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**Abstract:** This report examined whether uniform partial harvesting can be used to speed up the restoration of late successional species in stands that were dominated by early successional intolerant hardwood species such as white birch, red maple, and aspen. In 1978, seven (7) intolerant hardwood stands were thinned at different intensities; 20%, 40%, and 60% of the basal area was removed uniformly, also part of the experimental design were un-thinned controls. The growth and species composition changes were tracked over time using permanent sample plots. There was virtually no re-introduction of white birch and aspen despite containing a significant component of these species originally, therefore this study has shown that partial harvesting can be used to extract timber without setting back succession; if clearcut it is likely these pioneer species would have proliferated once again. Partial harvesting however did not guarantee a swift transition directly to late successional species, mid-successional stages where balsam fir and red maple are common may dominate for decades.

After thirty-seven (37) years, three (3) sites are still classed as early successional and the remaining four (4) sites are early-mid to mid successional. The proportion of long-lived, intermediate to shade tolerant (LIT) species for the following treatments (un-thinned control, 20%, 40%, and 60% basal area removed) was 23%, 18%, 22%, and 18% respectively; starting from 11%, 1%, 3%, and 6%, this represents an increase of 12%, 17%, 19%, and 12%. The average basal area of the new growth for the following treatments (un-thinned control, 20%, 40%, and 60% basal area removed) was 5 m<sup>2</sup>/ha, 8 m<sup>2</sup>/ha, 10 m<sup>2</sup>/ha, and 9 m<sup>2</sup>/ha respectively, this suggests there is a slight acceleration in the growth of the next cohort due to the release from partial harvesting.

The results of this study suggest succession may be aided slightly by a lighter removal (20-40% of the basal area) but hindered by a heavier removal (60% of the basal area). The 60% removal tended to promote red maple which can prolong the early and mid successional stages. The 20% and 40% removals showed similar results but the 20% is deemed less desirable from an economic standpoint as less volume is removed which further reduces the economic viability of the treatment. The 40% basal area removal was deemed the preferred option as it strikes a balance between the recruitment of late successional species, new growth, and economics. As shown in this study, restoring late successional species requires very long time periods, decades, potentially even centuries and while uniform partial harvesting does not appear to hinder succession it also does not appear to speed it up to any great extent, slight gains occurred but no substantial gains thus far.

*Keywords:* Forestry, silviculture, partial harvesting, restoration, late-successional species, succession

## 1. Introduction

Forest succession is defined as a change in tree species composition over time often initiated by a disturbance (Taylor et al., 2020). These changes generally proceed through stages classed as early, mid, and late succession. Forests dominated by shade intolerant hardwood species such as white birch, aspen, and red maple, are classified as early successional according to Nova Scotia's Forest Ecosystems Classification (FEC) (Neily et al., 2023). These forests are dominated by fast-growing, shade-intolerant tree species that thrive following stand replacing disturbances due to an abundance of light and nutrient availability. In general, intolerant hardwood stands that are clearcut perpetuate the establishment of the same species because of the abundance of vegetative sprouts that occur when the parent tree is cut (Olson and Wager, 2011; Taylor et al. 2017b).

One of the main objectives of the Nova Scotia Silvicultural Guide for the Ecological Matrix (SGEM) is to restore late-succession, shade tolerant tree species where they would naturally occur but are currently low in number (McGrath et al., 2021). According to Nova Scotia's Ecological Landscape Analysis some areas have been identified as having a shortage in late succession stages. For example, the current amount of late-succession forest area of the Tolerant Hardwood Drumlins and Hummocks element of the Saint Mary's River ecodistrict (370) is reported as 19% when natural levels would be expected to be higher (NSDLF, 2019). In these cases, much of the area is dominated by intolerant hardwoods where restoration focused towards late succession mature cover may be beneficial to the ecological integrity of Nova Scotia's forests where land use and past management history has resulted in an over-abundance of early succession forests.

A research trial started now would take decades to provide any meaningful results; therefore, historic permanent sample plot (PSP) data was examined to see if any immediate results could be obtained from past trials. In 1978, a uniform commercial thinning trial was established by the Nova Scotia Department of Lands and Forests to explore the effects of different levels of tree removal in various intolerant hardwood stands. In general, trees responded poorly in terms of vigor to the treatment and in some cases health declined. Despite limited overstory growth response, these trials provided an opportunity to look at the long-term impacts of various partial harvesting intensities on stand succession in numerous intolerant hardwood stands in Nova Scotia.

With the introduction of the Nova Scotia Silvicultural Guide for the Ecological Matrix (SGEM) partial harvesting techniques such as shelterwoods, commercial thinnings, and selection harvests now dominate the silviculture practices employed on Crown lands. The goal of this report is to provide a better understanding of succession under different partial harvesting regimes and also the time frames that are involved to restore late succession mature cover and to provide a scientific basis for removal recommendations.

### 1.1. Sites

There were seven sites that were part of this study (Figure 1). Sand River and Roseway Lake were dominated by white birch (Table 1). Vaughan, Springhill JCT, and Upper Sixty Lk were dominated by white birch with a strong component of red maple. Maybee Rd was dominated by red maple with a strong component of white birch. Simpson's Corner was dominated by aspen. According to Nova Scotia's Forest Ecosystem Classification (FEC) system, the vegetation types were as follows; three IH6 (White birch-Red maple/Sarsaparilla-Bracken), two IH6b (White birch-Red maple/Sarsaparilla-Bracken, white birch variant), one IH8 (White birch-Red maple/Lambkill-Huckleberry) and one IH1 (Large-tooth aspen/Lambkill/Bracken) (Neily et al., 2023). In terms of ecosite, Springhill JCT and Simpson's Corner were classified as AC6 which has a poor nutrient regime. Sand River, Roseway Lake and Vaughan were classified as AC10, and Maybee Rd was classified as AC10/11, all of which have a medium nutrient regime. Upper Sixty Lk was classified as AC14(AC11) which has a rich nutrient regime (Table 1).

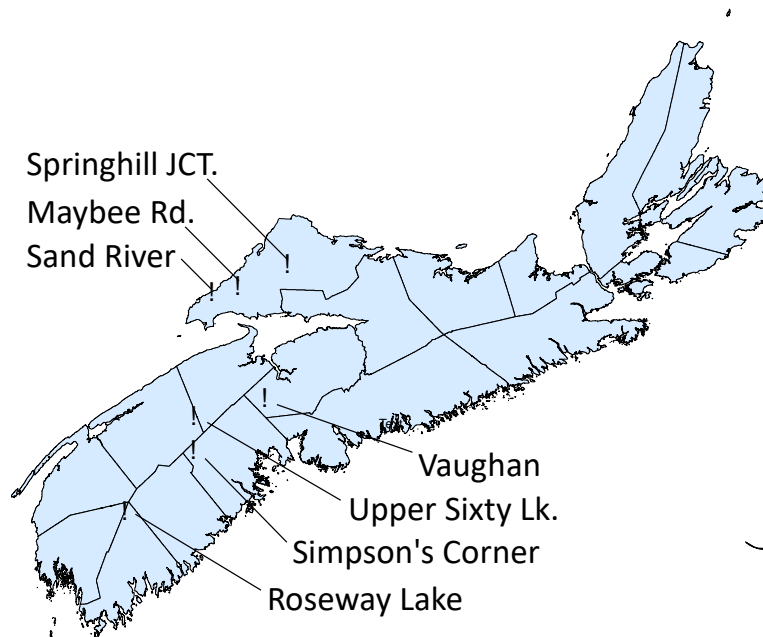


Fig. 1. The locations of the study sites in Nova Scotia.

Table 1. Site descriptions after partial harvesting in 1978.

Location	Species <sup>1</sup> Composition	Age	Veg Type	Soil Type <sup>2</sup>	Ecosite <sup>3</sup>	Nutrient Regime
Sand River	wB97yB01gB01	22	IH6b	ST2	AC10	Medium
Roseway Lake	wB95yB04gB01	28	IH6b	ST2(B)	AC10	Medium
Vaughan	wB71rM23yB04rO02sM01	51	IH6	ST2BS	AC10	Medium
Springhill JCT.	wB65rM29gB04tA01	60	IH8	ST2	AC6	Poor
Maybee Rd.	rM74wB18yB04sM03	44	IH6	ST5/ST6	AC10/11	Medium
Upper Sixty Lk.	wB74rM11sM10wA03yB02	62	IH6	ST9(3L)	AC14(AC11)	Rich
Simpson's Corner	lA80tA12rM04rO04	42	IH1	ST2	AC6	Poor

## 2. Methods

There were three harvest intensities (20%, 40%, and 60% of the basal area was removed uniformly) and an un-thinned control replicated twice at each site for a total of 8 blocks per site. These 8 blocks were randomly assigned to one of the four treatments. Each block was approximately 1 acre or 0.4 ha in size. Chainsaws and skidders were used to carry out the treatments. Following treatment, one permanent sample plot (PSP) per block was established in fully stocked areas to track growth and species composition changes over time. All trees with a minimum diameter of 4 cm or greater, including non-commercial tree species, were tagged and measured within each PSP. PSP's were re-measured on a 5 year cycle. During these subsequent re-measurements, additional trees were added once they reached the minimum diameter (4 cm). For the purposes of this study only 1978 and 2015 measurements were used. In 2015, trees below 4 cm in diameter (height classes: 0.3 m tall - 1.2 m tall, 1.3 m tall - 3.9 cm at diameter) were also tallied for the purpose of projecting the species composition into the future. Five of the original PSPs were lost since establishment for various reasons, including road construction, and therefore were removed from this analysis. PSP's removed from analysis include three (3) at Vaughan (a control, a 20% BAR, and a 60% BAR), one (1) at Springhill JCT. (a 20% BAR), and one (1) at Maybee Rd. (a 20% BAR).

<sup>1</sup>**Species:** gB=grey birch (*Betula populifolia* Marsh.), lA=large tooth aspen (*Populus grandidentata* Michx.), rM=red maple (*Acer rubrum* L.), rO=red oak (*Quercus rubra* L.), sM=sugar maple (*Acer saccharum* Marsh.), tA=trembling aspen (*Populus tremuloides* Michx.), wA=white ash (*Fraxinus americana* L.), wB=white birch (*Betula papyifera* Marsh.), yB=yellow birch (*Betula alleghaniensis* Britt.).

<sup>2</sup>**Soil Type:** ST2=Fresh-Medium textured, ST3=Moist-Medium textured, ST5= Fresh-Fine textured, ST6=Moist-Fine textured, ST9=Rich Moist-Medium textured. B=Boulder phase, L=Loamy phase, S=stony phase (Neily et al., 2023).

<sup>3</sup>**Ecosite:** AC6=Fresh-Poor/Black spruce-White pine, AC10=Fresh-Medium/Red spruce-Hemlock, AC11=Moist-Medium/Red spruce-Yellow birch, AC14=Moist-Rich/Sugar maple-Yellow birch (Neily et al., 2023).

Sand River was younger than the other sites so removals were done by spacing (1.8x1.8 m, 2.4x2.4 m, and 3.0x3.0 m) rather than by basal area resulting in 40%, 60%, and 80% BAR respectively. A clearcut treatment would have provided a valuable comparison but was not part of the original experimental design. It is surmised that if a clearcut had been performed it would have perpetuated the same intolerant species.

### 3. Results

#### 3.1. Long-Lived, Intermediate to Tolerant (LIT) Species

Long-lived, intermediate to tolerant (LIT)<sup>4</sup> species is a term used in the Nova Scotia Silvicultural Guide for the Ecological Matrix (SGEM). Tree species assigned to the category LIT are considered long-lived due to their inherent natural longevity and have a shade tolerance range of intermediate to tolerant. LITs are generally considered the species that dominate in late succession climax forest communities on zonal sites. The harvest treatments prescribed in the SGEM are designed to maintain, promote and restore LIT species where ecologically appropriate.

