Forest Technical Note

Nova Scotia Department of Natural Resources

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Forest Research and Planning

Old Forest Assessment in the Lawlor Lake Area of Guysborough County, Nova Scotia

Peter Bush

Executive Summary

The Department of Natural Resources (DNR) assessed 27 forest stands in the Lawlor Lake area of Guysborough County in March 2018 in response to public concern about forest harvesting and forest product utilization. DNR used the old forest scoring system, outlined in the Old Forest Policy (2012) to assess these stands. The assessment looked at 12 stands that were recently partially harvested and 15 stands that were planned for partial harvest in the area. DNR found that 2 of the 12 recently partially harvested stands were old growth forest (OGF), and a further 8 were considered old forest that did not meet the criteria for old growth. Of the planned harvest stands (not treated), 11 of the stands were OGF; 1 was old forest; 1 was mature forest, and 2 were immature. Old forest scoring age for all the stands surveyed had a mean of 134 years, with a range of 45-167 years. The Old Forest Policy currently has 27,825 ha (15.7% of the Eastern Interior Ecodistrict) of conserved OGF and restoration opportunities. An examination of the Pre-treatment Assessment indicator currently used to flag potential stands for old forest scoring found that 5 of the 13 OGF stands in this study would have been flagged if used. The Old Forest Policy and its associated tools (old forest scoring) provides a science-based approach to evaluate OGF and appropriate policy mechanisms to conserve that forest when it is found.

Old Forest Assessment of Lawlor Lake Area of Guysborough County, Nova Scotia

1.0 Introduction

This report presents the detailed findings of an old forest assessment of 27 forest stands in the Lawlor Lake area of Guysborough County, Nova Scotia. The assessment was undertaken in March of 2018 in response to public concern about forest harvesting and forest product utilization in the area.

1.1 Old Forest Policy

The Old Forest Policy was introduced in 1999, and updated in 2012 with the addition of Integrated Resource Management (IRM) procedures for administering the old forest lands. The policy intent is to conserve old growth forests on public land and ensure that a network of the best old forest restoration opportunities is established. The policy emphasizes that existing protected areas should provide the first choice for meeting the guidelines, with lands outside protected areas used to fill gaps.

- Guidelines, procedures, and evaluation criteria are established under the Old Forest Policy (2012):
    - Department of Natural Resources (DNR) staff will identify old growth (>125 years old) and the best old forest restoration opportunities (climax forests > 40 years old) on at least eight percent of publicly owned forest land in each of the province's 38 forested ecodistricts (Ecological Land Classification for Nova Scotia, Neily et. al., 2017).
    - The policy applies to all public forest land owned by the Province of Nova Scotia, including lands administered outside of the Department of Natural Resources, such as Wilderness Areas and Nature Reserves, as well as an accounting of forest inventory in the National Parks of Kejimkujik, Cape Breton Highlands, and Louisbourg.
    - Forests identified under the policy are set aside for long term conservation with the priority on natural development of old growth forest conditions.
    - Forest identified under the policy are designated as C2E class land under the IRM system of Crown land use classification. Proposals to conduct activities that impact old forests, or de-designate old forest are subject to IRM Review following the Old Forest Policy procedures.

The Old Forest Policy provides definitions of key terms:

Old Growth Forest (OGF): A forest stand where:

1) 30% or more of the basal area is composed of trees 125 years or older,
2) at least half of the basal area is composed of climax species,
3) and total crown closure is a minimum of 30%.

OGF are dynamic and represent the shifting mosaic phase of forest development, marked by mature canopy processes of gap formation and recruitment from a developed understory. Typical characteristics include a patchy, multi-layered, multi-species canopy with trees of several age classes dominated by large overstory trees, occasional dead topped stag trees and decadent wolf trees, and the presence of snags and fallen woody debris. Ideally this stage represents a long period of ecological continuity.

Old Forest: Any stand or collection of stands containing old growth and/or mature climax conditions. In this report, old forest specifically refers to stands that have the old growth condition of over 125 years, but are not greater than 50% climax species.

Mature climax forest: A forest stand where 30% or more of the oldest basal area is in trees 80 - 125 years old, at least half of the basal area is composed of climax species, and total crown closure is a minimum of 30%.

Immature Climax: A forest stand where 70% or more of the basal area is in trees younger than 80 years old, at least half of the basal area is composed of climax species, and total crown closure is a minimum of 30%.

Climax Species: Species which typically dominate stand composition during the late stages of natural succession. These are usually the longest lived and most shade tolerant species characteristic of the climatic and site conditions within an ecosystem. On zonal Acadian Forest ecotypes they include hemlock, red spruce, white pine, sugar maple, yellow birch and American beech; while on Maritime Boreal ecotypes and edaphically limited sites (e.g. bogs, fens, highlands, coastal) balsam fir, red maple and black spruce are more likely to form the climax forest.

2.0 Methods

2.1 Study Area Description

This study was conducted in eastern mainland Nova Scotia approximately 15-20 km southwest of the town of Guysborough. The study area is within the Eastern Interior Ecodistrict (440), one of the largest in the province with an area of 457,493 hectares (Neily et. al., 2017). It includes the eastern part of mainland Nova Scotia that extends from Halifax in the west to the community of Guysborough in the east. The ecodistrict includes the inner coastal waters of some of the longer harbours to the south and extends northerly into the center of the province. The composition of the forests in this ecodistrict strongly reflects the depth of the soil profile. On shallow soils, repeated fires have impoverished soils and reduced forest cover to scrub hardwoods (such as red maple, white birch, grey birch, and red oak with scattered white pine and black spruce) underlain by a dense layer of ericaceous vegetation. On deeper, well drained soils, stands of red spruce are found. On crests and upper slopes of hills, drumlins and some hummocks, stands of tolerant hardwood (such as sugar maple and yellow birch) occur.

Ecodistricts are composed of smaller ecosystems, known as elements. These elements are

described by their physical features – such as soil and landform – and ecological features – such as climax forest type (NSDNR in press). Elements in the study are dominated by Tolerant Hardwood Drumlins and Hummocks, with a few stands located on Spruce Hemlock Pine Hummocks and Hills (Figure 1).

