primary deforestation during that time (Beaudry 2019).

The fate of natural forested landscapes in Ontario is following the pathway of forest loss that has characterized most of the forested landscapes in the USA (Noss et al. 1995). In particular, the problem in Ontario has reached an extreme level in the southern parts of the province. For example, the Environmental Commissioner of Ontario (ECO) (2018) stated that,

> "Since European settlement, southern Ontario has lost most of its forest cover to land clearing for agriculture and development – and forests continue to disappear. Today, many watersheds have below the 30% forest cover required to ensure marginally functional ecosystems… southern Ontario as a whole has only about 25% forest cover, which is less than the minimum needed to support healthy wildlife and ecosystems".

The most valuable portions of the remaining least-disturbed forested landscapes are old-growth forests (OGFs), which are important for the ecosystem services they provide including *regulating services* that help to maintain natural levels for climate (Luyssaert et al. 2008), floods, disease, wastes, and water quality; *cultural services* that provide scientific, educational, recreational, aesthetic, and spiritual benefits; *supporting services* such as soil formation, photosynthesis, and nutrient cycling; and *provisioning services* such as food and water (Millennium Ecosystem Assessment 2005).

Large and/or old trees that are typical of OGFs have been characterized as keystone ecological structures (e.g., unique wildlife habitat) in forests, savannas, farmlands, and urban landscapes (Lindenmayer et al. 2012). In particular, "Because large-diameter trees constitute roughly half of the mature forest biomass worldwide, their dynamics and sensitivities to environmental change represent potentially large controls on global forest carbon cycling. [Protecting] …existing large-diameter trees or those that can soon reach large diameters [is] a simple way to conserve and potentially enhance ecosystem services" (Lutz et al. 2018). In fact, one large tree can remove the same amount of carbon from the atmosphere within a year as is contained in one mid-sized tree (Stephenson et al. 2014).

However, it is now generally accepted that OGFs in Ontario, south of the Boreal Forest region, are rare ecosystems at minimum. More likely, they are endangered, as has been documented for North America's red and eastern white pine OGFs (Quinby 1993, EAB 1994). In addition, "the loss of large old trees in many ecosystems around the world poses a threat to ecosystem integrity" (Lindenmayer et al. 2012). The effective stewardship of OGFs and large old trees depends on an understanding of the composition and quantity of what remains, where it is located, and how much is protected.

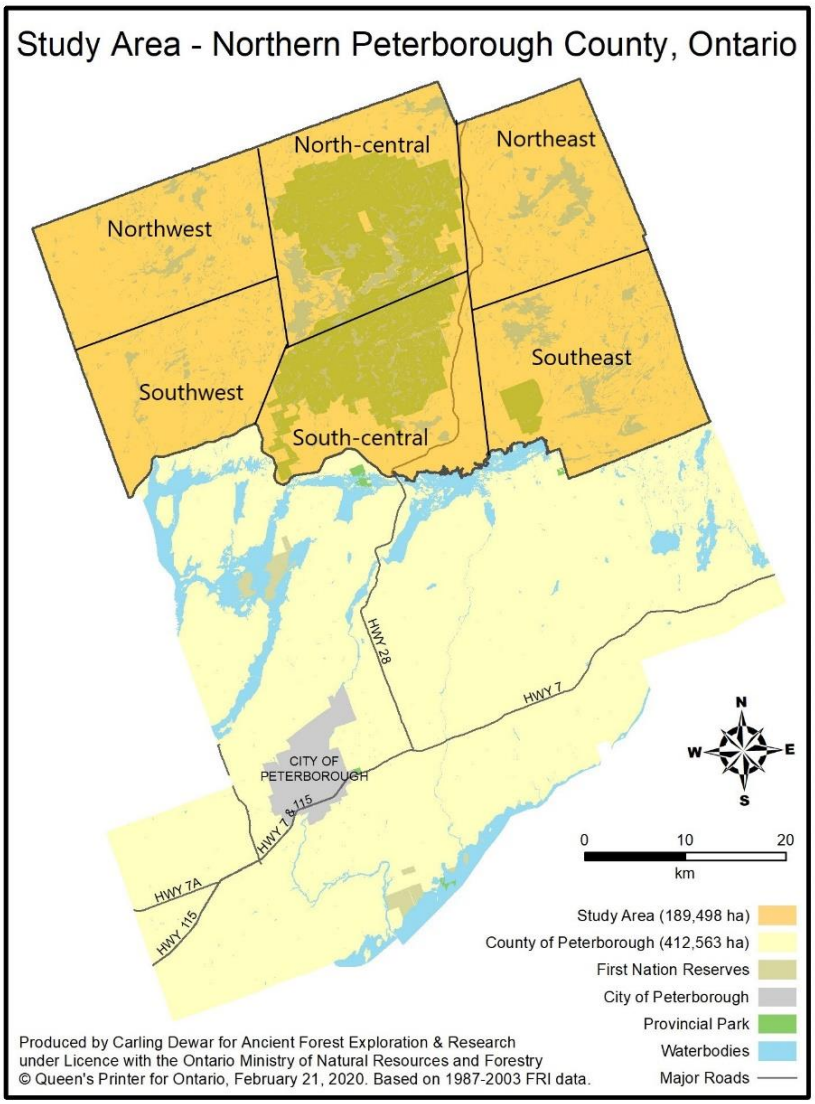
The purpose of this work was to utilize data and OGF policy guidance from the Ontario government to locate, map, and describe the variety of OGF types in northern Peterborough County (NPC; the study area). The southern portion of the County was excluded from this analysis due to the lack of useful digital forest resource inventory data for that area. These results can be applied to forest conservation issues in NPC including consideration of OGF protection to meet the 30% land protection target of the federal government. Currently, only 12% of Ontario's terrestrial landscapes are protected. Logged areas based on government data were also assessed in the study area.

Since the location, composition, and other features of the OGFs in NPC is currently unknown, this work is necessary in order to facilitate consideration of OGFs through the provincial land-use policy development process. For example, the 1,655 ac (662 ha) eastern hemlock OGF located at the north end of Catchacoma Lake was found to be the largest of its kind in Canada (Quinby 2019a), and natural (unlogged) eastern hemlock forests have been found to be very rare in Ontario (Quinby 2019b). If this nationally-significant OGF had been assessed and evaluated prior to approval of the last ten-year forest management plan, it is highly likely that it would have been set aside as a protected area, unavailable for logging. Instead, this rare and unique OGF is currently being logged with no current plans for protection.

Study Area

Northern Peterborough County (Figure 1) makes up roughly 46% (189,498 ha) of Peterborough County. This area was divided into six sections to facilitate the descriptions of OGF spatial distributions including northwest, southwest, north-central, south-central, northeast, southeast. The total area of 20+ yr. old forests in the study area is estimated at 132,500 ha (69.9%).

Figure 1. Study Area with Six Sections

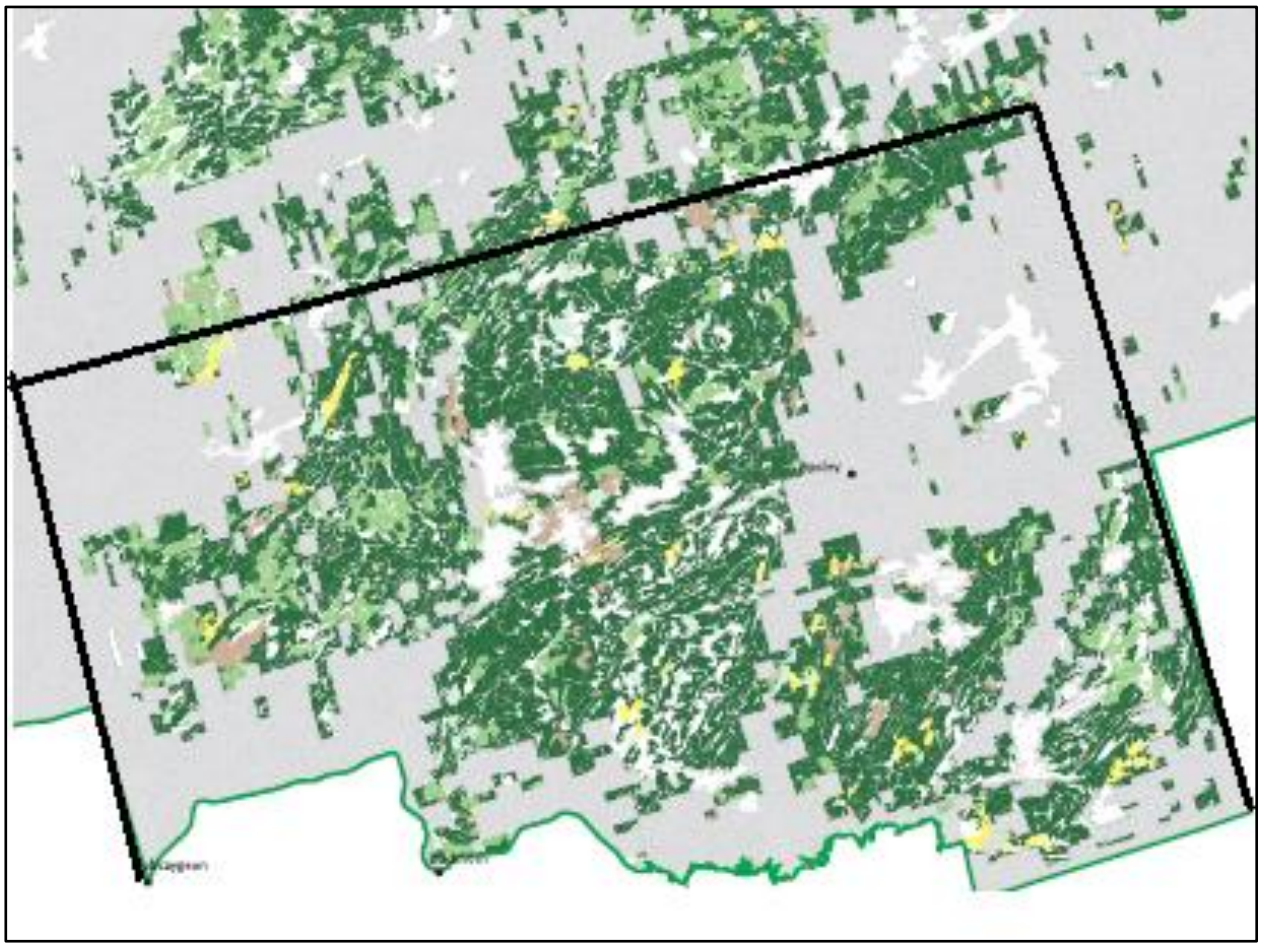


The only assessment for OGFs in NPC was completed by Clark et al. (2012) as part of the local forest management planning process (Figure 2). However, this mapping did not differentiate OGFs by tree species composition, landscape-level features, population-level features, land ownership, or protection. Clark et al. (2012) stated that, 1) "very little forest left in this management unit… could be considered old growth", 2) "some residual patches exist across the landscape where logging was not feasible, mostly due to the terrain", and 3) "old growth in the Bancroft-Minden Forest is contained largely in… parks and conservation reserves".

According to Clark et al. (2012), these three findings are based on professional opinion since they did not perform any OGF field assessments or perform any digital mapping analyses to identify OGF polygon clusters. And finally, they used only age of onset to identify OGFs as specified in provincial OGF definitions (OMNR 2003a). We refer to this type of forest as "policy-based old-growth forest" (policy OGF; OMNR 2003b). They did not consider the other four primary OGF features including old tree density, snags, logs, and integrity (stump density), which are associated with the scientific concept of OGFs (scientific OGF; Wirth et al. 2009).

Future ground-truthing will likely determine that many of the OGFs shown on maps in this report are not "old growth" when evaluated using the five primary features of OGFs. However, they are some of the most high integrity forests remaining in the study area and therefore represent landscapes with the greatest potential for OGF restoration.

Figure 2. Old-growth Forests in Northern Peterborough County
(brown areas=OGF; approximate boundaries; from Clark et al. 2012)



Methods

Forest Resource Inventory (FRI) data for the period 1987-2003 (LIO 2019) for NPC were analyzed using ESRI ArcMap 10.7 GIS software. OGFs and their types were identified using age-of-onset values for each "lead species" (OMNR 2003a) applied to the FRI data. Stand ages provided in the FRI data were increased to reflect the number of years between the map production date and 2019. Other FRI variables assessed included: stand size (min size=2 ha; from Larson et al. 1999), stand stocking (density), stand height, land ownership, and protection status.