In 2015, thirty-seven years after seven (7) intolerant hardwood stands were partially harvested, the proportion of LIT species for the following treatments (control, 20%, 40%, and 60% basal area removed) was 23%, 18%, 22%, and 18% respectively; this represents an increase of 12%, 17%, 19%, and 12% (Table 2). These treatment averages represent all sites and replicates and are based on basal area. It should be noted that the controls initially had a higher level of LIT species than those that were partially harvested, this was attributed to favoring the main intolerant hardwood species during the thinning process.

Table 2. The change in the proportion of LIT species that occurred over a 37-year period following different levels of partial harvesting.

Year	Size Class	Control	20% BAR	40% BAR	60% BAR
1978 (post-treatment)	≥ 4 cm dbh	11%	1%	3%	6%
2015	≥ 4 cm dbh	23%	18%	22%	18%
	Difference	12%	17%	19%	12%

<sup>4</sup> Long-lived, Intermediate to Tolerant (LIT) Species: red spruce (*Picea rubens* Sarg.), eastern hemlock (*Tsuga canadensis* (L.) Carriere), white pine (*Pinus strobus* L.), sugar maple (*Acer saccharum* Marsh.), yellow birch (*Betula alleghaniensis* Britt.), red oak (*Quercus rubra* L.), white ash (*Fraxinus americana* L.) and white spruce (*Picea glauca* (Moench) Voss) (non OF, CO, HL). White spruce grown in Old Field (OF), Coastal (CO), and Highland (HL) forest groups are not considered LIT (McGrath et al., 2021).

### 3.2. Long-Lived, Intermediate to Tolerant (LIT) Species: Regeneration

In terms of the regeneration that developed within the understory in the 37 years following partial harvesting, the proportion of LIT species for the following treatments (control, 20%, 40%, and 60% basal area removed) was 47%, 47%, 45%, and 44% respectively (Table 3). Compared to the other treatments, the 60% removal had a greater proportion of LIT species in the smaller size class (Table 3).

Table 3. The proportion of the regeneration by size class that is comprised of LIT species in 2015 broken down by harvest intensity (BAR=basal area removed).

Regeneration	Size Class	Control	20% BAR	40% BAR	60% BAR
2015 - Saplings <sup>5</sup>	≥ 4 cm dbh	54%	53%	47%	34%
2015 - Seedlings <sup>6</sup>	≥ 0.3 m tall-3.9 cm dbh	44%	42%	45%	52%
Regeneration = Saplings + Seedlings		47%	47%	45%	44%

### 3.3. Results by Site

Figure 2 shows the species composition of just the LIT species, whereas Figure 3 shows all species; visualization of the LIT status of each site is easier when the other species are removed. Sand River, Vaughan and Maybee Rd showed advanced levels of LIT saplings and seedlings, often more than 50% (Figure 2 a,c,e). Roseway Lake, Springhill JCT and Upper Sixty Lk showed moderate levels of LIT saplings and seedlings (Figure 2 b,d,f). Simpson's Corner showed very little in the sapling category, but LIT species did appear in the seedling category with results ranging between 44% to 55% (Figure 2g).

- Sand River:** In 1978, Sand River was predominantly a pure white birch stand (Figure 3a). In 2015, Sand River was 59 years old and had lost a significant component of the original white birch. Despite containing no red maple in the overstory at the time of treatment, a significant component of red maple saplings and seedlings became established in the 60% removal. The re-introduction of white birch was minor with slightly more in the 60% removal. Balsam fir in conjunction with red spruce is likely to form a significant portion of the stand for the next half century but due to balsam fir's shorter life span it is expected to ultimately die out leaving the red spruce (a LIT).

<sup>5</sup> Saplings: Does not include the original trees that were measured at the time of PSP establishment in 1978. Only includes new additions to the plots, those trees that developed within the understory and were added in subsequent re-measurements once they reached the minimum size (≥4 cm dbh). The % LIT species is based on basal area.

<sup>6</sup> Seedlings: Trees in this size class (≥ 0.3 m tall-3.9 cm dbh) were only measured once in 2015 for the purpose of projecting the species composition into the future. The % LIT species is based on density.



- **Roseway Lake:** In 1978, Roseway Lake was mostly white birch with minor amounts of yellow birch (Figure 3b). In 2015, this stand was 65 years-old and a large component of the original white birch was still present. White birch did not re-establish under the shade of the canopy that was left. Like Sand River, balsam fir and potentially some black spruce and red maple will delay succession at the mid-successional stage, but will ultimately succeed to red spruce, white pine, and yellow birch.
- **Vaughan:** In 1978, Vaughan contained mainly white birch with some red maple and scattered yellow birch, sugar maple and red oak (Figure 3c). In 2015, this stand was 88 years-old and the original red maple was still present, but the white birch was starting to decline and mortality was evident. The sapling size class was mainly comprised of LIT species (>75%), therefore this stand may advance more quickly than others to a late successional species mix. This was the only stand where hemlock was present. There was more sugar maple and yellow birch regeneration in the heavier removals, but also more red maple. There was a significant component of mountain maple (~20%) and striped maple (~5%) in the seedling category but they are unlikely to impede succession as they were in the smallest size class and are relatively short lived.
- **Springhill JCT:** In 1978, Springhill JCT was mostly white birch and red maple (Figure 3d). In 2015, this stand was 97 years-old and the original overstory was receding, mostly the white birch component. The stand was regenerating to black spruce, white spruce, balsam fir, and red maple with the red maple more prevalent in the 60% removal treatment. Given enough time, this stand could eventually succeed to black spruce but will have a significant amount of balsam fir and red maple for the foreseeable future.
- **Maybee Rd:** In 1978, Maybee Rd contained mainly red maple with some white birch and scattered sugar maple and yellow birch (Figure 3e). In 2015, this stand was 81 years-old and the proportion of original red maple had decreased significantly. The stand was mainly regenerating to red spruce (~75% of the understory comprised of red spruce), with scattered white spruce and white pine. Striped maple also formed a significant part of the regeneration (~25%), but likely won't impede succession as this species is relatively short-lived compared to the other species present. Despite significant red maple in the original overstory there was almost no red maple present in the sapling or seedling categories.
- **Upper Sixty Lk:** In 1978, Upper Sixty Lk contained mainly white birch with some red maple and scattered sugar maple, yellow birch, and white ash (Figure 3f). In 2015 the stand was 99 years-old, there had been little change and much of the original canopy was still intact. In terms of saplings, the un-thinned control contained more balsam fir than the other treatments, while the heavier removals (40%BAR and 60% BAR) promoted sugar maple regeneration. White ash was abundant in the seedling layer. Upper Sixty Lk is a richer ecosite, AC14(AC11), unlike the other trial locations this area is likely to transition to a tolerant hardwood stand type containing mainly sugar maple, red maple, and white ash.

- **Simpson's Corner:** In 1978, Simpson's Corner was predominantly a large tooth aspen stand with some trembling aspen and scattered red maple and red oak (Figure 3g). In 2015 the stand was 79 years-old, and showed little change from 1978 species composition as much of the original canopy was still intact. Even though this stand was predominantly aspen, there was no evidence of suckering after it was partially harvested. The majority of the sapling category was composed of red maple, while red oak and white pine appeared in the seedling layer. Given enough time, this stand could eventually succeed to red oak and white pine but will have a significant amount of red maple for the foreseeable future.

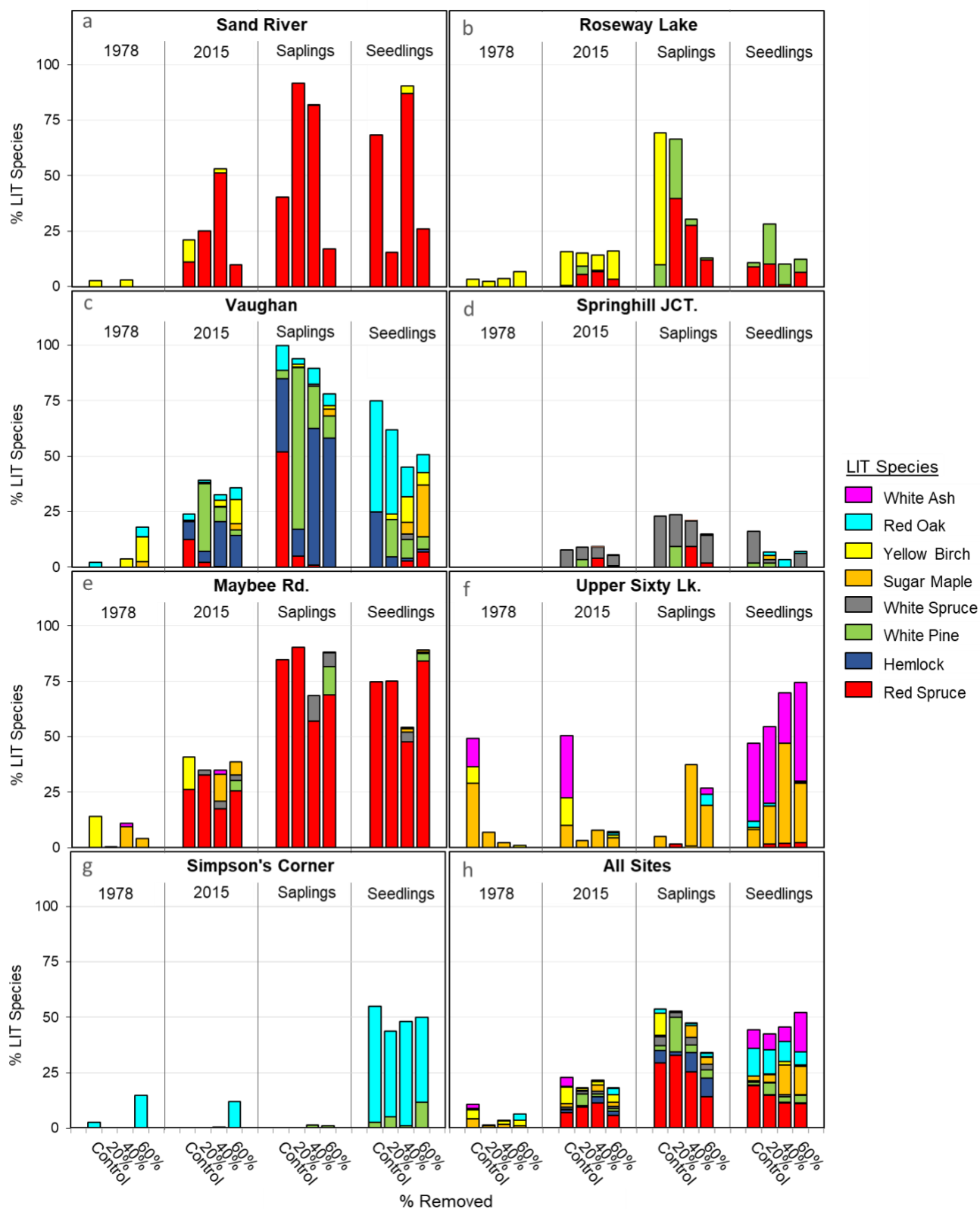


Fig. 2. The proportion of long-lived, intermediate to tolerant (LIT) species 37 years after seven (7) intolerant hardwood stands were partially harvested.