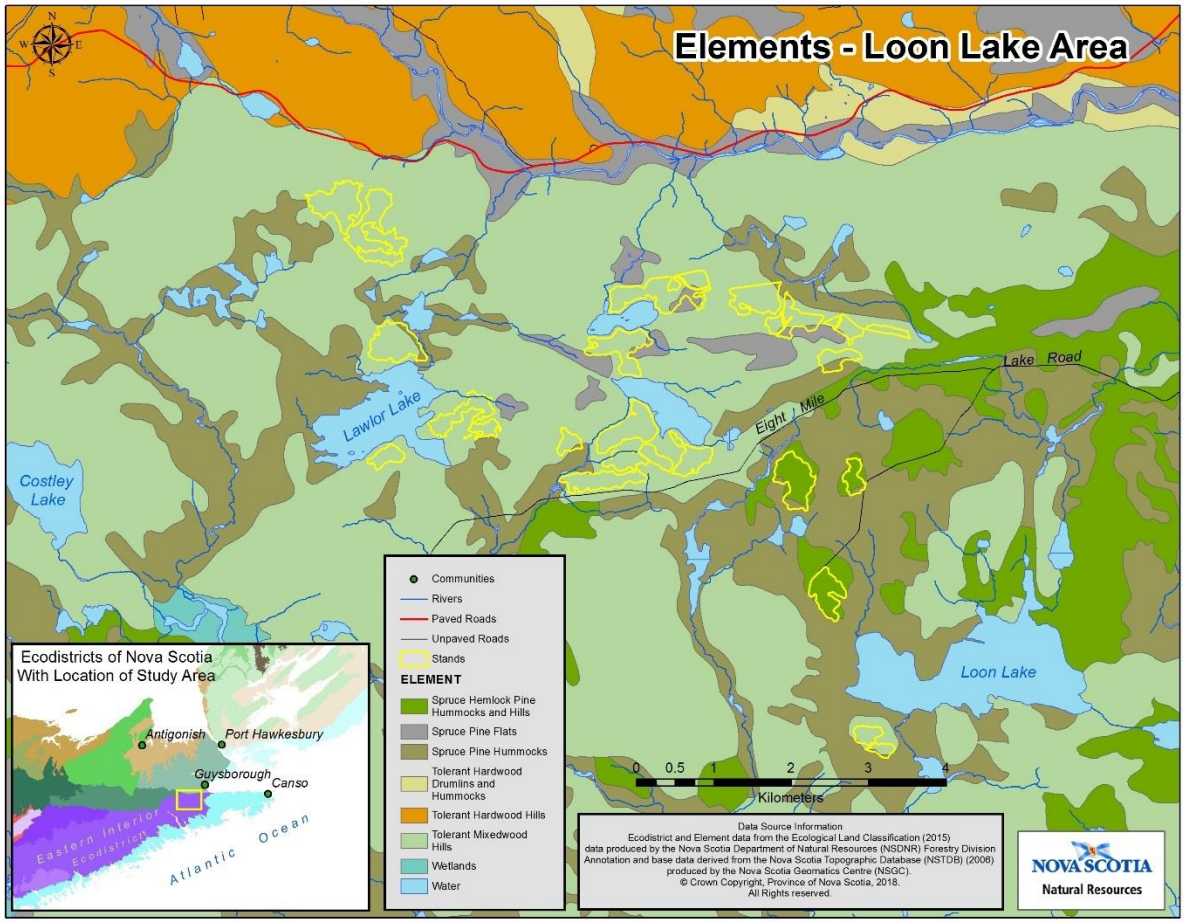

Figure 1. Study area and Ecological Land Classification

2.2 Selection of stands and plots.

The study area was selected based on the area of public concern. Port Hawkesbury Paper, under its Forest Utilization License Agreement with the province conducted a DNR approved forest harvest of several hardwood stands using a method known as group selection. The study assessed 12 stands that had been recently harvested and 15 stands that were scheduled to be harvested based on Port Hawkesbury Paper 1-3-year operating plan (Figure #2). Stands were defined by the forest inventory (NSDNR 2008), using natural stand boundaries, as prescribed in the Old Forest Policy, and not by the forest harvest blocks identified in the harvest plan. Forest stands were sampled using 3 to 5 plots per stand, based on area. Plots were originally randomly selected in ArcGIS using the Generate Random Point Tool. Plots were only moved if the plots fell within the already

harvested group or trail. Plots were moved in a systematic way to find a large enough area within the stand that was not harvested (up to 50m north, then east, south and west).