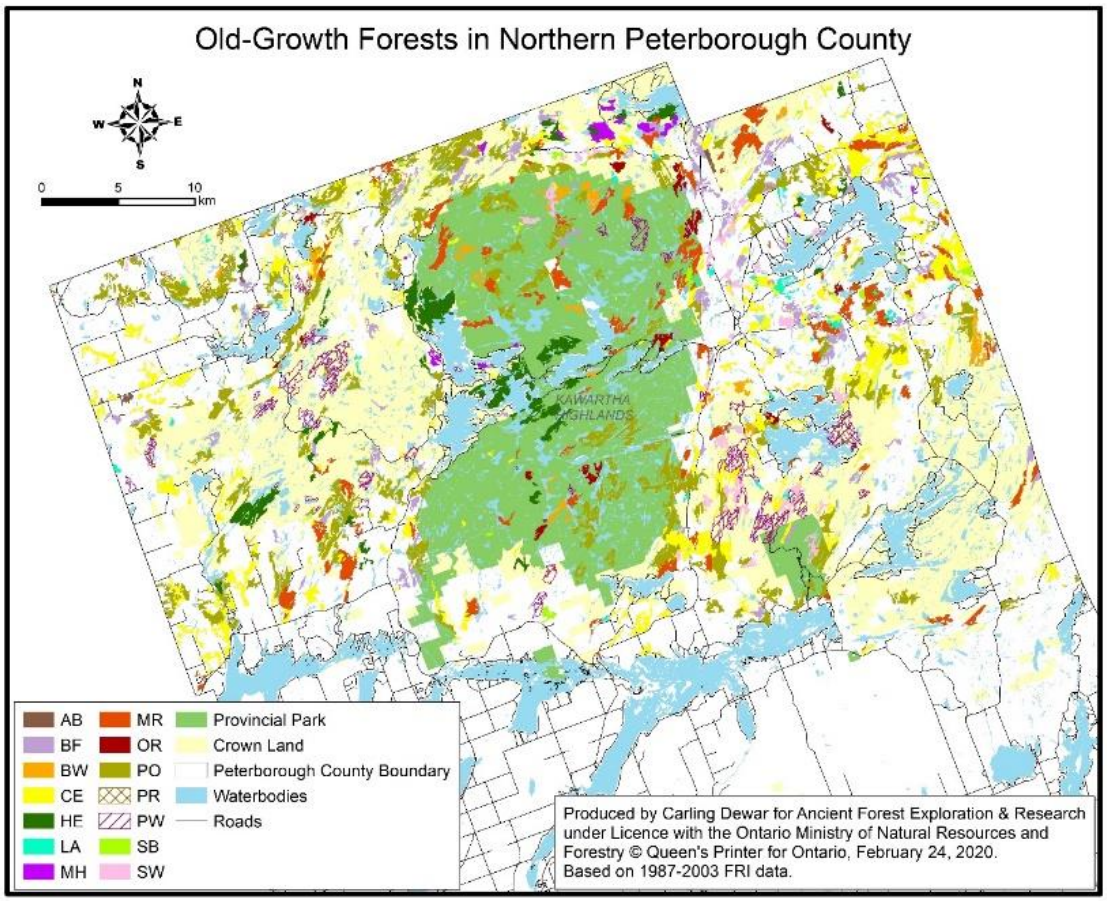
The study area was divided into six sections to facilitate OGF type descriptions. Maximum lifespan values for tree species were obtained from USDA (2020a), USDA (2020b) and D'Amato (2013). Medians are based on the means associated with each of the 14 OGF types and areas logged were obtained from the 2007 FRI dataset (LIO 2019). Maps and basic statistics were produced to describe these forests.

Since these OGF areas were identified solely on minimum stand age (OMNR 2003a), they will need to be evaluated through ground-truthing to determine if they meet the minimum standards associated with the primary features that make up an OGF including old tree density, snags, logs, and integrity (stump density) (Wirth et al. 2009).

Old-growth Forest Maps and Descriptions

A total of 14 OGF types across 18.1% (34,333 ha) of the study area were found (Figure 3). Protected OGFs make up 4.7% of the study area. Other tree species that are found in these stands but do not occur as lead species included American beech, basswood, elm spp., ironwood, white ash, white oak, and yellow birch.

Figure 3



For each OGF type, we provide a map and a brief description based on FRI data analysis and on the spatial distribution of the stands associated with each OGF type. To facilitate this, each of the 14 OGF types was assigned to one of the following broader forest categories.

- *Long-lived Conifer OGFs* (eastern hemlock, eastern white pine, red pine, white cedar, white spruce)
- *Late-Successional Deciduous OGFs* (red oak, sugar maple)
- *OGFs with Wetland Ecotypes* (black ash, black spruce and tamarack)
- *Short-lived Conifer OGFs* (balsam fir)
- *Early-Successional Deciduous OGFs* (red maple, poplar, white birch)

Definitions of tree species acronyms are as follows: Ab-black ash, Aw-white ash, Be-American beech, Bf-balsam fir, Bw-white birch, Ce-white cedar, He-eastern hemlock, Mr-red maple, Ms-sugar maple, Or-red oak, Po-poplar, Pr-red pine, Pt-trembling aspen, Pw-white pine, Sb-black spruce, Sw-white spruce and Ta-tamarack.

Long-lived Conifer OGFs: *Eastern Hemlock (maximum lifespan - 900+ yrs.)*

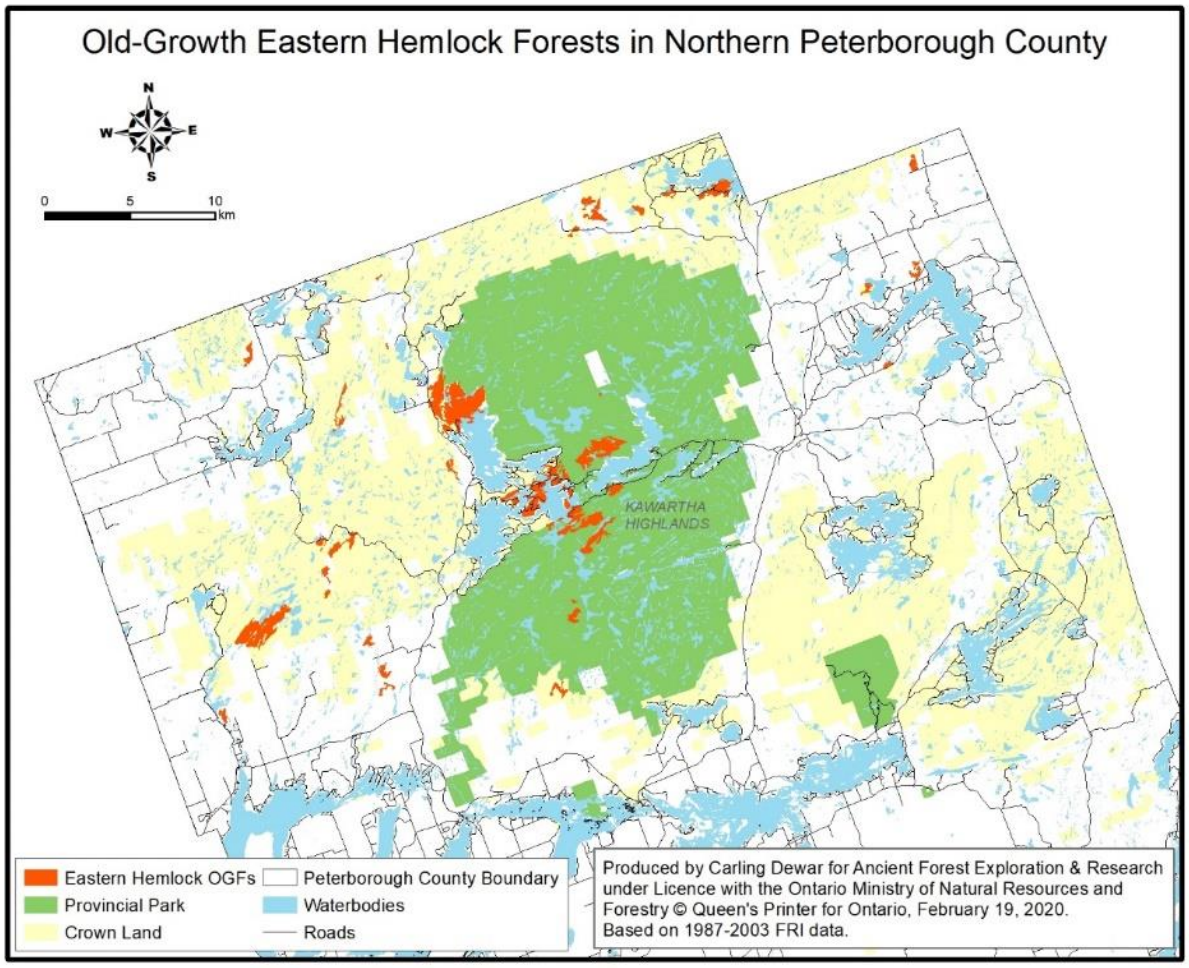
There are 108 eastern hemlock OGF stands located in the study area totalling 2,522 ha with a mean of 23 ha and a maximum of 550 ha (Table 1). Mean stand age is 164 yrs. and the oldest stands are 207 yrs. Mean stand density is 90 %cover and mean stand height is 20 m with a maximum of 25 m. Sixty-two percent of these stands is located on public land, the nine largest of these are found on public land, and 32% of their total area is protected.

Table 1. Eastern Hemlock Stands (140+ yrs)

Number of Stands		108	
Size (ha)	total	2,522	
	mean	23	(2-550)
Age (yrs)	max	207	
	mean	164	
Density (%cover)	mean	90	(50-100)
Height (m)	mean	20	(16-25)
Land Ownership (ha)	public	1,559	62%
	private	963	38%
Protection	yes	811	32%
	no	1,711	68%

The majority of the eastern hemlock OGF is located in the north-central portion of the study area (Fig. 4). There is also a significant amount located in the southwest section. At least five medium to large stands are located within Kawartha Highlands Provincial Park and the largest contiguous collection of eastern hemlock OGF stands is found at the north end of Catchacoma Lake with a total area of 550 ha.

Figure 4



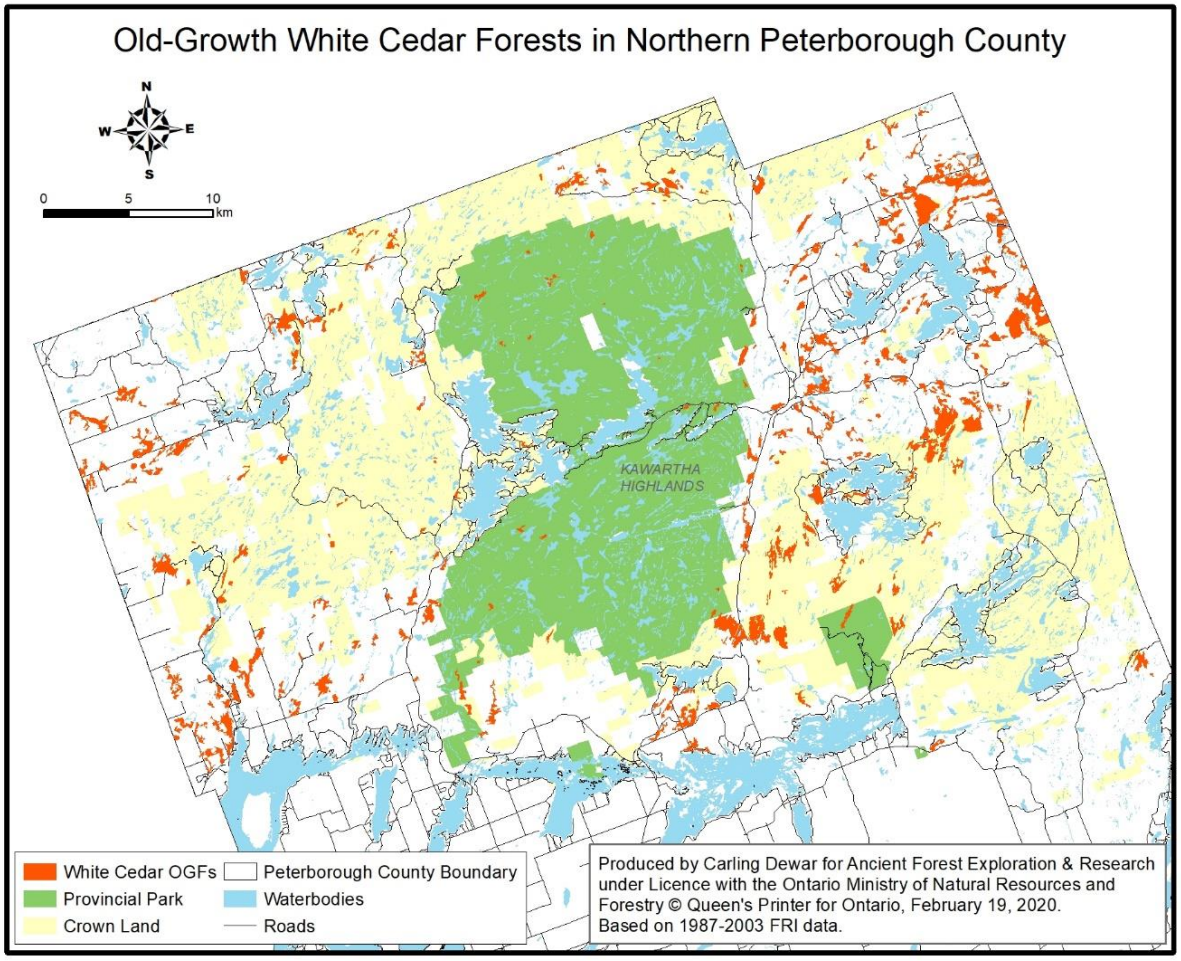
Long-lived Conifer OGFs: *White Cedar (maximum lifespan - 800+ yrs.)*

There are 484 white cedar OGF stands located in the study area totalling 7,195 ha with a mean of 15 ha and a maximum of 136 ha (Table 2). Mean stand age is 123 yrs. and the oldest stands are 187 yrs. Mean stand density is 80 %cover and mean stand height is 14 m with a maximum of 26 m. Twenty-four percent of these stands is located on public land, two of the four largest of these are found on public land, and 17% of their total area is protected.

Table 2. White Cedar Stands (110+ yrs)			
Number of Stands		484	
Size (ha)	total	7,195	
	mean	15	(2-136)
Age (yrs)	max	187	
	mean	123	
Density (%cover)	mean	80	(30-100)
Height (m)	mean	14	(9-26)
Land Tenure (ha)	Public	1,734	24%
	Private	5,461	76%
Protection	yes	1,253	17%
	no	5,942	83%

The white cedar OGFs are well distributed throughout the study area but stand abundance is lowest in the north- and south-central sections (Fig. 5). Only 23 of the 484 stands (146 ha) are located within Kawartha Highlands Provincial Park and the largest collection of white cedar OGF stands is located in the northeast section where the majority of land is privately owned.