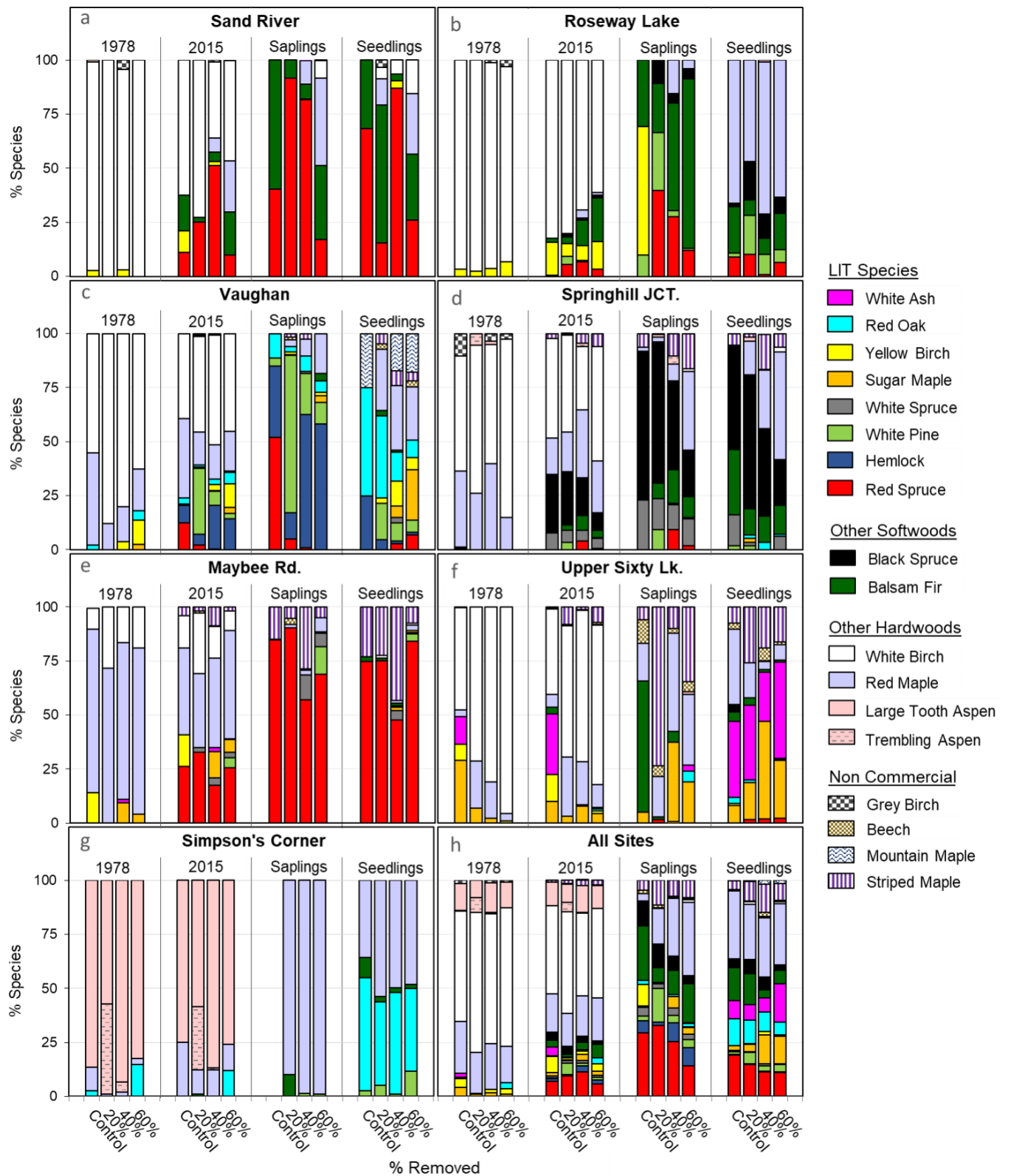


Fig. 3. The species composition 37 years after seven (7) intolerant hardwood stands were partially harvested.



### 3.4. Vegetation Type and Successional Stage

In 2015, after 37 years, Roseway Lake, Upper Sixty Lk. and Simpson’s Corner were still largely where they started at the early successional stage (Table 4 & Table 5). Sand River, Vaughan, Maybee Rd and Springhill JCT moved from early succession to early-mid to mid successional stages. In terms of removal levels, the 20% and the 40% basal area removals at Sand River and Vaughan are mid successional while controls are still early successional suggesting succession has been aided by these lighter removals; whereas the 60% removal is still at the early successional stage.

Table 4. Vegetation type (VT) and successional stages (Neily et al., 2023).

		2015				Predicting Future Development			
		Control	20% BAR	40% BAR	60% BAR	Control	20% BAR	40% BAR	60% BAR
Location	1978	Vegetation Types							
Sand River	IH6b	MW8	MW2	MW2	MW8	SH5b	SH5	SH5	MW7
Roseway Lk	IH6b	IH6b	IH6b	IH6b	IH6b	MW7	SH4	SH5b	SH8
Vaughan	IH6	IH6	MW12	MW4	IH6	SH3	SH2	SH2	MW4
Maybee Rd.	IH6	MW2	MW2	IH6	MW2	SH5	SH5	MW2	SH4
Up. Sixty Lk	IH6	IH6/TH9	IH6	IH6	IH6	TH9	TH9	TH9	TH9
<u>Azonal</u>									
Springhill JCT	IH8	MW9	MW9	MW9	IH8	SP5	SP5	SP5	MW9
Simpson’s C.	IH1	IH1	IH1	IH1	IH1a	IH2a	IH2a	IH2a	IH2a
Location	1978	Successional Stage							
Sand River	E	E*	M	M	E	M	M	M	E-M
Roseway Lk	E	E	E	E	E	E-M	L	M	E-M
Vaughan	E	E	E-M	M	E	L	L	L	M
Maybee Rd.	E	M	M	E	M	M	M	M	L
Up. Sixty Lk	E	E-L	E	E	E	L	L	L	L
<u>Azonal</u>									
Springhill JCT	E	M	M	M	E	L	L	L	M
Simpson’s C.	E	E	E	E	E	E	E	E	E

\*E = Early, M= Mid, L=Late

### 3.5. Predicting Future Development

A prediction was made regarding the vegetation types and successional stages that are likely to develop in the future (Table 4: predicting future development). This prediction was largely based on the sapling layer, but the seedlings were also taken into consideration. In terms of the next stage of stand development, it was projected that Simpson’s Corner will still be at the early successional stage; Sand River, Roseway Lake and Maybee Rd will largely be mid successional; while Vaughan, Upper Sixty Lk and Springhill JCT will largely be late-successional. At Sand River, Roseway Lk, Vaughan and Springhill JCT the lighter removals (20% and 40% basal area removed) are predicted to be farther along successional than the 60% removal. There tended to be a greater proportion of red maple associated with the 60% removals which can delay succession.

Table 5. Vegetation type (VT) codes, successional stages, and names (Neily et al., 2023).

VT Code	Successional Stage	Vegetation Type Name
<b>Intolerant Hardwood (IH) Forest Group</b>		
IH1	Early	Large-tooth aspen/Lambkill/Bracken
IH1a	Early	Large-tooth aspen/Lambkill/Bracken, red oak variant
IH2a	Early	Red oak/Witch-hazel-Lambkill, red maple variant
IH6	Early	White birch-Red maple/Sarsaparilla-Bracken
IH6b	Early	White birch-Red maple/Sarsaparilla-Bracken, white birch variant
IH8	Early	White birch-Red maple/Lambkill-Huckleberry
<b>Mixedwood<sup>7</sup> (MW) Forest Group</b>		
MW2	Mid	Red spruce-Red maple-White birch/Goldthread
MW4	Mid	Hemlock-Red maple/Wood fern-Starflower
MW7	Early-Mid	Balsam fir-Red maple/Wood-sorrel-Goldthread
MW8	Early	White birch-Balsam fir/Starflower
MW9	Mid	Black spruce-Red maple/Bracken-Sarsaparilla
MW12	Early-Mid	White pine-Red maple/Velvet-leaf blueberry/Bracken
<b>Spruce Hemlock (SH) Forest Group</b>		
SH2	Late	Hemlock-White pine/Sarsaparilla
SH3	Late	Red spruce-Hemlock/Wild lily-of-the-valley
SH4	Late	Red spruce-White pine/Lambkill/Bracken
SH5	Mid	Red spruce-Balsam fir/Schreber's moss-Stair-step moss
SH5b	Mid	Red spruce-Balsam fir/Schreber's moss-Stair-step moss, balsam fir variant
SH8	Early-Mid	Balsam fir/Wood fern/Schreber's moss
<b>Spruce Pine (SP) Forest Group</b>		
SP5	Late	Black spruce/Feathermoss
<b>Tolerant Hardwood (TH) Forest Group</b>		
TH9	Late	Red maple-Sugar maple/Hay-scented fern-Evergreen wood fern

<sup>7</sup> Mixedwoods: Stands where softwood is < 75% but > 25% of the overstory.

Softwoods: Stands with > 75% softwood in the overstory.

Hardwoods: Stands with > 75% hardwood in the overstory.

### 3.6. Successional Path

#### Zonal

Sand River, Roseway Lake, Vaughan, Maybee Rd and Upper Sixty Lk were all IH6 stands (White birch-Red maple/Sarsaparilla-Bracken), Sand River and Roseway Lake were the white birch variant of the IH6. As stated in Neily et al., (2023), “IH6 is associated with a range of site conditions ranging from relatively dry, coarse textured soils of medium fertility to relatively moist, richer, fine textured soils” which allows for a broad range of successional paths. This report provides additional supporting field data for the vegetation types and successional links described in Neily et al., (2023) and further validates their work.

- **Spruce Hemlock (SH) Forest Group:** Sand River, Roseway Lake, Vaughan, and Maybee Rd appear to be transitioning to a Spruce Hemlock forest group which contains softwood stand types found on zonal sites which typically support the development of zonal climax forests<sup>8</sup> (Table 4).
- **Tolerant Hardwood (TH) Forest Group:** Upper Sixty Lk is projected to transition to a Tolerant Hardwood forest group which contains hardwood stand types found on zonal sites which typically support the development of zonal climax forests (Table 4). A rich soil type along with other clues such as Christmas fern and tolerant hardwood regeneration point to this eventual outcome.

#### Azonal

Azonal sites are characterized by a poor nutrient regime which often leads to an edaphic (azonal) climax forest, which is a forest community that cannot progress to the zonal climax due to site limitations.

- **Azonal Mixedwoods (MW) or Spruce Pine (SP) Forest Group:** Springhill JCT is currently an MW9 vegetation type (Black spruce-Red maple/Bracken-Sarsaparilla) and may transition to an SP5 vegetation type (Black spruce/Feathermoss) with time as the red maple dies out and more black spruce dominate the site (Table 4). SP5 is the successional endpoint for many vegetation types in the Spruce Pine forest group. Simpson’s Corner is presently an IH1 vegetation type (Large-tooth aspen/Lambkill/Bracken) and is likely to transition to an IH2a vegetation type (Red oak/Witch-hazel-Lambkill, red maple variant). Over time and in the absence of fire the IH2a will succeed to MW11 (Red oak – White pine/teaberry) or SP4 (White pine/blueberry/Bracken) (Neily et al., 2023).

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<sup>8</sup> Zonal Climax Forest: Results when a forest community reflects regional climate norms and is not unduly affected by local extremes in site conditions (Neily et al., 2023).

### 3.7. Case Study – Sand River

A visual representation of the projected succession at Sand River is shown in Figure 4. In 1978, Sand River was an IH6b vegetation type (White birch-Red maple/Sarsaparilla-Bracken, white birch variant). In 2015, it transitioned to an MW8 vegetation type (White birch-Balsam fir/Starflower) or an MW2 vegetation type (Red spruce-Red maple-White birch/Goldthread) which are early and mid-successional respectively. The MW8 and MW2 stages will be short-lived as the white birch is already in decline, during the last 37 years it went from 96% to 55%. Once the white birch dies out, balsam fir and red spruce vegetation types will dominate (SH5 Red spruce-Balsam fir/Schreber's moss-Stair-step moss and MW7 Balsam fir-Red maple/Wood-sorrel-Goldthread). This stand will likely have a significant balsam fir component for the next half century but will ultimately transition to more red spruce as the shorter-lived fir falls out of the overstory.



**IH6b: White birch-Red maple/Sarsaparilla-Bracken, white birch variant**  
*"The IH6b variant is an early successional vegetation type that is strongly dominated by white birch and usually follows stand-level disturbances in both softwood and hardwood forests." (Neily et al., 2023)*



**SH5: Red spruce-Balsam fir/Schreber's moss-Stair-step moss**  
*"A mid-successional vegetation type that has abundant red spruce with varying amounts of balsam fir. Typically minor amounts of red maple and white birch indicate recent disturbance events, whereas yellow birch, white pine and hemlock indicate development toward a later successional stage." (Neily et al., 2013, 2023)*

Fig. 4. A visual representation of the projected succession at Sand River (photos are not of Sand River, but are meant to represent it).



