FOREST RESEARCH REPORT

Nova Scotia Department of Natural Resources
Forest Management Planning

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# Selection Harvest Survey:
## 8 Year Post-Harvest Results

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### Introduction

Selection harvesting is a method of regenerating a forest stand and maintaining an uneven-aged structure by removing some trees in all size classes either singly or in small groups or strips (NFDP 2016). This system provides shaded openings for species that prefer this kind of environment for regeneration. The trees that are less likely to survive to the next re-entry are taken first (diseased, broken crowns), thereby improving the quality of the stand, leaving the best trees as a seed source while capturing volume that might otherwise be lost to mortality. When attempting selection harvests there is the risk of degrading stands by removing the best and leaving low quality stems (high grade).

Historically, selection harvesting has made up a small proportion of the total harvest in Nova Scotia, but this is increasing (Figure 1). Over the period 2011-2015, the annual average proportion of selection harvest=6%, commercial thinning and shelterwood= 9%, and clearcuts =85% (by area).

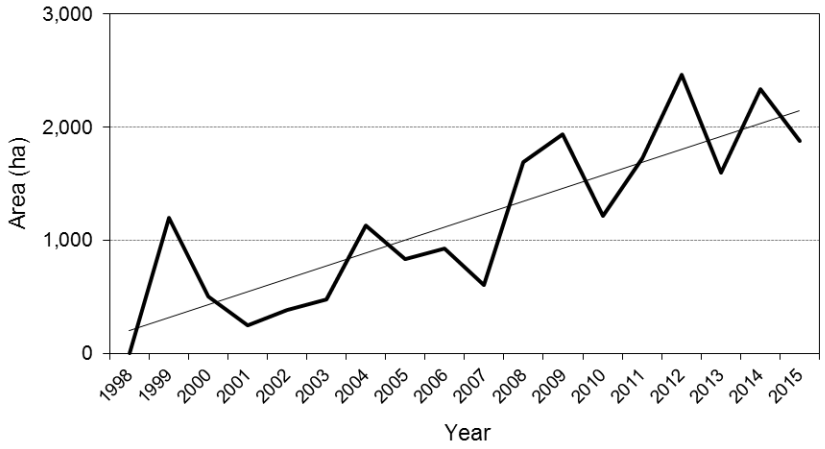


Figure 1. Selection harvest (ha) in Nova Scotia 1998-2015.

The Nova Scotia Natural Resources Strategy aims to implement ecosystem based management and reduce clearcutting (NSDNR 2011). Non-clearcutting harvest methods such as selection harvesting must be increased to meet this goal. The objective of the survey was to identify issues relating to the successful implementation of selection harvesting, including the impact of the treatment on growth response, wind throw severity, harvest damage, and removal rates.

**Methods**

Sample

There were 34 selection harvest sites surveyed throughout the province (Figure 2). These sites were randomly chosen from selection harvest operations performed in 2004, 2005, and 2006 (1705ha). The sample was stratified by year, ownership, company, and job to ensure representivity. Stands less than 2ha were excluded. Selected sites were assessed between 2011 and 2013, 7-9 years after harvest. The survey sampled 24% (402ha/1705ha) of the area that was selection harvested during this period.

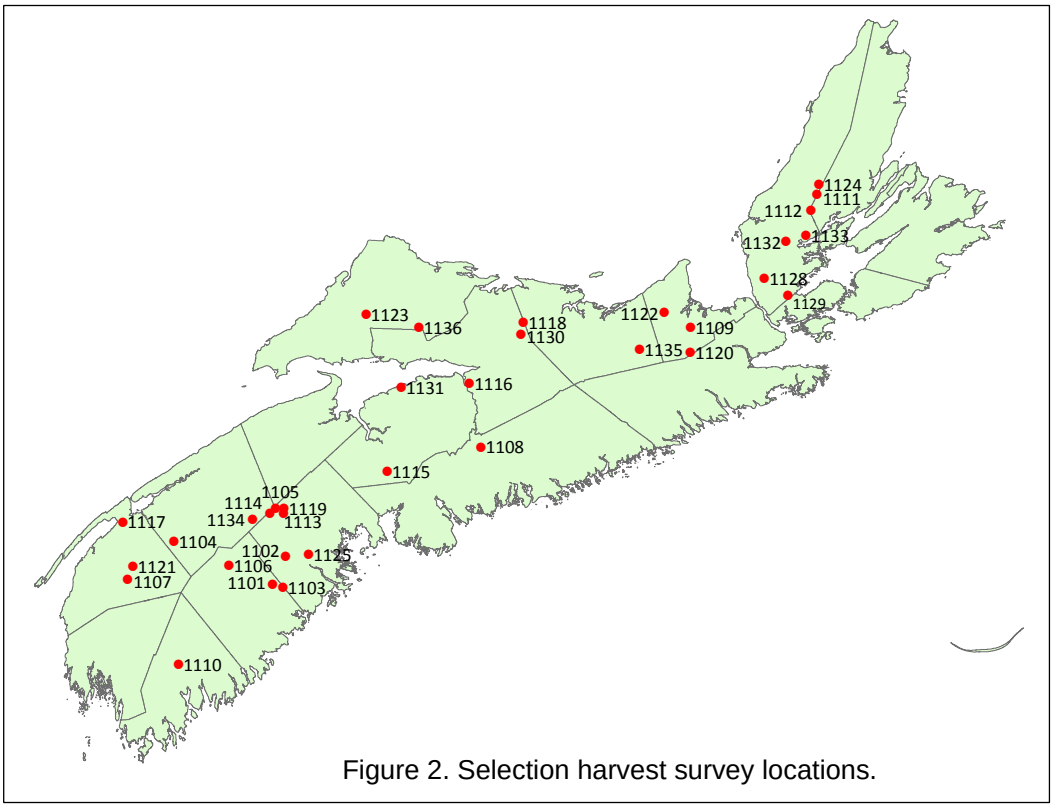


Figure 2. Selection harvest survey locations.

Field Methods

A sampling intensity of 1 plot/ha was used with a minimum of 5 plots and a maximum of 25 plots per stand. Plots were established in a uniform grid pattern to provide full coverage of each site (Figure 3). Within the circular sample plots (radius=7.98m or 1/50 of a hectare), all living, dead, and cut trees were tallied. The crop potential of all living trees was assessed (acceptable growing stock or unacceptable growing stock) (McGrath *et al.* 2015). Soil and vegetation types were determined using the forest ecosystem classification (Neily *et al*. 2013). Two regeneration plots (radius=1.36m) were established within each larger 7.98m radius plot. A regeneration plot size of 1.36m radius enables stocking to be calculated at tree spacings of 2.4m (1736 stems/ha). Regeneration plots were established 4m from the plot centre in the north and south direction. The condition of the regeneration plots was described (i.e. selection

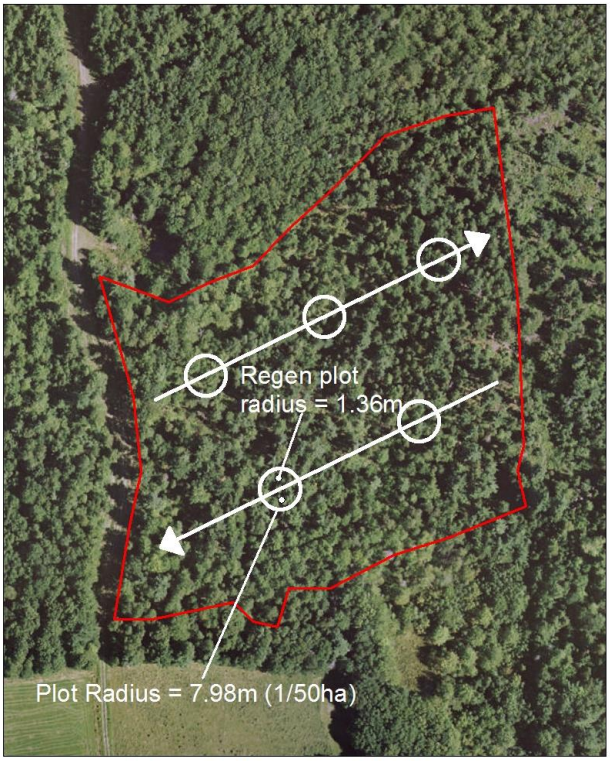


Figure 3. Example of plot layout.

harvested, unthinned, on trail, in patch opening). All trees by species were counted within the regeneration plots. The dominant height for each species present was recorded.

One tree per 7.98m radius plot (average tree of average release) was selected to be cored for analysis. Three hundred and four cores were examined for release response (diameter increment) to the selection harvest using the WinDENDRO™ system.[1] Increment cores were used to establish the diameter at breast height (dbh) of the trees at the time of the selection harvest. A stump and dbh relationship based on regression from site measurements was used to estimate the dbh of the cut trees for each individual site. This was done so that stand conditions could be estimated at the time of the selection harvest.

Summary of Sites

Figure 4 shows a summary of the sites that were surveyed. There was representation across all regions, ownership classes, year harvested, and pre-harvest stand types[2]. Of the sites selected, 65% were less than 10ha in size. The smallest site was 3ha and the largest 41ha. The stands harvested ranged in age from 33 to 117 years old, with 35% between the 71-90 year age range (Figure 4 and Appendix 1).

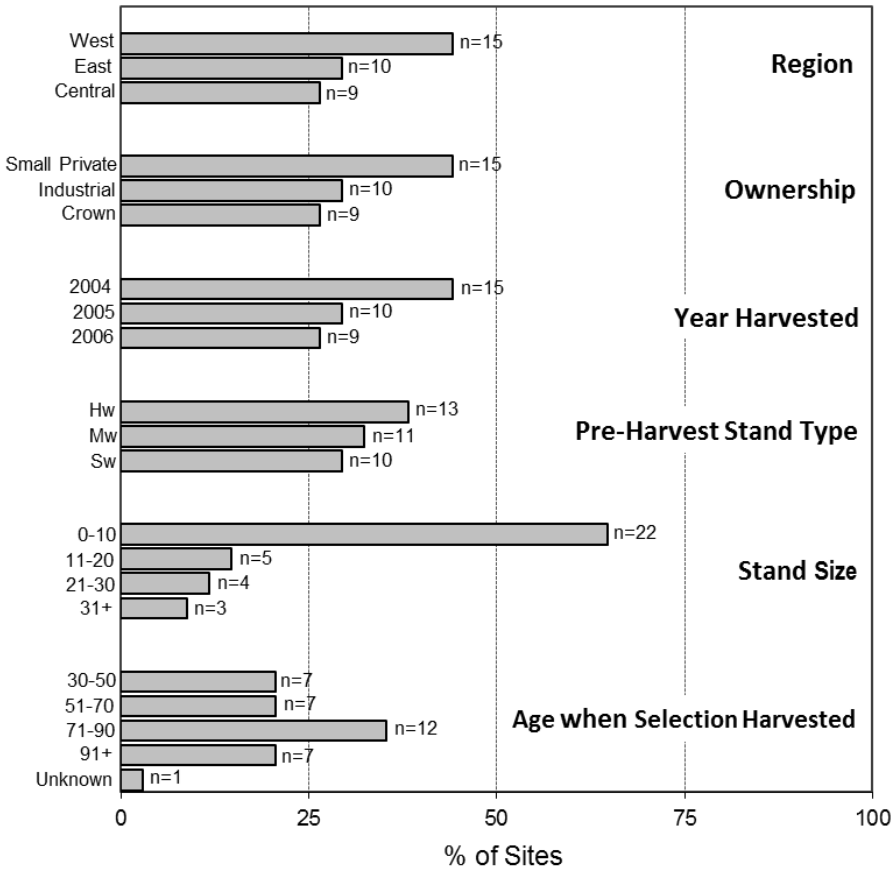


Figure 4. Summary of surveyed selection harvest sites (n= # of sites). Age when selection harvested: one site is unknown because it was clearcut before it was surveyed.

[1]WinDENDRO™ – Registered trademark of Regent Systems Inc.
[2]Stands were assigned a pre-harvest stand type as follows; Hardwood (Hw): 75% or greater hardwood species in the overstory; Softwood (Sw):75% or greater softwood species in the overstory; Mixedwood (Mw): all other stands (Neily *et al.* 2013).

**Results**

Harvest Types

Figure 5 shows examples of some of the different harvest types encountered during the survey.

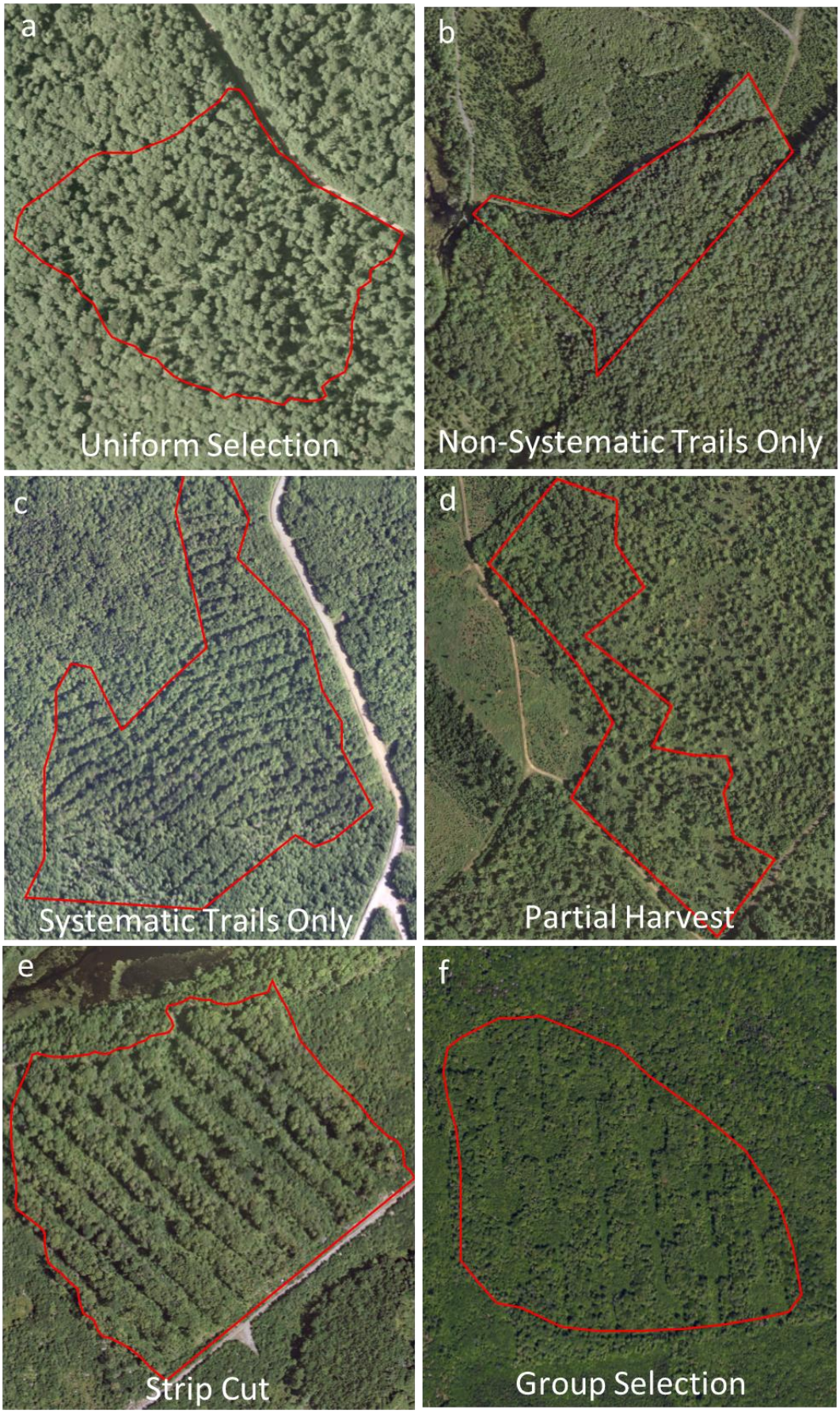


Figure 5. Aerial photos of the different harvest types encountered during the selection harvest survey. a:uniform selection (site 1111), b: non-systematic trails only (site 1102), c: systematic trails only (site 1128), d: partial harvest (site 1113), e: strip cut (site 1121), f: group selection (site1130).

The following are descriptions of the harvest types sampled during the selection harvest survey;

**Uniform selection/single-tree selection:** A method of regenerating uneven-aged stands in which individual trees of any size are removed uniformly throughout the stand (NFDP 2016).

**Non-systematic trails only:** Removals were done using trails laid out in no pattern resulting in large areas not treated. Trees on trail edges were released, but the remainder is left untreated. In these sites, 19% of area was in trails and the rest (81%) was not thinned.

**Systematic trails only:** Removals were done using trails that were laid out uniformly resulting in full site coverage. Trees on trail edges were released, but leave strips between trails were left untreated (average trail width=8m, average leave strip width between trails=18m, % of stand in trails=31%).

**Partial harvests:** Any cutting in which only part of the stand is harvested (NFDP 2016). In Nova Scotia, the softwood component is typically removed; leaving unwanted lower quality hardwoods.

**Strip cut:** Removal of the trees in strips in more than one operation, generally for encouraging natural regeneration (NFDP 2016). Strip cut is like the systematic trails only system but the cleared strips were wider. Typically, in a strip cut, the cleared trails were as wide as the average height of the trees (average cleared strip width=18m, average leave strip width=29m, % of stand in cleared strips=38%).

**Group selection:** A method of regenerating and maintaining uneven-aged stands in which trees are removed in small groups (NFDP 2016).

**Diameter limit cut**: The bigger dominant and co-dominant trees were removed leaving the lower quality suppressed trees.

**Understory cleaning**: Few trees of merchantable size were removed. Mostly smaller suppressed unmerchantable trees (<9cmdbh) were cut and left on site.

Figure 6 shows the abundance and frequency of the different harvest types encountered during the survey. Figure 6a is based on area and Figure 6b is based on the number of sites. Uniform selections are the most abundant (34%) and frequently (56%) used selection harvest type. Systematic trails only (24%), group selections (16%), and strip cuts (11%) are the next most abundant and tended to be used on larger Crown and Industrial sites. Five percent was harvested using non-systematic trails only. Three percent was a diameter limit cut. Partial harvests occurred on small sites on small private ownership amounting to 1% of the area surveyed. One percent was an understory cleaning. One percent of the area was clearcut at the time of the selection harvest. One site was selection harvested using the strip cut method, but 6 years later it was clearcut. This site was large (37ha) and accounted for 9% of the area surveyed.