Figure 5



Long-lived Conifer OGFs: *Eastern White Pine (maximum lifespan - 450+ yrs.)*

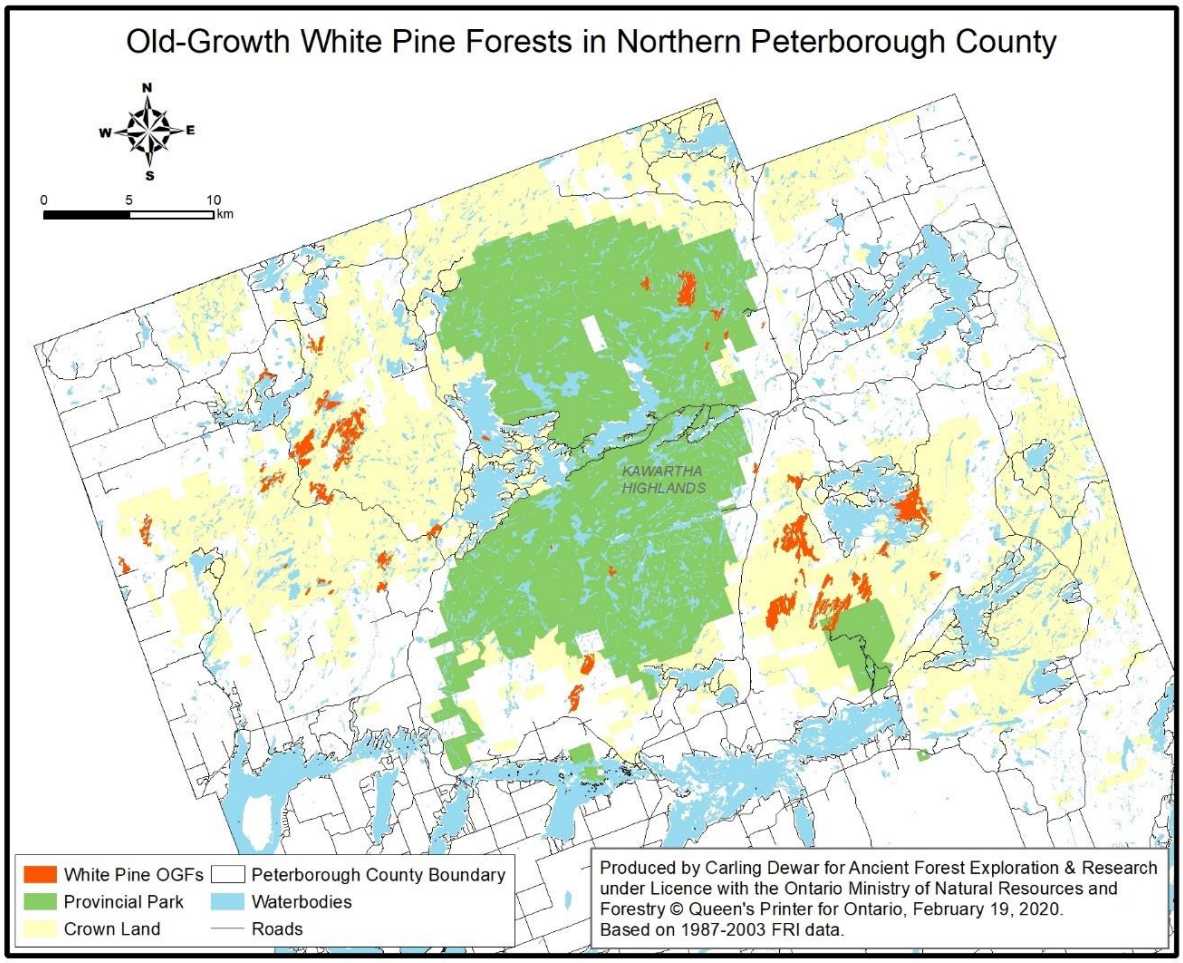
There are 94 eastern white pine OGF stands located in the study area totalling 2,447 ha with a mean of 26 ha and a maximum of 238 ha (Table 3). Mean stand age is 127 yrs. and the oldest stands are 152 yrs. Mean stand density is 60 %cover and mean stand height is 23 m with a maximum of 27 m. Eighty-six percent of these stands is located on public land, the four largest of these are found on public land, and 54% of their total area is protected.

Table 3. White Pine Stands (120+ yrs)

Number of Stands		94	
Size (ha)	total	2,447	
	mean	26	(2-238)
Age (yrs)	max	152	
	mean	127	
Density (%cover)	mean	60	(30-100)
Height (m)	mean	23	(18-27)
Land Tenure (ha)	public	2,102	86%
	private	345	14%
Protection (ha)	yes	1,322	54%
	no	1,125	46%

Significant amounts of eastern white pine OGF are located in four sections of the study area (Fig. 6) including both north- and south-central, the southeast and the northwest. At least one large stand and five small stands are located within Kawartha Highlands Provincial Park, and the largest contiguous collection of eastern white pine OGF stands is found in the Jack Lake region (SE section).

Figure 6



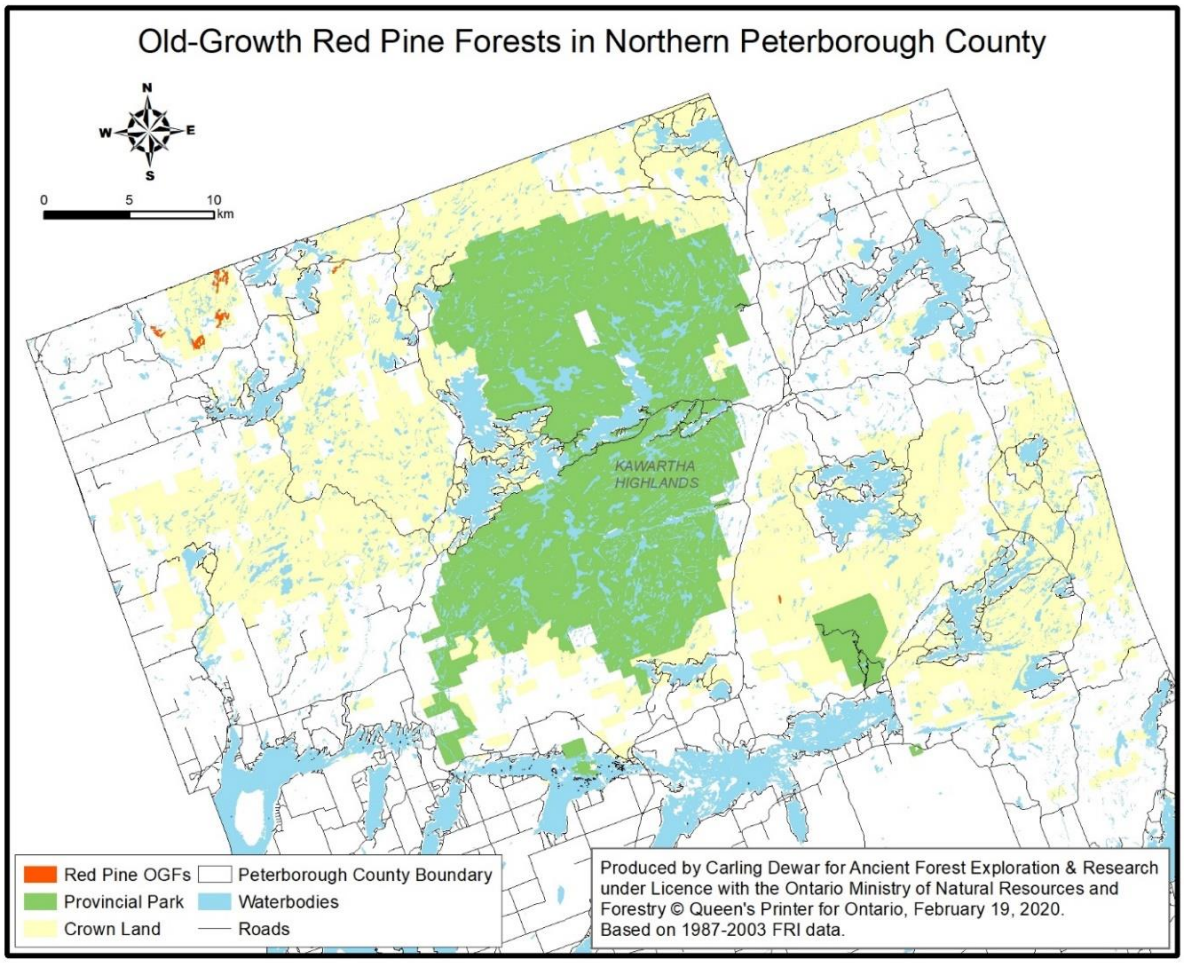
Long-lived Conifer OGFs: *Red Pine (maximum lifespan - 400 yrs.)*

There are eight red pine OGF stands located in the study area totalling 156 ha with a mean of 20 ha and a maximum of 34 ha (Table 4). Mean stand age is 126 yrs. and the oldest stands are 132 yrs. Mean stand density is 60 %cover and mean stand height is 23 m with a maximum of 25 m. Eighty-five percent of these stands is located on public land, the three largest of these are found on public land, and 3% of their total area is protected.

Table 4. Red Pine Stands 120+ yrs)			
Number of Stands		8	
Size (ha)	total	156	
	mean	20	(5-34)
Age (yrs)	max	132	
	mean	126	
Density (%cover)	mean	60	(30-100)
Height (m)	mean	23	(21-25)
Land Tenure (ha)	public	132	85%
	private	24	15%
Protection (ha)	yes	5	3%
	no	151	97%

The very small amount of red pine OGF present in the study area is almost exclusively located within the northeast section; one small stand is located within the southeast section (Fig. 7). None of these stands are located within Kawartha Highlands Provincial Park and the largest collection of red pine OGF stands is located just west of Salerno and White Lakes (NW section).

Figure 7



Long-lived Conifer OGFs: *White Spruce (maximum lifespan - 300+ yrs.)*

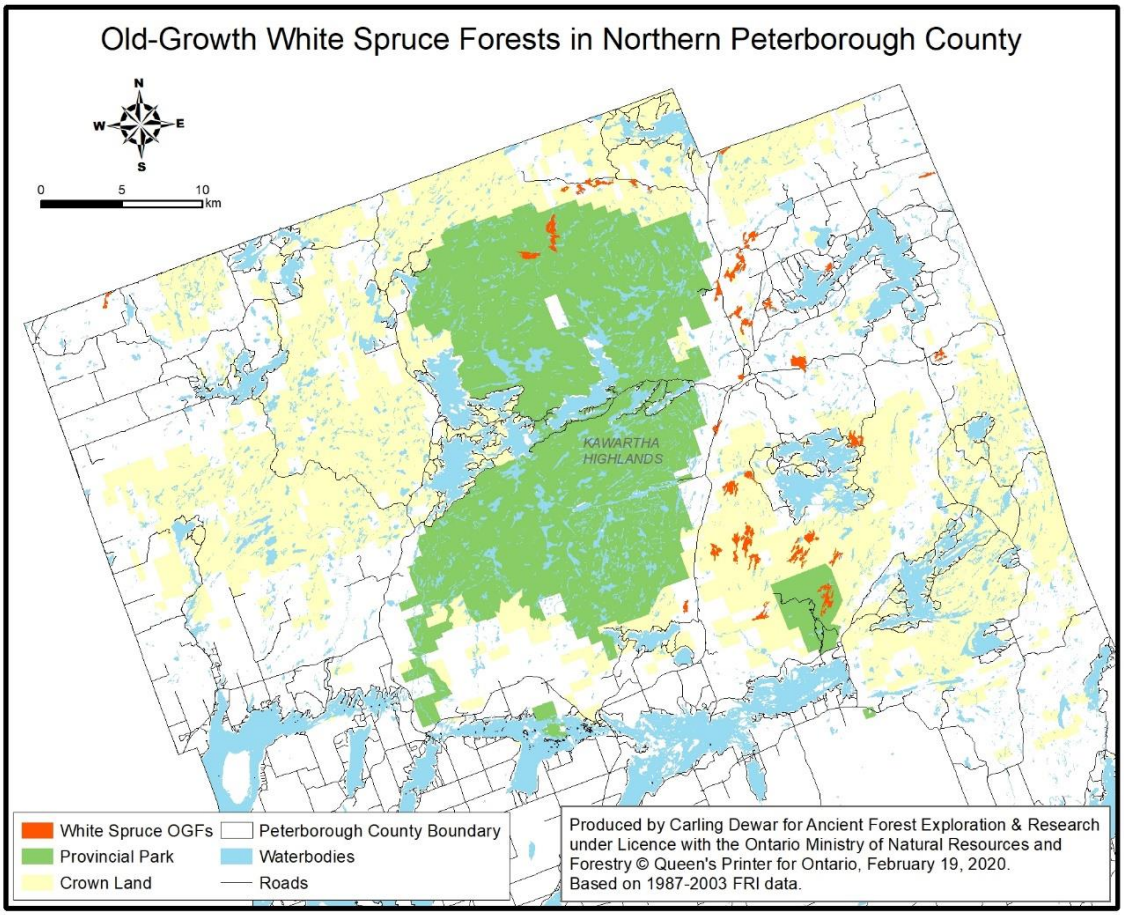
There are 57 white spruce OGF stands located in the study area totalling 1,172 ha with a mean of 20 ha and a maximum of 53 ha (Table 5). Mean stand age is 111 yrs. and the oldest stands are 137 yrs. Mean stand density is 60 %cover and mean stand height is 17 m with a maximum of 19 m. Sixty-one percent of these stands is located on public land, the five largest of these are found on public land, and 56% of their total area is protected.