### 3.8. Regeneration by Site

To get an understanding of the next stage of stand development, the regeneration by species (Figure 5) and size class (Figure 6) was looked at concurrently. For example, at Roseway Lake there was an abundance of red maple (Figure 5b), however the bulk of it was in the smallest size class (Figure 6b) whereas the LITs and other softwoods tended to be larger. Therefore, red maple may not play as significant a role in the next stage of stand development as Figure 5b on its own implies.

- **LIT Species:** Red spruce was common on many sites after partial harvesting (Figure 5 a,b,e,h). At Vaughan there was a wide variety of LIT species present (Figure 5c). At Upper Sixty Lk there was an abundance of white ash and sugar maple, particularly in the heavier removals (40%BAR and 60%BAR) (Figure 5f); however, approximately half of the sugar maple in the heavier removals are of sprout origin (Appendix 8). The LIT species in the heavier removals also tended to be larger (Figure 6f). At Simpsons Corner red oak was abundant (Figure 5g) but small in size (Figure 6g).
- **Other Softwoods (Sw):** There was a significant component of balsam fir at Sand River and balsam fir and black spruce at Roseway Lake (Figure 5 a,b), this will likely cause succession to stall at the mid-successional stage for decades. Springhill JCT also contained a significant component of black spruce; however in this case, given that it's a poor ecosite, black spruce is the ecologically appropriate successional end point for this stand (Figure 5d).
- **Other Hardwoods (Hw):** The most common and abundant hardwood competition after partial harvesting was red maple (Figure 5 a,b,c,d,f,g,h). At some sites the controls had no red maple regeneration (Figure 5 a,c), or a lesser amount compared to treated plots (Figure 5 d,e,g). At Sand River the heaviest removal (60% BAR) showed an increase in the density of larger red maple and white birch compared to the other removals (Figure 5a, 6a). This stand was immature (age=22) at the time of treatment and the heaviest removal allowed light to reach the understory resulting in the introduction of red maple and the resurgence of white birch. At Springhill JCT there was a similar situation where the 60% basal area removal resulted in an increase in the density of larger red maple compared to the other removals (Figure 5d, 6d). Thirty-seven years after partial harvesting, there was almost no re-introduction of white birch (Figure 5) even though most sites had a significant component of white birch originally (Figure 3). There was also no re-introduction of aspen at Simpson's Corner (Figure 5g) even though this site was originally largely comprised of aspen (Figure 3g).
- **Non Commercial (Com.):** Striped maple competition was present, especially at Maybee Rd and Upper Sixty Lk (Figure 5 e,f), but is less of a concern as this species is relatively short-lived.

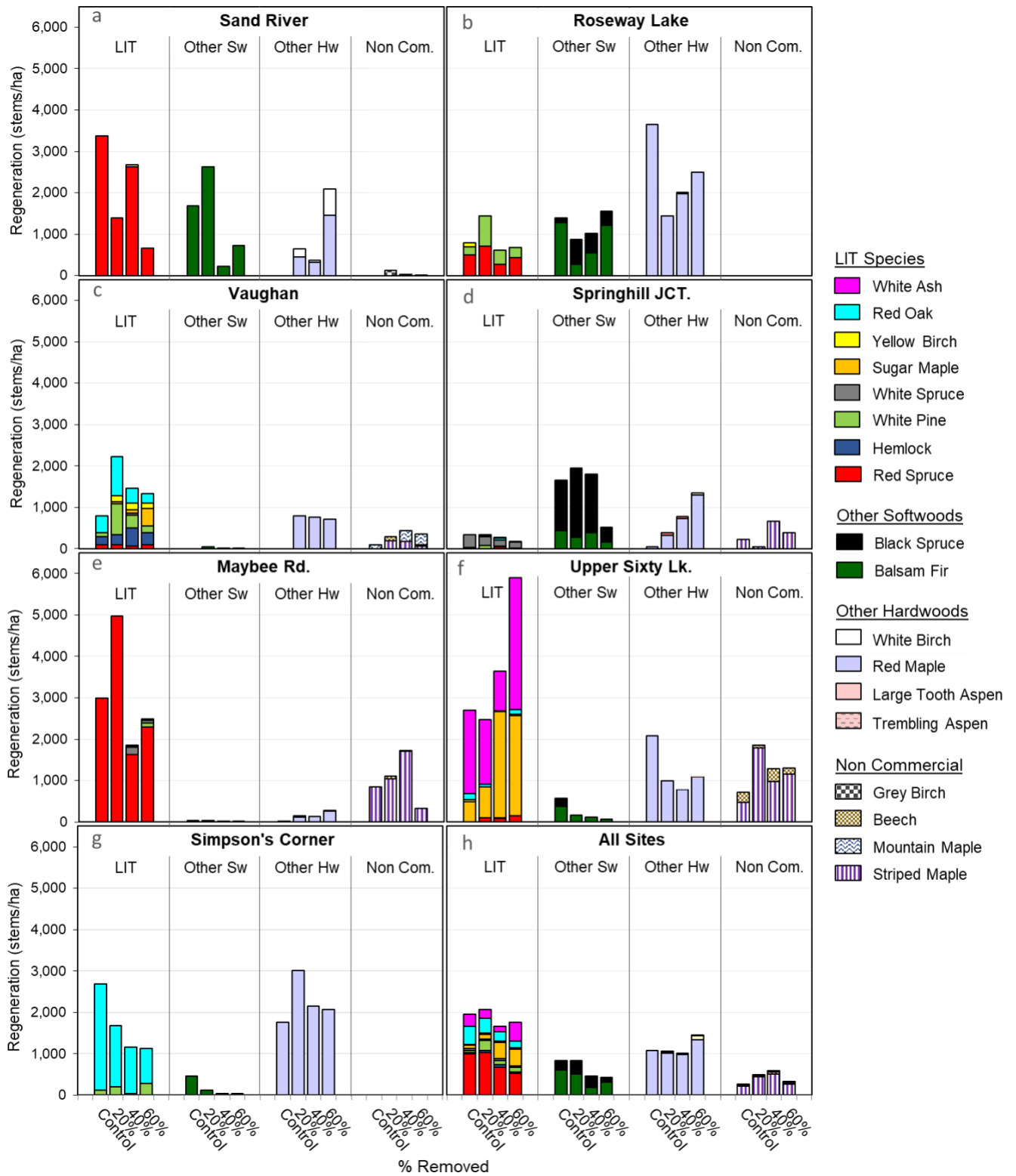


Fig. 5. The density of the regeneration by species 37 years after seven (7) intolerant hardwood stands were partially harvested.

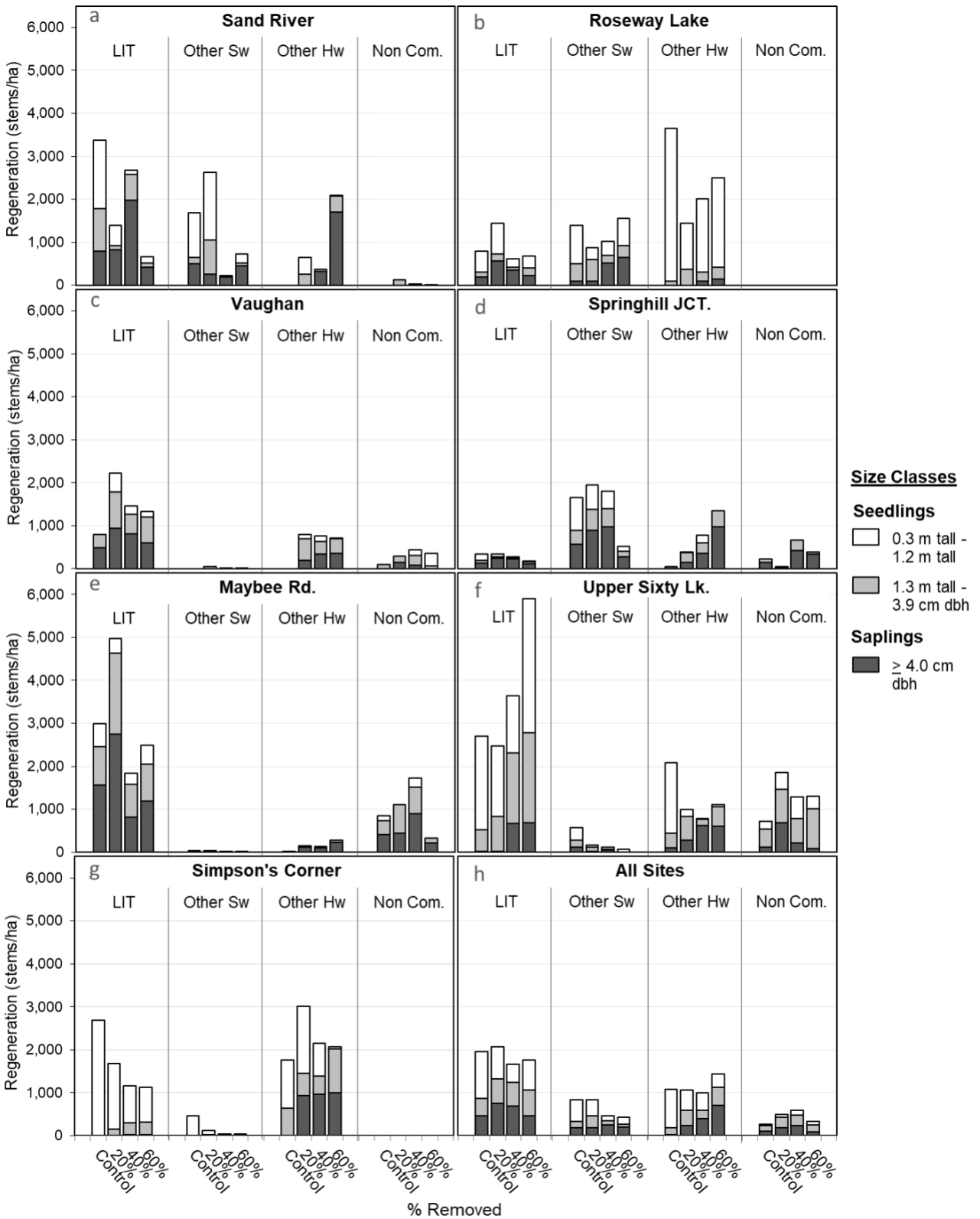


Fig. 6. The density of the regeneration by size class 37 years after seven (7) intolerant hardwood stands were partially harvested.

### **3.9. Basal Area**

Figure 7 shows the basal area growth over time broken down by strata, original vs. saplings (i.e. new growth). Thirty-seven years after seven (7) intolerant hardwood stands were partially harvested, the average basal area of the new growth for the following treatments (control, 20%, 40%, and 60% basal area removed) was 5 m<sup>2</sup>/ha, 8 m<sup>2</sup>/ha, 10 m<sup>2</sup>/ha, and 9 m<sup>2</sup>/ha respectively (Figure 7 h). In general, increased new growth occurred in the treated plots compared to controls (Figure 7 a,b,c,d,f,g,h), and the heavier removals tended to have the most new growth (Figure 7 a,b,f,h). There was minimal new growth at Upper Sixty Lk and Simpson's Corner (Figure 7 f,g), the overstory of these stands was still mainly intact, limiting the development of the next cohort.

### **3.10. Height**

Figure 8 shows the average height of the saplings relative to the remaining original overstory 37 years after partial harvesting. On average across all sites the original overstory was 15m tall and the saplings 8m tall (Figure 8h).