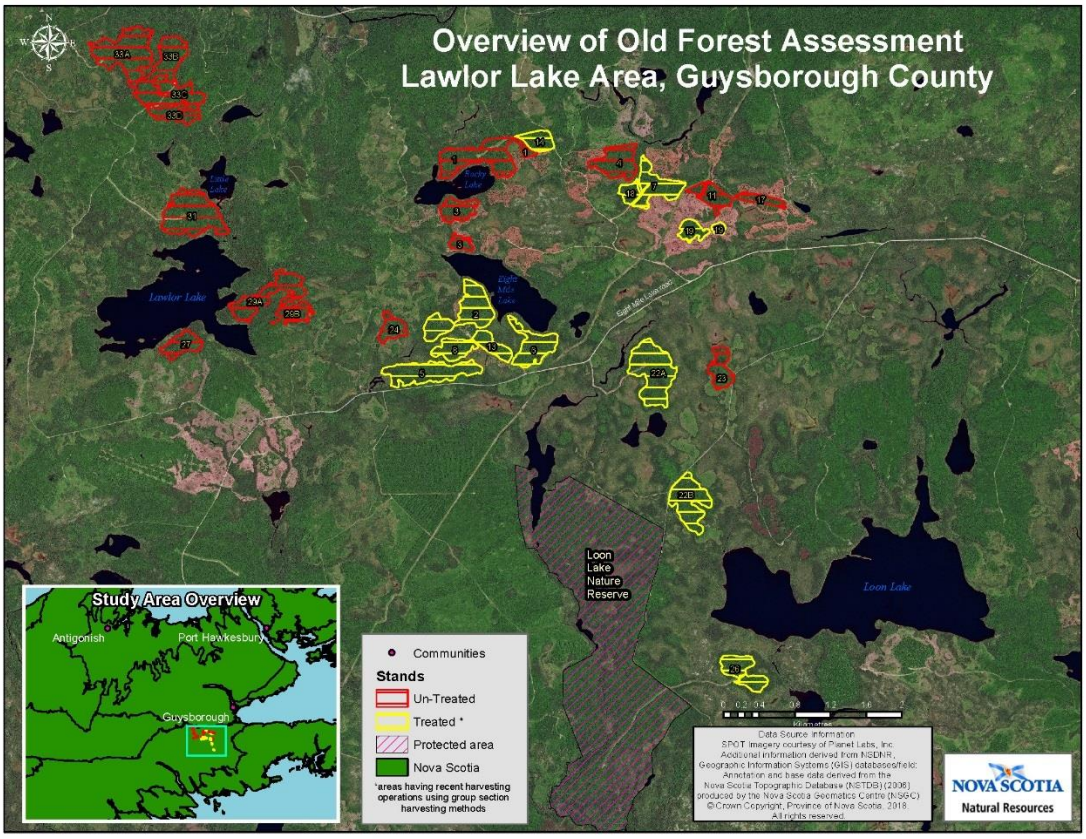

Figure 2. Overview of Old Forest Assessment selected stands

2.3 Old Forest Scoring System

This study follows DNR old forest scoring that has been used by the department for over 15 years (Stewart et al. 2003, NSDNR 2012). The old forest scoring system is intended to be a decision support tool to better understand the degree to which a forest stand has OGF characteristics. Scoring is based on a 100-point score using six stand attributes: age, degree of anthropogenic disturbance, occurrence of large diameter live trees, amount of large diameter dead wood, presence of canopy gaps, and amount of understory development (Table 1), with the "age," variable having the largest weight (see Appendix I for more detailed field sampling procedures and Appendix II for tally and scoring system). The scoring system also provides an objective means of determining a reference age for unevenaged stands.

2.4 Counting of tree ages

The study used an independent expert to count all tree cores that were collected in the field. Ben Phillips, the Director of the Acadian Forest Dendrochronology Lab at Mount Allison University in Sackville, New Brunswick, was contacted to count the tree rings, except for one stand (stand 24 counted by DNR staff). Mr. Phillips reported the tree age based on

rings observed, estimated missing rings and number of rings missed if pith not observed. For the stand age, the calculated age (observed rings plus estimated missing rings) of the sampled trees was used to determine the mean age of the sampled trees. Old forest scoring protocol, defines that: one tree per plot be sampled. This tree should be selected from the common climax species in the stand, and should be larger in diameter than two-thirds of the basal area. This will provide the minimum age of the oldest third of the stand (Appendix I).

3.0 Results and Discussion

3.1 Old Forest Assessment

The study examined a total of 27 stands representing 12 stands that were recently partially harvested, and 15 that were planned for harvest (Figure 2). In total, it was determined that 2 of the partially harvested stands were OGF (according to the Old Forest Policy definitions); 8 of the partially harvested stands were old (> 125 years) but not greater than 50% climax tree species; 1 stand was immature, and 1 stand was mature (Table 1). Of the planned harvest stands (not treated), 11 of the stands were OGF, 1 was old forest, 2 were immature and 1 was mature forest (Table 2). Note, that one stand that was 124 years old was considered to be old growth (stand 33C) because the other stands in the same block (33A, 33B and 33D) were old growth. Also note, that stand 18's age was only 4 years under the "old growth" threshold (i.e. 122 years) and could very well be old, as 2 of the 3 trees were over 125 years.

Old forest scores ranged from 14-70 (X= 55), with OGF ranging from 50-70 (X= 58) (Full old forest scoring in Appendix III). Because the old forest scoring occurred with a few inches of snow on the ground, it is possible that some downed woody debris may have been missed, and therefore underestimated in the stands. The Primal Forest Value for all 27 stands was assigned a value of 10 for Suspected or Light Human Disturbance. Like the measurement challenges of the downed woody debris, determining past human disturbance was difficult with the snow cover. Instead, historical air photos from 1945 were used to determine that most of this area was accessed for timber harvesting. The photos showed evidence of recent logging/ forest management (i.e. 1930-1940s), including evidence of logging trails. It is possible this harvesting resulted in high-grading of maple and yellow birch. The overall old forest scores were generally higher for old growth stands. However, some old forest scores were high for stands that are listed as old, which suggest these stands may be good old forest restoration opportunities under the Old Forest Policy.

Stand number	Old Forest Status	Stand Age	OF Score	Climax %	Group Selection Harvest	ha
18	MATURE	122	40	44.4	Yes	4.1
19	IMMATURE	45	14	6.0	Yes	6.8
2	OLD	130	68	25.6	Yes	21.2
5	OLD	147	50	32.7	Yes	19.3
6	OLD	164	50	46.7	Yes	13.6
7	OLD	136	53	44.9	Yes	13.3
8	OLD	171	65	43.8	Yes	8.2
13	OLD	131	53	23.3	Yes	6.8
14	OLD	130	50	37.5	Yes	6.5
22A	OLD	133	53	39.2	Yes	24.7
22B	**OGF**	**178**	**60**	**61.3**	**Yes**	**17.6**
26	**OGF**	**142**	**55**	**68.1**	**Yes**	**11.2**

Note- Bold stand identifies OGF harvested.
-OLD is not OGF because of Climax Species mix below 50%