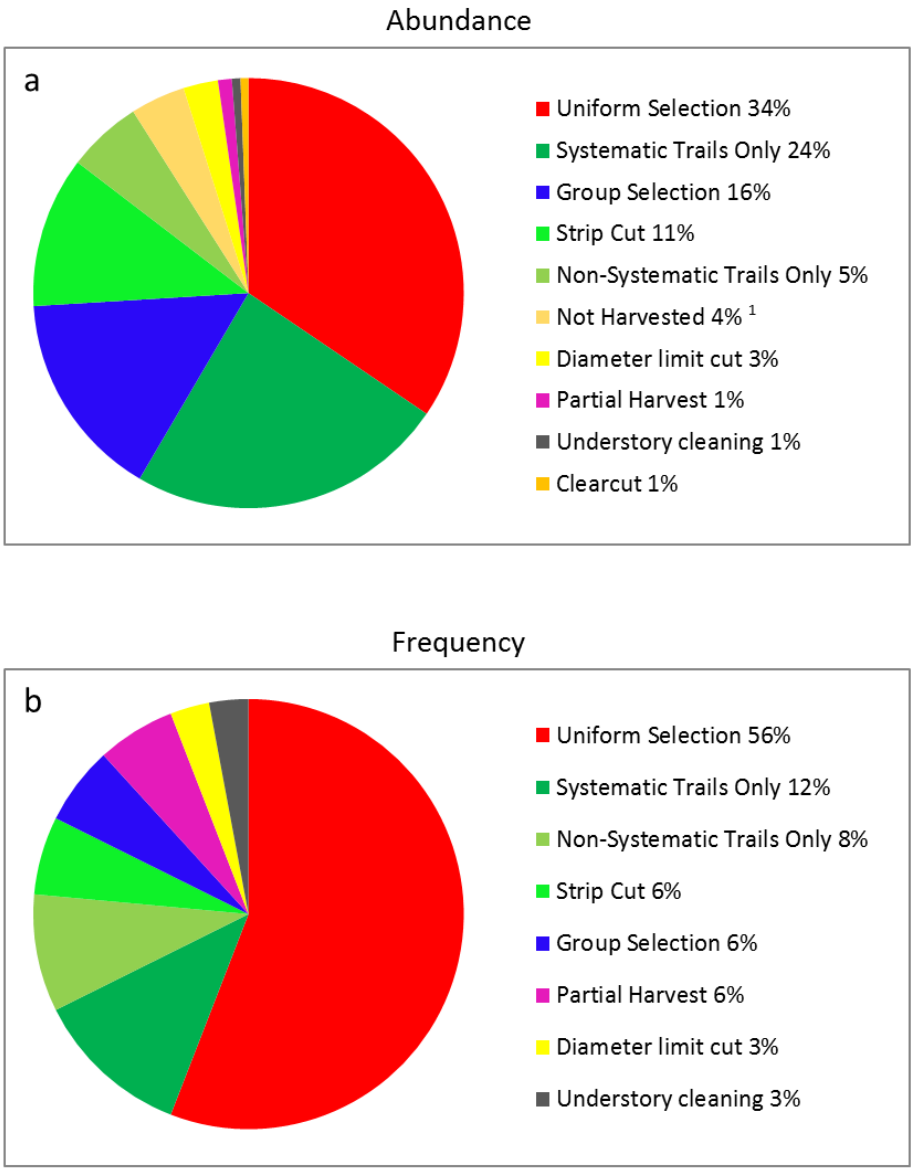


Figure 6. The abundance and frequency of the different harvest types.
a) Abundance: based on area (larger sites have more weighting).
b) Frequency: based on the main harvest type per site (each site has equal weighting).

[1]Not harvested: Portions of a stand in which no treatment was done. The non-harvested portions of group selections, strips cuts, systematic trails only, and non-systematic trails only are not included in this number as it is implied by the name that these types of harvests will have unharvested portions as part of the treatment.

Figure 7 shows basal area removal by harvest type. Partial harvests show the largest removal at 62%. Uniform selections, group selections, diameter limit cuts, strip cuts, and systematic trails only all range between 31%-42% basal area removal. Sites which employed non-systematic trails only had an average basal area removal of 19% and the understory cleaning was 12%.

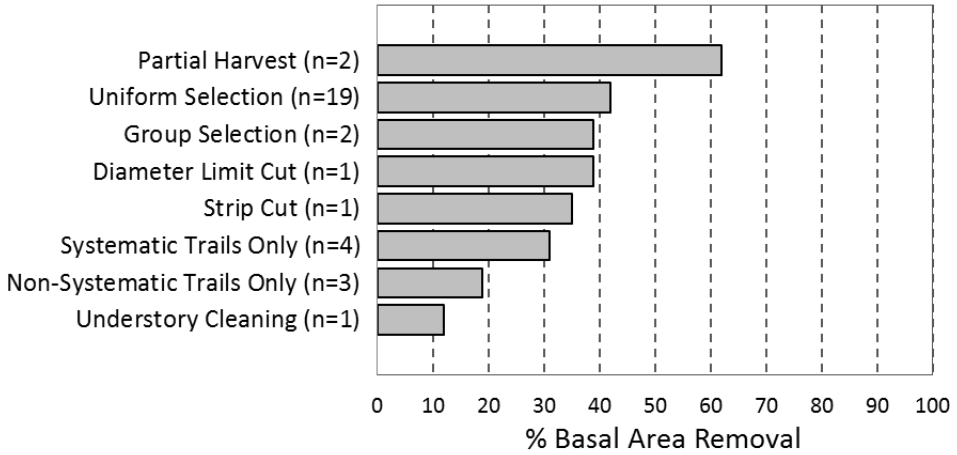


Figure 7. Basal area removals associated with the different harvest types (main harvest type per site).

Indicators of Job Quality

In this study, a selection harvest must adhere to the following principals in order to be deemed successful;

- Produce desirable regeneration
- Minimize blowdown
- Stand Improvement

Desirable regeneration: A selection harvest should promote the establishment of tolerant, long-lived species (red spruce, hemlock, sugar maple, white pine, yellow birch, red oak and white ash). This is accomplished by leaving mature tolerant long-lived species on site after selection harvest, thereby providing a seed source and shade for the next cohort. The stand should be of seed bearing age (biologically mature) to increase the chance of successful regeneration.

**Standards used for evaluation of success:**

- **Leave 10m$^2$/ha of tolerant long-lived species.**
- **Age of stand ≥ Age of maturity (full seed production) for the main tolerant long-lived species (McGrath *et al*. 2015, p17).**

Minimize blowdown: Every precaution should be taken to minimize the amount of blowdown associated with selection harvesting. The trees must stand after harvest to realize any return on the investment made by the selection harvest. By choosing appropriate stands for selection harvest

(appropriate species, soils, and exposure) and maintaining a minimum amount of basal area post-harvest the risk of blowdown is reduced. The more that is removed the less windfirm a stand becomes.

**Standards used for evaluation of success:**

- **Basal area removed (%BAR) ≤ 50%.**
- **Minimum post-harvest basal area: Hw ≥ 14m$^2$/ha, Mw ≥ 16m$^2$/ha, Sw ≥ 18m$^2$/ha.**
- **No selection harvesting in softwood and mixedwood stands with a high windthrow hazard rating[1]**

Stand Improvement: Prior to harvest a stand should have above a minimum amount of quality trees, enough to warrant the investment of a selection harvest, and those trees should be able to stand and respond to a release from selection harvest. It is desirable to continually improve a stand in terms of quality and species with each successive harvest. This is done by taking the worst and leaving the best trees as a seed source for the next cohort. Also, the amount of damage to the residual trees should be kept to a minimum.

**Standards used for evaluation of success:**

- **Acceptable growing stock[2] post-harvest: Hw ≥ 4m$^2$/ha, Mw ≥8m$^2$/ha, Sw ≥ 12m$^2$/ha.**
- **Harvest Damage ≤ 10% of residual basal area.**

For the purposes of this report the previously mentioned standards (see bullets in bold typeset) were used to provide a standard with which to measure success. Figure 8 shows the surveyed sites in relation to these standards, 60% of the area did not meet these standards. The sites were sourced from different programs and ownerships and may have been subject to different standards. The random sample resulted in 46% of the area being selected from the Wood Acquisition program (WAP), 27% from Crown, 24% from Industry outside of the WAP program, and 3% from the Association for Sustainable Forestry (ASF) program. These sites cover the period between 2004-2006 prior to the introduction of the pre-treatment assessments (PTA) and Nova Scotia forest management guides (McGrath 2007, 2010, McGrath *et al.* 2015, Neily *et al.* 2015).

[1]Windthrow hazard rating: Taken from the tolerant softwood and mixedwood guide and the forest ecosystem classification soil type guide book (McGrath 2010, Neily *et al.* 2013).

[2]Acceptable growing stock (AGS) (McGrath *et al*. 2015): Trees are acceptable growing stock (AGS) when they are healthy with potential to produce high value stems suitable to meet sawlog or studwood specifications in the future and the ability to thrive after thinning until the time of the next harvest.

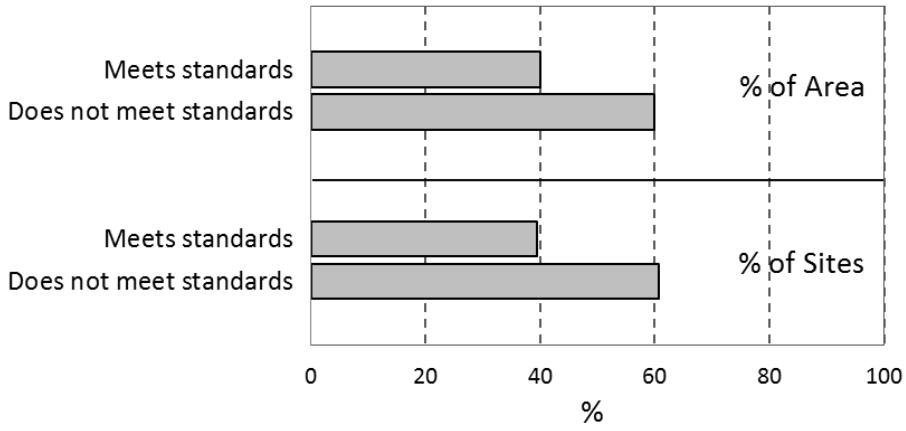


Figure 8 . The proportion of the selection harvest survey that meet the standards used for the evaluation of success (expressed in both % of area and % of sites).

Table 1 shows a summary of the sites that did not meet the standards used for the evaluation of success and provides reasons for the shortfall.

- Two sites (1116, 1128) had post-harvest basal areas and/or tolerant long-lived species basal areas slightly less than the minimum. Their pre-harvest basal areas were low (23-24 $m^2$/ha) and even though removal rates were reasonable (37-41%); the resulting post-harvest basal areas were less than the standard. Also, 1116 had greater than 10% harvest damage.

- 1118 was a poorly stocked hardwood stand. Low initial basal area did not allow reasonable removals while staying within the minimum post-harvest basal area standard (pre-harvest=17$m^2$/ha, cut=5$m^2$/ha, post-harvest=12$m^2$/ha).

- Sites 1101, 1102, and 1134 were too young (39 years, 33 years, 39 years respectively) and inappropriate for selection harvest.

- Site 1136 was 70 years old at the time of selection harvest which is slightly less than the age of maturity (full seed production) for sugar maple (McGrath *et al.* 2015).

- At sites 1106, 1108, 1110 and 1114 high removal rates resulted in below standard post-harvest basal areas and/or percent basal area removals.

- Several sites had the wrong species mix for a selection harvest (1104, 1107, 1120, 1121, 1123, 1105, 1113). These sites were dominated by balsam fir, black spruce, red maple, and white spruce. In addition, sites 1105 and 1113 fell short of the post-harvest basal area and percent basal area removal standards due to excessive harvesting.

- Several softwood and mixedwood sites (1107, 1108, 1113, 1117, 1129, 1134) had a high windthrow hazard.

Table 1. Summary of sites that did not meet the standards used for the evaluation of success (red font denotes that it is below the minimum level).

| Reason | Stand ID | Age | High Wind-throw Hazard. | Basal Area: Pre-Harvest ($m^2$/ha) | Cut ($m^2$/ha) | Post-Harvest ($m^2$/ha) | % BAR | Tol./LL[1] Post-Harvest ($m^2$/ha) | AGS ($m^2$/ha) | % Harvest Damage | Species Composition: Before Harvest (Top 3 species)[2] | Pre-Treatment Assessment: Stand Type | Qualify for selection (Y/N) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Marginal Pre-Harv. Basal Area | 1116 | 90 | | 24 | 10 | 14 | 41% | 8 | 9 | 11% | $RM^{31}RS^{27}YB^{23}$ | Mw | N |
| | 1128 | 97 | | 23 | 9 | 15 | 37% | 6 | 5 | 3% | $YB^{34}RM^{27}BE^{25}$ | Hw | N |
| Low Pre-Harv. Basal Area | 1118 | 79 | | 17 | 5 | 12 | 27% | 10 | 7 | 1% | $SM^{76}YB^{10}BE^{7}$ | Hw | N |
| Too Young | 1101 | 39 | | 22 | 3 | 19 | 12% | 15 | 16 | 1% | $RS^{73}LTA^{9}WP^{7}$ | Sw | N |
| | 1102 | 33 | | 16 | 2 | 14 | 11% | 7 | 10 | 2% | $RS^{32}RM^{29}RO^{13}$ | Mw | N |
| | 1134 | 39 | Y | 17 | 7 | 10 | 41% | 6 | 8 | 2% | $RS^{60}RM^{29}BF^{8}$ | Mw | N |
| | 1136 | 70 | | 26 | 10 | 16 | 39% | 15 | 8 | 1% | $SM^{92}RM^{3}YB^{3}$ | Hw | Y |
| Too Much Removed | 1106 | 52 | | 25 | 12 | 14 | 46% | 12 | 13 | 1% | $RS^{47}HE^{24}WP^{14}$ | Sw | N |
| | 1108 | 72 | Y | 40 | 23 | 17 | 57% | 13 | 15 | 1% | $RS^{25}HE^{22}RM^{21}$ | Mw | N |
| | 1110 | 60 | | 39 | 21 | 18 | 54% | 13 | 12 | 2% | $WP^{59}RM^{16}HE^{13}$ | Sw | N |
| | 1114 | 47 | | 34 | 28 | 6 | 81% | 4 | 3 | 3% | $WP^{33}BF^{33}HE^{17}$ | Sw | Y |
| Wrong species Mix | 1104 | 78 | | 31 | 11 | 20 | 35% | 8 | 12 | 6% | $RM^{53}YB^{33}RS^{8}$ | Hw | N |
| | 1107 | 56 | Y | 36 | 6 | 30 | 18% | 5 | 15 | 0% | $WS^{37}BF^{28}RM^{16}$ | Sw | N |
| | 1120 | 56 | | 27 | 9 | 17 | 35% | 4 | 9 | 0% | $RM^{43}YB^{24}BF^{23}$ | Mw | N |
| | 1121 | 69 | | 27 | 9 | 18 | 35% | 6 | 6 | 4% | $RM^{74}YB^{10}SM^{10}$ | Hw | N |
| | 1123 | 79 | | 21 | 4 | 17 | 21% | 0 | 14 | 2% | $BS^{85}BF^{9}WP^{2}$ | Sw | N |
| Wrong Species Mix/ | 1105 | 46 | | 29 | 16 | 13 | 54% | 2 | 7 | 0% | $BF^{54}RM^{30}RS^{10}$ | Mw | N |
| Too Much Removed | 1113 | 45 | Y | 25 | 18 | 7 | 71% | 0 | 3 | 9% | $RM^{53}BF^{19}BS^{17}$ | Mw | N |
| High Windthrow Hazard | 1117 | 71 | Y | 40 | 20 | 20 | 51% | 9 | 12 | 6% | $RS^{49}WS^{29}RM^{6}$ | Sw | N |
| | 1129 | 111 | Y | 34 | 13 | 20 | 40% | 13 | 10 | 2% | $YB^{41}RM^{25}WS^{12}$ | Mw | N |

[1]Tolerant (Tol.) and long lived (LL) species: red spruce, hemlock, sugar maple, white pine, yellow birch, red oak and white ash.

[2]See appendix 1 for total species composition.

Nova Scotia's pre-treatment assessment (PTA) system and forest management guides (FMG) were developed with the intent of implementing ecosystem-based management. Before a harvest operation is carried out, stand-level details such as vegetation type, soil type, ecosite, and windthrow hazard along with stand characteristics such as basal area, species, tree diameter, and quality must be collected. This information facilitates prescribing appropriate treatments specific to stand attributes. At the time of this survey the PTA and FMG system were not in place, but if a PTA had been performed and recommendations from the FMGs followed, 18 sites out of the 20 that failed to meet the job quality indicators would not have qualified for selection harvest (Table 1). Many inappropriate stands (poor quality or species composition, high windthrow hazard, too young) were selection harvested in this survey. By carrying out PTAs and using FMGs more appropriate stands are selected for selection harvest.

At Time of Selection Harvest

The average merchantable volume of all survey sites was 165 $m^3$/ha before harvest, on average, 68 $m^3$/ha was removed, and 97 $m^3$/ha remained after harvest (Table 2, Appendix 2). This covers all area within the boundaries of the stands (i.e. untreated/treated portions, trails, openings). In terms of basal area, stands averaged 28 $m^2$/ha before harvest, with 11 $m^2$/ha removed, and 17 $m^2$/ha remaining after harvest. On average 39% of the basal area was removed. The softwood sites tended to have more merchantable volume, basal area, and stems before and after harvest. The hardwood sites were older than the softwood and mixedwood sites when harvested. The hardwood sites had fewer stems that were larger in diameter and had less basal area to begin with.

Table 2. The merchantable volume, basal area, number of stems, diameter at breast height, height, and age of the survey stands before harvest, cut, and after harvest broken down by pre-harvest stand type (softwood, mixedwood, hardwood).

| | **Softwood Stand Type** | | | **Mixedwood Stand Type** | | | **Hardwood Stand Type** | | | **Total** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Be-fore | Cut | After | Be-fore | Cut | After | Be-fore | Cut | After | Be-fore | Cut | After |
| Merch. Vol. ($m^3$/ha) | 202 | 85 | 117 | 149 | 70 | 79 | 150 | 53 | 97 | 165 | 68 | 97 |
| Basal Area ($m^2$/ha) | 33 | 13 | 19 | 27 | 12 | 15 | 25 | 8 | 17 | 28 | 11 | 17 |
| % Basal Area | | 39% | 61% | | 43% | 57% | | 33% | 67% | | 39% | 61% |
| # Stems/ha | 1,370 | 499 | 871 | 1,215 | 521 | 694 | 627 | 169 | 458 | 1,048 | 386 | 662 |
| DBH (cm) | 18 | 18 | 17 | 17 | 18 | 17 | 23 | 26 | 22 | 19 | 21 | 19 |
| Height (m) | 15 | 15 | 15 | 14 | 15 | 14 | 16 | 17 | 16 | 15 | 16 | 15 |
| Age (years) | | | 65 | | | 64 | | | 88 | | | 73 |

8 Years after Selection Harvest

Table 3 shows the growth since selection harvest (8 year post-harvest period). Merchantable volume net growth during that period was 20$m^3$/ha (21%), and basal area net growth was 2$m^2$/ha (12%) in that 8 year time period. The net periodic annual increment for merchantable volume after selection harvest was 2.5$m^3$/ha/year. At this rate, it will take 27 years for the volume to grow back to pre-harvest levels. This only includes the growth of residual trees and does not account for the volume that may result from the ingrowth of regeneration.

Table 3. The growth of the surveyed stands 8 years after selection harvest by pre-harvest stand type (softwood, mixedwood, hardwood).

| | **Merchantable Volume ($m^3$/ha)** | | | | **Basal Area ($m^2$/ha)** | | | |
|---|---|---|---|---|---|---|---|---|
| | Sw Stand Type | Mw Stand Type | Hw Stand Type | **Total** | Sw Stand Type | Mw Stand Type | Hw Stand Type | **Total** |
| Before | 202 | 149 | 150 | **165** | 33 | 27 | 25 | **28** |
| Cut | 85 | 70 | 53 | **68** | 13 | 12 | 8 | **11** |
| After | 117 | 79 | 97 | **97** | 19 | 15 | 17 | **17** |
| 8 Years Later (all living trees) | 142 | 103 | 109 | **117** | 22 | 18 | 18 | **19** |
| Net Growth (over 8 Yrs.) | 25 | 24 | 12 | **20** | 3 | 3 | 1 | **2** |
| Net Periodic Annual Increment | 3.1 | 3 | 1.5 | **2.5** | 0.38 | 0.38 | 0.13 | **0.25** |
| Mortality | 20 | 10 | 5 | **11** | 3 | 2 | 1 | **2** |
| Gross Growth (over 8 Yrs.) | 45 | 34 | 17 | **31** | 6 | 5 | 2 | **4** |
| Gross Periodic Annual Increment | 5.6 | 4.3 | 2.1 | **3.9** | 0.8 | 0.6 | 0.3 | **0.5** |

Basal Area Class

Figure 9 shows the proportion of sites in each basal area class (before, percent removed, and after harvest). Three sites had less than 20$m^2$/ha before harvest (Figure 9a). When initial basal area is this low, operable removal rates are not likely while still meeting a minimum residual basal area. Three sites only had 11-20% basal area removed. At another two sites, excessive removals occurred (>71% basal area removed) (Figure 9b). Eleven sites had less than 16$m^2$/ha after harvest (Figure 9c).