The vast majority of the white spruce OGFs are located within three sections of the study area: the two eastern sections and the north-central section (Fig. 8). Most of these stands are located in the southeast section and two large stands are located in Kawartha Highlands Provincial Park.

Table 5. White Spruce Stands (100+ yrs)

Number of Stands		57	
Size (ha)	total	1,172	
	mean	20	(2-53)
Age (yrs)	max	137	
	mean	111	
Density (%cover)	mean	60	(30-100)
Height (m)	mean	17	(13-19)
Land Tenure (ha)	public	713	61%
	private	459	39%
Protection	yes	658	56%
	no	514	44%

Figure 8



Late-Successional Deciduous OGFs: *Red Oak (maximum lifespan - 500 yrs.)*

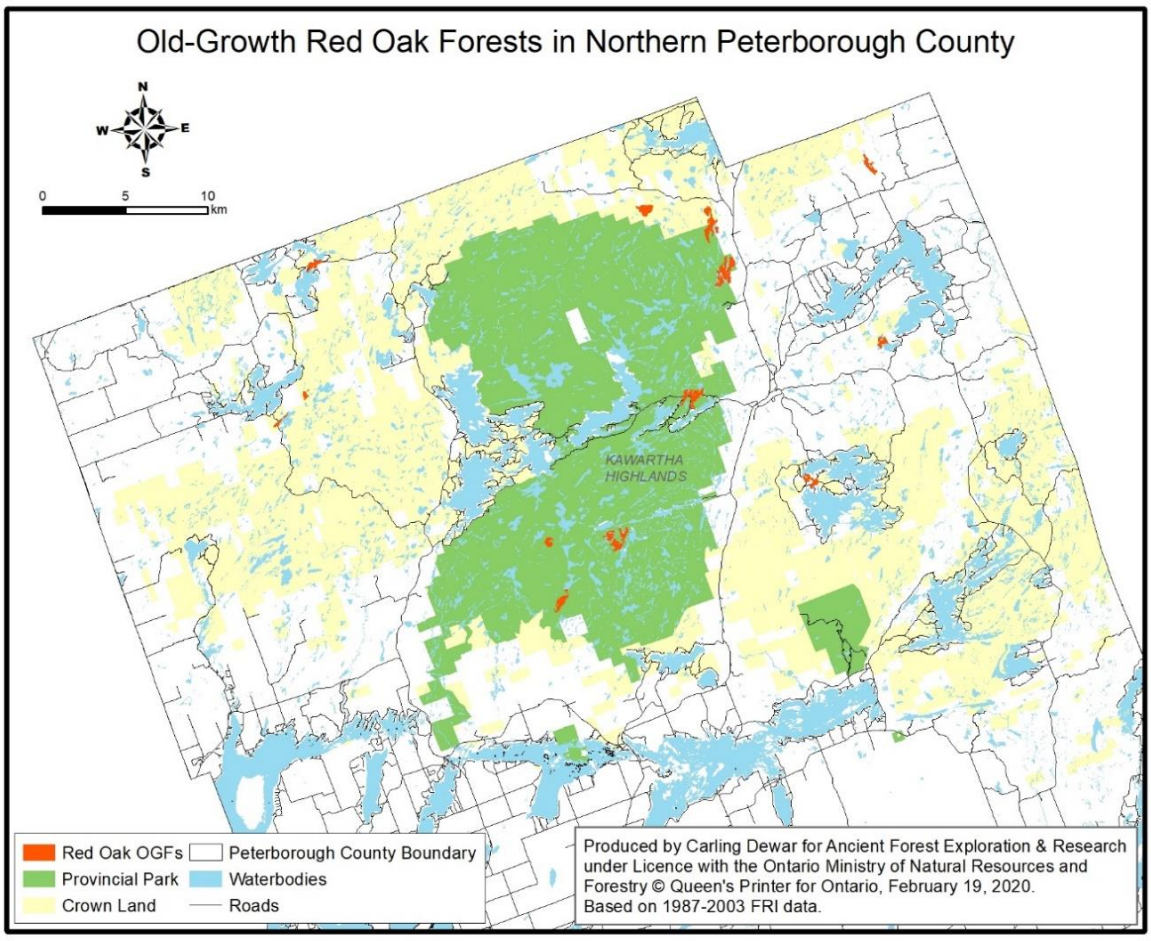
There are 24 red oak OGF stands located in the study area totalling 587 ha with a mean of 24 ha and a maximum of 60 ha (Table 6). Mean stand age is 129 yrs. and the oldest stand is 164 yrs. Mean stand density is 70 %cover and mean stand height is 18 m with a maximum of 21 m. Seventy-five percent of these stands is located on public land, the six largest of these are found on public land, and 34% of their total area is protected.

The vast majority of the red oak OGFs are located within the north-central and south-central sections of the study area (Fig. 9). Most of these stands, including the six largest stands, are located within Kawartha Highlands Provincial Park.

Table 6. Red Oak Stands (120+ yrs)

Number of Stands		24	
Size (ha)	total	587	
	mean	24	(3-60)
Age (yrs)	max	164	
	mean	129	
Density (%cover)	mean	70	(40-100)
Height (m)	mean	18	(15-21)
Land Tenure (ha)	public	441	75%
	private	146	25%
Protection	yes	198	34%
	no	389	66%

Figure 9



Late-Successional Deciduous OGFs: *Sugar Maple (maximum lifespan - 400 yrs.)*

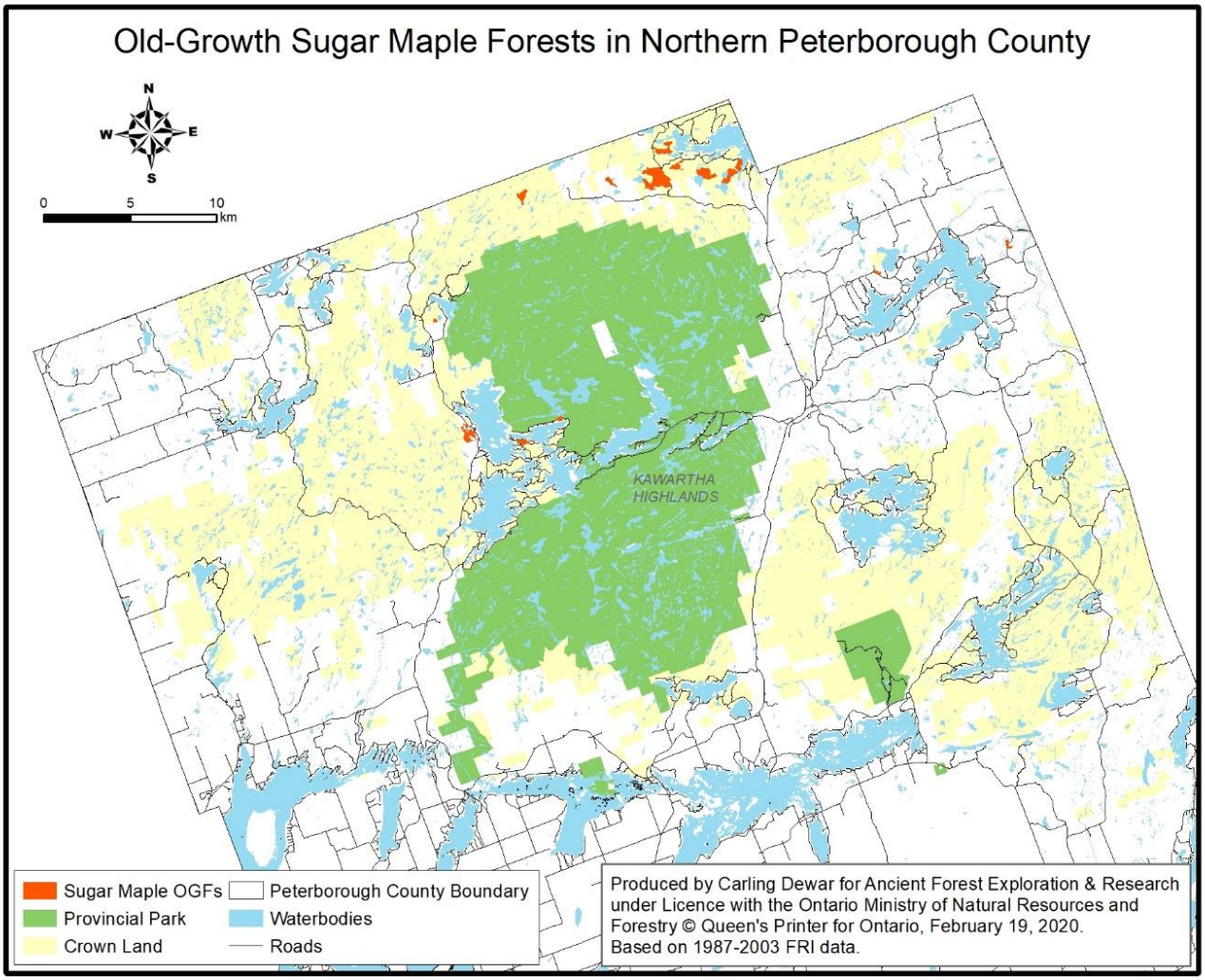
There are 16 sugar maple OGF stands located in the study area totalling 444 ha with a mean of 28 ha and a maximum of 137 ha (Table 7). Mean stand age is 153 yrs. and the oldest stand is 202 yrs. Mean stand density is 90 %cover and mean stand height is 22 m with a maximum of 27 m. Seventy-nine percent of these stands is located on public land, eight of the nine largest of these are found on public land including the largest stand (137 ha), and 2% of their total area is protected.

The sugar maple OGFs are located exclusively within the north-central section of the study area (Fig. 10). Most of these stands are located in the southwest Eels Lake region and only one small stand (8 ha) is located within Kawartha Highlands Provincial Park.

Table 7. Sugar Maple Stands (140+ yrs)

Number of Stands		16	
Size (ha)	total	444	
	mean	28	(4-137)
Age (yrs)	max	202	
	mean	153	
Density (%cover)	mean	90	(40-100)
Height (m)	mean	22	(14-27)
Land Tenure (ha)	Public	351	79%
	Private	93	21%
Protection	yes	8	2%
	no	436	98%

Figure 10



OGFs with Wetland Ecotypes: *Black Ash (maximum lifespan - 320+ yrs.)*

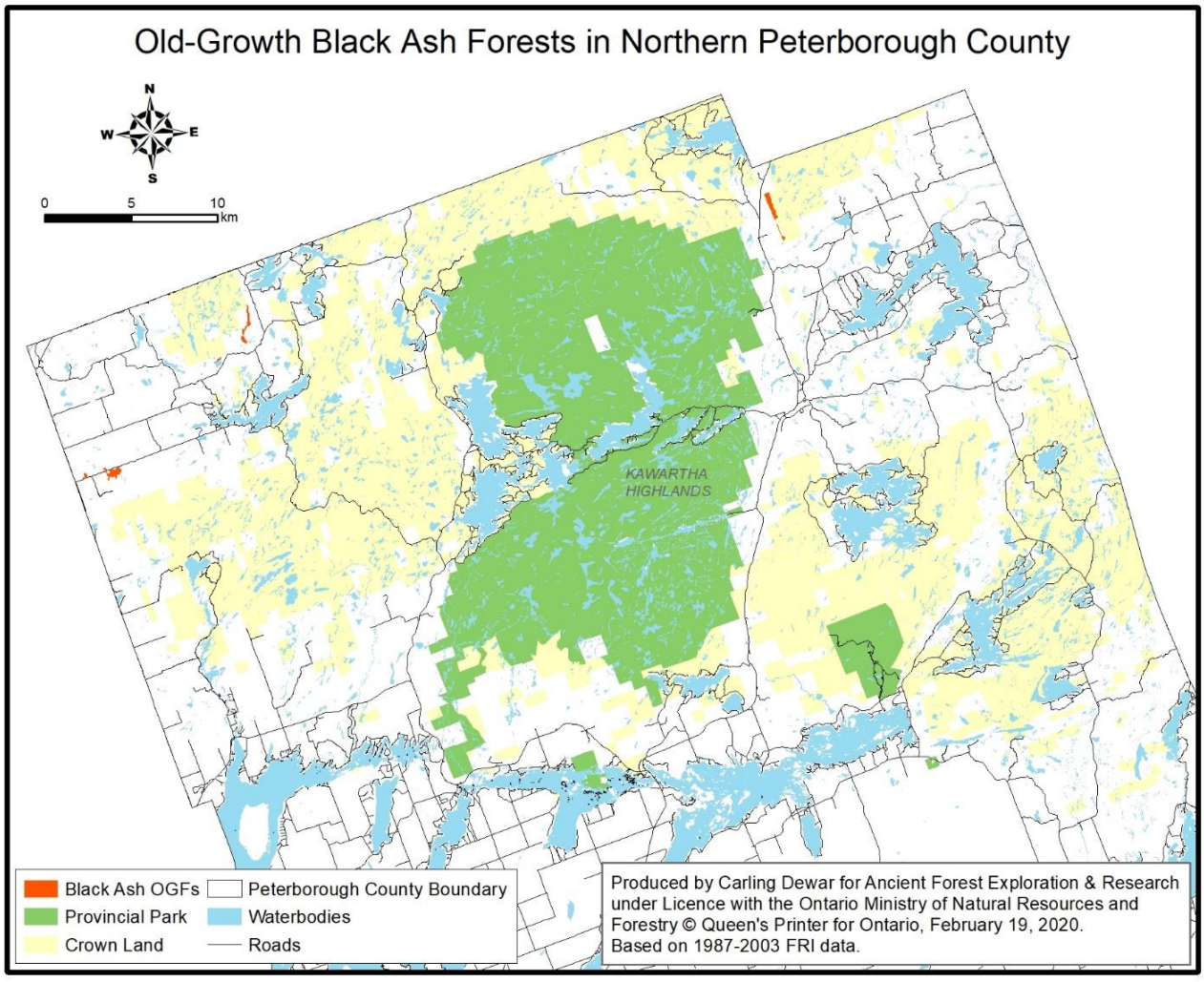
There are 8 black ash OGF stands located in the study area totalling 116 ha with a mean of 14 ha and a maximum of 31 ha (Table 8). Mean stand age is 124 yrs. and the oldest stand is 132 yrs. Mean stand density is 90 %cover and mean stand height is 16 m with a maximum of 19 m. Seven percent of these stands is located on public land, the four largest stands are found on private land, and none of these stands are protected.