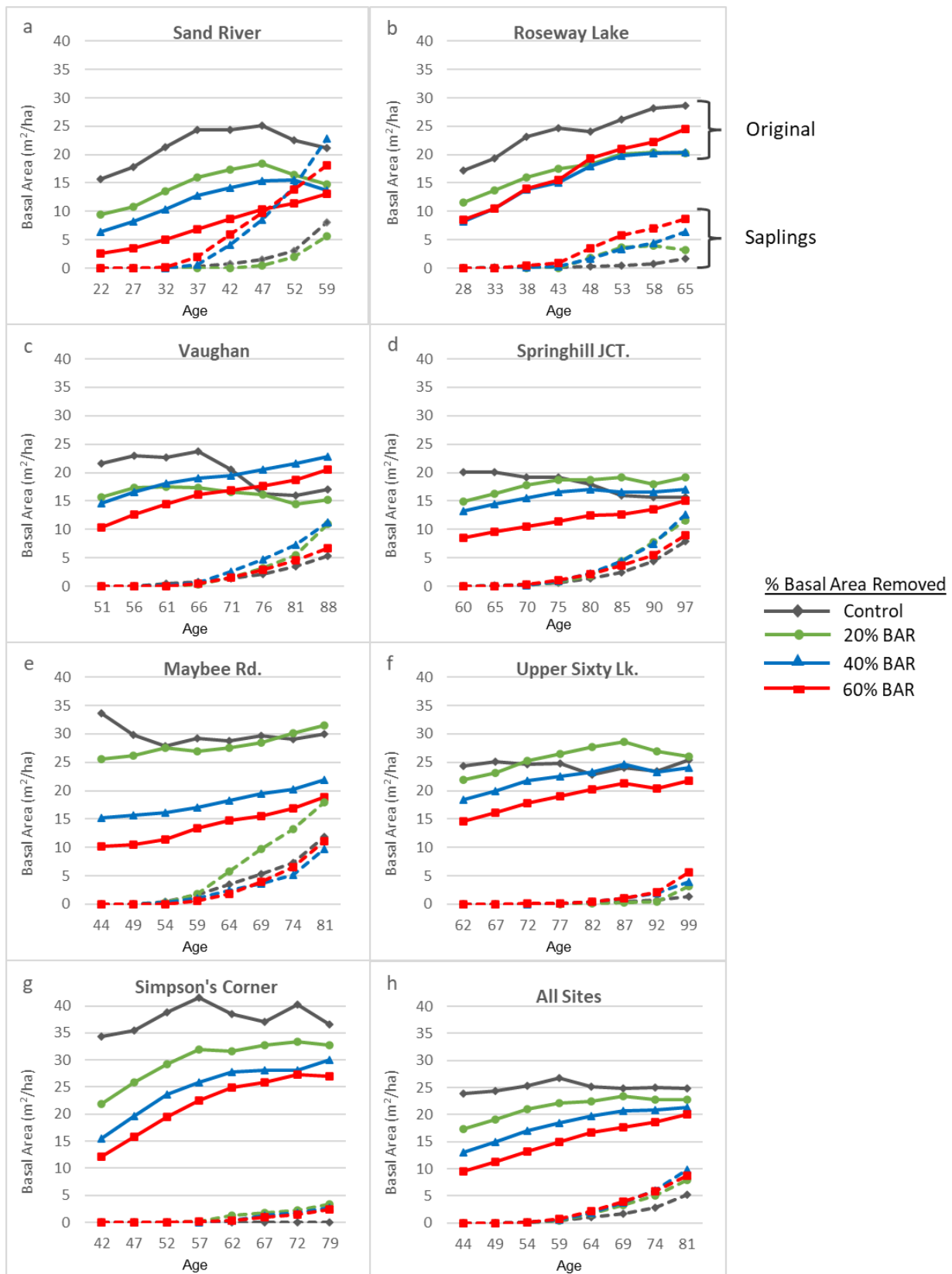


Fig. 7. The basal area growth broken down by strata (original vs. saplings) during the 37-year period following partial harvesting in seven (7) intolerant hardwood stands.

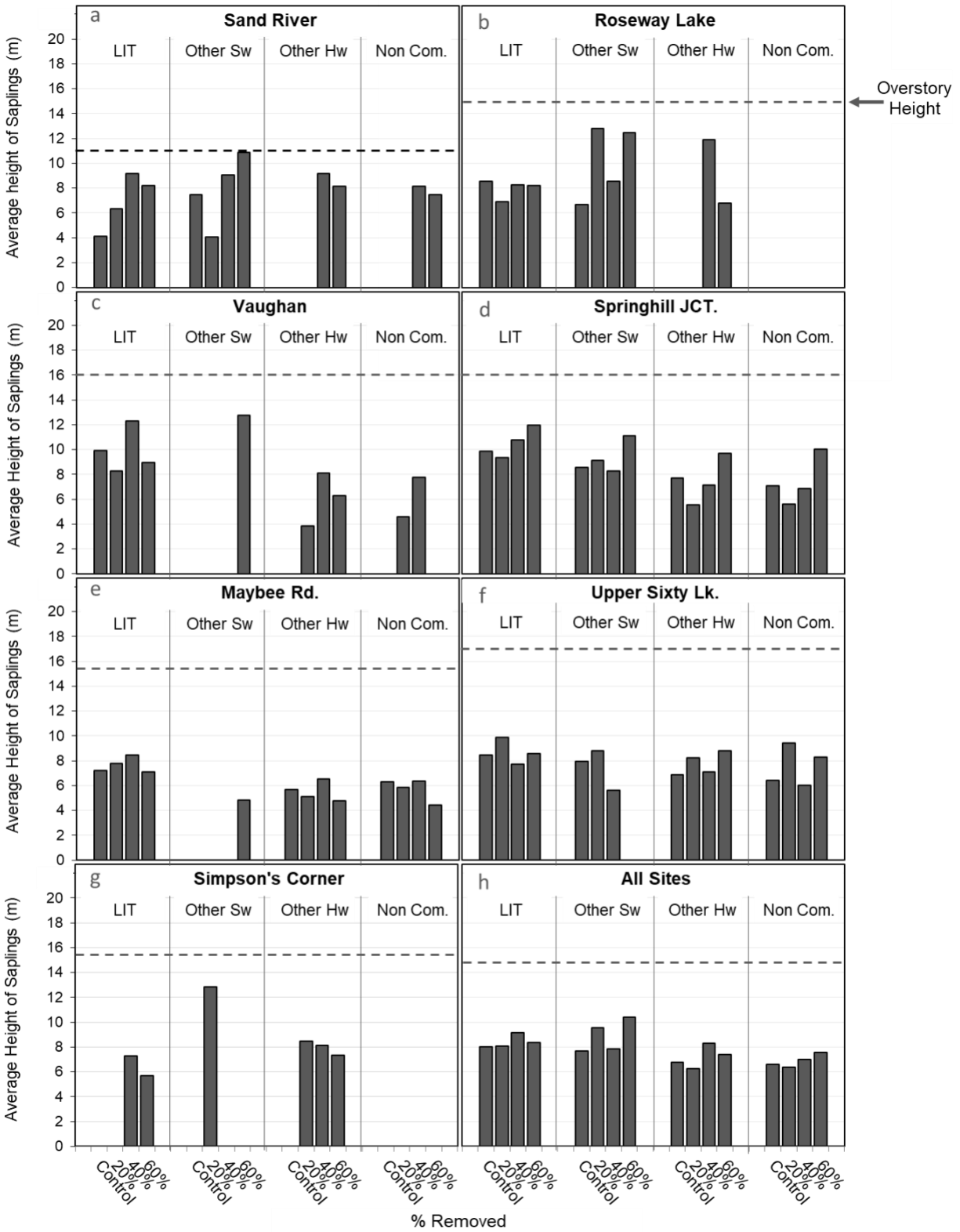


Fig. 8. The height of the saplings relative to the overstory 37 years after seven (7) intolerant hardwood stands were partially harvested.

#### 4. Discussion

Uniform or continuous cover partial harvesting was effective at controlling white birch and aspen, both are early successional pioneer species. There was almost no re-introduction of white birch even though most sites contained a significant component originally. There was also no re-introduction of aspen at Simpson's Corner even though this site was originally largely comprised of this species. Clearcutting of aspen can trigger prolific suckering, therefore uniform partial harvesting shows potential to avoid this problem. These findings are reassuring given Nova Scotia's Silvicultural Guide for the Ecological Matrix (SGEM) prescribes predominantly partial harvesting techniques and one of its objectives is to transition early successional forests to late-successional conditions where appropriate.

In terms of successional stage, three (3) sites are still classed as early successional and the other four (4) sites are early-mid to mid successional. On two of seven sites the 20% and 40% basal area removals were mid successional whereas controls were still early successional. On four of seven sites, the lighter removals (20% and 40% basal area) are predicted to be further along successional compared to the 60% removal. This suggests succession may be aided slightly by a lighter removal (20-40% basal area) but hindered by a heavier removal (60%). The 60% removal tended to promote the establishment of red maple which in certain instances prolonged the early and mid-successional stages. In terms of removal levels 40% is preferred, 20% showed comparable results but was deemed less desirable due to reduced volume extraction. It is important to make these treatments as economically feasible as possible without sacrificing future species composition.

From a timber perspective, intolerant hardwood stands in Nova Scotia are some of the least desirable, as the majority of what is present is classed as "low-grade hardwood". A partial harvest involves removing only a portion of the timber which further reduces economic viability. If partial harvest treatments were to occur in marginal stands such as these it is likely that financial incentives/support would be needed to make them economically viable. Based on the results from this study, the outcomes thus far may not warrant this type of investment and it may be best to leave these marginal stands alone and let them develop naturally.

In terms of the regeneration that developed within the understory in the 37 years following uniform partial harvesting, the proportion of LIT species for the following treatments (un-thinned control, 20%, 40%, and 60% basal area removed) was 47%, 47%, 45%, and 44% respectively. This could be an indication of how the stands may develop in the future, however this will take time as the original canopy has to recede before the next cohort can mature. This assumes that existing regeneration represents the species content over the long-term. While overall LIT proportions across treatments are similar, the size of the LIT trees decrease with increasing removal.

Many of the intolerant hardwood stands from this study, 4 out of the 7 sites, are on a successional path that is likely to culminate in a spruce hemlock forest group which typically contain late successional softwood species such as red spruce, white pine, and hemlock. As

shown in this study, restoration using partial harvesting techniques requires very long time periods. If quicker restoration is the goal, the site could be cleared and planted with the aforementioned late successional species where appropriate. This option avoids the mid successional stages, where species such as balsam fir and red maple can dominate for decades. However, the establishment of late successional climax species may not be the only factor under consideration, partial harvesting has the advantage of maintaining a component of mature and multi-aged forest which can fulfill other values such as habitat, biodiversity, recreation, and aesthetics. Also, planting a stand that recently contained white birch, red maple or aspen likely requires repeated manual weeding or herbicides to keep these pioneer species from re-establishing.

Reading the site, using concepts described in the Nova Scotia Forest Ecosystem Classification manual (Neily et al., 2023) and using clues such as soil type, surrounding stands, elevation, trees in the understory, and other vegetation that indicate site richness, or the lack of site richness, can be used to diagnose the ecologically appropriate successional path of an intolerant hardwood stand and therefore the most logical restoration option.

## References

- McGrath, T., Pulsifer, M., Seymour, R., Doucette, L., Forbes, G., McIntyre, R., Milton, R., Cogan, L., Retallack, M., & Crewe, T. (2021). *Nova Scotia Silvicultural Guide for the Ecological Matrix*. Halifax, NS: Nova Scotia Department of Lands and Forestry.
- Neily, P., Keys, K., Quigley, E., Basquill, S., & Stewart, B. (2013). *Forest Ecosystem Classification for Nova Scotia (2010)* [Report FOR 2013-1]. Truro, NS: Nova Scotia Department of Natural Resources, Renewable Resources Branch.
- Neily, P., Basquill, S., Quigley, E., Keys, K., Maston, S., & Stewart, B. (2023). *Forest Ecosystem Classification for Nova Scotia (2022): Field Guide*. [Biodiversity Tech Report 2023-002]. Truro, NS: Nova Scotia Department of Natural Resources and Renewables, Renewable Resources Branch.
- Nova Scotia Department of Lands and Forestry. (2019 Update). *Ecological Landscape Analysis of St. Marys River Ecodistrict 370*. Truro, NS: Nova Scotia Department of Lands and Forestry.
- Olson, M.G., Wagner, R.G. (2011). Factors affecting species richness of tree regeneration in mixed-wood stands of central Maine. *J. Veg. Sci.* 22, 303-311.
- Taylor, A. R., MacLean, D.A., McPhee, D., Dracup, E., Keys, K. (2017b). Salvaging has minimal impacts on vegetation regeneration 10 years after severe windthrow. *For. Ecol. Manage.* 406, 19-27.
- Taylor, A. R., Endicott, S., & Hennigar, C. (2020). Disentangling mechanisms of early succession following harvest: Implications for climate change adaption in Canada's boreal-temperate forests. *Forest Ecology and Management*, 461, 1-15.