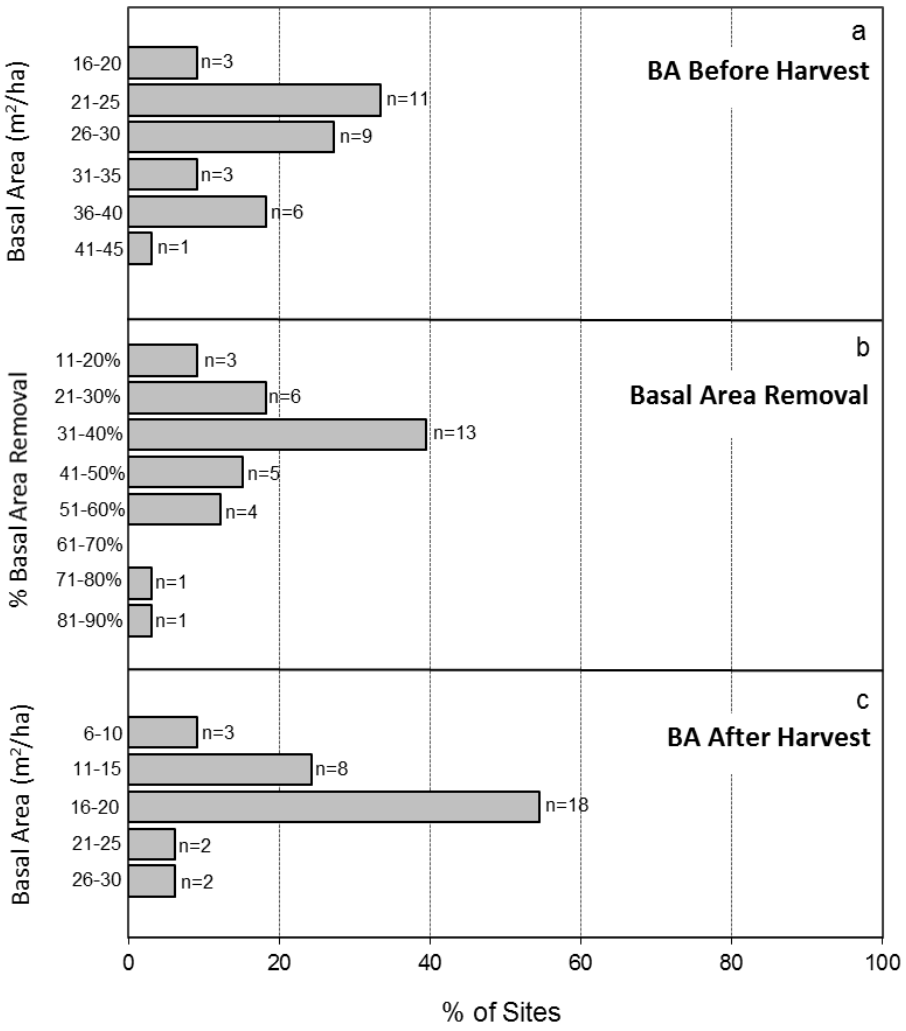


Figure 9. Summary of surveyed selection harvest sites in terms of basal area. The basal area before harvest (a), the % basal area removed (b), and the basal area after harvest (c) (n= # of sites).

Acceptable Growing Stock

Across all sites, the average amount of acceptable growing stock[1] after harvest is 10m$^2$/ha and ranges between 3-25m$^2$/ha (Figure 10a). The average percent of acceptable growing stock is 58% and ranges between 28-94% (Figure 10b).

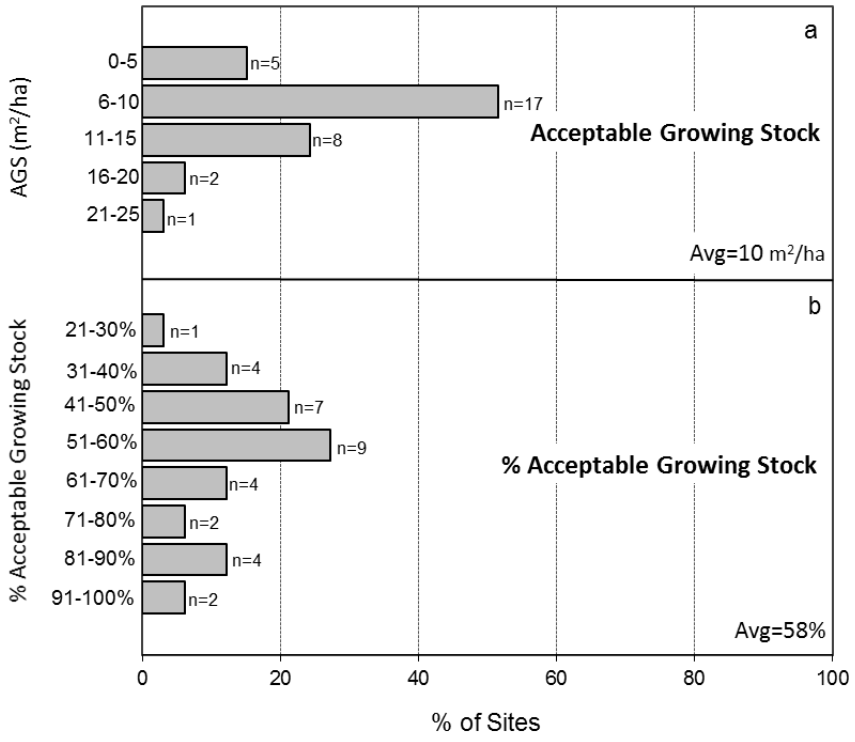


Figure 10 . The percent of sites in each acceptable growing stock category. The basal area of acceptable growing stock (a), the percent of the basal area that is acceptable growing stock (b). (n=# sites)

[1]Acceptable growing stock (AGS) (McGrath *et al*. 2015): Trees are acceptable growing stock (AGS) when they are healthy with potential to produce high value stems suitable to meet sawlog or studwood specifications in the future and the ability to thrive after thinning until the time of the next harvest.

Softwood stand types had a greater proportion of acceptable growing stock (74%) after selection harvest followed by mixedwood stand types (58%) and hardwood stand types (45%) (Table 4).

| Table 4. The AGS (acceptable growing stock) after selection harvest by pre-harvest stand type (softwood, mixedwood, hardwood). | | | | |
|---|---|---|---|---|
| | **Stand Type** | | | |
| | Sw Stand Type | Mw Stand Type | Hw Stand Type | Total |
| % AGS (basal area) | 74% | 58% | 45% | 58% |
| AGS (basal area) | 14 | 9 | 7 | 10 |

Harvest Damage

Harvest damage is defined as a tree that has an area of exposed wood due to mechanical damage from the selection harvest operation. Most sites (88%, n=29) had very little harvest damage (≤5% of the after-harvest volume damaged) (Figure 11). Nine percent of sites (n=3) had between 6-10% of the volume damaged, and 3% of sites (n=1) had between 11-15%. On average, across all sites the merchantable volume damaged by harvesting activities was 2% (appendix2).

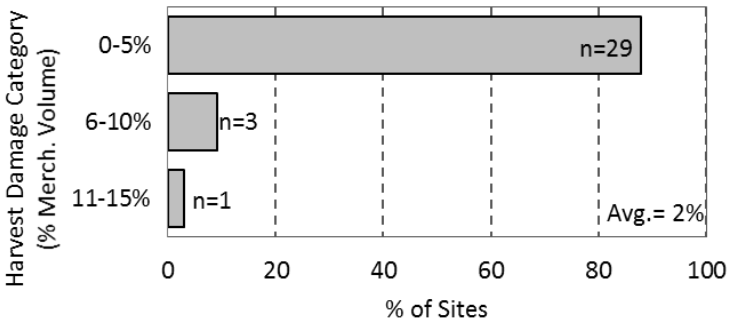


Figure 11 . The percent of sites in each harvest damage category. Harvest damage category = % of after harvest merchantable volume damaged by harvesting activities at each site. (n=# sites).

Selection Harvest Release Response

Figure 12 shows the response of different tree species to release from selection harvest. Figure 12 includes only trees that were released. The individual tree level response should not be extrapolated to the stand level as not all trees were released. White pine, hemlock, red spruce and yellow birch all showed a marked increase in diameter increment after selection harvest; while sugar maple and black spruce both showed lower response (Figure 12). Red maple did not show any growth response.

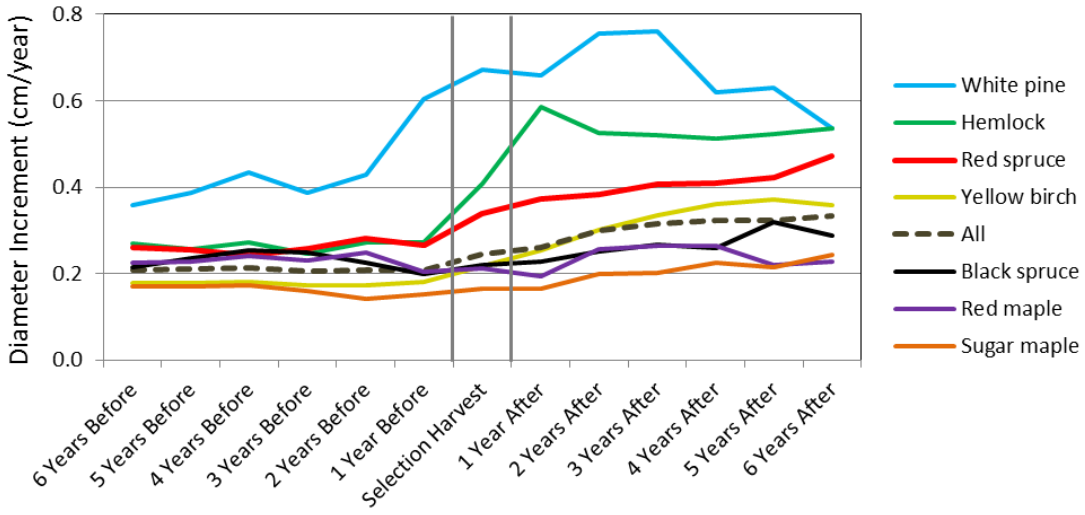


Figure 12 . The diameter increment of different tree species before and after selection harvest (193 cores were analyzed) (see Table 4 for sample size).

Table 5 lists the species in decreasing order from greatest gains to least, comparing the 6 years prior to selection harvest relative to the first 6 years afterwards. The diameter increment of released hemlock increased by 104% over pre-treatment levels, and yellow birch by 83%. Red spruce showed a 58% increase over pre-treatment levels. The response of white pine was 53% over pre-treatment levels, these trees were young (54 years) and growing well before the selection harvest. Sugar maple showed a moderate response to selection harvest at 31%.

Table 5. The results of the analysis of increment cores taken from trees released after selection harvest. The cores were taken from released trees (the average tree of average release).

## Increment Cores

| | # Cores | # Sites | Avg. Age of Cores (years) | Avg. annual diameter increment in the 6 years prior to selection harvest (cm) | Avg. annual diameter increment in the 6 years after selection harvest (cm) | Change in diameter increment after selection harvest (%) |
|---|---|---|---|---|---|---|
| Hemlock | *5 | 2 | 89 | 0.26 | 0.53 | 104% |
| Yellow birch | 52 | 14 | 103 | 0.18 | 0.33 | 83% |
| Red spruce | 37 | 8 | 62 | 0.26 | 0.41 | 58% |
| White pine | *6 | 3 | 54 | 0.43 | 0.66 | 53% |
| Sugar maple | 55 | 11 | 96 | 0.16 | 0.21 | 31% |
| Black spruce | *7 | 2 | 72 | 0.23 | 0.27 | 17% |
| Red maple | 31 | 13 | 67 | 0.23 | 0.24 | 4% |
| **All** | **193** | **29** | **84** | **0.21** | **0.31** | **48%** |

*Very few samples and sites represented so results should be treated with caution.

Figure 13 shows the diameter increment of released yellow birch, sugar maple, red maple, and red spruce by age class before and after selection harvest. For yellow birch, all age classes responded to release, even trees more than 126 years; however, trees between 76-125 years showed the greatest increase relative to growth prior to selection harvest. Compared to yellow birch the growth response of sugar maple was less, however, sugar maple trees more than 100 years showed a response to release. For red maple, trees greater than 50 years of age showed no response to release, where trees 25-50 years showed minimal response. All red spruce, even trees more than 75 years responded favorably to selection harvest.

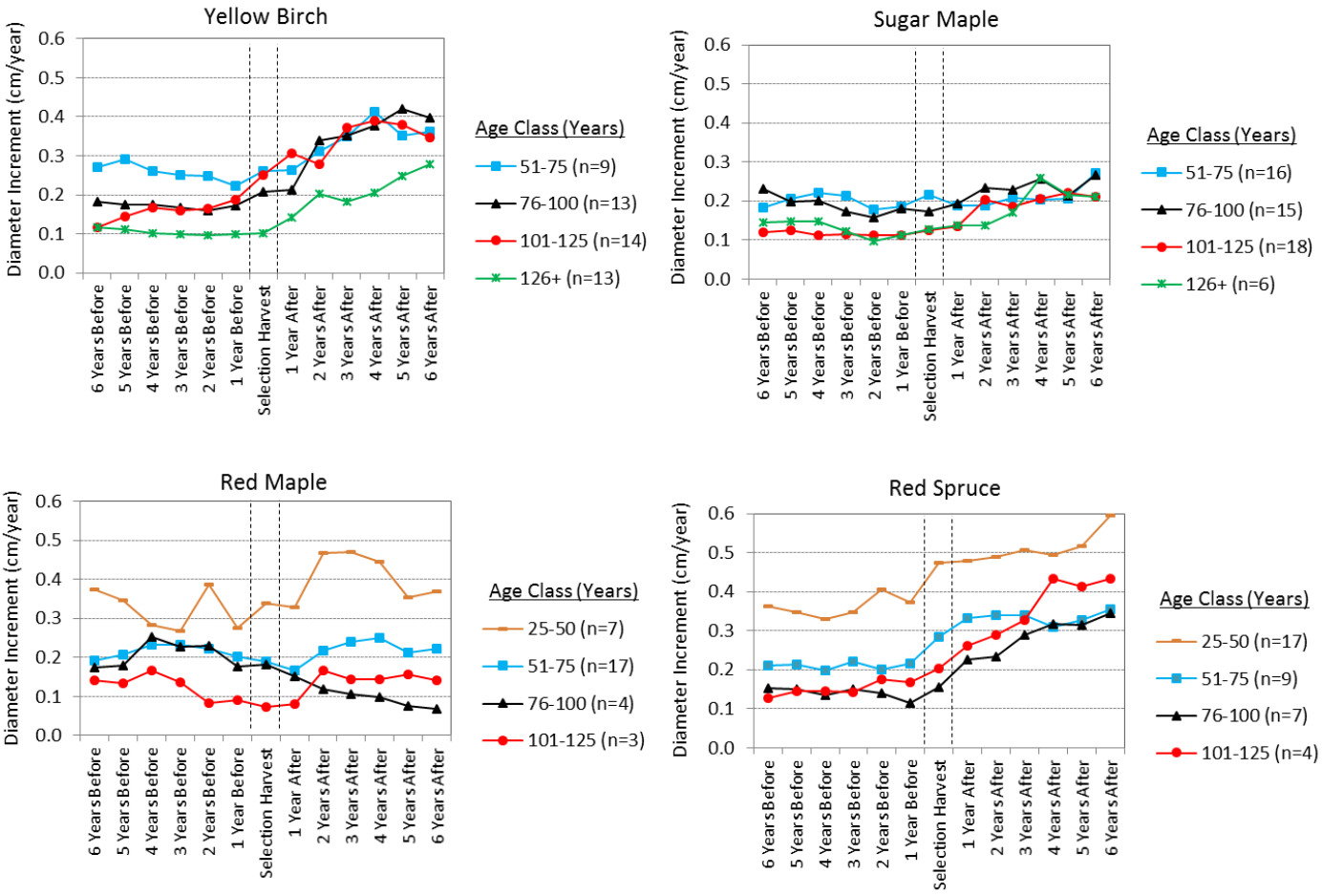


Figure 13 . The diameter increment of released yellow birch, sugar maple, red maple, and red spruce by age class before and after selection harvest (n=# cores).

Wind Damage

**Wind damage** is classed into one of two categories;

**1) blowdown** is the uprooting of trees.

**2) broken tops** is the snapping off of the stem.

After selection harvest, the merchantable volume lost to wind damage of residuals averaged 8% (4% blowdown and 4% broken tops) (Table 6 and appendix 3). The most wind damage occurred in softwood stand types (12%), followed by mixedwood stand types (9%), and much less occurred in hardwood stand types (3%). The proportion of broken tops was more in softwood stand types compared to the others (softwood stand types=8%, mixedwood stand types=2%, hardwood stand types=2%).

Table 6. The amount of blowdown, broken tops, and total wind damage that occurred after selection harvest (at 7-9 years post-selection harvest). The data is presented by pre-harvest stand type; softwood, mixedwood, hardwood, and total.

| | **Wind Damage** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Softwood Stand Type** | | | **Mixedwood Stand Type** | | | **Hardwood Stand Type** | | | **Total** | | |
| 7-9 Years Post-Harvest | Blow-down | Bro-ken Tops | Total | Blow-down | Bro-ken Tops | Total | Blow-down | Bro-ken Tops | Total | Blow-down | Bro-ken Tops | Total |
| Merch. Vol. (%) | 4% | 8% | 12% | 6% | 2% | 9% | 1% | 2% | 3% | 4% | 4% | 8% |
| Merch. Vol. ($m^3$/ha) | 5 | 7 | 12 | 5 | 2 | 7 | 1 | 2 | 3 | 4 | 4 | 7 |
| Basal Area (%) | 4% | 6% | 10% | 5% | 2% | 8% | 1% | 2% | 3% | 3% | 4% | 7% |
| Basal Area ($m^2$/ha) | 0.8 | 1.1 | 1.9 | 0.8 | 0.4 | 1.2 | 0.2 | 0.4 | 0.5 | 0.6 | 0.6 | 1.2 |
| Stems (#/ha) | 31 | 39 | 70 | 23 | 18 | 40 | 3 | 11 | 14 | 18 | 21 | 40 |
| DBH (cm) | 17 | 22 | | 17 | 16 | | 25 | 19 | | | | |

Species Susceptibility to Wind Damage

Table 7 shows the susceptibility of the different species to wind damage regardless of stand type. Balsam fir was the most susceptible to wind damage (24%), particularly broken tops (19%). The spruces and hemlock were also susceptible to wind damage (black spruce 19%, white spruce 15%, hemlock 12%, red spruce 8%). Overall, softwood species were more likely to be affected by wind damage (softwood species=13% merch. volume lost to wind damage; hardwood species=3%).