The black ash OGFs are located within the northwest and northeast sections of the study area (Fig. 11). None of these stands are located in Kawartha Highlands Provincial Park.

Table 8. Black Ash Stands (120+ yrs)

Number of Stands		8	
Size (ha)	total	116	
	mean	14	(3-31)
Age (yrs)	max	132	
	mean	124	
Density (%cover)	mean	90	(60-100)
Height (m)	mean	16	(12-19)
Land Tenure (ha)	Public	8	7%
	Private	108	93%
Protection	yes	0	0%
	no	116	100%

Figure 11



OGFs with Wetland Ecotypes: *Black Spruce (maximum lifespan - 300 yrs.)*

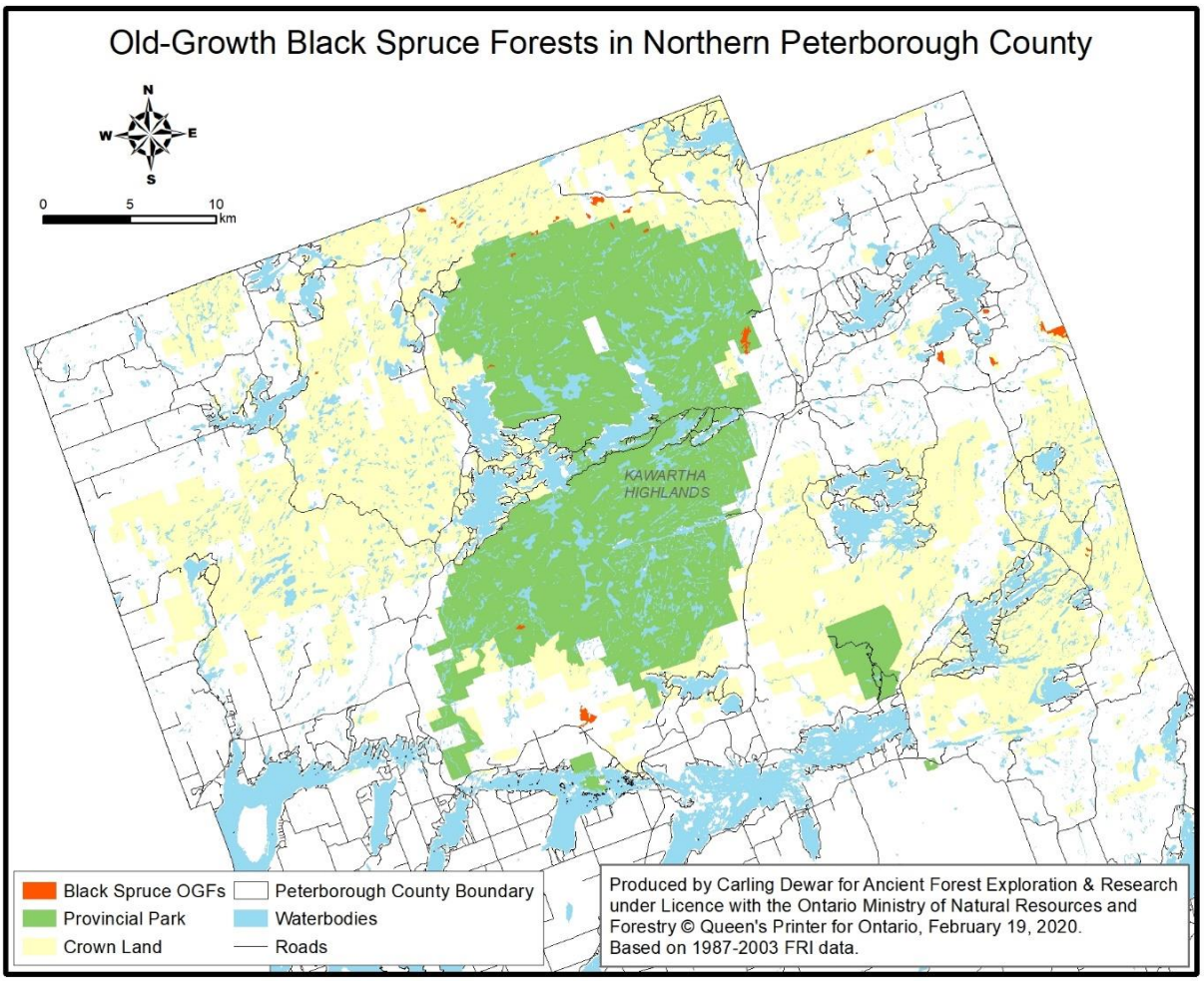
There are 26 black spruce OGF stands located in the study area totalling 300 ha with a mean of 12 ha and a maximum of 53 ha (Table 9). Mean stand age is 121 yrs. and the oldest stand is 152 yrs. Mean stand density is 60 %cover and mean stand height is 14 m with a maximum of 18 m. Sixty-one percent of these stands is located on public land, three of the five largest stands are found on private land, and 30% of these stands are protected.

Table 9. Black Spruce Stands (100+ yrs)

Number of Stands		26	
Size (ha)	total	300	
	mean	12	(2-53)
Age (yrs)	max	152	
	mean	121	
Density (%cover)	mean	60	(40-100)
Height (m)	mean	14	(11-18)
Land Tenure (ha)	public	183	61%
	private	117	39%
Protection	yes	90	30%
	no	210	70%

Most of the black spruce OGFs are located within the north-central section of the study area and additional stands are located in the northeast and south-central sections (Fig. 12). Six of these stands are located in Kawartha Highlands Provincial Park including the third largest black spruce stand (47 ha).

Figure 12



OGFs with Wetland Ecotypes: *Tamarack (maximum lifespan - 180+ yrs.)*

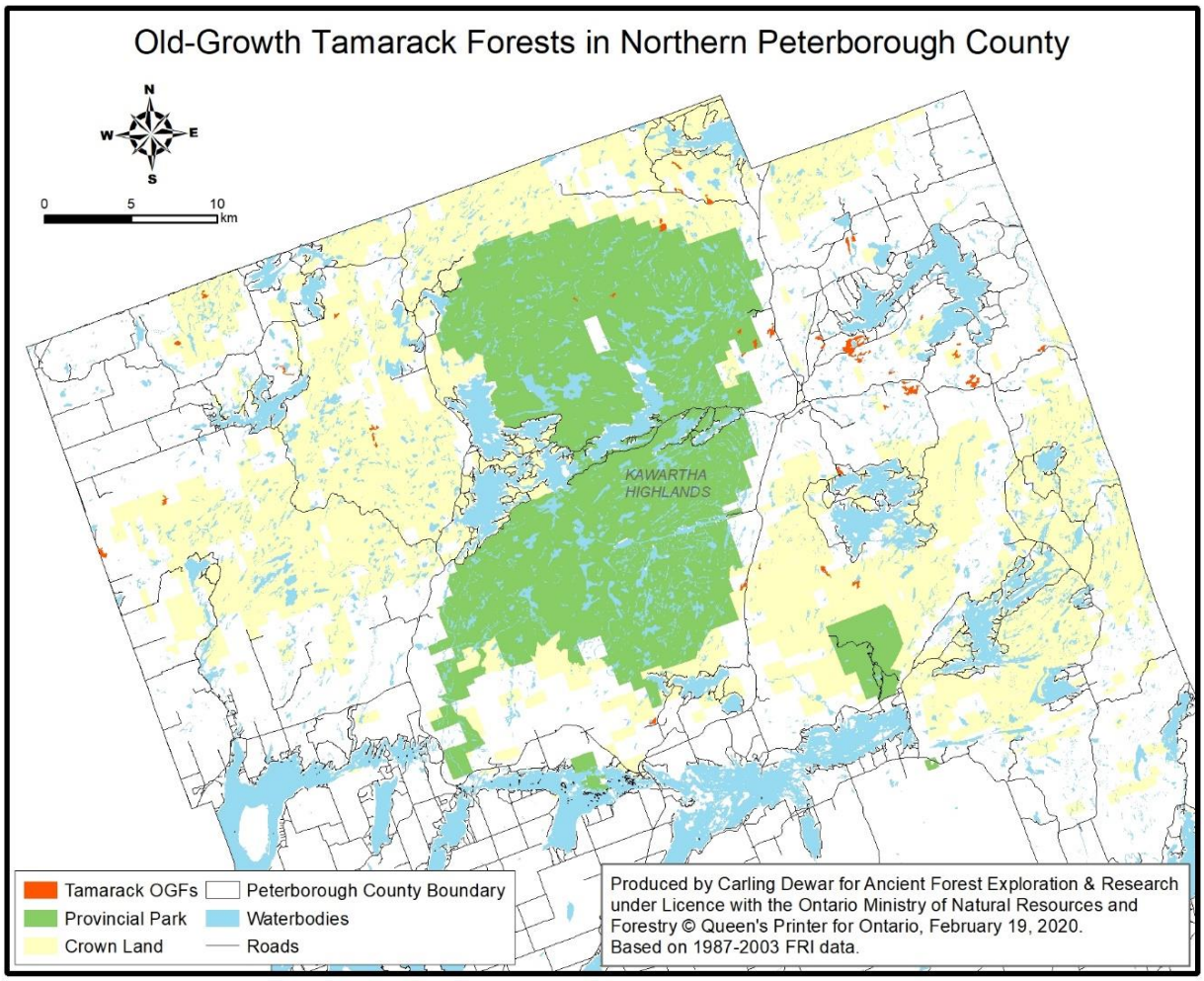
There are 49 tamarack OGF stands located in the study area totalling 421 ha with a mean of 9 ha and a maximum of 51 ha (Table 10). Mean stand age is 110 yrs. and the oldest stand is 152 yrs. Mean stand density is 80 %cover and mean stand height is 16 m with a maximum of 25 m. Thirty percent of these stands is located on public land, the three largest stands are found on private land, and 11% of these stands are protected.

Tamarack OGFs are located in every section of the study area except for the southeast (Fig. 13). The highest concentration of these forests is found in the Chandos Lake region. Five small stands are located in Kawartha Highlands Provincial Park.

Table 10. Tamarack Stands (90+ yrs)

Number of Stands		49	
Size (ha)	total	421	
	mean	9	(2-51)
Age (yrs)	max	152	
	mean	110	
Density (%cover)	mean	80	(40-100)
Height (m)	mean	16	(8-25)
Land Tenure (ha)	Public	125	30%
	Private	296	79%
Protection	yes	47	11%
	no	374	89%

Figure 13



Short-lived Conifer OGFs: *Balsam Fir (maximum lifespan - 200 yrs.)*

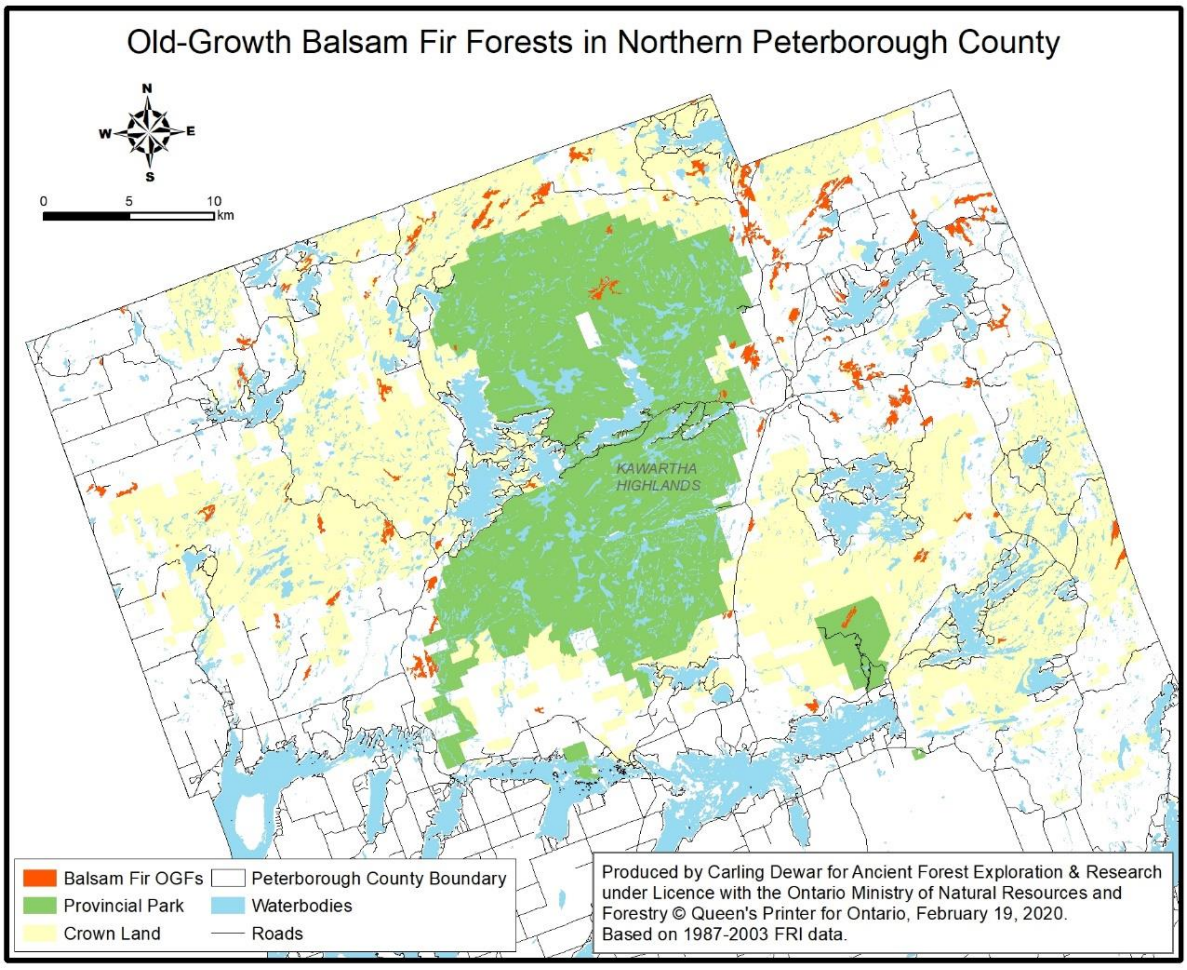
There are 164 balsam fir OGF stands located in the study area totalling 2,708 ha with a mean of 17 ha and a maximum of 66 ha (Table 11). Mean stand age is 96 yrs. and the oldest stand is 137 yrs. Mean stand density is 70 %cover and mean stand height is 16 m with a maximum of 30 m. Thirty-six percent of these stands is located on public land, the three largest stands are found on private land, and 6% of these stands are protected.