## 1978 % Species Composition

Appendix 1. The percent species composition (based on basal area) in 1978 post-treatment.

Location/ #	Stand in 1978	Stump Age when treated	Spacing / Basal Area Removed (BAR)	Long-Lived, Intermediate to Tolerant (LIT) Species									Other Softwoods		Other Hardwoods				Non-Commercial				
				Red spruce	Hem- lock	White Pine	White Spruce	Sugar Maple	Yellow Birch	Red Oak	White Ash	Total LIT Species	Balsam Fir	Black Spruce	Red Maple	White Birch	T. Aspen	LT Aspen	Beech	Striped Maple	Grey Birch		
Sand River 0211	22	≥ 4 cm dbh	Control 1.8mx1.8m 2.4mx2.4m 3.0mx3.0m						3%					3%			96%	1%					4%
Roseway Lake 0311	28	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR						3%					3%			97%						1%
Vaughan 0411	51	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR								2%			2%			43%	55%					3%
Springhill JCT. 0511	60	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR												1%		35%	53%					11%
Maybee Rd. 0911	44	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR	0.04%					14%					14%			75%	10%					
Upper Sixty Lk. 3311	62	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR				0.1%							0.1%			71%	29%					
Simpson's Corner 2211	42	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR								3%			3%			11%			86%			
All Sites		≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR	0.01%			0.01%	4%	4%	1%	1%	2%	11%		0.2%	24%	51%	0.1%	12%	0.1%		2%	
								1%	0.3%			0.2%	1%			19%	65%	7%	8%			1%	
								2%	1%				3%			21%	60%	1%	14%				
								1%	3%	3%			6%			17%	64%		12%			1%	

## 1978 Basal Area

Appendix 2. Basal area (m<sup>2</sup>) in 1978 post-treatment.

Location/ #	Stand in 1978	Stump Age when treated	Size Class	Spacing / Basal Area Removed (BAR)	Long-Lived, Intermediate to Tolerant (LIT) Species								Other Softwoods		Other Hardwoods				Non-Commercial			Total					
					Red spruce	Hem- lock	White Pine	White Spruce	Sugar Maple	Yellow Birch	Red Oak	White Ash	Total LIT Species	Balsam Fir	Black Spruce	Red Maple	White Birch	T. Aspen	LT Aspen	Beech	Striped Maple		Grey Birch				
Sand River 0211	22	≥ 4 cm dbh	Control 1.8mx1.8m 2.4mx2.4m 3.0mx3.0m							0.43			0.43				15.10	0.15						15.68			
																			9.46						9.46		
																				5.86					0.28	6.32	
																				2.61						2.61	
Roseway Lake 0311	28	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR							0.58			0.58				16.62							17.20			
																			11.28						11.55		
																				7.81					0.09	8.18	
																				7.71					0.26	8.55	
Vaughan 0411	51	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR									0.45	0.45				9.21	11.91						21.57			
																			1.91	13.83						15.74	
																				2.33	11.69						14.58
																				1.99	6.46						10.31
Springhill JCT. 0511	60	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR													0.22	7.07	10.63						2.11	20.03		
																			3.87	10.23	0.80					14.90	
																				5.27	7.33		0.20			0.48	13.28
																				1.26	7.04					0.21	8.52
Maybee Rd. 0911	44	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR							0.01			4.73				25.38	3.27						33.38			
																			18.27	7.30						25.59	
																				11.04	2.51						15.20
																				7.85	1.94						10.20
Upper Sixty Lk. 3311	62	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR														0.78	11.48					0.10	24.37			
																			4.84	15.63						21.96	
																				3.04	14.91						18.38
																				0.52	13.95						14.61
Simpson's Corner 2211	42	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR														3.75				29.67			34.33			
																			0.24		9.09	12.51				21.84	
																				0.32		0.71	14.43				15.46
																				0.32			10.00				12.12
All Sites		≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR							0.002			2.73			0.03	6.60	9.86	0.02	4.24	0.01		0.30	23.79			
																			4.16	9.68	1.41	1.79				17.29	
																				3.14	7.16	0.10	2.09			0.12	13.06
																				1.71	5.67		1.43			0.07	9.56



## 1978 Height

Appendix 3. Average height (m) in 1978 post-treatment.

Location/ #	Stand	Stump Age when treated in 1978	Spacing / Basal Area Size Removed (BAR)	Long-Lived, Intermediate to Tolerant (LIT) Species									Other Softwoods		Other Hardwoods				Non-Commercial			Avg.			
				Red spruce	Hem- lock	White Pine	White Spruce	Sugar Maple	Yellow Birch	Red Oak	White Ash	Balsam Fir	Black Spruce	Red Maple	White Birch	T. Aspen	LT Aspen	Beech	Striped Maple	Grey Birch					
Sand River 0211		22	≥ 4 cm	Control						6							6	6				6			
			dbh	1.8m x 1.8m						6								6					6		
				2.4m x 2.4m						6													7	7	
				3.0m x 3.0m																				6	6
Roseway Lake 0311		28	≥ 4 cm	Control						7													7		
			dbh	20% BAR						7														7	
				40% BAR						7														8	7
				60% BAR						6														8	7
Vaughan 0411		51	≥ 4 cm	Control								7												10	
			dbh	20% BAR																					12
				40% BAR							11														14
				60% BAR					14	12	13														14
Springhill JCT. 0511		60	≥ 4 cm	Control											12									13	
			dbh	20% BAR																					12
				40% BAR															15						14
				60% BAR																15					14
Maybee Rd. 0911		44	≥ 4 cm	Control																				13	
			dbh	20% BAR																					14
				40% BAR																					13
				60% BAR																					11
Upper Sixty Lk. 3311		62	≥ 4 cm	Control																				10	
			dbh	20% BAR																					14
				40% BAR																					15
				60% BAR																					14
Simpson's Corner 2211		42	≥ 4 cm	Control																				9	
			dbh	20% BAR																					10
				40% BAR																					11
				60% BAR																					12

## 1978 Density

Appendix 4. Density (stems/ha) in 1978 post-treatment.

Location/ #	Stand treated in 1978	Stump Age when Size Class	Spacing / Basal Area Removed (BAR)	Long-Lived, Intermediate to Tolerant (LIT) Species									Other Softwoods		Other Hardwoods				Non-Commercial			Total				
				Red spruce	Hem- lock	White Pine	White Spruce	Sugar Maple	Yellow Birch	Red Oak	White Ash	Total LIT Species	Balsam Fir	Black Spruce	Red Maple	White Birch	T. Aspen	LT Aspen	Beech	Striped Maple	Grey Birch					
Sand River 0211	22	≥ 4 cm dbh	Control							247			247				9,957	151								10,354
			1.8mx1.8m															4,063								4,063
			2.4mx2.4m									74		74				1,680						49		1,804
			3.0mx3.0m															927								927
Roseway Lake 0311	28	≥ 4 cm dbh	Control							395			395				5,535								5,930	
			20% BAR								99		99				3,323								3,422	
			40% BAR								74		74				2,125						25		2,224	
			60% BAR								198		198				1,754						62		2,014	
Vaughan 0411	51	≥ 4 cm dbh	Control								99		99			1,483	890								2,471	
			20% BAR													148	1,236								1,384	
			40% BAR								75		75			171	846								1,092	
			60% BAR					20	119	40			178			138	297								613	
Springhill JCT. 0511	60	≥ 4 cm dbh	Control												25	519	766						124		1,433	
			20% BAR													272	865	25							1,161	
			40% BAR													251	392		9				35		686	
			60% BAR													51	314						12		377	
Maybee Rd. 0911	44	≥ 4 cm dbh	Control		37						19		56			1,328	80								1,464	
			20% BAR				37						37			964	222								1,223	
			40% BAR								106		12	119			630	124								872
			60% BAR								62		62			766	74								902	
Upper Sixty Lk. 3311	62	≥ 4 cm dbh	Control						1,804	148		148	2,100			99	964					25			3,188	
			20% BAR							222			222			204	649								1,075	
			40% BAR							43			43			216	618								877	
			60% BAR							14	14		27			27	808								862	
Simpson's Corner 2211	42	≥ 4 cm dbh	Control									124	124			2,076					3,632				5,832	
			20% BAR													49			1,186	1,606					2,842	
			40% BAR													60			139	2,108					2,307	
			60% BAR									111		111			74				927					1,112
All Sites		≥ 4 cm dbh	Control		5					258	116	32	21	432			4	786	2,599	22	519		4	18	4,382	
			20% BAR					5		32	14			51				234	1,480	173	229				2,167	
			40% BAR							21	32		2	55				190	826	20	302			16	1,409	
			60% BAR							14	47	22		82				151	596		132			11	972	



## 2015 % Species Composition

Appendix 5. The percent species composition (based on basal area) in 2015.

Location/ Stand #	Stump Age (2015)	Strata	Size Class	Spacing / Basal Area Removed (BAR)	Long-Lived, Intermediate to Tolerant (LIT) Species									Other Softwoods		Other Hardwoods					Non-Commercial					
					Red spruce	Hem- lock	White Pine	White Spruce	Sugar Maple (seed)	Sugar Maple (sprout)	Yellow Birch	Red Oak	White Ash	Total LIT Species	Balsam Fir	Black Spruce	Red Maple (seed)	Red Maple (sprout)	White Birch	T. Aspen	LT Aspen	Beech	Striped Maple	Grey Birch		
Springhill JCT. 0511	97	Original*	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR												6%	23%	1%	70%							
			20% BAR															28%		72%						
			40% BAR															49%		51%						
			60% BAR															17%		83%						
		Saplings**	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR				23%								6%	0.4%	68%		2%					6%	
			20% BAR															7%	65%			1%				1%
			40% BAR	9%								0.2%	0.1%					16%	41%			4%				10%
			60% BAR	2%								0.5%						10%	22%		4%	33%	1%			16%
		All	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR				8%								8%	0.1%	27%		16%	1%	46%			2%	
			20% BAR														3%	25%		18%	1%	45%	0.5%		0.2%	
			40% BAR	4%									0.1%	0.1%				7%	17%		29%	3%	29%	2%		4%
			60% BAR	1%								0.2%					4%	8%		12%	12%	53%			6%	
Maybee Rd. 0911	81	Original*	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR	3%															56%		21%				
			20% BAR																	53%		44%				
			40% BAR												3%					59%		21%				
			60% BAR																	76%		15%				
		Saplings**	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR	85%														0.4%							
			20% BAR	90%																1%	1%			3%	5%	
			40% BAR	57%				11%												1%	1%			1%	29%	
			60% BAR	69%			13%	6%			0.3%						0.3%			1%	5%				5%	
		All	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR	26%														40%	0%	15%					
			20% BAR	33%															34%	1%	28%			1%	2%	
			40% BAR	18%					12%					2%						41%	0%	15%			0.2%	9%
			60% BAR	26%			5%	2%	6%							0.1%			48%	2%	9%				2%	
Upper Sixty Lake 3311	99	Original*	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR					10%										5%		42%					
			20% BAR																28%		68%					
			40% BAR																16%		81%					
			60% BAR																5%		93%					
		Saplings**	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR					5%									17%								
			20% BAR	2%															9%	10%				11%	6%	
			40% BAR																6%	40%				5%	73%	
			60% BAR																11%	22%		1%			5%	35%
		All	≥ 4 cm dbh	Control 20% BAR 40% BAR 60% BAR					10%										5%	1%	40%					
			20% BAR	0.2%															26%	1%	61%			1%	8%	
			40% BAR																15%	6%	70%			0.3%	1%	
			60% BAR																6%	5%	74%	0.2%		1%	7%	

\*Original: Trees that were measured at the time of PSP establishment in 1978.

\*\*Saplings: Does not include original trees, only includes new additions to the plots, those trees that developed within the understory and were added in subsequent re-measurements once they reached the minimum size.