Table 1. Old forest assessment of 12 harvested stands in Lawlor Lake area

Stand Number	Old Forest Status	Stand Age	OF Score	Climax %	Group Selection Harvest	ha
17	MATURE	101	55	27.9	No	4.3
23	IMMATURE	67	28	0.0	No	8.5
24	IMMATURE	79	30	3.0	No	6.2
27	OLD	155	56	35.9	No	7.9
1	OGF	136	70	54.5	No	23.8
3	OGF	136	65	51.5	No	11.5
4	OGF	137	50	54.3	No	13.7
11	OGF	133	65	75.7	No	8.1
29A	OGF	160	65	60.3	No	16.9
29B	OGF	153	55	51.9	No	5.6
31	OGF	142	53	88.7	No	25.9
33A	OGF	144	55	59.6	No	25.6
33B	OGF	144	70	78.3	No	23.0
33C	OGF	124	50	66.7	No	9.8
33D	OGF	167	50	86.1	No	7.4

Note- OLD is not OGF because of Climax Species mix below 50%

Table 2. Old forest assessment of 15 stands planned harvest in Lawlor Lake area

3.2 Tree ages and past disturbances

Old forest scoring age for all the stands surveyed had a mean of 134 years, with a range of 45- 167 years. By examining all the tree cores, it was found that the average sample tree age was 144 years and the maximum tree age was 210 years (Appendix IV). Examining the tree ages from across all the plots helps give a picture of some of the structure and past disturbances in the area (Figure 3). As identified by past aerial photos, there appears to be an age group that originated from a disturbance between 1930 – 1950. This is likely reflected by the red maple (and some yellow birch) components in stands. Another age group, between 1860 – 1870's, appears to have been established around the time of a hurricane known as the 1869 Saxby Gale (Dwyer 1958), and is reflected by a cohort of mainly yellow birch with some red and sugar maple. The earliest age group appears to have been established in the early 1800's, possibly from a hurricane event or blow-down which created mineral soil seedbeds that favoured yellow birch establishment.

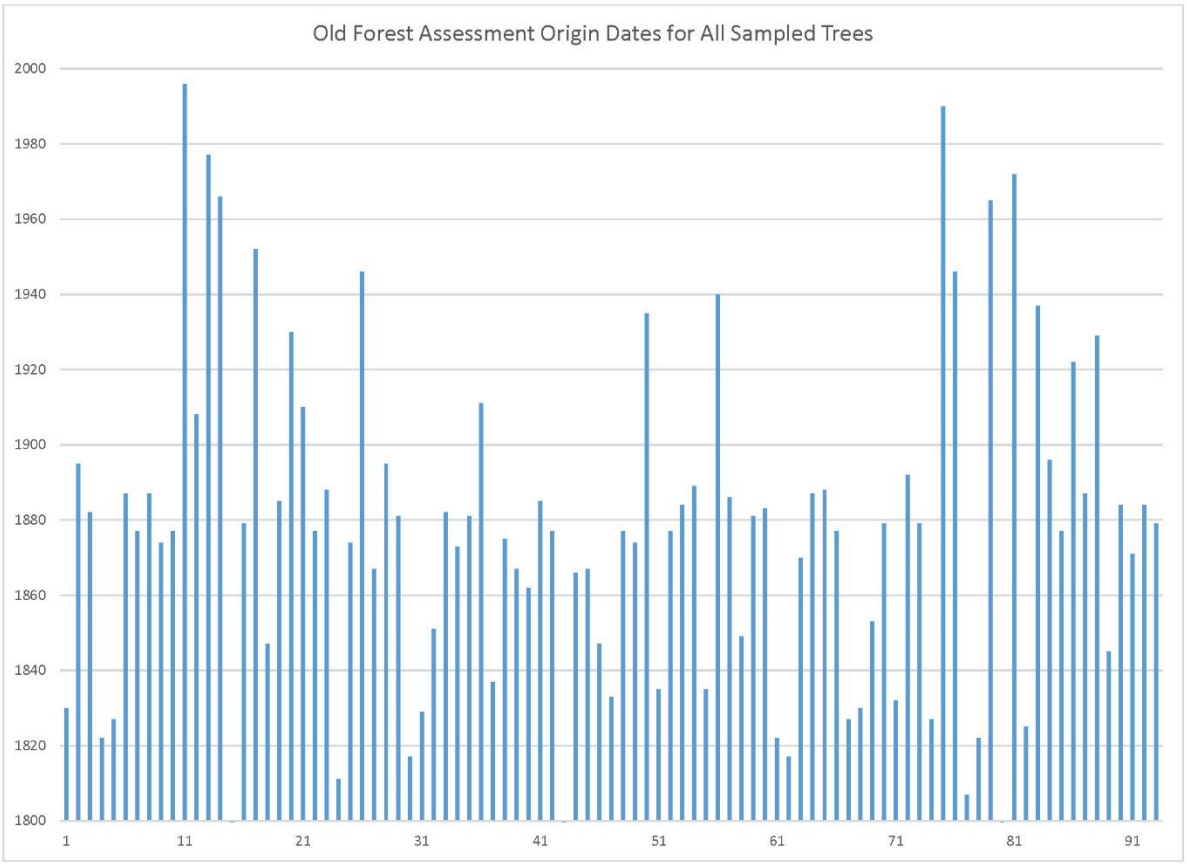

Figure 3. Old forest assessment origin dates for sampled trees.

3.3 Assessment of status of Old Forest Policy in the Eastern Interior Ecodistrict

The old forest policy currently has 27,825 ha (15.7% of the Eastern Interior Ecodistrict) conserved OGF and restoration opportunities. There is currently not enough data to confirm how much of this conserved forest is actually OGF. There is also good representation of the different forest elements including Tolerant Hardwood Drumlins and Hummocks, and Spruce Hemlock Pine Hummocks and Hills (see Table 2), with only Spruce Hemlock Pine Hummocks and Hills element having lower than 8% representation.

Element	Provincial Crown Forest (site class >= 3) (ha)	Old Forest in Protected Areas (ha)	Old Forest Policy Conserved in the Working landscape (ha)	Total (ha)	Old Forest Policy Representation (%)
Red and Black Spruce Hummocks	49,888	9,975	1,284	11,258	22.6%
Spruce Hemlock Pine Hummocks and Hills	21,150	825	89	914	4.3%
Spruce Pine Flats	5,333	355	103	458	8.6%
Spruce Pine Hummocks	60,700	5,803	1,168	6,971	11.5%
Tolerant Hardwood Drumlins and Hummocks	18,994	2,286	316	2,602	13.7%
Tolerant Mixedwood Hills	45,964	3,492	1,029	4,522	9.8%
Total Ecodistrict 440 (includes some small elements not listed above)	**176,984**	**23,758**	**4,067**	**27,825**	**15.7%**

Table 2. Old Forest Policy representation by Element for Eastern Interior Ecodistrict.