Table 11. Balsam Fir Stands (70+ yrs)

Number of Stands		164	
Size (ha)	total	2,708	
	mean	17	(2-66)
Age (yrs)	max	137	
	mean	96	
Density (%cover)	mean	70	(30-100)
Height (m)	mean	16	(6-30)
Land Tenure (ha)	public	965	36%
	private	1,743	64%
Protection	yes	155	6%
	no	2,553	94%

Balsam fir OGFs are located in every section of the study area but they are most abundant in the northeast section and least abundant in the south-central section (Fig. 14). The highest concentration of these forests is found in the Chandos Lake region. Twelve stands ranging from 2 to 31 ha are located in Kawartha Highlands Provincial Park.

Figure 14



Early-Successional Deciduous OGFs: *Red Maple (maximum lifespan - 200 yrs.)*

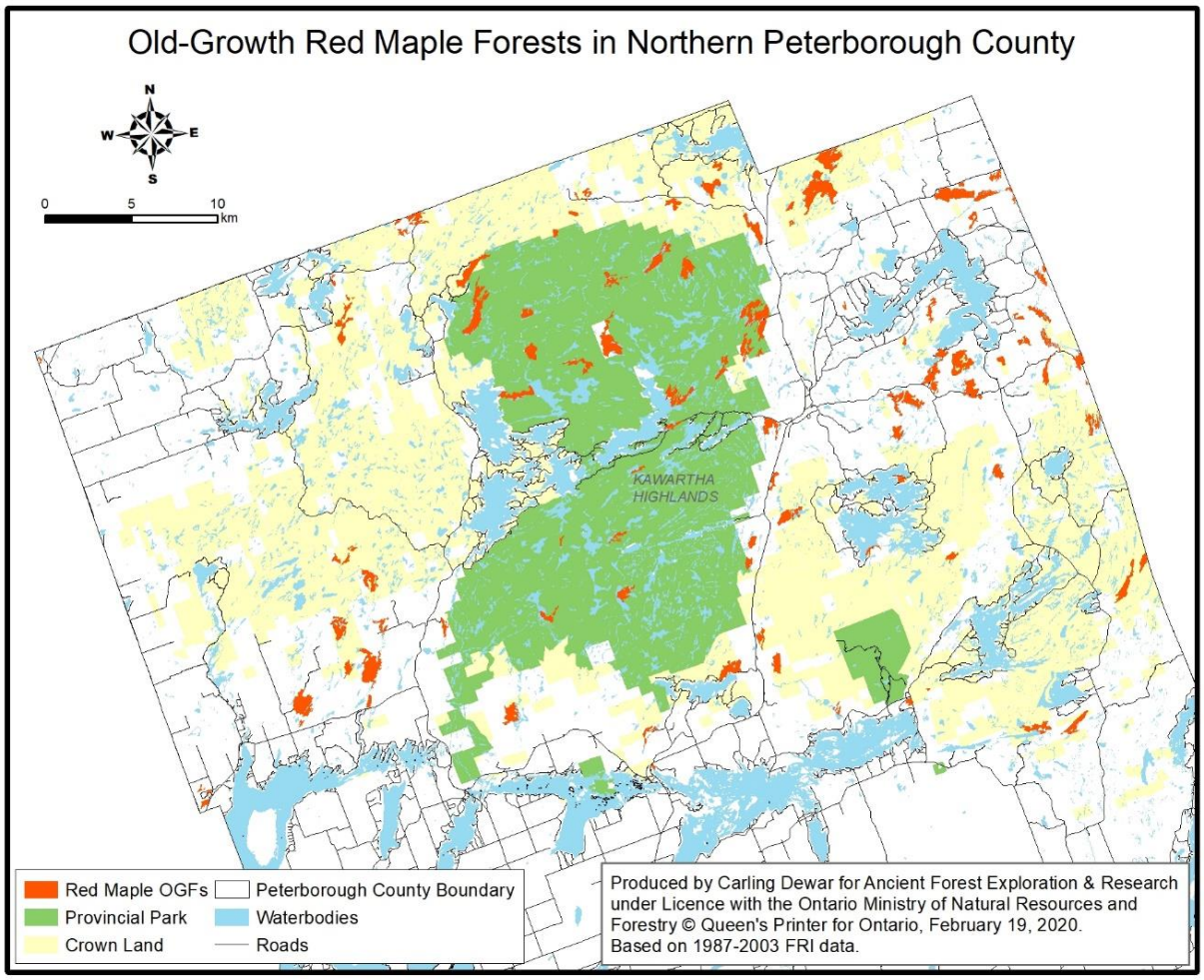
There are 200 red maple OGF stands located in the study area totalling 4,253 ha with a mean of 21 ha and a maximum of 132 ha (Table 12). Mean stand age is 101 yrs. and the oldest stand is 132 yrs. Mean stand density is 80 %cover and mean stand height is 19 m with a maximum of 26 m. Forty-eight percent of these stands is located on public land, three of the four largest stands are found on public land, and 21% of these stands are protected.

Table 12. Red Maple Stands (90+ yrs)

Number of Stands		200	
Size (ha)	total	4,253	
	mean	21	(2-132)
Age (yrs)	max	132	
	mean	101	
Density (%cover)	mean	80	(30-100)
Height (m)	mean	19	(13-26)
Land Tenure (ha)	Public	2,040	48%
	Private	2,213	52%
Protection	yes	912	21%
	no	3,341	79%

Red maple OGFs are distributed throughout the entire study area but they are least abundant in the northwest and southeast sections (Fig. 15). The highest concentration of these forests is found in the northern portion of Kawartha Highlands Provincial Park and in the Chandos Lake region. Thirty-seven stands ranging from 2 to 73 ha are located in the Park.

Figure 15



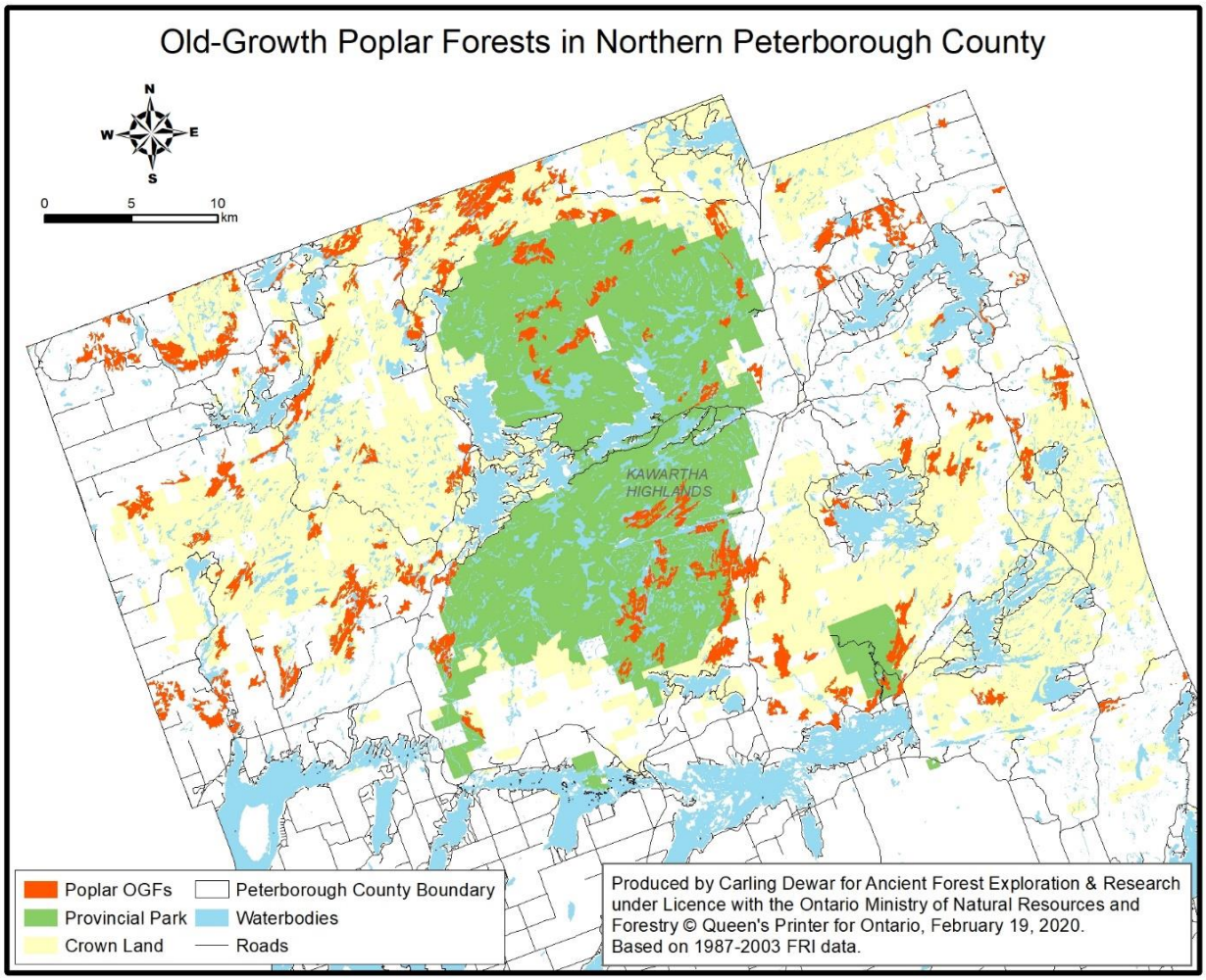
Early-Successional Deciduous OGFs: *Poplar (maximum lifespan - 150 yrs.)*

There are 424 poplar OGF stands located in the study area totalling 11,033 ha with a mean of 26 ha and a maximum of 194 ha (Table 13). Mean stand age is 98 yrs. and the oldest stand is 127 yrs. Mean stand density is 70 %cover and mean stand height is 21 m with a maximum of 28 m. Sixty-three percent of these stands is located on public land, two of the three largest stands are found on public land, and 26% of these stands are protected.

Table 13. Poplar Stands (90+ yrs)			
Number of Stands		424	
Size (ha)	total	11,033	
	mean	26	(2-194)
Age (yrs)	max	127	
	mean	98	
Density (%cover)	mean	70	(30-100)
Height (m)	mean	21	(14-28)
Land Tenure (ha)	public	6,999	63%
	private	4,034	37%
Protection	yes	2,906	26%
	no	8,127	74%

Poplar OGF stands are distributed throughout the entire study area and they are least abundant in the northeast and southeast sections (Fig. 16). The highest concentration of these forests is found in the north-central and south-central portion of the study area. One-hundred stands ranging from 2 to 94 ha are located in Kawartha Highlands Provincial Park.