## 2015 % Species Composition

Appendix 5. The percent species composition (based on basal area) in 2015.

Location/ Stand #	Stump Age (2015)	Strata	Spacing / Basal Area Removed (BAR)	Long-Lived, Intermediate to Tolerant (LIT) Species										Other Softwoods		Other Hardwoods					Non-Commercial							
				Red spruce	Hem- lock	White Pine	White Spruce	Sugar Maple (seed)	Sugar Maple (sprout)	Yellow Birch	Red Oak	White Ash	Total LIT Species	Balsam Fir	Black Spruce	Red Maple (seed)	Red Maple (sprout)	White Birch	T. Aspen	LT Aspen	Beech	Striped Maple	Grey Birch					
Simpson's Corner 2211	79	Original*	≥ 4 cm	Control																								
			20% BAR																									
			40% BAR																									
		Saplings**	≥ 4 cm	Control																								
	20% BAR																											
	40% BAR																											
	All	≥ 4 cm	Control																									
20% BAR																												
40% BAR																												
All sites	Original*	≥ 4 cm	Control	0.4%					1%		9%		4%	15%														
		20% BAR					0.5%	0.5%			1%			2%														
		40% BAR							3%		3%		0.4%	6%														
		Saplings**	≥ 4 cm	Control	29%	6%	2%	4%	1%		10%	2%		54%	25%	11%		3%								2%	5%	
	20% BAR				33%	2%	16%	2%		0.1%	0.2%	0.3%		53%	7%	11%		2%	15%		0.2%				1%	12%		
	40% BAR				25%	9%	3%	3%	1%	5%	0.0%	1%	0.0%	47%	11%	6%		5%	22%		1%				0.4%	7%		
	All	≥ 4 cm	Control	7%	1%	0.2%	1%	1%		7%	0.4%	4%	23%	3%	4%		6%	28%	1%	0.2%				1%	8%			
20% BAR				9%	1%	5%	1%	0.5%		1%	0.1%		18%	1%	4%		14%	2%	47%	4%	8%			0.3%	2%			
40% BAR				11%	3%	1%	1%	2%	0.4%	2%	0.3%	0.3%	22%	3%	3%		16%	3%	38%	0.4%	12%			0.1%	2%			
			60% BAR	6%	2%	1%	1%	2%	0.4%	4%	3%	0.1%	18%	6%	1.3%		14%	6%	41%		11%			0.1%	2%			

\*Original: Trees that were measured at the time of PSP establishment in 1978.

\*\*Saplings: Does not include original trees, only includes new additions to the plots, those trees that developed within the understory and were added in subsequent re-measurements once they reached the minimum size.

## 2015 Basal Area

Appendix 6. Basal area (m<sup>2</sup>) in 2015.

Location/ Stand #	Stump Age (2015)	Strata	Size Class	Spacing / Basal Area Removed (BAR)	Long-Lived, Intermediate to Tolerant (LIT) Species									Other Softwoods		Other Hardwoods					Non-Commercial		Total							
					Red spruce	Hem- lock	White Pine	White Spruce	Sugar Maple (seed)	Sugar Maple (sprout)	Yellow Birch	Red Oak	White Ash	Total LIT Species	Balsam Fir	Black Spruce	Red Maple (seed)	Red Maple (sprout)	White Birch	T. Aspen	LT Aspen	Striped Maple		Grey Birch						
Sand River 0211	59	Original*	≥ 4 cm	Control							2.84				2.84														21.14	
			dbh	1.8m x 1.8m																										14.80
				2.4m x 2.4m									0.64				0.64												0.27	13.66
				3.0m x 3.0m																										13.08
		Saplings**	≥ 4 cm	Control	3.28											3.28	4.84													8.12
			dbh	1.8m x 1.8m	5.13											5.13	0.46													5.59
	2.4m x 2.4m		18.68								0.05			18.73	1.61											0.08		22.86		
	3.0m x 3.0m		3.10											3.10	6.24											0.03		18.17		
All	≥ 4 cm	Control	3.28											6.12	4.84													29.26		
	dbh	1.8m x 1.8m	5.13											5.13	0.46													20.40		
		2.4m x 2.4m	18.68								0.69			19.37	1.61											0.08	0.27	36.52		
		3.0m x 3.0m	3.10											3.10	6.24											0.03		31.25		
Roseway Lake 0311	Original*	≥ 4 cm	Control								3.69				3.69													28.55		
		dbh	20% BAR								1.43				1.43														20.26	
			40% BAR								1.82				1.82														20.39	
			60% BAR								4.15				4.15														24.44	
	Saplings**	≥ 4 cm	Control				0.16					0.96			1.11	0.50													1.61	
		dbh	20% BAR	1.27			0.87							2.14	0.73	0.34													3.21	
			40% BAR	1.77			0.19							1.96	3.22	0.28						0.99							6.45	
			60% BAR	1.05			0.07							1.12	6.76	0.41						0.34							8.62	
	All	≥ 4 cm	Control				0.16					4.65			4.80	0.50													30.16	
		dbh	20% BAR	1.27			0.87					1.43			3.57	0.73	0.34												23.47	
		40% BAR	1.77			0.19					1.82			3.78	3.22	0.28					0.99							26.83		
		60% BAR	1.05			0.07					4.15			5.28	6.76	0.41					0.34							33.06		
Vaughan 0411	Original*	≥ 4 cm	Control																									17.11		
		dbh	20% BAR																										15.20	
			40% BAR														1.05												22.76	
			60% BAR													4.51	2.88	1.07											20.59	
	Saplings**	≥ 4 cm	Control	2.80	1.79	0.19									5.41														5.41	
		dbh	20% BAR	0.54	1.32	7.93									10.26												0.14	0.20	10.92	
			40% BAR	0.10	6.92	2.12	0.10								10.05														11.23	
			60% BAR		3.89	0.68									5.22	0.23							0.20	1.04					6.70	
	All	≥ 4 cm	Control	2.80	1.79	0.19									5.41														22.52	
		dbh	20% BAR	0.54	1.32	7.93									10.26												0.14	0.20	26.12	
		40% BAR	0.10	6.92	2.12	0.10								11.10														33.98		
		60% BAR		3.89	0.68									9.73	0.23							3.97	1.04	12.31				27.29		

\*Original: Trees that were measured at the time of PSP establishment in 1978.

\*\*Saplings: Does not include original trees, only includes new additions to the plots, those trees that developed within the understory and were added in subsequent re-measurements once they reached the minimum size.





## 2015 Basal Area

Appendix 6. Basal area (m<sup>2</sup>) in 2015.

Location/ Stand #	Stump Age (2015)	Strata	Size Class	Spacing / Basal Area Removed (BAR)	Long-Lived, Intermediate to Tolerant (LIT) Species									Other Softwoods		Other Hardwoods					Non-Commercial			Total			
					Red spruce	Hem- lock	White Pine	White Spruce	Sugar Maple (seed)	Sugar Maple (sprout)	Yellow Birch	Red Oak	White Ash	Total LIT Species	Balsam Fir	Black Spruce	Red Maple (seed)	Red Maple (sprout)	White Birch	T. Aspen	LT Aspen	Beech	Striped Maple		Grey Birch		
Simpson's Corner 2211	79	Original*	≥ 4 cm	Control												9.13										36.64	
			dbh	20% BAR												1.08			10.58	21.10						32.76	
				40% BAR												1.32			0.31	28.44						30.07	
			60% BAR										3.48		1.20				22.34						27.02		
		Saplings**	≥ 4 cm	dbh	Control										0.34											0.00	
				20% BAR												0.17			3.00							3.34	
	40% BAR														0.03			2.49							2.69		
			60% BAR												0.03			2.38							2.44		
	All	≥ 4 cm	dbh	Control										0.34		9.13									36.64		
			20% BAR												1.08			10.58	21.10						36.10		
			40% BAR												1.49			3.00	28.44						32.76		
			60% BAR										3.48		1.23				22.34						29.46		
All sites	Original*	≥ 4 cm	dbh	Control	0.12				0.37		2.29		1.06		3.85		0.13	5.63		11.39		3.93				24.93	
				20% BAR				0.15	0.12		0.20				0.48			4.88		12.92	1.51	3.01				22.80	
				40% BAR					0.64		0.50			0.08	1.22			4.40		11.62	0.04	4.06			0.04	21.39	
			60% BAR					0.35		1.05	0.65		2.06			3.26		11.61		3.19					20.12		
		Saplings**	≥ 4 cm	dbh	Control	2.30	0.26	0.05	0.26	0.01	0.14	0.09		3.10	0.89	0.77		0.06						0.02	0.34		5.18
				20% BAR	3.31	0.19	1.41	0.24		0.01	0.02	0.04		5.22	0.34	1.12		0.08	0.55		0.02			0.11	0.52		7.96
				40% BAR	3.89	0.99	0.34	0.38	0.02	0.18	0.01	0.12	0.003	5.93	1.00	0.78		0.39	1.03		0.07			0.02	0.69		9.92
				60% BAR	1.71	0.56	0.32	0.26	0.04	0.15	0.01	0.09	0.02	3.16	2.01	0.34		0.64	1.81	0.22	0.01		0.04	0.57	0.004	8.80	
		All	≥ 4 cm	dbh	Control	2.43	0.26	0.05	0.26	0.38		2.43	0.09	1.06	6.95	0.89	0.91		5.63	0.06	11.39		3.93		0.02	0.34	
	20% BAR			3.31	0.19	1.41	0.39	0.13		0.22	0.04		5.70	0.34	1.12		4.96	0.55	12.92	1.53	3.01		0.11	0.52		30.76	
	40% BAR			3.89	0.99	0.34	0.38	0.74	0.10	0.51	0.12	0.08	7.16	1.00	0.78		4.79	1.03	11.62	0.11	4.06		0.02	0.69	0.04	31.31	
			60% BAR	1.71	0.56	0.32	0.26	0.44	0.10	1.07	0.75	0.02	5.21	2.01	0.34		3.90	1.81	11.83	0.01	3.19		0.04	0.57	0.004	28.92	

\*Original: Trees that were measured at the time of PSP establishment in 1978.

\*\*Saplings: Does not include original trees, only includes new additions to the plots, those trees that developed within the understory and were added in subsequent re-measurements once they reached the minimum size.

## 2015 Height

Appendix 7. Average height (m) in 2015.

Location/ Stand #	Stump Age (2015)	Strata	Spacing / Basal Area Removed (BAR)	Long-Lived, Intermediate to Tolerant (LIT) Species										Other Softwoods		Other Hardwoods					Non-Commercial			Avg.					
				Red spruce	Hem- lock	White Pine	Sugar Maple		Yellow Birch	Red Oak	White Ash	Avg. Species	LIT	Balsam Fir	Black Spruce	Red Maple (seed)	Red Maple (sprout)	White Birch	T. Aspen	LT Aspen	Beech	Striped Maple	Grey Birch						
							Spruce	(seed)																	(sprout)				
Sand River 0211	59	Original*	≥ 4 cm	Control																									
			dbh	1.8mx1.8m																									
				2.4mx2.4m																									
				3.0mx3.0m																									
	Saplings**	≥ 4 cm	Control																										
		dbh	1.8mx1.8m	4																									
			2.4mx2.4m	6																									
All	≥ 4 cm	Control																											
	dbh	1.8mx1.8m	4																										
		2.4mx2.4m	6																										
		3.0mx3.0m	8																										
Roseway Lake 0311	65	Original*	≥ 4 cm	Control																									
			dbh	20% BAR																									
				40% BAR																									
				60% BAR																									
	Saplings**	≥ 4 cm	Control																										
		dbh	20% BAR	7		4																							
			40% BAR	9		6																							
All	≥ 4 cm	Control																											
	dbh	20% BAR	7		4																								
		40% BAR	9		6																								
		60% BAR	8		8																								
Vaughan 0411	88	Original*	≥ 4 cm	Control																									
			dbh	20% BAR																									
				40% BAR																									
				60% BAR																									
	Saplings**	≥ 4 cm	Control																										
		dbh	20% BAR	11	14	8																							
			40% BAR	6	8	12																							
All	≥ 4 cm	Control																											
	dbh	20% BAR	6	8	12																								
		40% BAR	7	14	12																								
		60% BAR	7	14	12																								

\*Original: Trees that were measured at the time of PSP establishment in 1978.