3.4 Pre-treatment Assessment Old Forest Trigger

DNR requires all Crown Land forest licencees to use a Pre-treatment Assessment (PTA) system to determine the forest management treatment (prescription) for each forest stand. The current version of the PTA Version 6.3.7 is available on-line at: **https://novascotia.ca/natr/forestry/programs/timberman/pta.asp**. The assessment system has a trigger to flag a stand for old forest scoring. The old forest trigger was introduced with PTA version 5.04 on June 15, 2017. Port Hawkesbury Paper completed the pre-treatment assessment of the Lawlor Lake Area prior to this date using an older version of the PTA program which did not have the old forest scoring trigger.

The current PTA trigger uses three tree diameter categories (>100 trees per ha >= 40 cm, > 20 trees per ha >= 50 cm, and > 5 trees per ha >= 60 cm) and the percentage of climax species (> 50 % climax species) to flag stands for old forest scoring. Old forest scoring results for all 27 stands were examined to determine if the trigger would have identified the need for old forest scoring. Five of the 13 OGF stands would be flagged for old forest scoring (Table 3). The current PTA trigger for tolerant hardwood old growth needs to be reviewed based on these study results, as well as other old forest scoring that has been completed by the department.

Stand #	Old Forest	Age	OF Score	# >= 40 cm trees per ha	# >= 50 cm trees per ha	# >= 60 cm trees per ha	Would PTA Trigger Old forest scoring
1	OGF	136	70	68	26	6	Yes
3	OGF	136	65	42	21	6	Yes
11	OGF	133	65	63	20	10	Yes
29A	OGF	160	65	65	33	8	Yes
33B	OGF	144	70	52	14	9	Yes
4	OGF	137	50	32	5	2	No
22 B	OGF	178	60	49	13	0	No
26	OGF	142	55	82	13	2	No
29B	OGF	153	55	34	6	2	No
31	OGF	142	53	67	18	1	No
33A	OGF	144	55	32	14	2	No
33C	OGF	124	50	42	6	0	No
33D	OGF	167	50	33	15	2	No
2	OLD	130	68	27	20	6	Yes
5	OLD	147	50	36	11	3	No
6	OLD	164	50	29	11	5	No
7	OLD	136	53	44	12	5	No
8	OLD	171	65	41	24	9	No
13	OLD	131	53	15	11	2	No
14	OLD	130	50	31	3	0	No
22 A	OLD	133	53	44	19	4	No
27	OLD	155	56	66	20	4	No
17	MATURE	101	55	30	21	6	No
18	MATURE	122	40	19	5	5	No
19	IMMATURE	45	14	0	0	0	No
23	IMMATURE	67	28	5	0	0	No
24	IMMATURE	79	30	5	0	0	No

Table 3. Old forest scoring and PTA trigger

4.0 Conclusions

The old forest assessment found that two of the forest stands that were harvested (by group selection method) were OGF and 8 stands were old forest. It was also found that 11 stands planned for harvest are OGF. Several stands that were greater than 125 years are listed as old forest and not as old growth because of the definition of climax species in the Old Forest Policy. Red maple is only considered a climatic climax species in Boreal ecosites and edaphically limited sites. DNR research through the Forest Ecosystem Classification (Neily et al. 2013) might provide a better rationale to consider if a species is a climatic climax species. The study area appears to be in a climatic transition from the Acadian to the Boreal ecosites, and as a result, red maple may be acting like a climax species in this area.

The old forest policy and its associated tools (old forest scoring) provides a science-based approach to evaluate OGF and contains appropriate policy mechanisms to conserve OGF when it is found. DNR will continue to use an adaptive management approach to better improve the old forest scoring and assessment procedures and to update the old forest policy as required. Particularly there is opportunity to improve the identification of OGF forest in tolerant hardwoods using the PTA (i.e. new triggers need to be developed).

5.0 References

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Appendix I: Old forest scoring procedures

Old Forest Scoring - Cruise Procedures
REVISED 2005

1. Complete the top of the cruise sheet.

2. *If the stand appears to be* ***<80 years of age*** *record the species, dbh, age, and height of at least one codominant tree, representative of the stand. Circle the most appropriate forest community type.*

3. If the stand appears to be **> 80 years of age**, complete the full Old Forest Scoring as follows:

   1. Establish a minimum of 3 sample plots per stand.

   2.Use prism sample to tally live trees by species and dbh class. Trees in the smaller dbh classes do not contribute to Old Forest score and are therefor grouped in two large classes that can usually be visually estimated for diameter. Trees larger than 30 cm dbh should be measured for diameter class.

   3. During the prism sample, tally all snags that have a dbh ≥ 20 cm. Estimate the top diameter and height, as well as the height at each diameter class limit (see example). For example, consider a snag with a dbh of 42 cm, and a total length of 7 meters to a broken top of 24 cm diameter. It will be tallied in the 42 cm dbh row. In the snag section tally 7 m under the ≥20 cm class as "7", under the ≥30 cm class perhaps as 4 m , and under the ≥ 40 cm class perhaps as 2 m.

   4. Measure the age of one tree at each plot. This should be selected from the most common climax species, and should be larger in diameter than 2/3's of the basal area (This will provide the age of the oldest third of the stand). This can be found by dividing the total number of live trees tallied in the prism sample by 3. Count back this number of tally points from the largest tree tallied. Select a representative tree of the corresponding dbh to bore for age. For example, if 9 trees have been tallied, then count back 3 trees from the largest tree tallied.