Table 7. The susceptibility of different species to wind damage after selection harvest.
Example: Volume lost due to wind damage (species 1) = Species Suceptibility (Species 1)
Total Volume (Species 1)

| | Sample Size | **Species Susceptibility to Wind Damage** (% of Merchantable Volume) Blowdown | Broken Tops | Total |
|---|---|---|---|---|
| Balsam fir | 1,076 | 5% | 19% | 24% |
| Black spruce | 213 | 11% | 8% | 19% |
| White spruce | 218 | 11% | 4% | 15% |
| Hemlock | 146 | 6% | 6% | 12% |
| Red spruce | 1,380 | 5% | 3% | 8% |
| White pine | 122 | 0% | 3% | 3% |
| Eastern larch | 13 | 2% | 1% | 3% |
| Softwood species | 3,168 | 6% | 7% | 13% |
| White birch | 109 | 5% | 1% | 6% |
| Red maple | 1,256 | 1% | 2% | 3% |
| Sugar maple | 1,118 | 1% | 1% | 3% |
| Yellow birch | 555 | 0% | 2% | 3% |
| Beech | 296 | 1% | 2% | 3% |
| White ash | 26 | 2% | 0% | 2% |
| Hardwood species | 3,360 | 1% | 2% | 3% |

Reasons for Blowdown

Figure 14 shows the proportion of blowdown by windthrow hazard rating[1] categories (low risk, moderate risk, high risk) broken down by pre-harvest stand types. Windthrow hazard rating categories are based on a combination of soil type and wind exposure. A high rating is assigned when the soil and exposure conditions are predicted to result in a higher risk of blowdown. Softwood and mixedwood stand types showed higher blowdown in stands considered high risk (softwood stand type: low risk=0%, moderate risk=4%, high risk=11%) (mixedwood stand type: low risk=2%, moderate risk=2%, high risk=14%). Hardwood stands show little blowdown even in high risk stands. Hardwood stands are not as prone to blowdown because they typically have deep root systems growing on deep soils. Presently, Nova Scotia has implemented a system to avoid prescribing selection harvest in high wind-throw risk stands through the application of its forest management guides (McGrath 2010, Neily *et al.* 2013) (Note:stands surveyed were selection harvested before these guides were available).

[1]Windthrow hazard rating: Taken from the tolerant softwood and mixedwood guide and the forest ecosystem classification soil type guide book (McGrath 2010, Neily *et al.* 2013)

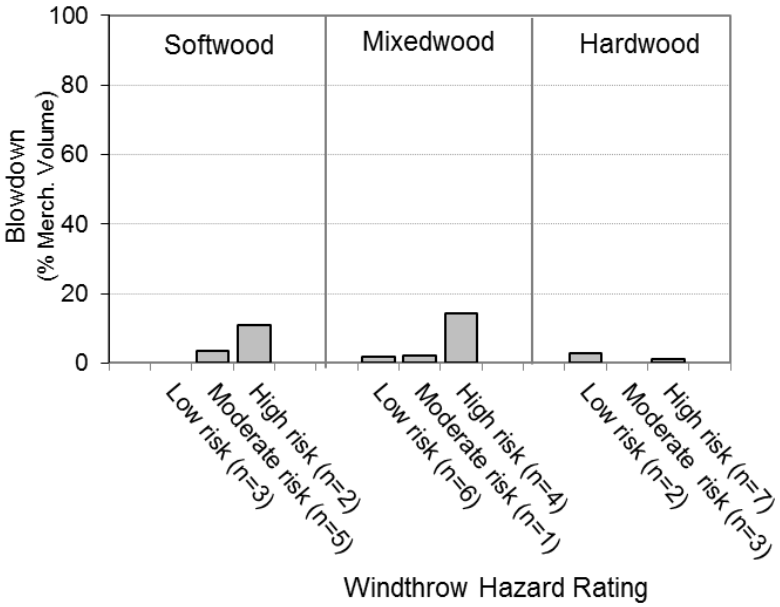


Figure 14. The amount of blowdown (expresssed as a proportion of after harvest merchantable volume) in different stand types and windthrow hazard rating categories.

There was more blowdown in softwood and mixedwood stands that contained shallow and imperfectly drained soils (shallow and imperfect=19%, shallow=11%, imperfect=5%, None=1%) (Figure 15). These soil characteristics are known to be risk factors for blowdown and are incorporated into the hazard rating system used in the forest management guides. S-phase[1] soils which have shown to be a risk factor in the past (Kent *et al.* 2012) did not show any conclusive trends, but this characteristic was sometimes found in combination with one of the other risk factors (shallow, imperfect drainage) making it difficult to isolate. Hardwood stands are less susceptible to blowdown so were removed for this analysis.

[1]S-phase soils have 60% or more cobbles, stones, and/or boulders in the upper 30 cm of mineral soil such that rooting is restricted (Neily *et al.* 2013).

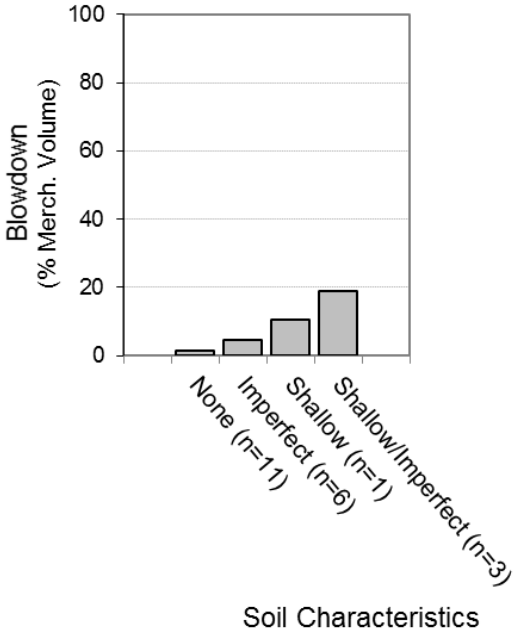


Figure 15. The amount of blowdown (expresssed as a proportion of after harvest merchantable volume) in imperfectly drained soil types, shallow soil types, and soil types that are both imperfectly drained and shallow (includes softwood and mixedwood stand types).

Regeneration

Figure 16 shows the stocking (at 1.36m radius or 2.4m spacing) of the dominant trees following uniform selection harvest by stand type (softwood, mixedwood, and hardwood) (Appendix 4). This represents the likely species composition of the regenerating stand in the absence of further intervention. In softwood stands balsam fir is the dominant regenerating species at 30%, followed by red maple at 23%, hemlock at 18%, and red spruce at 14%. In mixedwood stands, red maple (29%) and balsam fir (28%) are the most dominant regenerating species. In hardwood stands there is even representation of sugar maple (23%) and yellow birch (23%), followed by mountain maple (12%), balsam fir (11%), and striped maple (10%).

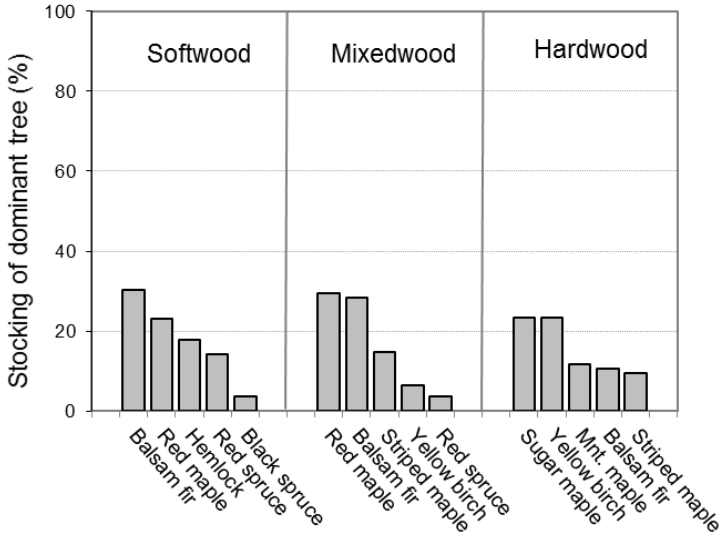


Figure 16. The stocking of dominant regeneration following uniform selection harvest by pre-harvest stand type (based on dominant tree per plot). The top five species are shown in decreasing order of abundance.

Figure 17 shows the total stocking of each species regardless of height dominance (Appendix 5). This is the maximum potential stocking that each species could attain. After selection harvest in softwood stands, balsam fir (66%) was the most abundant in terms of stocking followed by red spruce (41%), hemlock (39%), and red maple (36%). Although red spruce stocking exceeds 40%, red maple is on average taller (151cm) and would likely overtop red spruce (70cm) when growing in close proximity (Figure 18) (Appendix 6). In mixedwood stands, balsam fir stocking was 78%, followed by red maple (64%), and yellow birch (37%) (Figure 17). In mixedwood stands the hardwood species are taller than the softwood species (Figure 18). In hardwood stands, stocking of sugar maple is 69% (Figure 17), however in terms of height it is the shortest at 117cm (Figure 18). Yellow birch stocking is 48% and is relatively tall at 172cm. Striped maple was the tallest at 187cm.

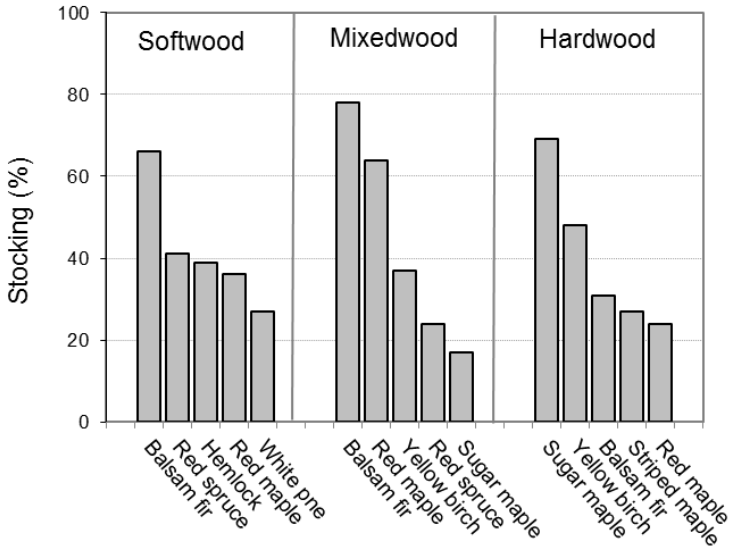


Figure 17. The stocking of tree species (regardless of height dominance) following uniform selection harvest by pre-harvest stand type. The top 5 species are shown in order of decreasing abundance.

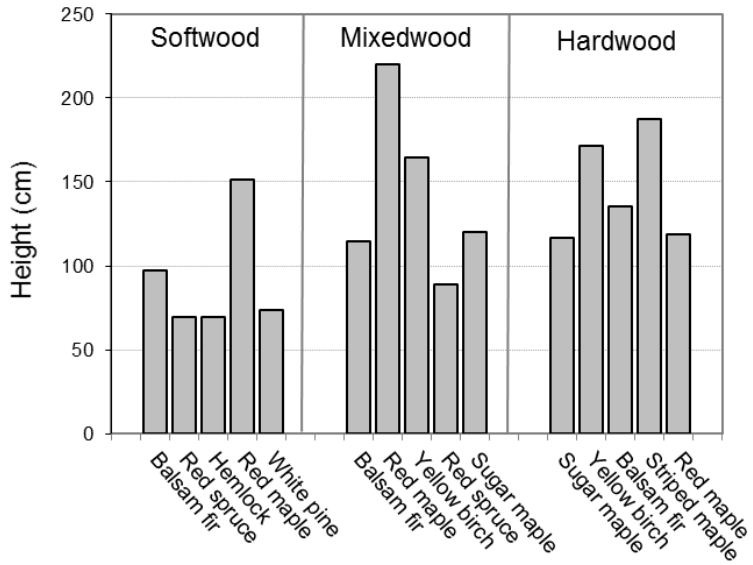


Figure 18. The average dominant height of regeneration following uniform selection harvest by pre-harvest stand type.

Figure 19 compares the regeneration, specifically sugar maple and yellow birch, that occurred following different selection harvest techniques used in the surveyed hardwood stands. Sugar maple regeneration was higher in uniform selections and all derived from seed source. Trails and group selections had a greater proportion of coppice sourced sugar maple regeneration compared to uniform selections. Yellow birch regeneration was higher in trails and group selections (Figure 19, Appendices 5, 6, 7). For regeneration results for individual stands see appendices 8 and 9.

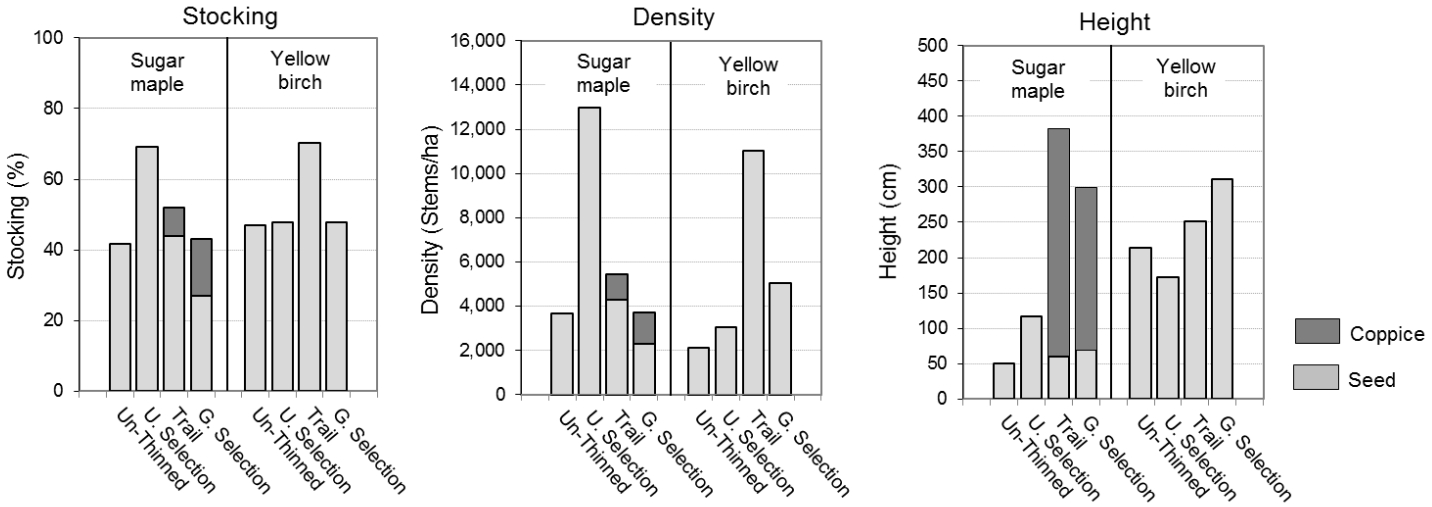


Figure 19. Comparing un-thinned (n=134), uniform selections (n=94), trails (n=64), and group selection patches (n=44) in tolerant hardwood stands in terms of sugar maple and yellow birch regeneration stocking, density, and height 7-9 years after selection harvest. Coppice or seed was assigned based on dominance.

## Summary

### Harvest Types (p7)

- Abundance (area): 34% uniform selection, 24% systematic trails only, 16% group selection, 11% strip cut, 5% non-systematic trails only, 4% not harvested, 3% diameter limit cut, 1% partial harvests, 1% understory cleaning, and 1% clearcut.
- Frequency (# of sites): 56% uniform selection, 12% systematic trails only, 8% non-systematic trails only, 6% strip cut, 6% group selections, 6% partial harvest, 3% diameter limit cut, and 3% understory cleaning.

### Indicators of job quality (p10)

- 60% of the area failed to meet the standards used for the evaluation of success.
- Using the pre-treatment assessment (PTA) including the use of forest management guides (the PTA system was not available at the time this survey was done), 18 out of the 20 sites that failed to meet the job quality indicators would not have qualified for selection harvest.

**Avg. Merchantable Volume (p12)**

- All: 165 $m^3$/ha before harvest, 68 $m^3$/ha removed, and 97 $m^3$/ha left after harvest.
- Sw stand types: 202 $m^3$/ha before harvest, 85 $m^3$/ha removed, and 117 $m^3$/ha left after harvest.
- Mw stand types: 149 $m^3$/ha before harvest, 70 $m^3$/ha removed, and 79 $m^3$/ha left after harvest.
- Hw stand types: 150 $m^3$/ha before harvest, 53 $m^3$/ha removed, and 97 $m^3$/ha left after harvest.

**Avg. Basal Area (p12)**

- All: 28 $m^2$/ha before harvest, 11 $m^2$/ha was removed, and 17 $m^2$/ha left after harvest.
- Sw stand types: 33 $m^2$/ha before harvest, 13 $m^2$/ha removed, and 19 $m^2$/ha left after harvest.
- Mw stand types: 27 $m^2$/ha before harvest, 12 $m^2$/ha removed, and 15 $m^2$/ha left after harvest.
- Hw stand types: 25 $m^2$/ha before harvest, 8 $m^2$/ha removed, and 17 $m^2$/ha left after harvest.

**% Basal Area Removed (p12)**

- All=39%, Sw stand types=39%, Mw stand types=43%, Hw stand types=33%

**8 Years after Selection Harvest (p13)**

- Merchantable volume net growth after selection harvest (8 year post-harvest period) was 2.5 $m^3$/ha/year. At this rate, it will take 27 years for the volume to grow back to pre-harvest levels.

**Acceptable Growing Stock (p15)**

- Across all sites, the average amount of acceptable growing stock after harvest is 10$m^2$/ha and ranges between 3-25$m^2$/ha. The average percent of acceptable growing stock is 58% and ranges between 28-94%.

**Harvest Damage (p16)**

- 88% of sites had low-levels of harvest damage ($\leq$5% volume damaged).
- On average, across all sites the volume damaged by selection harvesting was 2%.

**Release Response (p17)**

- Hemlock (104%), yellow birch (83%), red spruce (58%), white pine (53%), sugar maple (31%), and black spruce (17%) all benefited from release from selection harvest in terms of increased diameter growth in the 6 years following harvest relative to the 6 years prior.
- Yellow birch, red spruce, and sugar maple showed response to release even with advanced age.
- Red maple showed little response to release from selection harvest (4% increase in diameter increment).

**Wind Damage (p20)**

- Across all stand types, the merchantable volume losses due to wind damage was 8% (7$m^3$/ha) after selection harvest. (Sw stand types=12%, Mw stand types=9%, Hw stand types=3%).

**Species Susceptibility to Wind Damage (P21)**

- Balsam fir was the most susceptible to wind damage (24%), and particularly broken tops (19%).
- The spruces and hemlock were also susceptible to wind damage (black spruce 19%, white spruce 15%, hemlock 12%, red spruce 8%).
- Overall, softwood species were more likely to be affected by wind damage (softwood species=13% merch. volume losses to wind damage; hardwood species=3%).

**Reasons for Blowdown (P22)**

- Softwood and mixedwood stand types show more blowdown in stands considered high risk (low risk=1% merchantable volume losses, moderate risk=3%, high risk=13%).
- Hardwood stand types show little blowdown.
- There was more blowdown in softwood and mixedwood stand types that contained shallow and imperfectly drained soils (shallow and imperfect=19% merchantable volume losses, shallow=11%, imperfect=5%, None=1%).