Figure 16



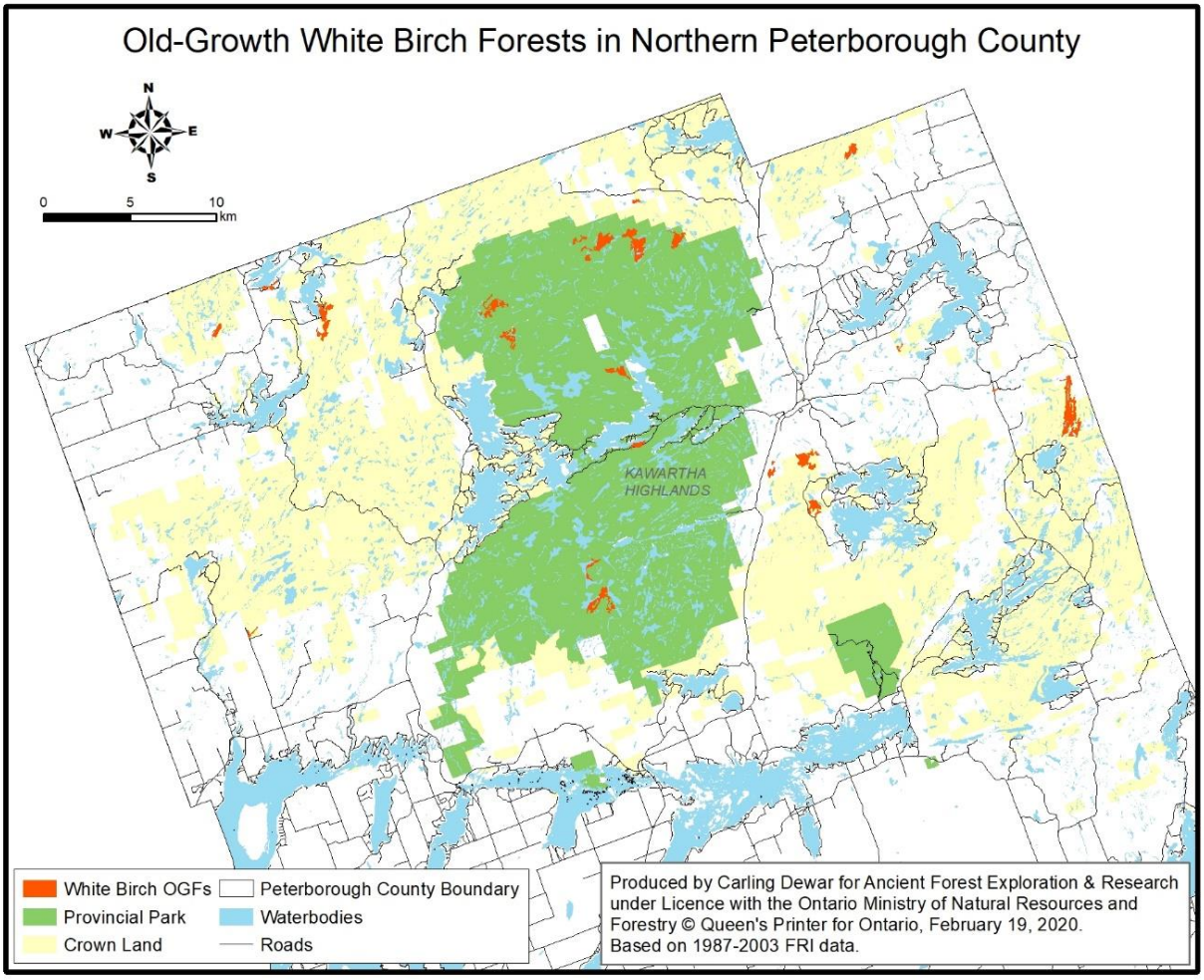
Early-Successional Deciduous OGFs: *White Birch (maximum lifespan - 140 yrs.)*

There are 43 white birch OGF stands located in the study area totalling 979 ha with a mean of 23 ha and a maximum of 105 ha (Table 14). Mean stand age is 107 yrs. and the oldest stand is 142 yrs. Mean stand density is 80 %cover and mean stand height is 17 m with a maximum of 27 m. Ninety-one percent of these stands is located on public land, the 13 largest stands are found on public land, and 46% of these stands are protected.

Table 14. White Birch Stands (100+ yrs)			
Number of Stands		43	
Size (ha)	total	979	
	mean	23	(2-105)
Age (yrs)	max	142	
	mean	107	
Density (%cover)	mean	80	(30-100)
Height (m)	mean	17	(12-27)
Land Tenure (ha)	public	895	91%
	private	84	9%
Protection	yes	452	46%
	no	527	54%

Most of the white birch OGF stands are located in the north-central and southeast sections of the study area (Fig. 17). Very little of the OGF type is located in the southwest and northeast sections. The highest concentration of these forests is found in the northern portion of Kawartha Highlands Provincial Park. Twenty-two stands ranging from 2 to 105 ha are located in the Park.

Figure 17



Comparing OGF Types

In this section, OGF types in NPC are compared using basic metrics including the following.

- Landscape features – total amount, number of stands, and stand size
- Population features – age, density, and height
- Land ownership – public and private
- Protection – protected and not protected

Landscape Features (Table 15)

Total Stand Area

- Total OGF stand area was 34,333 ha (2+ ha).
- Mean total OGF stand area was 2,452 ha, ranging from 116 ha (black ash) to 11,033 ha (poplar) (Figure 18).
- Poplar and white cedar OGFs made up 53% of the total OGF area, the other 12 OGFs made up 47% of the OGFs in NPC.
- The top 50% of the OGF types with the most area (ha) made up 91% of the OGFs in NPC; the other half made up only 9% of the total OGF area.
- Eight of the OGF types made up less than 3.5% of the total OGF area including those with the following lead species: white spruce, white birch, red oak, sugar maple, tamarack, black spruce, red pine and black ash (in decreasing order).

Number of Stands

- The total number of OGF stands was 1,705, ranging from 8 (black ash) to 484 (white cedar).
- The top two OGF types with the highest number of stands each have more than 400 stands (white cedar – 484, poplar - 424).
- Five OGF types have 26 or fewer stands including black spruce, red oak, sugar maple, red pine and black ash (in decreasing order).

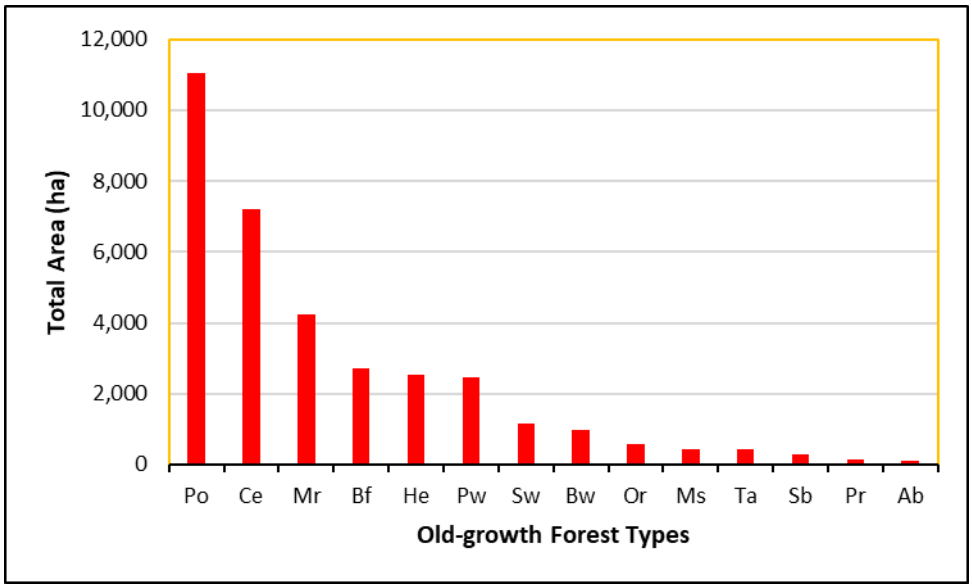
Median and Maximum Stand Size

- The median stand size of the OGF types was 20.5 ha, ranging from 9 ha for tamarack to 28 ha for sugar maple.
- The highest maximum stand size was 550 ha for eastern hemlock and 238 ha for white pine.
- Five OGF types had a maximum stand size of between 100 and 200 ha including poplar, sugar maple, white cedar, red maple, and white birch (in decreasing order).
- Seven OGFs had a maximum stand size of less than 100 ha including balsam fir, red oak, white spruce, black ash, tamarack, red pine, and black ash (in decreasing order).

Table 15. OGF Total Area, Number of Stands, Mean Size and Maximum Size

OGF	Total Area (Ha)	Total Area (%)	Cummulative Amount (Ha)	Cummulative Amount (%)	OGF	No. Stands	OGF	Mean Size (Ha)	OGF	Max. Size (Ha)
Po	11,033	32.1	11,033	32.1	Ce	484	Ms	28	He	550
Ce	7,195	21.0	18,228	53.1	Po	424	Pw	26	Pw	238
Mr	4,253	12.4	22,481	65.5	Mr	200	Po	26	Po	194
Bf	2,708	7.9	25,189	73.4	Bf	164	Or	24	Ms	137
He	2,522	7.3	27,711	80.7	He	108	He	23	Ce	136
Pw	2,447	7.1	30,158	87.8	Pw	94	Bw	23	Mr	132
Sw	1,172	3.4	31,330	91.3	Sw	57	Mr	21	Bw	105
Bw	979	2.9	32,309	94.1	Ta	49	Sw	20	Bf	66
Or	587	1.7	32,896	95.8	Bw	43	Pr	20	Or	60
Ms	444	1.3	33,340	97.1	Sb	26	Bf	17	Sw	53
Ta	421	1.2	33,761	98.3	Or	24	Ce	15	Sb	53
Sb	300	0.9	34,061	99.2	Ms	16	Ab	14	Ta	51
Pr	156	0.5	34,217	99.7	Pr	8	Sb	12	Pr	34
Ab	116	0.3	34,333	100.0	Ab	8	Ta	9	Ab	31

Figure 18. Total Area for 14 OGF Types



Population Features (Table 16)

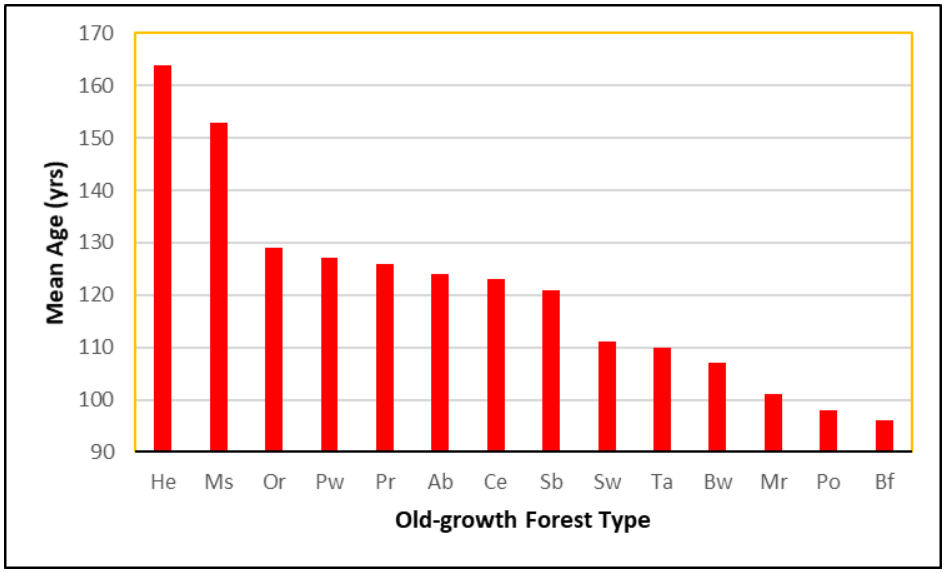
Maximum and Mean Stand Age

- Maximum stand age varied from 127 yrs. (poplar) to 207 yrs. (eastern hemlock) with a median of 147 yrs.
- Mean stand age varied from 96 yrs. (balsam fir) to 164 yrs. (eastern hemlock) with a median of 122 yrs. (Figure 19).
- Only eastern hemlock stands (164 yrs.) and sugar maple stands (153 yrs.) had a mean stand age greater than 150 yrs.
- Six OGF types had a mean stand age between 120 and 149 yrs. including red oak, white pine, red pine, black ash, white cedar, and black ash (from oldest to youngest).
- Six OGF types had a mean stand age less than 120 yrs. including white spruce, tamarack, white birch, red maple, poplar, and balsam fir (from oldest to youngest).

Table 16. Maximum Age, Mean Age, Density and Height of OGF Types

OGF	Max. Age	OGF	Mean Age	OGF	Density	OGF	Height
He	207	He	164	Ms	90	Pw	23
Ms	202	Ms	153	He	90	Pr	23
Ce	187	Or	129	Ab	90	Ms	22
Or	164	Pw	127	Mr	80	Po	21
Sb	152	Pr	126	Ta	80	He	20
Pw	152	Ab	124	Ce	80	Mr	19
Ta	152	Ce	123	Bw	80	Or	18
Bw	142	Sb	121	Po	70	Sw	17
Sw	137	Sw	111	Or	70	Bw	17
Bf	137	Ta	110	Bf	70	Ta	16
Pr	132	Bw	107	Sw	60	Bf	16
Mr	132	Mr	101	Sb	60	Ab	16
Ab	132	Po	98	Pw	60	Sb	14
Po	127	Bf	96	Pr	60	Ce	14

Figure 19. Mean Age for 14 Old-growth Forest Types



Stand Canopy Density and Stand Height

- The median of the mean canopy density was 75 %cover ranging from 60 to 90 %cover.
- The three OGF types with the highest mean canopy density were sugar maple, eastern hemlock, and black ash all with a mean of 90 %cover.
- The four OGF types with the lowest mean canopy density included white spruce, black spruce, white pine and red pine all with a mean of 60 %cover.
- Mean height varied from 14 to 23 m with a median mean height of 17.5 m.
- White pine OGFs had the highest mean height (23 m).
- Black spruce and white cedar had the lowest mean height (14 m).

Land Ownership (Table 17)

- OGFs on public land occupied 18,247 ha (53%) and OGFs on private land occupied 16,086 ha (47%).
- The top five OGFs in total area (ha) on public land included poplar, white pine, red maple, white cedar, and eastern hemlock (in decreasing order).
- The top five OGFs in total area (ha) on private land included white cedar, poplar, red maple, balsam fir, and eastern hemlock (in decreasing order).
- Three of the most rare OGF types in Ontario's Temperate Forest Region (Quinby 2019b) are also rare on both public and private lands in NPC including black ash, red pine, and red oak.