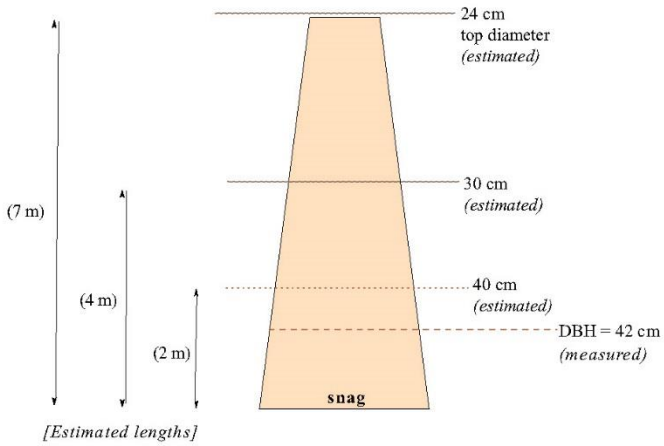
   5. Establish three 20 meter line transects in a triangular shape (see example) at each plot to determine the length of downed tree bole (m/ha) by diameter class. Tally each piece of wood intersected by the transect under the diameter classes corresponding to the diameter of the bole at the point of intersection. For example, a tree bole with a diameter of 42 cm at the point where it is crossed by the transect line will be given 1 dot tally under each of the ≥20 cm, ≥30 cm, and ≥40cm classes.

   Note: A dead tree is considered to be a snag if it is standing at 45 degrees or more from horizontal, in which case it will be sampled using the prism plot. If it is laying horizontally at less than 45 degrees it is considered "downed" and will be measured using the line transect plot. All deadwood is sampled regardless of its state of decay.

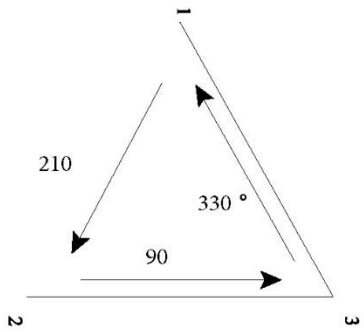
   6. Record Primal Value, Crown Closure, and Understory Structure comments and score based on visual assessment after completion of cruise.

   7. Circle the most appropriate forest community type.

Example of how to measure a snag



Line transect plot layout diagram for CWD measurement



Example of how to tally the snag example above (assuming 2 BAF was used)

DBH cm	LIVE TREES Basal Area Tally - [Prism Plots] SPECIES						SUM TALLY	TREES[a] PER HA	Tree Density Factor TDF (2 BAF prism)	Tree Density Factor TDF (3 BAF prism)	DEAD STANDING TREES - SNAGS Tally of Bole Length (m) - [Prism Plots]							
											≥ 20 cm		≥ 30 cm		≥ 40 cm		≥ 50 cm	
											m	m/ha[b]	m	m/ha[b]	m	m/ha[b]	m	m/ha[b]
40									16	24								
42									14	22	(7)	98	(4)	56	(2)	28		0
44									13	20								

[a] Calculate: SUM TALLY * TDF ÷ Nplots
[b] Calculate: LENGTH TALLY * TDF ÷ Nplots

Appendix II: Old forest scoring tally sheet

OLD FOREST TALLY SHEET

GIS Mapstand #_____ Date _____ Prism BAF _____ Plot# _____ Length Transect (m/plot) _____ Cruisers _____

DBH cm	LIVE TREES Basal Area Tally - [Prism Plots] SPECIES						SUM TALLY	TREES [a] PER HA	Tree Density Factor TDF (2 BAF prism)	Tree Density Factor TDF (3 BAF prism)	DEAD STANDING TREES - SNAGS Tally of Bole Length (m) - [Prism Plots]							
											≥20 cm		≥30 cm		≥40 cm		≥50 cm	
											m	m/ha [b]	m	m/ha [b]	m	m/ha [b]	m	m/ha [b]
2-19									254	382								
20-29									44	66								
30									28	42								
32									25	37								
34									22	33								
36									20	29								
38									18	26								
40									16	24								
42									14	22								
44									13	20								
46									12	18								
48									11	17								
50									10	15								
52									9	14								
54									9	13								
56									8	12								
58									8	11								
60									7	11								
62									7	10								
64									6	9								
66									6	9								
68+									6	8								

Total Trees/ha ≥ 40 cm		1. Total Snag Bole Length (m/ha)					
Total Trees/ha ≥ 50 cm		{ Line Transect Plots	2. Downed Wood Tally (# of pieces)				
Total Trees/ha ≥ 60 cm			3. Total Downed Wood Length (m/ha) [c]				
Percent Climax Species		**Total Length of Dead Wood (m/ha) [sum 1 &3]**					

[a] Calculate: SUM TALLY * TDF ÷ Nplots

[b] Calculate: LENGTH TALLY * TDF ÷ Nplots

[c] Calculate: Downed Wood Tally * 15720 ÷ Total Length of Line Transect from all plots

Note: Deadwood (snags and downed) from large diameter classes should also be tallied in the small diameter classes (eg. a log of 42 cm at the line transect will be tallied in the ≥20cm, ≥30cm, and ≥40cm, columns.)

Appendix II (continued)

Age:

Plot	Species	Dbh (cm)	Age (yrs)	Height (m)	Easting (X) UTM	Northing (Y) UTM
Average					UTM Zone:	

Primal Value Description: _____

_____

Overstory Crown Closure: _____

Understory Structure: _____

Old Growth Score Summary - Part II:

Stand Feature	Score
1. Age	
2. Primal Value	
3. Diameter	
4. Deadwood	
5. Crown Closure	
6. Stand Structure	
Total	

Score Sheet

			Score
1.	Age of 30% of the basal area	60 - 80	5
		81 - 100	10
		101 - 125	20
		126 - 177	30
		> 175	40
2	Primal Forest Value	Past Logging Evident	0
		Suspected or Light Human Disturbance	10
		Past Logging unlikely	20
3	Diameter	> 50 trees/ha with dbh >= 40cm	3
		> 70 trees/ha with dbh >= 40 cm	5
		> 100 trees/ha with dbh >= 40 cm	9
		> 20 trees/ha with dbh >= 50 cm	12
		> 5 trees/ha with dbh >= 60 cm	15
4	Total Bole Length of Dead trees	400 m with diameter >= 20 cm	3
		200 m with diameter >= 30 cm	5
		200 m with diameter >= 40 cm	10
		200 m with diameter >= 50 cm	15
5	Overstory Crown Closure	Uniform closure with little light penetration	2
		Small canopy openings (hardwood)	5
		Mosaic of different densities (softwood)	5
6	Stand Structure	One understory	2
		Multiple layers in the understory	5