**Regeneration - Stocking of dominant regeneration in uniform selections (top 5 species) (p23,33)**

- All: 22% balsam fir, 19% red maple, 11% yellow birch, 10% sugar maple, 10% striped maple.
- Sw stand types: 30% balsam fir, 23% red maple, 18% hemlock, 14% red spruce, 4% black spruce.
- Mw stand types: 29% red maple, 28% balsam fir, 15% striped maple, 6% yellow birch, 4% red spruce.
- Hw stand types: 23% sugar maple, 23% yellow birch, 12% mountain maple, 11% balsam fir, 10% striped maple.

**Regeneration – Stocking (all dominance classes) in uniform selections (top 5 species) (p24,34)**

- All: 58% balsam fir, 44% red maple, 33% yellow birch, 32% sugar maple, 22% striped maple.
- Sw stand types: 66% balsam fir, 41% red spruce, 39% hemlock, 36% red maple, 27% white pine.
- Mw stand types: 78% balsam fir, 64% red maple, 37% yellow birch, 24% red spruce, 17% sugar maple.
- Hw stand types: 69% sugar maple, 48% yellow birch, 31% balsam fir, 27% striped maple, 24% red maple.

**Regeneration - Comparing selection harvest methods in tolerant hardwood stand types (p25,34,36)**

- Sugar maple regeneration stocking and density was higher in uniform selections;
  Stocking: unthinned=42%, uniform selection=69%, trails=52%, group selection=43%.
  Density: unthinned=3,660stems/ha, uniform selection=12,975stems/ha, trails=5,456stems/ha, group selection=3,691 stems/ha.
- Yellow birch regeneration was higher in trails and group selections;
  Stocking: unthinned=47%, uniform selection=48%, trails=70%, group selection=48%
- Density: unthinned=2,109stems/ha, uniform selection=3,058stems/ha, trails=11,038stems/ha, group selection=5,020 stems/ha.
- All sugar maple in thinned portions of uniform selections is derived from seed, as opposed to some coppice in trails and group selections.

**Management Recommendations**

Yellow birch and red spruce showed a marked increase in diameter increment after selection harvest and demonstrated response to release even at advanced age. Therefore, yellow birch and red spruce make desirable candidates for selection harvest. Sugar maple exhibited a moderate response to release from selection harvest. The red maple in this survey did not respond to release, therefore this species may not be a desirable candidate for selection harvest.

This survey highlights the value of using the pre-treatment assessment (PTA), forest management guides (FMG), and forest ecosystem classification (FEC) to ensure appropriate stands are chosen for selection harvest. Sixty percent of the area surveyed failed to meet the job quality standards used in this report. Furthermore, several stands (n=6, 18% of area) with soils that put them at high risk for wind damage were selection harvested (low risk soils =1% merchantable volume loses due to blowdown, moderate risk soils =3%, high risk soils =13%).

Many of these issues were caused by choosing inappropriate stands for selection harvest; either because of the wrong soil conditions, species composition, pre-harvest basal area or the stands were too young. It should be noted that these sites were selection harvested (2004-2006) before Nova Scotia introduced many of the tools used today to help with proper implementation of selection harvesting. If the below mentioned publications had been available at the time of the survey, many of the sites would not have qualified as candidates for selection harvest.

- Forest Management Guides (FMG)
    - Tolerant Softwood & Mixedwood Management Guide (McGrath 2010)
    - Tolerant Hardwood Management Guide (McGrath 2007)
    - Intolerant Hardwood Management Guide (McGrath *et al.* 2015)
    - Spruce-Pine Management Guide (Neily *et al.* 2015)
- Forest Ecosystem Classification (FEC) (Neily *et al.* 2013)

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Appendix 1: Summary of selection harvest survey by stand in terms of harvest description and species composition.

| | | | | | | | | Harvest Description | | | | | | | | Species Composition[6] (% of Basal Area) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stand ID | Area (ha) | Stand Type[1] | Ownership[2] | Region[3] | Stump Age when Harv. | DBH Age when Harv. | Year Harv. | % Treat | Treatment[4] | % Stand not treated | Clear cut after wards | Patch Size (ha) | Trail/ Cut Strip (m) | Leave strip (m) | % Stand in Trails | 1st Sp | LC[5] | Before Harvest | After Harvest |
| 1101 | 2.6 | Sw | IN | WE | 39 | 33 | 2004 | 100% | Understory cleaning | | | | | | | rS | 5.0 | $RS^{73}LTA^{9}WP^{7}RM^{7}BF^{4}$ | $RS^{73}WP^{8}RM^{8}LTA^{7}BF^{4}$ |
| 1102 | 3.1 | Mw | SP | WE | 33 | 27 | 2004 | 80% | Non-Systematic Trails Only | 20% | | | | | | rM | 5.9 | $RS^{32}RM^{29}RO^{13}WP^{9}LTA^{5}GB^{4}BF^{4}WB^{2}LA^{1}$ | $RM^{33}RS^{28}RO^{15}WP^{10}LTA^{6}GB^{5}WB^{2}BF^{1}LA^{1}$ |
| 1103 | 3.3 | Sw | SP | WE | 117 | 111 | 2006 | 100% | U. Selection | | | | | | | He | 4.3 | $HE^{49}RS^{40}YB^{4}WB^{3}RM^{3}BF^{1}$ | $HE^{51}RS^{43}WB^{3}YB^{3}$ |
| 1104 | 3.8 | Hw | IN | WE | 78 | 72 | 2004 | 95% | U. Selection | 5% | | | | | | rM | 2.8 | $RM^{53}YB^{33}RS^{8}SM^{5}BF^{1}StM^{1}$ | $RM^{58}YB^{25}RS^{7}SM^{7}BF^{2}StM^{1}$ |
| 1105 | 3.9 | Mw | SP | WE | 46 | 40 | 2004 | 95% | Partial Harvest | 5% | | | | | | rM | 2.4 | $BF^{54}RM^{30}RS^{10}WB^{4}WP^{2}$ | $RM^{63}BF^{13}RS^{11}WB^{8}WP^{5}$ |
| 1106 | 3.9 | Sw | SP | WE | 52 | 46 | 2004 | 100% | U. Selection | | | | | | | rS | 7.0 | $RS^{47}HE^{24}WP^{14}RM^{8}YB^{3}RO^{2}BF^{2}WB^{1}$ | $RS^{46}WP^{23}HE^{17}RM^{10}RO^{4}WB^{1}$ |
| 1107 | 3.9 | Sw | IN | WE | 56 | 50 | 2004 | 100% | Non-Systematic Trails Only | | | | 11 | 58 | 16% | wS | 5.4 | $WS^{37}BF^{28}RM^{16}RS^{14}BS^{4}$ | $WS^{33}BF^{25}RM^{18}RS^{17}BS^{5}PC^{1}$ |
| 1108 | 4.0 | Mw | CR | CE | 72 | 66 | 2005 | 100% | U. Selection | | | | | | | rM | 3.9 | $RS^{25}HE^{22}RM^{21}BF^{17}YB^{13}SM^{2}WA^{1}$ | $HE^{28}RS^{23}RM^{23}YB^{17}SM^{3}BF^{3}WA^{2}BS^{1}$ |
| 1109 | 4.5 | Mw | SP | EA | 71 | 65 | 2004 | 100% | U. Selection | | | | | | | rM | 2.6 | $WS^{28}RM^{25}WA^{17}YB^{12}BF^{11}HE^{3}SM^{2}IR^{1}$ | $RM^{39}WA^{27}YB^{21}HE^{6}SM^{4}IR^{2}WS^{1}$ |
| 1110 | 4.5 | Sw | SP | WE | 60 | 54 | 2006 | 100% | U. Selection | | | | | | | wP | 7.4 | $WP^{59}RM^{16}HE^{13}BF^{5}BS^{4}RO^{4}$ | $WP^{54}RM^{23}HE^{15}BS^{6}RO^{2}BF^{1}$ |
| 1111 | 4.5 | Hw | CR | EA | 79 | 73 | 2004 | 90% | U. Selection | 10% | | | | | | sM | 2.4 | $SM^{76}YB^{20}WS^{3}BE^{1}$ | $SM^{77}YB^{19}WS^{4}$ |
| 1112 | 4.7 | Hw | CR | EA | 107 | 101 | 2006 | 75% | U. Selection | 25% | | | | | | sM | 2.5 | $SM^{70}BF^{13}RM^{10}YB^{6}WS^{1}$ | $SM^{67}RM^{14}BF^{10}YB^{8}WS^{1}$ |
| 1113 | 5.2 | Mw | SP | WE | 45 | 39 | 2006 | 80%/20% | Partial Harvest/Clearcut | | | | | | | rM | 2.8 | $RM^{53}BF^{19}BS^{17}WB^{10}YB^{1}$ | $RM^{69}WB^{18}BS^{14}$ |
| 1114 | 5.5 | Sw | SP | WE | 47 | 41 | 2005 | 100% | U. Selection | | | | | | | wP | 8.9 | $WP^{33}BF^{33}HE^{17}RS^{11}RM^{4}WB^{1}BS^{1}RO^{1}$ | $WP^{34}HE^{29}RM^{14}BF^{11}WB^{7}RS^{2}RO^{2}$ |
| 1115 | 6.0 | Mw | IN | CE | 72 | 66 | 2004 | 75%/25% | U. Selection/Systematic Trails Only | | | | | | | yB | 2.4 | $YB^{32}SM^{23}RS^{20}RM^{19}BF^{7}$ | $YB^{36}SM^{25}RM^{20}RS^{16}BF^{3}$ |
| 1116 | 6.4 | Mw | SP | CE | 90 | 84 | 2005 | 90% | U. Selection | 10% | | | | | | rM | 2.4 | $RM^{31}RS^{27}YB^{23}BF^{15}WB^{2}SM^{1}WA^{1}$ | $RM^{39}YB^{32}RS^{20}WB^{4}BF^{3}SM^{2}WA^{1}$ |
| 1117 | 6.6 | Sw | IN | WE | 71 | 65 | 2006 | 65%/15% | U. Selection/Plantation | 20% | | | | | | rS | 5.7 | $RS^{49}WS^{29}RM^{6}LA^{4}BF^{3}YB^{2}LTA^{2}BS^{1}WA^{1}GB^{1}$ | $RS^{36}WS^{23}RM^{12}LA^{9}YB^{5}BF^{5}LTA^{4}BS^{2}WA^{2}GB^{2}$ |
| 1118 | 7.7 | Hw | SP | CE | 79 | 73 | 2006 | 100% | Non-Systematic Trails Only | | | | 7 | 34 | 17% | sM | 2.8 | $SM^{76}YB^{10}BE^{7}BF^{4}WB^{3}StM^{1}RM^{1}$ | $SM^{66}YB^{13}BE^{9}BF^{6}WB^{4}StM^{1}RM^{1}$ |
| 1119 | 8.2 | Mw | SP | WE | 65 | 59 | 2004 | 100% | U. Selection | | | | | | | rS | 5.5 | $RS^{38}RM^{27}BF^{17}YB^{14}WA^{2}WP^{1}WB^{1}$ | $RS^{34}RM^{31}YB^{21}BF^{7}WA^{3}WP^{2}WB^{1}$ |
| 1120 | 8.9 | Mw | CR | EA | 56 | 50 | 2005 | 75%/15% | U. Selection/Clearcut | 10% | | | | | | rM | 2.7 | $RM^{43}YB^{24}BF^{23}RS^{6}WB^{3}WS^{2}$ | $RM^{52}YB^{20}BF^{18}WB^{4}RS^{4}WS^{3}$ |
| 1121 | 9.1 | Hw | IN | WE | 69 | 63 | 2004 | 100% | Strip Cut | | | | 15 | 17 | 47% | rM | 3.1 | $RM^{74}YB^{10}SM^{10}RS^{7}$ | $RM^{69}SM^{12}YB^{11}RS^{8}$ |
| 1122 | 10.2 | Hw | SP | EA | 85 | 79 | 2006 | 100% | U. Selection | | | | | | | sM | 3.0 | $SM^{66}YB^{25}RS^{4}BF^{2}RM^{2}$ | $SM^{59}YB^{29}RS^{5}BF^{4}RM^{3}StM^{1}$ |
| 1123 | 11.7 | Sw | IN | CE | 79 | 73 | 2005 | 70%/30% | U. Selection/Systematic Trails Only | | | | | | | bS | 5.3 | $BS^{85}BF^{9}WP^{2}RM^{2}RP^{1}$ | $BS^{84}BF^{9}WP^{3}RM^{2}RP^{2}$ |
| 1124 | 12.9 | Hw | CR | EA | 98 | 92 | 2005 | 100% | U. Selection | | | | | | | yB | 2.1 | $YB^{72}SM^{12}BF^{10}RM^{4}RS^{1}WB^{1}WS^{1}$ | $YB^{82}SM^{10}RM^{4}RS^{2}WB^{1}BF^{1}$ |
| 1125 | 13.1 | Sw | SP | WE | 83 | 77 | 2004 | 80% | Diameter limit cut | 20% | | | | | | rS | 4.6 | $RS^{68}BF^{12}RM^{5}WP^{4}HE^{4}LA^{3}RO^{2}WA^{1}YB^{1}WB^{1}$ | $RS^{52}BF^{17}RM^{9}WP^{6}HE^{6}LA^{5}WA^{2}YB^{2}RO^{1}WB^{1}$ |
| 1128 | 18.6 | Hw | CR | EA | 97 | 91 | 2006 | 100% | Systematic Trails Only | | | | 7 | 17 | 29% | yB | 2.1 | $YB^{34}RM^{27}BE^{25}SM^{8}WB^{3}BF^{2}WS^{2}$ | $RM^{29}YB^{28}BE^{25}SM^{10}WB^{5}BF^{3}$ |
| 1129 | 20.3 | Mw | IN | EA | 111 | 105 | 2004 | 100% | U. Selection | | | | | | | yB | 2.0 | $YB^{41}RM^{25}WS^{12}BF^{8}SM^{8}WP^{3}BE^{1}HE^{1}StM^{1}WB^{1}$ | $YB^{46}RM^{26}SM^{10}WP^{5}WS^{5}BF^{4}HE^{2}StM^{1}BE^{1}$ |
| 1130 | 21.2 | Hw | CR | CE | 87 | 81 | 2004 | 100% | Group Selection | | | 0.2 | | | | sM | 2.8 | $SM^{64}YB^{25}BE^{7}RM^{4}$ | $SM^{62}YB^{30}BE^{6}RM^{1}$ |
| 1131 | 21.5 | Sw | SP | CE | 47 | 41 | 2005 | 100% | Systematic Trails Only | | | | 9 | 32 | 22% | rS | 7.6 | $RS^{52}BF^{33}RM^{13}WB^{1}YB^{1}$ | $RS^{46}BF^{35}RM^{16}WB^{2}$ |
| 1132 | 23.6 | Hw | CR | EA | 102 | 96 | 2005 | 100% | Systematic Trails Only | | | | 8 | 20 | 29% | sM | 2.1 | $SM^{41}YB^{31}BE^{16}RM^{8}BF^{3}WB^{1}$ | $SM^{38}YB^{34}BE^{19}RM^{7}BF^{2}WB^{1}$ |
| 1133 | 27.4 | Hw | IN | EA | 107 | 101 | 2005 | 100% | Systematic Trails Only | | | | 8 | 16 | 33% | sM | 2.5 | $YB^{40}SM^{39}RM^{8}BE^{6}BF^{6}WS^{1}$ | $SM^{45}YB^{34}RM^{10}BF^{5}BE^{5}WS^{1}$ |
| 1134 | 33.6 | Mw | SP | WE | 39 | 33 | 2004 | 50%/25% | U. Selection/Non-Systematic Trails Only | 25% | | | | | | rS | 6.5 | $RS^{60}RM^{29}BF^{8}WB^{3}BS^{1}$ | $RS^{55}RM^{30}BF^{9}WB^{5}BS^{1}WP^{1}$ |
| 1135 | 36.5 | Hw | IN | CE | | | 2005 | 100% | Strip cut | | Yes | | 20 | 40 | 33% | | | | |
| 1136 | 41.4 | Hw | CR | CE | 70 | 64 | 2006 | 100% | Group Selection | | | 0.2 | | | | sM | 2.5 | $SM^{92}RM^{3}YB^{3}RS^{1}BF^{1}$ | $SM^{90}YB^{5}RM^{2}RS^{2}BF^{1}$ |
| | 402.3 | | | | | | | | | | | | | | | | | | |

[1]Stand Type: Hw=Hardwood, Mw=Mixedwood, Sw=Softwood. Hardwood: 75% or greater hardwood species in the overstory; Softwood: 75% or greater softwood species in the overstory; Mixedwood: all other stands (Neily *et al.* 2013).

[2]Ownership: CR=Crown, IN=Industrial, SP=Small Private

[3]Region:EA=East (Antigonish, Cape Breton, Guysborough, Inverness, Richmond, Victoria); CE=Central (Colchester, Cumberland, Halifax, Hants, Pictou); WE=West (Annapolis, Digby, Kings, Lunenburg, Queens, Shelburne, Yarmouth)

[4]Treatment: for definitions see page 6

[5]LC= Land capability is a measure of site productivity and is explained in the Nova Scotia Forestry Field Handbook (NSDNR 1993), LC is based on the dominant species in the stand.