Table 17. Amount of Public and Private Land in NPC OGFs

OGF	Public (Ha)	OGF	Public (%)	OGF	Private (Ha)	OGF	Private (%)
Po	6,999	Bw	91	Ce	5,461	Ab	93
Pw	2,102	Pw	86	Po	4,034	Ta	79
Mr	2,040	Pr	85	Mr	2,213	Ce	76
Ce	1,734	Ms	79	Bf	1,743	Bf	64
He	1,559	Or	75	He	963	Mr	52
Bf	965	Po	63	Sw	459	Sw	39
Bw	895	He	62	Pw	345	Sb	39
Sw	713	Sw	61	Ta	296	He	38
Or	441	Sb	61	Or	146	Po	37
Ms	351	Mr	48	Sb	117	Or	25
Sb	183	Bf	36	Ab	108	Ms	21
Pr	132	Ta	30	Ms	93	Pr	15
Ta	125	Ce	24	Bw	84	Pw	14
Ab	8	Ab	7	Pr	24	Bw	9

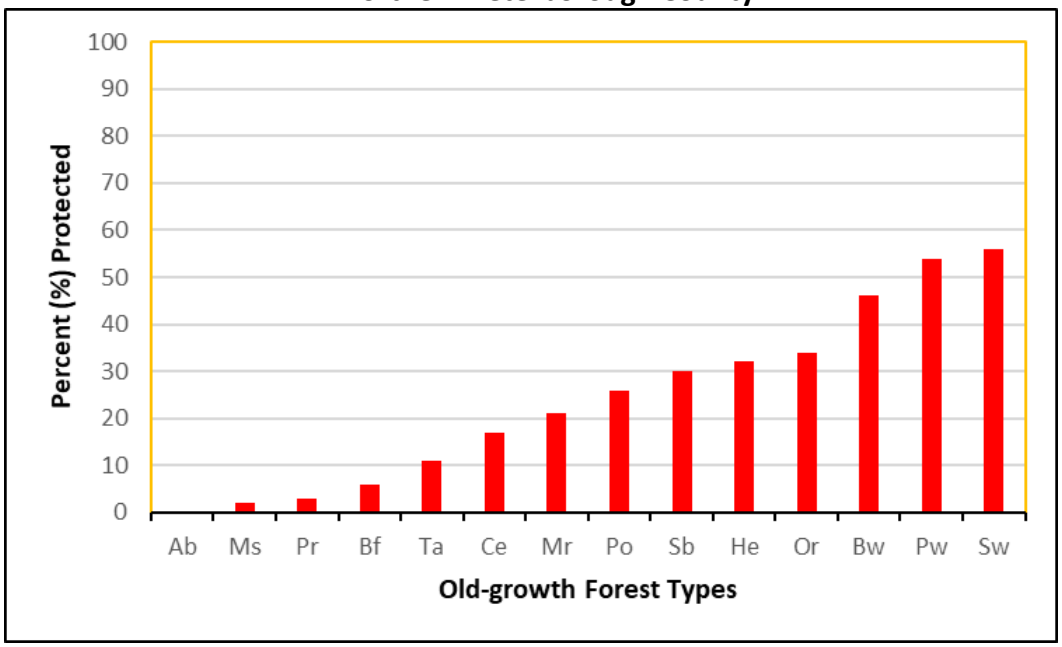
Land Protection (Table 18)

- Twenty-six percent of the OGF area in NPC was protected (8,817 ha).
- A total of 74% of the OGFs in NPC were unprotected.
- The majority (>50%) of the area of each of 12 OGF types remains unprotected in NPC.
- Four of the rarest OGF types in Ontario (Quinby 2019b) have less that a third of their areas protected in NPC including black ash, red pine, red oak, and eastern hemlock (increasing order).

Table 18. Protection of OGFs in NPC

OGF	Protected (Ha)	OGF	Protected (% of each OGF)	OGF	Not Protected (Ha)	OGF	Not Protected (% of each OGF)
Po	2,906	Sw	56	Po	8,127	Ab	100
Pw	1,322	Pw	54	Ce	5,942	Ms	98
Ce	1,253	Bw	46	Mr	3,341	Pr	97
Mr	912	Or	34	Bf	2,553	Bf	94
He	811	He	32	He	1,711	Ta	89
Sw	658	Sb	30	Pw	1,125	Ce	83
Bw	452	Po	26	Bw	527	Mr	79
Or	198	Mr	21	Sw	514	Po	74
Bf	155	Ce	17	Ms	436	Sb	70
Sb	90	Ta	11	Or	389	He	68
Ta	47	Bf	6	Ta	374	Or	66
Ms	8	Pr	3	Sb	210	Bw	54
Pr	5	Ms	2	Pr	151	Pw	46
Ab	0	Ab	0	Ab	116	Sw	44

Figure 20. Percentage Protected of each Old-growth Forest Type in Northern Peterborough County



Logging

The total area logged in northern Peterborough County since 1987 was 5,201 ha composing 3% of the study area and 4% of the forested area, mean stand size was 35 ha, and 14 different forest types were included (Figure 21). The three most abundant forest types made up 87% (4,522 ha) of the logged area including those dominated by sugar maple, white pine and red maple (decreasing order; Figure 22). Four types make up 1.5 to 3% of the area logged including those dominated by red oak, red pine, poplar, and trembling aspen (decreasing order). Below 1.5% there were seven forest types including those dominated by hemlock, white spruce, beech, white ash, white cedar, white birch and balsam fir (decreasing order). The map of logged areas can be compared with the OGF maps (Figures 4 - 17) to identify mapped OGF stands that may have been affected by logging.

Figure 21. Logged Areas in Northern Peterborough County Since 1987
Based on Ontario Forest Resource Inventory Data

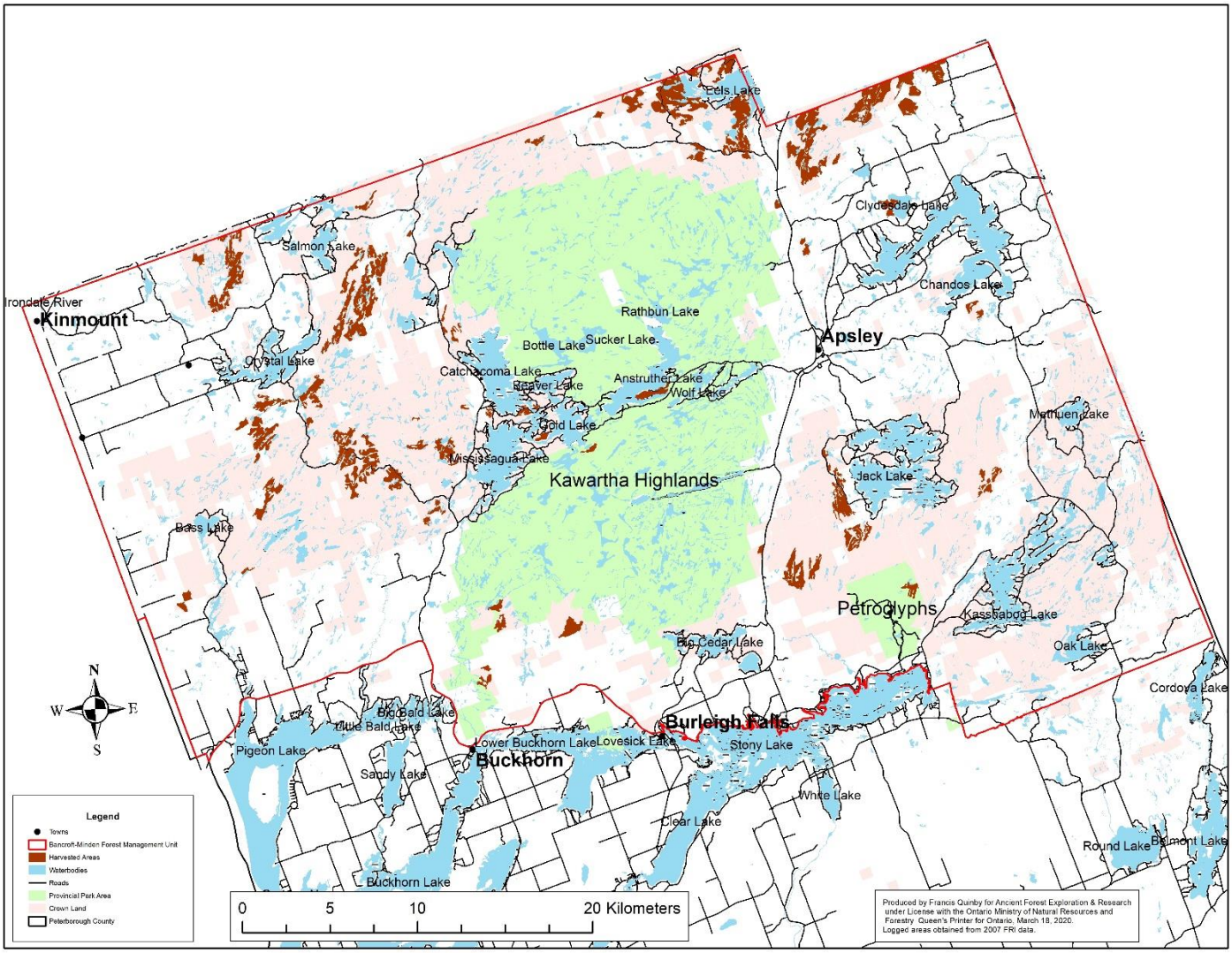
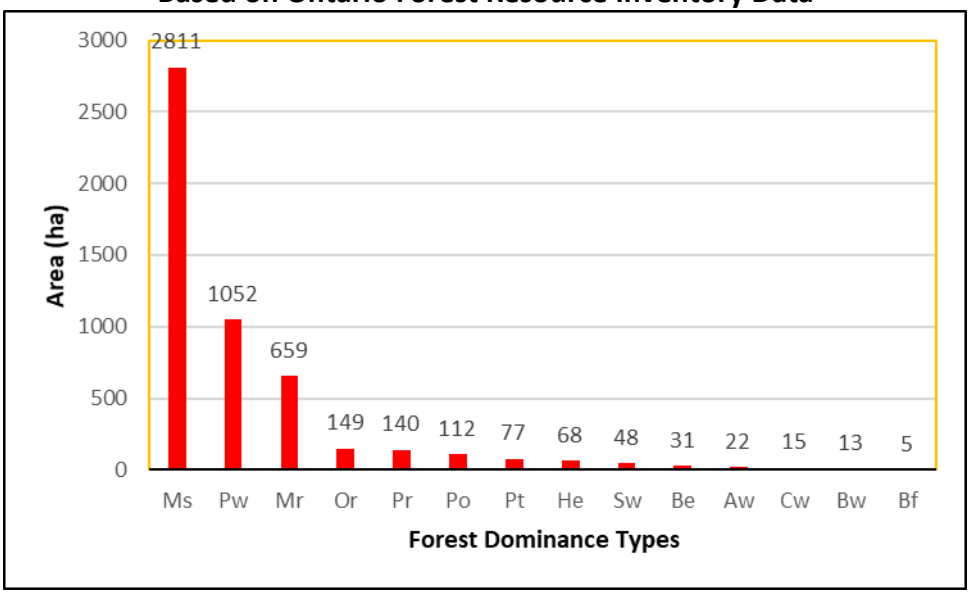


Figure 22. Amount of each Forest Type Logged in Northern Peterborough County Based on Ontario Forest Resource Inventory Data



Recommendations

Using our (or similar) mapping, OGFs of rare provincial forest types (Quinby 2019b) in NPC should be targeted for ground truthing including red pine, red oak, black ash, red maple and eastern hemlock. The spatial logging data should be used to further refine potential boundaries for these stands. Ground truthing of all other OGF types in NPC should be considered lower priority, however within this group, eastern white pine and white cedar OGFs should be prioritized. Ground truthing should include assessment of the five primary features of OGF including stand/tree age, density of old-growth trees, snags, logs and integrity (stump density).

Stands that are verified in the field as OGF based on the five primary OGF features should be proposed for protection at the most appropriate level including local, provincial and federal. Those OGF stands that are in close proximity to existing protected areas and/or may contribute to ecological connectivity at the landscape or regional levels should also be prioritized for protection. Since only 12% of Ontario's terrestrial landscapes are currently protected, another 18% of protected land is required (many millions of ha) to meet the federal goal of 30% land protection by 2030.

The assessment method presented in this report can be applied to other forested regions as the first step in identifying, describing and conserving OGFs. However, some mapped OGFs with no FRI record of logging will have cut stumps in them, which will not be discovered until field data are collected. One way to potentially avoid losing time discovering that an OGF has been logged would be to find an OGF feature other than age, such as *above-ground biomass* or *total tree biomass*, that has been or can be assessed using remote sensing and digitized for use in GIS analyses. Research is required to identify this/these additional OGF indicator(s), assuming that one or more exist.

AFER's Guiding Principles

AFER is a non-profit scientific organization with a mission to carry out research and education that lead to the identification, description and protection of ancient (pristine) forested landscapes, including old-growth forests. The earth-stewardship principles that guide our work include the following.

- Many forest ecosystem types are now endangered. We consider these ecosystems and other ancient forests to be non-renewable resources, which is not consistent with the practice of mining or logging them.
- We consider biodiversity conservation needs at local, provincial, federal and international scales.
- We support the Government of Canada's official commitment to increase protected areas to 30% of the Canadian land base by 2030.
- We support the New York Declaration on Forests to end natural forest loss by 2030.

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