Circle Appropriate Forest Community *(Crown Lands Forest Model-2005)*

Hardwood Covergroup (Softwood Species 0 - 24% of total basal area)

HTHw *Tolerant Hardwood* (THw≥ 60%of Hardwood BA)

HITHw *Intolerant/Tolerant Hardwood* (THw 30 - 59%of Hardwood BA)

HIHw *Intolerant Hardwood* (THw < 30% of Hardwood BA)

Mixedwood Covergroup (Softwood Species 25 - 74 % of total basal area)

MTHw *Tolerant Hardwood Mixedwood* (THw ≥50 % of Hardwood BA)

MIHwSH *Intolergnt Hardwood Mixedwood, Softwood Lead* (THw < 50 % of Hardwood BA, Softwood dominant)

MISwHS Intolerant Hardwood Mixedwood, Hardwood Lead (Thw< 50 % of Hardwood BA; Hardwood dominant)

Softwood Covergroup (Softwood Species ≥75 % of total basal area)
(work through list from top to bottom and accept first community to meet criteria)

SbFDom *Balsam Fir Dominant* (Fir ≥60%of Softwood BA)

SrSDom *RedSpruce Dominant* (Spruce≥60 %of Softwood BA, RS≥50% of Spruce BA)

SbSDom *BlackSpruce Domin* (Spruce≥60 %of Softwood BA, BS≥50% of Spruce BA)

SwSDom *WhiteSpruce Domin* (Spruce≥60% of Softwood BA,WS > 50% of Spruce BA)

SSpbFDom *Spruce/Fir Dominant* (Fir +Spruce ≥60 % of Softwood BA)

SpiDom *Pine Dominant* (Pine ≥60 % of Softwood BA)

SMHePiSp Mixed Spruce/Pine/Hemlock

Appendix III: Old forest scoring results

Stand	Old Forest	Age	OF score	Age Score	Primal Value	Dia-meter	Total Bole Standing and Fallen	Over-story	Stand Structure	# 40 cm trees per ha	# 50 cm trees per ha	# 60 cm trees per ha	CLIMAX %
1	OGF	136	70	30	10	15	5	5	5	68	26	6	54.5
2	OLD	130	68	30	10	15	3	5	5	27	20	6	25.6
3	OGF	136	65	30	10	15	0	5	5	42	21	6	51.5
4	OGF	137	50	30	10	0	0	5	5	32	5	2	54.3
5	OLD	147	50	30	10	0	0	5	5	36	11	3	32.7
6	OLD	164	50	30	10	0	0	5	5	29	11	5	46.7
7	OLD	136	53	30	10	0	3	5	5	44	12	5	44.9
8	OLD	171	65	30	10	15	0	5	5	41	24	9	43.8
11	OGF	133	65	30	10	15	0	5	5	63	20	10	75.7
13	OLD	131	53	30	10	0	3	5	5	15	11	2	23.3
14	OLD	130	50	30	10	0	0	5	5	31	3	0	37.5
17	MATURE	101	55	20	10	15	0	5	5	30	21	6	27.9
18	MATURE	122	40	20	10	0	0	5	5	19	5	5	44.4
19	IMMATURE	45	14	0	10	0	0	2	2	0	0	0	6.0
22 A	OLD	133	53	30	10	0	3	5	5	44	19	4	39.2
22 B	OGF	178	60	40	10	0	0	5	5	49	13	0	61.3
23	IMMATURE	67	28	5	10	0	3	5	5	5	0	0	0.0
24	IMMATURE	79	30	10	10	0	0	5	5	5	0	0	3.0
26	OGF	142	55	30	10	5	0	5	5	82	13	2	68.1
27	OLD	155	56	30	10	3	3	5	5	66	20	4	35.9
29A	OGF	160	65	30	10	15	0	5	5	65	33	8	60.3
29B	OGF	153	55	30	10	0	5	5	5	34	6	2	51.9
31	OGF	142	53	30	10	3	0	5	5	67	18	1	88.7
33A	OGF	144	55	30	10	0	0	5	5	32	14	2	59.6
33B	OGF	144	70	30	10	15	5	5	5	52	14	9	78.3
33C	OGF/OLD	124	50	30	10	0	0	5	5	42	6	0	66.7
33D	OGF	167	50	30	10	0	0	5	5	33	15	2	86.1

Appendix IV: Tree Ages of All Sampled Trees, counted by Ben Phillips, Director of Acadian Dendrochronology Lab, Mount Allison University, Sackville, NB