[6]Species Composition = Species[%]; BE=beech, BF=balsam fir, BS=black spruce, GB=grey birch, HE=hemlock, IR=ironwood, LA=larch, LTA=large tooth aspen, PC=pin cherry, RM=red maple, RO=red oak, RP=red pine, RS=red spruce, SM=sugar maple, StM=striped maple, WA=white ash, WB=white birch, WP=white pine, WS=white spruce, YB=yellow birch

Appendix 2: Summary of selection harvest survey by stand at the time of the harvest (before selection harvest, removals, and afterwards).

| | | | | | | Volume (Merchantable) ($m^3$/ha) | | | | | Basal Area ($m^2$/ha) | | | | | | | | | Frequency (# Stems/ha) | | | Avg. Diameter at Breast Height (cm) | | | Avg. Height (m) | | | Harvest Damage | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stand ID | Owner ship | WAP/ ASF[1] | Stand Type | PTA | Age @ Harv. | Before | Cut | After | Mor- tality | 7-9 Yrs later | Before | Cut | After | Mor- tality | 7-9 Yrs later | BAR | Tol. Sp. After[2] | AGS[3] | % AGS | Before | Cut | After | Before | Cut | After | Before | Cut | After | % trees | Merch. Volume |
| 1101 | IN | WAP | Sw | | 39 | 97 | 8 | 89 | 11 | 137 | 22 | 3 | 19 | 1.8 | 25 | 12% | 15 | 16 | 82% | 1,500 | 290 | 1,210 | 14 | 10 | 14 | 11 | 10 | 12 | 1% | 0% |
| 1102 | SP | WAP | Mw | Fail | 33 | 63 | 9 | 54 | 2 | 85 | 16 | 2 | 14 | 0.4 | 19 | 11% | 7 | 10 | 71% | 1,260 | 100 | 1,160 | 13 | 15 | 13 | 11 | 12 | 11 | 1% | 3% |
| 1103 | SP | WAP | Sw | | 117 | 315 | 113 | 202 | 7 | 238 | 42 | 15 | 27 | 0.9 | 30 | 36% | 26 | 25 | 94% | 1,020 | 370 | 650 | 23 | 23 | 23 | 18 | 18 | 18 | 2% | 0% |
| 1104 | IN | | Hw | | 78 | 198 | 75 | 122 | 6 | 136 | 31 | 11 | 20 | 1.1 | 22 | 35% | 8 | 12 | 58% | 890 | 190 | 700 | 21 | 27 | 19 | 18 | 19 | 17 | 9% | 5% |
| 1105 | SP | WAP | Mw | Fail | 46 | 156 | 93 | 63 | 1 | 100 | 29 | 16 | 13 | 0.2 | 19 | 54% | 2 | 7 | 54% | 1,210 | 500 | 710 | 17 | 20 | 15 | 14 | 15 | 13 | 1% | 0% |
| 1106 | SP | WAP | Sw | Fail | 52 | 169 | 75 | 94 | 33 | 113 | 25 | 12 | 14 | 4.1 | 16 | 46% | 12 | 13 | 91% | 930 | 490 | 440 | 19 | 17 | 20 | 16 | 16 | 16 | 2% | 0% |
| 1107 | IN | | Sw | Fail | 56 | 204 | 36 | 168 | 69 | 183 | 36 | 6 | 30 | 11.5 | 29 | 18% | 5 | 15 | 51% | 2,140 | 380 | 1,760 | 15 | 15 | 15 | 15 | 15 | 15 | 0% | 0% |
| 1108 | CR | | Mw | | 72 | 213 | 122 | 91 | 51 | 101 | 40 | 23 | 17 | 7.5 | 18 | 57% | 13 | 15 | 86% | 1,500 | 820 | 680 | 18 | 19 | 18 | 14 | 14 | 13 | 3% | 0% |
| 1109 | SP | WAP | Mw | | 71 | 245 | 127 | 118 | 0 | 154 | 38 | 19 | 19 | 0.0 | 24 | 49% | 11 | 9 | 46% | 1,280 | 650 | 630 | 19 | 19 | 20 | 18 | 18 | 17 | 0% | 0% |
| 1110 | SP | WAP | Sw | | 60 | 266 | 142 | 124 | 4 | 173 | 39 | 21 | 18 | 0.6 | 24 | 54% | 13 | 12 | 68% | 1,340 | 790 | 550 | 19 | 19 | 20 | 17 | 17 | 17 | 5% | 1% |
| 1111 | CR | | Hw | Fail | 79 | 127 | 45 | 82 | 4 | 97 | 22 | 7 | 15 | 0.6 | 17 | 34% | 14 | 5 | 34% | 460 | 90 | 370 | 25 | 33 | 22 | 16 | 16 | 15 | 0% | 0% |
| 1112 | CR | | Hw | | 107 | 145 | 38 | 106 | 1 | 122 | 22 | 6 | 17 | 0.2 | 19 | 25% | 13 | 8 | 47% | 460 | 70 | 390 | 25 | 32 | 23 | 18 | 19 | 17 | 3% | 3% |
| 1113 | SP | WAP | Mw | Fail | 45 | 115 | 82 | 33 | 7 | 42 | 25 | 18 | 7 | 1.2 | 9 | 71% | 0 | 3 | 39% | 1,490 | 1,060 | 430 | 15 | 15 | 15 | 13 | 13 | 13 | 12% | 8% |
| 1114 | SP | WAP | Sw | Fail | 47 | 183 | 154 | 29 | 1 | 63 | 34 | 28 | 6 | 0.3 | 11 | 81% | 4 | 3 | 55% | 1,630 | 1,210 | 420 | 16 | 17 | 14 | 13 | 14 | 12 | 5% | 2% |
| 1115 | IN | | Mw | | 72 | 123 | 36 | 87 | 6 | 107 | 23 | 7 | 16 | 1.1 | 18 | 31% | 12 | 8 | 48% | 1,008 | 416 | 591 | 17 | 15 | 18 | 15 | 14 | 15 | 0% | 0% |
| 1116 | SP | ASF | Mw | Fail | 90 | 142 | 57 | 85 | 16 | 100 | 24 | 10 | 14 | 2.2 | 16 | 41% | 8 | 9 | 64% | 1,216 | 608 | 608 | 16 | 14 | 17 | 16 | 16 | 16 | 8% | 11% |
| 1117 | IN | | Sw | | 71 | 251 | 142 | 109 | 15 | 121 | 40 | 20 | 20 | 2.4 | 21 | 50% | 9 | 12 | 63% | 1,164 | 393 | 771 | 21 | 26 | 18 | 15 | 16 | 14 | 3% | 8% |
| 1118 | SP | WAP | Hw | Fail | 79 | 95 | 28 | 67 | 6 | 80 | 17 | 5 | 12 | 0.9 | 14 | 27% | 10 | 7 | 53% | 650 | 112 | 537 | 18 | 23 | 17 | 16 | 17 | 15 | 1% | 1% |
| 1119 | SP | WAP | Mw | | 65 | 148 | 62 | 86 | 3 | 141 | 27 | 12 | 16 | 0.6 | 22 | 42% | 9 | 8 | 52% | 1,550 | 687 | 862 | 15 | 15 | 15 | 14 | 14 | 15 | 7% | 9% |
| 1120 | CR | | Mw | | 56 | 143 | 54 | 89 | 14 | 90 | 27 | 9 | 17 | 3.0 | 17 | 35% | 4 | 9 | 54% | 1,062 | 328 | 734 | 18 | 19 | 17 | 14 | 15 | 14 | 1% | 0% |
| 1121 | IN | | Hw | | 69 | 173 | 61 | 112 | 0 | 126 | 27 | 9 | 18 | 0.0 | 20 | 35% | 6 | 6 | 36% | 667 | 183 | 484 | 23 | 25 | 22 | 18 | 18 | 17 | 3% | 4% |
| 1122 | SP | WAP | Hw | | 85 | 180 | 65 | 115 | 13 | 124 | 27 | 10 | 17 | 1.7 | 18 | 37% | 16 | 9 | 55% | 610 | 265 | 345 | 24 | 22 | 25 | 18 | 18 | 19 | 3% | 1% |
| 1123 | IN | | Sw | Fail | 79 | 126 | 23 | 103 | 20 | 96 | 21 | 4 | 17 | 3.3 | 15 | 21% | 0 | 14 | 85% | 846 | 229 | 617 | 18 | 16 | 19 | 15 | 14 | 16 | 3% | 2% |
| 1124 | CR | | Hw | | 98 | 156 | 55 | 101 | 4 | 119 | 28 | 10 | 19 | 0.7 | 22 | 34% | 18 | 5 | 28% | 435 | 115 | 320 | 29 | 32 | 27 | 15 | 15 | 14 | 10% | 5% |
| 1125 | SP | WAP | Sw | | 83 | 257 | 107 | 150 | 10 | 161 | 36 | 14 | 22 | 1.7 | 23 | 39% | 15 | 18 | 81% | 1,132 | 354 | 778 | 20 | 22 | 19 | 17 | 18 | 17 | 2% | 4% |
| 1128 | CR | | Hw | Fail | 97 | 110 | 43 | 67 | 4 | 72 | 23 | 9 | 15 | 1.0 | 15 | 37% | 6 | 5 | 33% | 689 | 210 | 479 | 21 | 23 | 20 | 12 | 13 | 12 | 3% | 3% |
| 1129 | IN | | Mw | | 111 | 206 | 84 | 121 | 9 | 140 | 34 | 13 | 20 | 1.6 | 22 | 40% | 13 | 10 | 49% | 857 | 327 | 530 | 22 | 23 | 22 | 17 | 17 | 17 | 3% | 2% |
| 1130 | CR | | Hw | Fail | 87 | 154 | 61 | 92 | 8 | 96 | 24 | 10 | 15 | 1.2 | 15 | 40% | 14 | 7 | 46% | 600 | 243 | 357 | 23 | 23 | 23 | 18 | 18 | 18 | 0% | 0% |
| 1131 | SP | WAP | Sw | | 47 | 150 | 48 | 102 | 31 | 128 | 30 | 9 | 22 | 5.8 | 23 | 29% | 10 | 15 | 67% | 1,993 | 479 | 1,514 | 14 | 15 | 14 | 13 | 13 | 12 | 0% | 0% |
| 1132 | CR | | Hw | | 102 | 166 | 53 | 113 | 5 | 125 | 28 | 8 | 20 | 0.8 | 21 | 30% | 14 | 9 | 47% | 651 | 113 | 538 | 23 | 31 | 22 | 16 | 17 | 16 | 1% | 1% |
| 1133 | IN | | Hw | | 107 | 142 | 43 | 99 | 8 | 104 | 25 | 7 | 17 | 1.5 | 18 | 30% | 14 | 8 | 44% | 518 | 136 | 382 | 25 | 26 | 24 | 16 | 16 | 15 | 1% | 0% |
| 1134 | SP | WAP | Mw | Fail | 39 | 83 | 40 | 43 | 2 | 77 | 17 | 7 | 10 | 0.4 | 15 | 41% | 6 | 8 | 79% | 928 | 231 | 697 | 15 | 20 | 14 | 12 | 13 | 11 | 2% | 2% |
| 1136 | CR | | Hw | | 70 | 155 | 62 | 93 | 1 | 103 | 26 | 10 | 16 | 0.2 | 17 | 39% | 15 | 8 | 53% | 896 | 304 | 592 | 19 | 21 | 19 | 17 | 17 | 16 | 1% | 1% |
| | | | | | 73 | 165 | 68 | 97 | 11 | 117 | 28 | 11 | 17 | 2 | 19 | 39% | 10 | 10 | 58% | 1,048 | 386 | 662 | 19 | 21 | 19 | 15 | 16 | 15 | 3% | 2% |

[1]WAP= Wood Acquisition Plan; ASF=Association of Sustainnable Forestry

[2]Tolerant species after selection harvest : must contain at least 5 $m^2$/ha of the following tolerant species (red spruce, white pine, eastern hemlock, eastern cedar, sugar maple, yellow birch, red oak, and white ash).

[3]AGS=Acceptable growing stock (McGrath *et al.* 2015): Trees are acceptable growing stock when they are healthy with potential to produce high value stems suitable to meet sawlog or studwood specifications in the future and the ability to thrive after thinning until the time of the next harvest.

Appendix 3: Summary of wind damage which occurred at the selection harvest survey sites (total wind damage= blowdown+broken tops)

| Wind Damage | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Forest Ecosystem Classification | | | | | Height/Diameter Ratio | | | Volume (merchantable) ($m^3$/ha) | | | | | | Basal Area ($m^2$/ha) | | | | | | Frequency (# stems/ha) | | | DBH (cm) | |
| Stand ID | Stand Type | Elevation (m) | Exposure[1] | Soil Type[2] | Veg Type[3] | Shallow Soil (<30cm) | Imperfect Drainage | Windthrow Hazard[4] | Before Harv. | Cut Trees | Wind Damaged Trees | Blowdown ($m^3$/ha) | Broken Tops ($m^3$/ha) | Total ($m^3$/ha) | Blowdown (%) | Broken Tops (%) | Total (%) | Blowdown ($m^2$/ha) | Broken Tops ($m^2$/ha) | Total ($m^2$/ha) | Blowdown (%) | Broken Tops (%) | Total (%) | Blowdown (#/ha) | Broken Tops (#/ha) | Total (#/ha) | Blowdown (cm) | Broken Tops (cm) |
| 1101 | Sw | 114 | M | $ST2L^{100}$ | SH5 | | | Low | 0.76 | 0.80 | 0.72 | - | 8 | 8 | 0% | 9% | 9% | 0 | 1 | 1 | 0% | 7% | 8% | 10 | 50 | 60 | 8 | 19 |
| 1102 | Mw | 99 | M | $ST2L^{100}$ | MW2 | | | Low | 0.77 | 0.75 | 0.77 | - | 1 | 1 | 0% | 2% | 2% | 0 | 0 | 0 | 0% | 1% | 1% | - | 10 | 10 | - | 16 |
| 1103 | Sw | 82 | M | $ST2^{100}$ | SH3,1 | | | Low | 0.77 | 0.77 | 0.71 | - | 4 | 4 | 0% | 2% | 2% | 0 | 1 | 1 | 0% | 2% | 2% | - | 10 | 10 | - | 26 |
| 1104 | Hw | 178 | M | $ST2S^{100}$ | TH8 | | | Mod. | 0.87 | 0.77 | 0.92 | - | 4 | 4 | 0% | 3% | 3% | 0 | 1 | 1 | 0% | 3% | 3% | - | 30 | 30 | - | 16 |
| 1105 | Mw | 161 | M | $ST2^{100}$ | MW4 | | | Low | 0.83 | 0.77 | 0.97 | - | 0 | 0 | 0% | 0% | 0% | 0 | 0 | 0 | 0% | 1% | 1% | - | 10 | 10 | - | 10 |
| 1106 | Sw | 128 | M | $ST3L^{80}/ST6^{20}$ | SH3 | | Yes | Mod. | 0.85 | 0.88 | 0.67 | 6 | 12 | 18 | 6% | 13% | 19% | 1 | 1 | 2 | 6% | 10% | 16% | 20 | 10 | 30 | 23 | 42 |
| 1107 | Sw | 115 | M | $ST3GS^{60}/ST2GS^{40}$ | SH7 | | Yes | High | 1.03 | 1.03 | 0.99 | 19 | 15 | 34 | 11% | 9% | 20% | 3 | 2 | 6 | 11% | 8% | 19% | 170 | 120 | 290 | 16 | 16 |
| 1108 | Mw | 85 | M | $ST2L^{40}/ST15L^{20}$/ $ST16L^{20}(ST4^{20})$ | MW3,2,1 | Yes | Yes | High | 0.64 | 0.64 | 0.62 | 37 | 3 | 40 | 41% | 3% | 44% | 5 | 1 | 6 | 32% | 4% | 35% | 120 | 30 | 150 | 24 | 17 |
| 1109 | Mw | 44 | MS | $ST8^{6}/ST9^{4}$ | MW1 | | Yes | Low | 0.97 | 0.97 | - | 0 | 0 | 0 | 0% | 0% | 0% | 0 | 0 | 0 | 0% | 0% | 0% | - | - | - | - | - |
| 1110 | Sw | 60 | M | $ST2S^{80}/ST2^{20}$ | SH2,SP9 | | | Mod. | 0.89 | 0.91 | - | 0 | 0 | 0 | 0% | 0% | 0% | 0 | 0 | 0 | 0% | 0% | 0% | - | - | - | - | - |
| 1111 | Hw | 334 | E | $ST2L^{100}$ | TH1 | | | High | 0.65 | 0.56 | - | 0 | 0 | 0 | 0% | 0% | 0% | 0 | 0 | 0 | 0% | 0% | 0% | - | - | - | - | - |
| 1112 | Hw | 300 | E | $ST2L^{100}$ | TH1 | | | High | 0.72 | 0.61 | - | 0 | 0 | 0 | 0% | 0% | 0% | 0 | 0 | 0 | 0% | 0% | 0% | - | - | - | - | - |
| 1113 | Mw | 158 | M | $ST2^{40}/ST3^{20}$/ $ST16^{20}(ST4^{20})$ | MW4,IH6,SH9 | Yes | Yes | High | 0.83 | 0.83 | 0.77 | 5 | 0 | 5 | 16% | 0% | 16% | 1 | 0 | 1 | 13% | 0% | 13% | 40 | - | 40 | 18 | - |
| 1114 | Sw | 123 | M | $ST2^{100}$ | SH2,SP4 | | | Low | 0.76 | 0.74 | 0.56 | 0 | 7 | 7 | 0% | 22% | 22% | 0 | 1 | 1 | - | 13% | 13% | - | 10 | 10 | - | 33 |
| 1115 | Mw | 169 | M | $ST2S^{50}/ST8^{50}$ | TH1,MW1 | | | Mod. | 0.91 | 0.96 | 0.93 | 2 | 1 | 3 | 2% | 1% | 3% | 0 | 0 | 1 | 2% | 1% | 3% | 25 | 8 | 33 | 13 | 16 |
| 1116 | Mw | 102 | M | $ST2L^{100}$ | TH8 | | | Low | 1.01 | 1.05 | 0.91 | 7 | 5 | 12 | 9% | 6% | 14% | 1 | 1 | 2 | 8% | 5% | 12% | 42 | 25 | 67 | 18 | 19 |
| 1117 | Sw | 89 | M | $ST16^{60}/ST8^{20}(ST4^{20})$ | SH7,MW4,SP7 | Yes | | High | 0.64 | 0.60 | 0.65 | 12 | 1 | 12 | 11% | 0% | 11% | 2 | 0 | 2 | 9% | 1% | 10% | 50 | 21 | 71 | 21 | 11 |
| 1118 | Hw | 218 | M | $ST2^{90}(ST2S^{10})$ | TH1 | | | Low | 0.86 | 0.76 | 0.80 | 0 | 4 | 4 | 0% | 6% | 6% | 0 | 1 | 1 | 0% | 5% | 5% | - | 19 | 19 | - | 21 |
| 1119 | Mw | 170 | M | $ST2^{100}$ | TH8,MW2,1,SH4 | | | Low | 0.84 | 0.84 | 0.86 | 1 | 1 | 1 | 1% | 1% | 2% | 0 | 0 | 0 | 1% | 1% | 2% | 12 | 19 | 31 | 13 | 11 |
| 1120 | Mw | 172 | M | $ST2^{100}$ | TH8,SH8 | | | Low | 0.87 | 0.86 | 0.88 | 1 | 5 | 6 | 1% | 6% | 7% | 0 | 1 | 1 | 1% | 6% | 7% | 6 | 56 | 61 | 22 | 15 |
| 1121 | Hw | 166 | M | $ST2S^{60}/ST2^{30}(ST3^{10})$ | TH8 | | | Mod. | 0.87 | 0.79 | 0.82 | 0 | 13 | 13 | 0% | 11% | 11% | 0 | 2 | 2 | 0% | 11% | 11% | - | 39 | 39 | - | 25 |
| 1122 | Hw | 246 | E | $ST2^{100}$ | TH1,1b | | | High | 0.84 | 0.88 | 0.59 | 7 | 0 | 7 | 6% | 0% | 6% | 1 | 0 | 1 | 5% | 0% | 5% | 10 | - | 10 | 33 | - |
| 1123 | Sw | 67 | M | $ST3^{60}/ST2^{30}(ST4^{10})$ | SP5,7 | | Yes | Mod. | 0.76 | 0.77 | 0.77 | 10 | 11 | 20 | 9% | 10% | 20% | 2 | 2 | 3 | 9% | 11% | 20% | 46 | 71 | 117 | 20 | 18 |
| 1124 | Hw | 355 | E | $ST2^{90}(ST3^{10})$ | TH1b | | | High | 0.52 | 0.47 | - | 0 | 0 | 0 | 0% | 0% | 0% | 0 | 0 | 0 | 0% | 0% | 0% | - | - | | - | - |
| 1125 | Sw | 78 | M | $ST3^{50}/ST2^{50}$ | SH4,6 | | Yes | Mod. | 0.81 | 0.78 | 0.87 | 0 | 3 | 3 | 0% | 2% | 2% | 0 | 1 | 1 | 0% | 2% | 3% | 8 | 31 | 38 | 12 | 15 |
| 1128 | Hw | 261 | E | $ST2L^{70}/ST2LS^{30}$ | TH1,1a,8 | | | High | 0.61 | 0.58 | 0.68 | 1 | 0 | 1 | 1% | 0% | 1% | 0 | 0 | 0 | 1% | 0% | 1% | 3 | 5 | 8 | 24 | 10 |
| 1129 | Mw | 86 | ME-M | $ST2L^{80}/ST3L^{20}$ | TH8,MW1 | | Yes | High | 0.76 | 0.75 | 0.78 | 1 | 8 | 9 | 1% | 6% | 7% | 0 | 1 | 1 | 1% | 6% | 7% | 10 | 30 | 40 | 15 | 23 |
| 1130 | Hw | 197 | MS | $ST2^{100}$ | TH1,1a | | | Low | 0.82 | 0.82 | 0.83 | 5 | 2 | 7 | 5% | 3% | 8% | 1 | 0 | 1 | 5% | 3% | 8% | 10 | 17 | 26 | 31 | 18 |
| 1131 | Sw | 71 | M | $ST6^{100}$ | SH6 | | Yes | Mod. | 0.87 | 0.85 | 0.80 | 2 | 9 | 11 | 2% | 9% | 11% | 0 | 2 | 2 | 1% | 8% | 9% | 18 | 68 | 86 | 15 | 18 |
| 1132 | Hw | 266 | E-ME | $ST2^{100}$ | TH1a,1,1b,2,7,8 | | | High | 0.73 | 0.61 | 0.77 | 1 | 1 | 2 | 1% | 1% | 2% | 0 | 0 | 0 | 1% | 1% | 2% | 7 | 11 | 17 | 18 | 17 |
| 1133 | Hw | 253 | E-ME | $ST2^{100}$ | TH1a,1,2 | | | High | 0.61 | 0.59 | 0.65 | 1 | 1 | 3 | 1% | 1% | 3% | 0 | 0 | 1 | 2% | 2% | 3% | 10 | 10 | 20 | 18 | 19 |
| 1134 | Mw | 215 | M | $ST2S^{20}/ST15GS^{20}$/ $ST16^{10}/ST15^{10}$/ $ST3S^{10}/ST15S^{5}$/ $ST2^{5}/(ST4S^{15}/ST4^{5})$ | SH5,MW2,IH7, SH6 (WC1,5) | Yes | Yes | High | 0.74 | 0.67 | 0.70 | 0 | 1 | 1 | 0% | 2% | 2% | 0 | 0 | 0 | 0% | 1% | 2% | 3 | 5 | 8 | 12 | 19 |
| 1136 | Hw | 225 | ME | $ST2L^{90}(ST2LS^{10})$ | TH1 | | | Mod. | 0.91 | 0.87 | 0.64 | 0 | 1 | 1 | 0% | 1% | 1% | 0 | 0 | 0 | 0% | 1% | 1% | - | 2 | 2 | - | 29 |
| | | | | | | | | | 0.80 | 0.77 | 0.77 | 4 | 4 | 7 | 4% | 4% | 8% | 1 | 1 | 1 | 3% | 3% | 7% | 19 | 22 | 40 | 19 | 19 |

[1]Exposure: S=Sheltered, MS=Moderately Sheltered, M=Moderate, ME=Moderately Exposed, E=Exposed (Neily *et al*. 2013)

[2]Soil Type (Neily *et al.* 2013)

[3]Vegetation Type (Neily *et al.* 2013)

[4]Windthrow hazard (Neily *et al.* 2013)

Appendix 4. Stocking (%) of dominant regeneration by species, pre-harvest stand type, and location of plot.

| | Stocking of Dominant Trees | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Softwood | | | Mixedwood | | | Hardwood | | | | Total | | | |
| Species | Un-thinned | Uniform Selection | Trail | Un-thinned | Uniform Selection | Trail | Un-thinned | Uniform Selection | Trail | Group Selection | Un-thinned | Uniform Selection | Trail | Group Selection |
| Balsam fir | 44% | 30% | 31% | 39% | 28% | 18% | 15% | 11% | 8% | 11% | 27% | 22% | 16% | 11% |
| Red spruce | 16% | 14% | 25% | 13% | 4% | - | 1% | 2% | - | 5% | 7% | 5% | 7% | 5% |
| Hemlock | - | 18% | - | - | - | - | - | - | - | - | - | 4% | - | - |
| Black Spruce | 6% | 4% | 6% | - | 1% | - | - | - | - | - | 2% | 1% | 2% | - |
| White pine | - | 2% | - | - | - | 5% | - | - | - | - | - | 0.4% | 1% | - |
| White spruce | - | - | - | 3% | 4% | - | 1% | 1% | - | - | 1% | 2% | - | - |
| Softwood Total | 66% | 68% | 63% | 55% | 37% | 23% | 17% | 14% | 8% | 16% | 36% | 35% | 25% | 16% |
| Yellow birch | 2% | - | - | 11% | 6% | 5% | 22% | 23% | 38% | 20% | 15% | 11% | 21% | 20% |
| Red maple (seed) | 22% | 16% | 6% | 3% | 10% | 18% | 10% | 3% | 8% | 14% | 12% | 9% | 9% | 14% |
| Red maple (coppice) | 2% | 7% | 3% | 3% | 19% | 18% | - | 2% | 5% | 9% | 1% | 10% | 7% | 9% |
| Red maple | 23% | 23% | 9% | 5% | 29% | 36% | 10% | 5% | 13% | 23% | 13% | 19% | 16% | 23% |
| Sugar maple (seed) | - | - | - | 8% | 3% | - | 6% | 23% | - | - | 5% | 10% | - | - |
| Sugar maple (coppice) | - | - | - | - | - | - | - | - | 5% | 9% | - | - | 3% | 9% |
| Sugar maple | - | - | - | 8% | 3% | - | 6% | 23% | 5% | 9% | 5% | 10% | 3% | 9% |
| White ash | - | - | - | - | 2% | 9% | - | - | - | - | - | 1% | 2% | - |
| Red oak | 2% | 4% | - | - | - | 5% | - | - | - | - | 0.4% | 1% | 1% | - |
| Large tooth aspen | - | 2% | - | - | - | - | - | - | - | - | - | 0.4% | - | - |
| white birch | - | 2% | 6% | 3% | - | - | - | - | 2% | - | 0.4% | 0.4% | 3% | - |
| Hardwood Total | 27% | 30% | 16% | 26% | 40% | 55% | 38% | 52% | 56% | 52% | 33% | 42% | 45% | 52% |
| Softwood and Hardwood Total | 92% | 98% | 78% | 82% | 77% | 77% | 55% | 66% | 64% | 68% | 69% | 78% | 70% | 68% |
| Long Lived Species[1] | 19% | 38% | 25% | 32% | 15% | 23% | 30% | 49% | 42% | 34% | 27% | 32% | 34% | 34% |
| Tolerant Species[2] | 16% | 32% | 25% | 21% | 6% | - | 7% | 26% | 5% | 14% | 12% | 19% | 9% | 14% |
| Striped maple | - | - | - | 3% | 15% | 9% | 20% | 10% | 17% | 16% | 12% | 10% | 11% | 16% |
| Beech | - | - | - | - | 1% | - | 19% | 7% | 13% | 11% | 11% | 3% | 7% | 11% |
| Mountain maple | 3% | - | - | 5% | 3% | - | 3% | 12% | 5% | - | 3% | 5% | 3% | - |
| Pincherry | - | - | - | - | - | 5% | - | 1% | - | 2% | - | 0.4% | 1% | 2% |
| Grey Birch | - | - | 3% | - | - | - | - | - | - | - | - | - | 1% | - |
| Other[3] | - | - | 6% | - | 1% | - | - | 1% | - | - | - | 1% | 2% | - |
| Non-commercial Total | 3% | - | 9% | 8% | 19% | 14% | 42% | 31% | 34% | 30% | 26% | 19% | 24% | 30% |
| Not stocked | 5% | 2% | 13% | 11% | 4% | 9% | 3% | 3% | 2% | 2% | 5% | 3% | 6% | 2% |
| Number of plots | 64 | 56 | 32 | 38 | 109 | 22 | 134 | 94 | 64 | 44 | 236 | 259 | 118 | 44 |

[1]Long Lived species include red spruce, eastern hemlock, white pine, sugar maple, yellow birch, red oak, and white ash.

[2]Tolerant species include red spruce, eastern hemlock, and sugar maple.

[3]Other non-commercial includes serviceberry and alder.

Appendix 5. Stocking (%) of regeneration by species, pre-harvest stand type, and plot location.

| | Stocking (all dominance classes) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Softwood | | | Mixedwood | | | Hardwood | | | | Total | | | |
| Species | Un-thinned | Uniform Selection | Trail | Un-thinned | Uniform Selection | Trail | Un-thinned | Uniform Selection | Trail | Group Selection | Un-thinned | Uniform Selection | Trail | Group Selection |
| Balsam fir | 72% | 66% | 56% | 63% | 78% | 55% | 47% | 31% | 44% | 32% | 56% | 58% | 49% | 32% |
| Red spruce | 34% | 41% | 53% | 34% | 24% | 23% | 11% | 5% | 2% | 25% | 21% | 21% | 19% | 25% |
| Hemlock | - | 39% | 6% | 3% | 4% | - | - | 3% | - | - | - | 11% | 2% | - |
| Black Spruce | 14% | 14% | 9% | - | 2% | - | - | - | - | - | 4% | 4% | 3% | - |
| White pine | 6% | 27% | 6% | 3% | 1% | 5% | 1% | 4% | - | - | 3% | 8% | 3% | - |
| White spruce | 2% | 2% | 3% | 3% | 7% | - | 2% | 1% | 3% | 2% | 2% | 4% | 3% | 2% |
| Larch | 2% | 2% | 3% | - | - | - | - | - | - | - | - | - | 1% | - |
| Softwood Total | 89% | 93% | 81% | 66% | 83% | 59% | 51% | 36% | 47% | 50% | 64% | 68% | 58% | 50% |
| Yellow birch | 3% | 2% | 3% | 21% | 37% | 9% | 47% | 48% | 70% | 48% | 31% | 33% | 41% | 48% |
| Red maple (seed) | 67% | 30% | 53% | 32% | 51% | 45% | 41% | 22% | 41% | 36% | 47% | 36% | 45% | 36% |
| Red maple (coppice) | 3% | 7% | 3% | 3% | 20% | 18% | - | 2% | 5% | 9% | 1% | 11% | 7% | 9% |
| Red maple | 69% | 36% | 53% | 34% | 64% | 64% | 41% | 24% | 45% | 45% | 47% | 44% | 51% | 45% |
| Sugar maple (seed) | - | - | - | 16% | 17% | - | 42% | 69% | 52% | 32% | 26% | 32% | 28% | 32% |
| Sugar maple (coppice) | - | - | - | - | - | - | - | - | 8% | 16% | - | - | 4% | 16% |
| Sugar maple | - | - | - | 16% | 17% | - | 42% | 69% | 52% | 43% | 26% | 32% | 28% | 43% |
| White ash | - | - | 3% | 13% | 7% | 9% | - | - | - | - | 2% | 3% | 3% | - |
| Red oak | 5% | 14% | 6% | 3% | 2% | 5% | - | - | - | - | 2% | 4% | 3% | - |
| Trembling aspen | - | 2% | 3% | - | - | - | - | - | - | - | - | - | 1% | - |
| Large tooth aspen | - | 2% | - | - | - | - | - | - | - | - | - | - | - | - |
| white birch | - | 5% | 25% | 3% | 4% | 5% | - | 1% | 3% | 5% | - | 3% | 9% | 5% |
| Hardwood Total | 72% | 48% | 63% | 50% | 74% | 73% | 78% | 88% | 91% | 84% | 72% | 74% | 80% | 84% |
| Softwood and Hardwood Total | 95% | 98% | 88% | 94% | 98% | 86% | 88% | 90% | 95% | 95% | 91% | 95% | 92% | 95% |
| Long Lived Species[1] | 41% | 68% | 56% | 68% | 63% | 36% | 75% | 88% | 86% | 84% | 64% | 73% | 69% | 84% |
| Tolerant Species[2] | 34% | 55% | 53% | 50% | 43% | 23% | 51% | 76% | 53% | 59% | 46% | 58% | 47% | 59% |
| Striped maple | 5% | - | 6% | 11% | 29% | 9% | 46% | 27% | 50% | 41% | 29% | 22% | 31% | 41% |
| Beech | - | - | - | - | 2% | - | 24% | 13% | 41% | 32% | 14% | 5% | 22% | 32% |
| Mountain maple | 3% | - | 3% | 8% | 6% | - | 12% | 26% | 16% | - | 9% | 12% | 9% | - |
| Pincherry | - | - | - | - | 1% | 5% | - | 1% | - | 7% | - | 1% | 1% | 7% |
| Grey Birch | - | 2% | 6% | - | - | - | - | - | - | - | - | - | 2% | - |
| Other[3] | | | 9% | | 2% | | | 5% | | 2% | | 3% | 9% | 2% |
| Non-commercial Total | 6% | 2% | 25% | 16% | 39% | 14% | 62% | 57% | 75% | 66% | 39% | 38% | 50% | 66% |
| Not stocked | 5% | 2% | 13% | 11% | 4% | 9% | 3% | 3% | 2% | 2% | 5% | 3% | 6% | 2% |
| Number of plots | 64 | 56 | 32 | 38 | 109 | 22 | 134 | 94 | 64 | 44 | 236 | 259 | 118 | 44 |

[1]Long Lived species include red spruce, eastern hemlock, white pine, sugar maple, yellow birch, red oak, and white ash.

[2]Tolerant species include red spruce, eastern hemlock, and sugar maple.

[3]Other non-commercial includes serviceberry, chokecherry, alder, willow.

Appendix 6. Height (cm) of regeneration by species, pre-harvest stand type, and plot location.

| | Height (cm) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Softwood | | | Mixedwood | | | Hardwood | | | | Total | | | |
| Species | Un-thinned | Uniform Selection | Trail | Un-thinned | Uniform Selection | Trail | Un-thinned | Uniform Selection | Trail | Group Selection | Un-thinned | Uniform Selection | Trail | Group Selection |
| Balsam fir | 61 | 97 | 113 | 116 | 115 | 111 | 156 | 136 | 172 | 221 | 116 | 114 | 141 | 221 |
| Red spruce | 36 | 70 | 70 | 72 | 89 | 46 | 92 | 95 | 30 | 243 | 62 | 81 | 63 | 243 |
| Hemlock | | 69 | 50 | 135 | 124 | | | 57 | | | 135 | 76 | 50 | |
| Black Spruce | 117 | 81 | 143 | | 194 | | | | | | 117 | 104 | 143 | |
| White pine | 49 | 74 | 60 | 100 | 70 | 200 | 90 | 93 | | | 64 | 78 | 107 | |
| White spruce | 15 | 25 | 75 | 370 | 130 | | 100 | 177 | 90 | 150 | 137 | 124 | 85 | 150 |
| Larch | 200 | 60 | 45 | | | | | | | | 200 | 60 | 45 | |
| Softwood Total | 71 | 101 | 102 | 141 | 126 | 112 | 149 | 135 | 165 | 215 | 118 | 120 | 131 | 215 |
| Yellow birch | 20 | 20 | 50 | 226 | 164 | 70 | 214 | 172 | 251 | 310 | 210 | 167 | 239 | 310 |
| Red maple (seed) | 28 | 104 | 34 | 37 | 120 | 42 | 87 | 99 | 181 | 190 | 58 | 113 | 107 | 190 |
| Red maple (coppice) | 210 | 320 | 410 | 150 | 421 | 338 | | 320 | 290 | 495 | 190 | 400 | 329 | 495 |
| Red maple | 37 | 151 | 57 | 46 | 220 | 126 | 87 | 118 | 192 | 251 | 62 | 187 | 138 | 251 |
| Sugar maple (seed) | | | | 65 | 120 | | 51 | 117 | 61 | 69 | 52 | 117 | 61 | 69 |
| Sugar maple (coppice) | | | | | | | | | 383 | 299 | | | 383 | 299 |
| Sugar maple | | | | 65 | 120 | | 51 | 117 | 114 | 151 | 52 | 117 | 114 | 151 |
| White ash | | | 10 | 104 | 189 | 115 | | | | | 104 | 189 | 80 | |
| Red oak | 10 | 141 | 13 | 25 | 13 | 300 | | | | | 14 | 116 | 108 | |
| Trembling aspen | | 80 | 20 | | | | | | | | | 80 | 20 | |
| Large tooth aspen | | 200 | | | | | | | | | | 200 | | |
| white birch | | 97 | 74 | 60 | 166 | 10 | | 80 | 285 | 300 | 60 | 129 | 106 | 300 |
| Hardwood Total | 36 | 156 | 74 | 135 | 258 | 146 | 163 | 161 | 264 | 300 | 126 | 202 | 204 | 300 |
| Softwood and Hardwood Total | 78 | 130 | 122 | 162 | 247 | 155 | 179 | 176 | 270 | 310 | 148 | 196 | 212 | 310 |
| Long Lived Species[1] | 38 | 100 | 69 | 127 | 157 | 98 | 158 | 154 | 241 | 282 | 132 | 144 | 189 | 282 |
| Tolerant Species[2] | 36 | 87 | 71 | 70 | 106 | 46 | 61 | 114 | 112 | 192 | 58 | 106 | 93 | 192 |
| Striped maple | 12 | | 55 | 136 | 251 | 383 | 185 | 187 | 211 | 286 | 175 | 223 | 212 | 286 |
| Beech | | | | | 290 | | 281 | 254 | 245 | 295 | 281 | 259 | 245 | 295 |
| Mountain maple | 80 | | 120 | 227 | 290 | | 110 | 178 | 169 | | 123 | 203 | 165 | |
| Pincherry | | | | | 450 | 200 | | 410 | | 377 | | 430 | 200 | 377 |
| Grey Birch | | 40 | 145 | | | | | | | | | 40 | 145 | |
| Other[3] | | | 150 | | 175 | | | 138 | | 170 | | 149 | 150 | 170 |
| Non-commercial Total | 48 | 40 | 121 | 200 | 256 | 322 | 229 | 199 | 243 | 300 | 220 | 222 | 230 | 300 |
| Number of plots | 64 | 56 | 32 | 38 | 109 | 22 | 134 | 94 | 64 | 44 | 236 | 259 | 118 | 44 |

[1]Long Lived species include red spruce, eastern hemlock, white pine, sugar maple, yellow birch, red oak, and white ash.

[2]Tolerant species include red spruce, eastern hemlock, and sugar maple.

[3]Other non-commercial includes serviceberry, chokecherry, alder, willow.