Site	Plot	DBH	Species	First Year	Last Year	Age	Missing Ring Estimate	Absent Pith	Corrected Estimate	Estimated Recruitment Date
S8	P3a	60	YB	1845	2017	172	8 to 10	5 to 10	187	1830
S8	P3a	60	YB	1895	2017	122	3 TO 5	?		1895
S8	P4a	40	YB	1882	2017	135	1 TO 2	?		1882
S8	P8	52	YB	1822	2017	195		?		1822
S8	P8	52	YB	1837	2017	180	3 TO 5	3 TO 5	190	1827
S11	P1	33.8	YB	1906	2017	111	3 to 5	10 to 20	130	1887
S11	P2	50.2	YB	1879	2017	138		2	140	1877
S11	P3	50	YB	1895	2017	122		5 to 10	130	1887
S17	P1	35.7	YB	1876	2017	141	1 to 2	1 to 2	143	1874
S17	P2	33.3	SM	1881	2017	136		3 to 5	140	1877
S17	P3	23.5	YB	1997	2017	20		1 to 2	21	1996
S23	P1	30	BF	1910	2017	107		2 to 3	109	1908
S23	P2	13	BF	1977	2017	40				1977
S23	P3	14	RM	1966	2017	51		?		1966
S14	P2	36	YB							0
S22	P6	44	YB	1885	2017	132		5 to 8	138	1879
S3	P8	54	YB	1952	2017	65		?		1952
S3	P8	48	YB	1854	2017	163		6 to 12	170	1847
S3	P1a	40	YB	1888	2017	129		3 to 4	132	1885
S3	P8	38	YB	1930	2017	87		?		1930
S3	P6a	48	YB	1917	2017	100		5 to 10	107	1910
S27	P1	43.8	YB	1883	2017	134		5 to 10	140	1877
S27	P2	42.3	YB	1892	2017	125		3 to 5	129	1888
S27	P3	36	YB	1843	2017	174	6 to 10	20 to 50	206	1811
S27	P4a	44.1	SM	1874	2017	143		?		1874
S27	Xtra	31.8	RM	1946	2017	71				1946
S29	P1	54.8	YB	1867	2017	150				1867
S29	P2	47.8	YB	1901	2017	116		5 to 10	122	1895
S29	P3	40.8	YB	1881	2017	136				1881
S29	P4	43.2	YB	1820	2017	197		2 to 3	200	1817
S29	P5	34.2	YB	1836	2017	181	2 to 4	3 to 5	188	1829
S29	P6	42	YB	1854	2017	163		2 to 4	166	1851

S29	P7	33.7	YB	1890	2017	127		5 to 10	135	1882
S31	P1	36	SM	1879	2017	138	2 to 3	3 to 5	144	1873
S31	P2	38	YB	1881	2017	136				1881
S31	P3	40	SM	1926	2017	91		10 to 20	106	1911
S31	P4	44	YB	1849	2017	168	4 to 6	4 to 8	180	1837
S31	P5	46	SM	1880	2017	137		4 to 6	142	1875
S33	P1	39.1	YB	1891	2017	126	1 to 2	15 to 40	150	1867
S33	P2	39.2	YB	1865	2017	152	2 to 3	1 to 2	155	1862
S33	P3	40.6	SM	1889	2017	128	1 to 2	3 to 5	132	1885
S33	P4	34	YB	1881	2017	136	1 to 2	3 to 5	140	1877
S33	P5	26.5	YB							0
S33	P6	44	YB	1867	2017	150	1 to 2		151	1866
S33	P7	36	YB	1870	2017	147		3 to 5	150	1867
S33	P8a	36	YB	1850	2017	167	3 to 5	?	170	1847
S33	P3	50.3	YB	1839	2017	178	2 to 3	3 to 5	184	1833
S33	P9	37	YB	1886	2017	131	2 to 3	5 to 10	140	1877
S33	P8	37.8	SM	1878	2017	139		3 to 5	143	1874
S33	P9a	26	YB	1945	2017	72	?	5 to 10	82	1935
S33	P10	50	YB	1836	2017	181	1 to 2		182	1835
S5	P1	30	SM	1882	2017	135		3 to 5	140	1877
S5	P2	36	RM	1888	2017	129		3 to 5	133	1884
S5	P3	40	YB	1893	2017	124	1 to 2	3 to 5	128	1889
S14	P1	40	YB	1847	2017	170		10 to 15	182	1835
S14	P3	24	WS	1942	2017	75		1 to 2	77	1940
S26	P1	40	YB	1886	2017	131		?		1886
S26	P2	48	YB	1849	2017	168		?		1849
S26	P3	30	YB	1885	2017	132	1 to 2	3 to 5	136	1881
S26	P4	40	YB	1887	2017	130		3 to 5	134	1883
S22	P4	44	YB	1826	2017	191	1 to 2	3 to 5	195	1822
S22	P5	42	YB	1822	2017	195	2 to 3	2 to 3	200	1817
S7	P1	42	YB	1874	2017	143		3 to 5	147	1870
S7	P2	40	SM	1895	2017	122		5 to 10	130	1887
S7	P3	36	YB	1888	2017	129				1888
S6	P1a	32	RM	1887	2017	130		8 to 12	140	1877
S6	P2a		YB	1828	2017	189	1 to 2	?	190	1827
S6	P3a	58	YB	1836	2017	181		5 to 8	187	1830
S6	P3a	56	YB	1853	2017	164		?		1853
S6	P4a	40	YB	1879	2017	138				1879

S1	P4	40	SM	1834	2017	183	1 to 2	1 to 2	185	1832
S1	P5	40	SM	1912	2017	105	1 to 2	15 to 25	125	1892
S1	P3	44	YB	1883	2017	134	1 to 2	3 to 5	138	1879
S1	P6	50	YB	1832	2017	185	1 to 2	3 to 5	190	1827
S2	P1	26	BF	1990	2017	27				1990
S2	P2	22	RM	1948	2017	69		2 to 3	71	1946
S2	P3		YB	1814	2017	203		5 to 10	210	1807
S2	P4	42	YB	1824	2017	193	1 to 2		195	1822
S2	P5	24	RM	1968	2017	49		3 to 5	52	1965
S19	P2	16	RM							0
S19	P4	22	RM	1974	2017	43		1 to 2	45	1972
S13	P2	38	YB	1833	2017	184	2 to 3	5 to 10	192	1825
S13	P3a	28	RM	1942	2017	75	1 to 2	3 to 5	80	1937
S13	P4	36	RM	1900	2017	117	1 to 2	3 to 5	121	1896
S18	P1	36	SM	1880	2017	137		3 to 5	140	1877
S18	P2	40	YB	1929	2017	88		5 to 10	95	1922
S18	P3	36	YB	1895	2017	122	3 to 5	3 to 5	130	1887
S22	P1	46	YB	1929	2017	88		?		1929
S22	P2	36	SM	1852	2017	165	3 to 5	2 to 3	172	1845
S4	P2	38	SM	1884	2017	133		?		1884
S4	P12	22	YB	1871	2017	146		?		1871
S4	P4	24	YB	1885	2017	132		1 to 2	133	1884
S22	P3	40.2	YB	1883	2017	134		3 to 5	138	1879
Mean		39		1884		133			144	1880
Max		60		1997		203			210	1996
Min		13		1814		20			21	1807