Appendix 7. The density (# stems/ha) of regeneration by species, pre-harvest stand type, and plot location.

| | Density | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Softwood | | | Mixedwood | | | Hardwood | | | | Total | | | |
| Species | Un-thinned | Uniform Selection | Trail | Un-thinned | Uniform Selection | Trail | Un-thinned | Uniform Selection | Trail | Group Selection | Un-thinned | Uniform Selection | Trail | Group Selection |
| Balsam fir | 13,068 | 5,452 | 7,663 | 10,257 | 11,473 | 5,832 | 2,278 | 1,313 | 1,700 | 1,070 | 6,489 | 6,484 | 4,088 | 1,070 |
| Red spruce | 2,106 | 4,031 | 5,075 | 940 | 700 | 738 | 315 | 207 | 51 | 480 | 901 | 1,242 | 1,541 | 480 |
| Hemlock | - | 2,610 | 355 | 43 | 134 | - | - | 52 | - | - | 7 | 640 | 96 | - |
| Black Spruce | 1,066 | 1,247 | 406 | - | 30 | - | - | - | - | - | 289 | 282 | 110 | - |
| White pine | 152 | 1,044 | 152 | 43 | 15 | 74 | 12 | 69 | - | - | 55 | 257 | 55 | - |
| White spruce | 25 | 29 | 51 | 43 | 149 | - | 48 | 17 | 102 | 37 | 41 | 75 | 69 | 37 |
| Larch | 127 | 29 | 51 | - | - | - | - | - | - | - | 34 | 6 | 14 | - |
| Softwood Total | 16,545 | 14,442 | 13,754 | 11,325 | 12,501 | 6,644 | 2,654 | 1,659 | 1,852 | 1,587 | 7,817 | 8,985 | 5,973 | 1,587 |
| Yellow birch | 51 | 29 | 51 | 1,026 | 2,175 | 664 | 2,109 | 3,058 | 11,038 | 5,020 | 1,376 | 2,032 | 6,125 | 5,020 |
| Red maple (seed) | 14,439 | 1,479 | 5,481 | 4,274 | 11,502 | 4,872 | 3,696 | 829 | 2,588 | 1,735 | 6,703 | 5,462 | 3,799 | 1,735 |
| Red maple (coppice) | 51 | 493 | 203 | 85 | 2,548 | 2,879 | - | 86 | 203 | 886 | 28 | 1,210 | 702 | 886 |
| Red maple | 14,489 | 1,972 | 5,684 | 4,359 | 14,050 | 7,751 | 3,696 | 916 | 2,791 | 2,621 | 6,730 | 6,672 | 4,500 | 2,621 |
| Sugar maple (seed) | - | - | - | 983 | 2,086 | - | 3,660 | 12,975 | 4,288 | 2,288 | 2,236 | 5,587 | 2,326 | 2,288 |
| Sugar maple (coppice) | - | - | - | - | - | - | - | - | 1,167 | 1,403 | - | - | 633 | 1,403 |
| Sugar maple | - | - | - | 983 | 2,086 | - | 3,660 | 12,975 | 5,456 | 3,691 | 2,236 | 5,587 | 2,959 | 3,691 |
| White ash | - | - | 51 | 598 | 760 | 148 | - | - | - | - | 96 | 320 | 41 | - |
| Red oak | 102 | 551 | 203 | 256 | 30 | 74 | - | - | - | - | 69 | 132 | 69 | - |
| Trembling aspen | - | 29 | 51 | - | - | - | - | - | - | - | - | 6 | 14 | - |
| Large tooth aspen | - | 29 | - | - | - | - | - | - | - | - | - | 6 | - | - |
| white birch | - | 522 | 660 | 43 | 149 | 74 | - | 17 | 203 | 74 | 7 | 182 | 303 | 74 |
| Hardwood Total | 14,642 | 3,132 | 6,699 | 7,265 | 19,250 | 8,711 | 9,465 | 16,966 | 19,488 | 11,405 | 10,515 | 14,936 | 14,011 | 11,405 |
| Softwood and Hardwood Total | 31,186 | 17,574 | 20,453 | 18,591 | 31,751 | 15,354 | 12,120 | 18,625 | 21,341 | 12,992 | 18,332 | 23,922 | 19,984 | 12,992 |
| Long Lived Species[1] | 2,411 | 8,265 | 5,887 | 3,889 | 5,900 | 1,698 | 6,096 | 16,361 | 16,545 | 9,191 | 4,741 | 10,208 | 10,887 | 9,191 |
| Tolerant Species[2] | 2,106 | 6,641 | 5,430 | 1,966 | 2,920 | 738 | 3,975 | 13,234 | 5,506 | 4,171 | 3,145 | 7,468 | 4,597 | 4,171 |
| Striped maple | 279 | - | 305 | 556 | 1,788 | 369 | 1,673 | 950 | 1,700 | 1,809 | 1,115 | 1,097 | 1,074 | 1,809 |
| Beech | - | - | - | - | 45 | - | 970 | 466 | 2,563 | 3,396 | 551 | 188 | 1,390 | 3,396 |
| Mountain maple | 102 | - | 102 | 598 | 462 | - | 436 | 1,002 | 508 | - | 372 | 558 | 303 | - |
| Pincherry | - | - | - | - | 15 | 74 | - | 52 | - | 148 | - | 25 | 14 | 148 |
| Grey birch | - | 145 | 254 | - | - | - | - | - | - | - | - | 31 | 69 | - |
| Other[3] | - | - | 152 | - | 30 | - | - | 259 | - | 37 | - | 107 | 41 | 37 |
| Non-commercial Total | 381 | 145 | 812 | 1,154 | 2,339 | 443 | 3,078 | 2,730 | 4,771 | 5,389 | 2,037 | 2,007 | 2,890 | 5,389 |
| Number of plots | 64 | 56 | 32 | 38 | 109 | 22 | 134 | 94 | 64 | 44 | 236 | 259 | 118 | 44 |

[1]Long Lived species include red spruce, eastern hemlock, white pine, sugar maple, yellow birch, red oak, and white ash.

[2]Tolerant species include red spruce, eastern hemlock, and sugar maple.

[3]Other non-commercial includes serviceberry, chokecherry, alder, willow.

Appendix 8. Regeneration by individual stand ID: % stocking. Only the regeneration in the treated portions of the stand are included.

| | Stocking (all dominance classes) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stand ID | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Species | 1102* | 1103 | 1104 | 1105 | 1106 | 1107* | 1108 | 1109 | 1110 | 1111* | 1112* | 1113* | 1114 | 1115* | 1116 | 1117 | 1118* | 1119 | 1120 | 1121 | 1122 | 1123 | 1124 | 1125 | 1128 | 1129 | 1130 | 1131 | 1132 | 1133 | 1134 | 1136 |
| Balsam fir | 100% | | 30% | 89% | 80% | 100% | 67% | 80% | 90% | 33% | | 100% | 80% | 100% | 40% | 50% | 40% | 81% | 57% | | 40% | 50% | 23% | 70% | 84% | 65% | 5% | 69% | 28% | 38% | 88% | 64% |
| Red spruce | 100% | 80% | 50% | 44% | 90% | | 67% | | | | | 25% | 20% | | 10% | 50% | | 44% | 14% | 33% | | | | 60% | | | 5% | 69% | | | 42% | 32% |
| Hemlock | | 90% | 30% | | 50% | | 44% | | 60% | | | | 20% | | | | | | | | | | | 20% | | | | | | | | |
| Black Spruce | | | | | | | | | 30% | | | 25% | | | | | | | | | | 67% | | | | 3% | | | | | | |
| White pine | | 20% | 40% | 11% | 50% | | | | 40% | | | | 30% | | | | | | | | | 8% | | 20% | | | | | | | 4% | |
| White spruce | | | | 11% | | | | | | | | | | 100% | | 13% | | | | 8% | 5% | | | 10% | 11% | 15% | | | | | | |
| Larch | | | | | | | | | | | | | | | | | | | | | | 17% | | | | | | | | | | |
| Softwood Total | 100% | 90% | 80% | 89% | 100% | 100% | 89% | 80% | 100% | 33% | 0% | 100% | 80% | 100% | 40% | 88% | 40% | 88% | 57% | 42% | 45% | 83% | 23% | 80% | 89% | 71% | 10% | 88% | 28% | 38% | 96% | 73% |
| Yellow birch | | | 70% | 22% | | | 56% | 33% | | 100% | 33% | | | | | | 40% | 25% | 71% | 42% | 70% | | 50% | | 84% | 62% | 76% | 13% | 50% | 32% | | 41% |
| Red maple (seed) | 100% | | | 11% | 30% | | 78% | 33% | 20% | | | | 50% | 100% | 80% | | | 25% | 86% | | 30% | 67% | 38% | 40% | 58% | 88% | 33% | 75% | 33% | 35% | 8% | 45% |
| Red maple (coppice) | | | 30% | 22% | 20% | | | 20% | 20% | | | 25% | | | | | | 31% | 43% | 25% | | | | | 11% | 12% | 5% | 6% | | | 33% | |
| Red maple | 100% | | 30% | 33% | 50% | | 78% | 53% | 30% | | | 25% | 50% | 100% | 80% | | | 38% | 86% | 25% | 30% | 67% | 38% | 40% | 68% | 94% | 38% | 75% | 33% | 35% | 42% | 45% |
| Sugar maple (seed) | | | 10% | | | | | 20% | | 67% | 83% | | | | | | 80% | 6% | 14% | | 100% | | 54% | | 47% | 41% | 71% | | 56% | 70% | | 18% |
| Sugar maple (coppice) | | | | | | | | | | | | | | | | | | | | | | | | | | | 19% | | | 8% | | 23% |
| Sugar maple | | | 10% | | | | | 20% | | 67% | 83% | | | | | | 80% | 6% | 14% | | 100% | | 54% | | 47% | 41% | 71% | | 56% | 70% | | 41% |
| White ash | | | | | | | | 53% | | | | | | | 10% | | | 6% | | | | | | 10% | | | | | | | | |
| Red oak | | | | | 30% | | | | 40% | | | | 20% | | | | | | | | | | | 10% | | | | | | | 13% | |
| Trembling aspen | | | | | | | | | | | | | 20% | | | | | | | | | | | | | | | | | | | |
| Large tooth aspen | | | | | | | | | | | | | 10% | | | | | | | | | | | | | | | | | | | |
| white birch | 100% | | | | 20% | | | | | | | | 10% | | | 38% | | 6% | 29% | 8% | | 8% | 4% | | 11% | 3% | | 25% | | | | 5% |
| Hardwood Total | 100% | | 80% | 44% | 60% | | 89% | 80% | 60% | 100% | 83% | 25% | 70% | 100% | 80% | 38% | 80% | 56% | 100% | 67% | 100% | 67% | 92% | 40% | 95% | 97% | 95% | 81% | 89% | 84% | 46% | 82% |
| Softwood and Hardwood Total | 100% | 90% | 90% | 89% | 100% | 100% | 89% | 93% | 100% | 100% | 83% | 100% | 90% | 100% | 90% | 100% | 80% | 94% | 100% | 83% | 100% | 100% | 96% | 90% | 100% | 97% | 100% | 88% | 94% | 86% | 96% | 95% |
| Long Lived Species[1] | 100% | 90% | 90% | 56% | 100% | | 89% | 67% | 90% | 100% | 83% | 25% | 40% | | 20% | 50% | 80% | 63% | 71% | 67% | 100% | 8% | 85% | 60% | 89% | 71% | 95% | 81% | 83% | 81% | 46% | 86% |
| Tolerant Species[2] | 100% | 90% | 70% | 44% | 100% | | 89% | 20% | 60% | 67% | 83% | 25% | 20% | | 10% | 50% | 80% | 50% | 29% | 33% | 100% | | 54% | 60% | 47% | 41% | 76% | 69% | 56% | 70% | 42% | 55% |
| Striped maple | | | 40% | 11% | | | 56% | | | | | 50% | | | 50% | | 100% | 19% | 14% | 42% | 35% | | 12% | | 42% | 50% | 33% | 13% | 67% | 46% | | 32% |
| Beech | | | | | | | | | | | | | | | | | 20% | | | 8% | 20% | | | | 58% | 6% | 76% | | 50% | 27% | | |
| Mountain maple | | | | | | | | 47% | | 33% | | | | | | 13% | 20% | | | | 30% | | 58% | | 5% | | 5% | | 22% | 11% | | |
| Pincherry | | | | | | | | 7% | | | | | | | | | | | | 17% | | | | | | 3% | | | | 3% | | 5% |
| Grey Birch | | | | | | | | | | | | | | | | | | | | | | 25% | | | | | | | | | | |
| Other[3] | | | | | | | | 13% | | | | | 10% | | | | | | | 8% | 20% | | | | | | | 13% | | | | 5% |
| Non-commercial Total | | | 40% | 11% | | | 56% | 67% | | 33% | | 50% | 10% | | 50% | 13% | 100% | 19% | 14% | 67% | 75% | 25% | 65% | | 74% | 56% | 86% | 25% | 78% | 70% | | 36% |
| Not stocked | | 10% | 10% | 11% | | | 11% | | | | 17% | | 10% | | 10% | | | 6% | | | | | | 10% | | 3% | | 13% | | 5% | 4% | 5% |
| Number of plots | 1* | 10 | 10 | 9 | 10 | 2* | 9 | 15 | 10 | 6* | 6* | 4* | 10 | 2* | 10 | 8 | 5* | 16 | 7 | 12 | 20 | 12 | 26 | 10 | 19 | 34 | 21 | 16 | 18 | 37 | 24 | 22 |

* Small sample size (see number of plots at botton of table): Results for these stands should be treated with caution.

[1]Long Lived species include red spruce, eastern hemlock, white pine, sugar maple, yellow birch, red oak, and white ash.

[2]Tolerant species include red spruce, eastern hemlock, and sugar maple.

[3]Other non-commercial includes serviceberry, chokecherry, alder, willow.

Appendix 9. Regeneration by individual stand ID: average of dominant heigths. Only the regeneration in the treated portions of the stand are included.

| | Average of Dominant Heights (cm) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stand ID | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Species | 1102* | 1103 | 1104 | 1105 | 1106 | 1107* | 1108 | 1109 | 1110 | 1111* | 1112* | 1113* | 1114 | 1115* | 1116 | 1117 | 1118* | 1119 | 1120 | 1121 | 1122 | 1123 | 1124 | 1125 | 1128 | 1129 | 1130 | 1131 | 1132 | 1133 | 1134 | 1136 |
| Balsam fir | 60 | | 140 | 90 | 104 | 201 | 87 | 83 | 97 | 59 | | 158 | 98 | 40 | 198 | 105 | 145 | 115 | 200 | | 150 | 123 | 68 | 108 | 185 | 108 | 150 | 75 | 140 | 187 | 126 | 213 |
| Red spruce | 20 | 49 | 94 | 73 | 103 | | 90 | | | | | 140 | 40 | | 180 | 35 | | 64 | 100 | 203 | | | | 116 | | | 190 | 51 | | | 82 | 244 |
| Hemlock | | 76 | 57 | | 42 | | 124 | | 97 | | | | 45 | | | | | | | | | | | 30 | | | | | | | | |
| Black Spruce | | | | | | | | | 113 | | | 300 | | | | | | | | | | 93 | | | 88 | | | | | | | |
| White pine | | 88 | 93 | 70 | 66 | | | | 83 | | | | 40 | | | | | | | | | 75 | | 100 | | | | | | 200 | | |
| White spruce | | | | 40 | | | | | | | | | | 65 | | 25 | | | | 150 | 177 | | | 75 | 90 | 174 | | | | | | |
| Larch | | | | | | | | | | | | | | | | | | | | | | 53 | | | | | | | | | | |
| Softwood Total | 40 | 66 | 95 | 80 | 85 | 201 | 97 | 83 | 96 | 59 | | 178 | 71 | 53 | 194 | 65 | 145 | 97 | 180 | 192 | 153 | 98 | 68 | 99 | 174 | 119 | 170 | 63 | 140 | 187 | 115 | 223 |
| Yellow birch | | | 147 | 75 | | | 153 | 174 | | 246 | 220 | | | | | | 365 | 103 | 160 | 436 | 186 | | 103 | | 249 | 177 | 292 | 35 | 308 | 199 | | 212 |
| Red maple (seed) | 10 | | | 170 | 75 | | 64 | 38 | 25 | | | | 79 | 20 | 24 | | | 23 | 128 | | 88 | 128 | 79 | 86 | 193 | 169 | 118 | 26 | 183 | 214 | 85 | 167 |
| Red maple (coppice) | | | 310 | 495 | 275 | | | 350 | 365 | | | 600 | | | | | | 428 | 270 | 510 | | | | | 290 | 520 | 450 | 410 | | | 369 | |
| Red maple | 10 | | 310 | 387 | 155 | | 64 | 155 | 250 | | | 600 | 79 | 20 | 24 | | | 360 | 203 | 510 | 88 | 128 | 79 | 86 | 208 | 218 | 159 | 58 | 183 | 214 | 312 | 167 |
| Sugar maple (seed) | | | 80 | | | | | 250 | | 119 | 90 | | | | | | 80 | 80 | 270 | | 137 | | 129 | | 64 | 85 | 57 | | 82 | 83 | | 70 |
| Sugar maple (coppice) | | | | | | | | | | | | | | | | | | | | | | | | | | | 503 | | | 207 | | 276 |
| Sugar maple | | | 80 | | | | | 250 | | 119 | 90 | | | | | | 80 | 80 | 270 | | 137 | | 129 | | 64 | 85 | 184 | | 82 | 97 | | 184 |
| White ash | | | | | | | | 208 | | | | | | | 30 | | | 48 | | | | | | 10 | | | | | | | | |
| Red oak | | | | | 30 | | | | 258 | | | | 15 | | | | | | | | | | | 5 | | | | | | | 108 | |
| Trembling aspen | | | | | | | | | | | | | 50 | | | | | | | | | | | | | | | | | | | |
| Large tooth aspen | | | | | | | | | | | | | 200 | | | | | | | | | | | | | | | | | | | |
| white birch | 10 | | | | 90 | | | | | | | | 10 | | | 180 | | 170 | 177 | 390 | | 60 | 80 | | 285 | 140 | | 23 | | | | 210 |
| Hardwood Total | 10 | | 185 | 262 | 105 | | 101 | 188 | 254 | 195 | 127 | 600 | 67 | 20 | 25 | 180 | 175 | 221 | 189 | 455 | 147 | 121 | 106 | 60 | 196 | 177 | 223 | 48 | 187 | 151 | 265 | 188 |
| Softwood and Hardwood Total | 25 | 66 | 133 | 128 | 90 | 201 | 99 | 153 | 134 | 172 | 127 | 239 | 69 | 42 | 85 | 94 | 168 | 146 | 187 | 361 | 148 | 106 | 101 | 89 | 189 | 160 | 221 | 56 | 180 | 159 | 158 | 203 |
| Long Lived Species[1] | 20 | 66 | 106 | 73 | 71 | | 120 | 205 | 139 | 195 | 127 | 140 | 36 | | 105 | 35 | 175 | 76 | 167 | 332 | 157 | 75 | 116 | 81 | 182 | 140 | 238 | 49 | 189 | 130 | 96 | 211 |
| Tolerant Species[2] | 20 | 63 | 80 | 73 | 81 | | 104 | 250 | 97 | 119 | 90 | 140 | 43 | | 180 | 35 | 80 | 66 | 185 | 203 | 137 | | 129 | 94 | 64 | 85 | 185 | 51 | 82 | 97 | 82 | 210 |
| Striped maple | | | 163 | 70 | | | 168 | | | | | 155 | | | 302 | | 336 | 227 | 130 | 320 | 240 | | 53 | | 216 | 309 | 326 | 55 | 198 | 155 | | 253 |
| Beech | | | | | | | | | | | | | | | | | 200 | | | 260 | 268 | | | | 238 | 290 | 304 | | 256 | 222 | | |
| Mountain maple | | | | | | | | 290 | | 150 | | | | | | 120 | 250 | | | | 128 | | 179 | | 80 | | 150 | | 258 | 173 | | |
| Pincherry | | | | | | | | 200 | | | | | | | | | | | | 420 | | | | | | 450 | | | | 410 | | 290 |
| Grey Birch | | | | | | | | | | | | | | | | | | | | | | 110 | | | | | | | | | | |
| Other[3] | | | | | | | | 175 | | | | | 300 | | | | | | | 210 | 120 | | | | | | | 75 | | | | 170 |
| Non-commercial Total | | | 163 | 70 | | | 168 | 258 | | 150 | | 155 | 300 | | 302 | 120 | 304 | 227 | 130 | 323 | 190 | 110 | 158 | | 222 | 314 | 304 | 65 | 228 | 186 | | 248 |
| Number of plots | 1* | 10 | 10 | 9 | 10 | 2* | 9 | 15 | 10 | 6* | 6* | 4* | 10 | 2* | 10 | 8 | 5* | 16 | 7 | 12 | 20 | 12 | 26 | 10 | 19 | 34 | 21 | 16 | 18 | 37 | 24 | 22 |

* Small sample size (see number of plots at botton of table): Results for these stands should be treated with caution.

[1]Long Lived species include red spruce, eastern hemlock, white pine, sugar maple, yellow birch, red oak, and white ash.

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[3]Other non-commercial includes serviceberry, chokecherry, alder, willow.