\*\*Saplings: Does not include original trees, only includes new additions to the plots, those trees that developed within the understory and were added in subsequent re-measurements once they reached the minimum size.

## 2015 Height

Appendix 7. Average height (m) in 2015.

Location/ Stand #	Stump Age (2015)	Strata	Size Class	Spacing / Basal Area Removed (BAR)	Long-Lived, Intermediate to Tolerant (LIT) Species									Other Softwoods		Other Hardwoods					Non-Commercial			Avg.
					Red spruce	Hem- lock	White Pine	White Spruce	Sugar Maple (seed)	Sugar Maple (sprout)	Yellow Birch	Red Oak	White Ash	Avg. Species	LIT	Balsam Fir	Black Spruce	Red Maple (seed)	Red Maple (sprout)	White Birch	T. Aspen	LT Aspen	Beech	
Springhill JCT. 0511	97	Original*	≥ 4 cm dbh	Control										17		14								15
			20% BAR												14								14	
			40% BAR												17								16	
			60% BAR												17								17	
		Saplings**	≥ 4 cm dbh	Control										4		8					7			8
			20% BAR										8		5					6			9	
			40% BAR	14										10		6					7			8
			60% BAR	12										12		10					10			10
		All	≥ 4 cm dbh	Control										4		14					7			11
			20% BAR										8		13					6			11	
			40% BAR	14										10		6					7			10
			60% BAR	12										12		16					10			11
Maybee Rd. 0911	81	Original*	≥ 4 cm dbh	Control												16								16
			20% BAR												18								18	
			40% BAR												16								15	
			60% BAR												15								15	
		Saplings**	≥ 4 cm dbh	Control												6					6			7
			20% BAR												5					8			7	
			40% BAR	8												9					9			7
			60% BAR	7												4					4			6
		All	≥ 4 cm dbh	Control												16					6			9
			20% BAR												18					5			9	
			40% BAR	8												15					9			9
			60% BAR	7												13					5			9
Upper Sixty Lake 3311	99	Original*	≥ 4 cm dbh	Control												14								14
			20% BAR												19								18	
			40% BAR												16								19	
			60% BAR												17								17	
		Saplings**	≥ 4 cm dbh	Control										8		7					7			7
			20% BAR	10										9		8					9			9
			40% BAR												7					5			7	
			60% BAR												8					10			9	
		All	≥ 4 cm dbh	Control										8		14					7			12
			20% BAR										9		14					9			13	
			40% BAR										6		13					5			10	
			60% BAR										8		9					10			11	

\*Original: Trees that were measured at the time of PSP establishment in 1978.

\*\*Saplings: Does not include original trees, only includes new additions to the plots, those trees that developed within the understory and were added in subsequent re-measurements once they reached the minimum size.

## 2015 Height

Appendix 7. Average height (m) in 2015.

Location/ Stand #	Stump Age (2015)	Strata	Size Class	Spacing / Basal Area Removed (BAR)	Long-Lived, Intermediate to Tolerant (LIT) Species									Other Softwoods		Other Hardwoods					Non-Commercial			Avg.																													
					Red spruce	Hem- lock	White Pine	White Spruce	Sugar Maple (seed)	Sugar Maple (sprout)	Yellow Birch	Red Oak	White Ash	Avg. LIT Species	Balsam Fir	Black Spruce	Red Maple (seed)	Red Maple (sprout)	White Birch	T. Aspen	LT Aspen	Beech	Striped Maple		Grey Birch																												
Simpson's Corner 2211	79	Original*	≥ 4 cm	Control																																																	
			20% BAR																																																		
			40% BAR																																																		
			60% BAR																																																		
			≥ 4 cm	Control	No ingrowth																																																
			20% BAR																																																		
			40% BAR																																																		
			60% BAR																																																		
		All	≥ 4 cm	Control																																																	
			20% BAR																																																		
			40% BAR																																																		
			60% BAR																																																		
All sites		Original*	≥ 4 cm	Control	13																																																
			20% BAR																																																		
			40% BAR																																																		
			60% BAR																																																		
			≥ 4 cm	Control	8	14	6	10	8																																												
			20% BAR		7	8	11	8		3																																											
			40% BAR		9	14	8	11	7	8																																											
			60% BAR		9	12	9	10	8	6																																											
		All	≥ 4 cm	Control	8	14	6	10	11																																												
			20% BAR		7	8	11	11	9																																												
			40% BAR		9	14	8	11	11	8																																											
			60% BAR		9	12	9	10	9	9																																											

\*Original: Trees that were measured at the time of PSP establishment in 1978.

\*\*Saplings: Does not include original trees, only includes new additions to the plots, those trees that developed within the understory and were added in subsequent re-measurements once they reached the minimum size.

## 2015 Density

Appendix 8. Density (# stems/ha) by size class in 2015.

Location/ Stand #	Stump Age (2015)	Strata	Size Class	Spacing / Basal Area Removed (BAR)	Long-Lived, Intermediate to Tolerant (LIT) Species									Other Softwoods		Other Hardwoods					Non-Commercial			Total					
					Red spruce	Hem- lock	White Pine	White Spruce	Sugar Maple (Seed)	Sugar Maple (Sprout)	Yellow Birch	Red Oak	White Ash	Total LIT Species	Balsam Fir	Black Spruce	Red Maple (Seed)	Red Maple (Sprout)	White Birch	T. Aspen	LT. Aspen	Striped Beech	Grey Maple		M. Birch	M. Maple			
Sand River 0211	59	Original*	≥ 4 cm dbh	Control	-	-	-	-	-	-	247	-	-	247	-	-	-	-	1,495	-	-	-	-	-	-	-	1,742		
				1.8mx1.8m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,166	-	-	-	-	-	-	-	1,166
				2.4mx2.4m	-	-	-	-	-	-	-	25	-	-	25	-	-	-	-	-	890	-	-	-	-	-	25	-	939
				3.0mx3.0m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	698	-	-	-	-	-	-	-	698
	Saplings**	≥ 4 cm dbh	Control	796	-	-	-	-	-	-	-	-	-	796	494	-	-	-	-	-	-	-	-	-	-	-	1,290		
			1.8mx1.8m	819	-	-	-	-	-	-	-	-	-	819	261	-	-	-	-	-	-	-	-	-	-	-	-	1,081	
			2.4mx2.4m	1,952	-	-	-	-	-	-	-	25	-	1,977	198	-	173	149	-	-	-	-	-	25	-	-	-	2,521	
			3.0mx3.0m	414	-	-	-	-	-	-	-	-	-	414	445	-	389	803	501	-	-	-	-	-	6	-	-	2,558	
	Seedlings	1.3 m tall - 3.9 cm dbh	Control	988	-	-	-	-	-	-	-	-	988	151	-	-	-	-	-	-	-	-	-	-	-	-	1,139		
			1.8mx1.8m	99	-	-	-	-	-	-	-	-	99	791	-	64	-	198	-	-	-	-	-	-	-	-	1,278		
			2.4mx2.4m	568	-	-	-	-	-	-	-	25	-	593	25	-	-	49	-	-	-	-	-	-	-	-	667		
			3.0mx3.0m	105	-	-	-	-	-	-	-	-	-	105	74	-	148	87	142	-	-	-	-	-	-	-	556		
Seedlings	0.3 m tall - 1.2 m tall	Control	1,591	-	-	-	-	-	-	-	-	1,591	1,043	-	-	-	-	-	-	-	-	-	-	-	-	2,634			
		1.8mx1.8m	481	-	-	-	-	-	-	-	-	481	1,576	-	382	-	-	-	-	-	-	-	-	-	-	2,439			
		2.4mx2.4m	99	-	-	-	-	-	-	-	-	99	-	-	-	-	-	-	-	-	-	-	-	-	-	99			
		3.0mx3.0m	136	-	-	-	-	-	-	-	-	136	210	-	12	13	-	-	-	-	-	-	-	-	-	371			
Roseway Lake 0311	65	Original*	≥ 4 cm dbh	Control	-	-	-	-	-	-	395	-	-	395	-	-	-	-	1,680	-	-	-	-	-	-	2,076			
				20% BAR	-	-	-	-	-	-	99	-	-	99	-	-	-	-	-	1,248	-	-	-	-	-	-	1,347		
				40% BAR	-	-	-	-	-	-	74	-	-	74	-	-	-	-	-	1,236	-	-	-	-	-	-	-	1,310	
				60% BAR	-	-	-	-	-	-	161	-	-	161	-	-	-	-	-	1,087	-	-	-	-	-	-	-	1,248	
	Saplings**	≥ 4 cm dbh	Control	-	-	99	-	-	-	-	-	99	-	-	198	99	-	-	-	-	-	-	-	-	-	-	297		
			20% BAR	395	-	173	-	-	-	-	-	-	-	568	49	49	-	-	-	-	-	-	-	-	-	-	-	667	
			40% BAR	247	-	99	-	-	-	-	-	-	-	346	346	173	99	-	-	-	-	-	-	-	-	-	-	964	
			60% BAR	198	-	25	-	-	-	-	-	-	-	222	581	62	136	-	-	-	-	-	-	-	-	-	-	1,001	
	Seedlings	1.3 m tall - 3.9 cm dbh	Control	99	-	-	-	-	-	-	-	-	99	297	99	99	-	-	-	-	-	-	-	-	-	-	593		
			20% BAR	161	-	-	-	-	-	-	-	-	161	99	395	309	62	-	-	-	-	-	-	-	-	-	-	1,026	
			40% BAR	25	-	49	-	-	-	-	-	-	74	74	99	124	74	-	-	-	-	-	-	-	-	-	-	445	
			60% BAR	111	-	74	-	-	-	-	-	-	-	185	148	136	284	-	-	-	-	-	-	-	-	-	-	754	
Seedlings	0.3 m tall - 1.2 m tall	Control	395	-	99	-	-	-	-	-	-	494	890	-	3,558	-	-	-	-	-	-	-	-	-	-	4,942			
		20% BAR	148	-	556	-	-	-	-	-	-	704	124	148	1,075	-	-	-	-	-	-	-	-	-	-	2,051			
		40% BAR	-	-	198	-	-	-	-	-	-	198	124	198	1,680	-	-	-	-	-	25	-	-	-	-	-	2,224		
		60% BAR	124	-	148	-	-	-	-	-	-	272	482	148	2,076	-	-	-	-	-	-	-	-	-	-	-	2,978		

\*Original: Trees that were measured at the time of PSP establishment in 1978.

\*\*Saplings: Does not include original trees, only includes new additions to the plots, those trees that developed within the understory and were added in subsequent re-measurements once they reached the minimum size.



## 2015 Density

Appendix 8. Density (# stems/ha) by size class in 2015.

Location/ Stand #	Stump Age (2015)	Strata	Size Class	Spacing / Basal Area Removed (BAR)	Long-Lived, Intermediate to Tolerant (LIT) Species									Other Softwoods		Other Hardwoods					Non-Commercial			Total							
					Red spruce	Hem- lock	White Pine	White Spruce	Sugar Maple (Seed)	Sugar Maple (Sprout)	Yellow Birch	Red Oak	White Ash	Total LIT Species	Balsam Fir	Black Spruce	Red Maple (Seed)	Red Maple (Sprout)	White Birch	T. Aspen	LT. Aspen	Beech	Striped Maple		Grey Birch	M. Maple					
Vaughan 0411	88	Original*	≥ 4 cm dbh	Control	-	-	-	-	-	-	-	-	-	-	-	-	-	692	-	297	-	-	-	-	-	-	-	-	988		
				20% BAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	148	-	395	-	-	-	-	-	-	-	-	544
				40% BAR	-	-	-	-	-	-	63	-	-	-	-	-	-	-	-	141	-	591	-	-	-	-	-	-	-	-	795
				60% BAR	-	-	-	-	20	-	119	20	-	-	-	-	-	-	-	138	-	277	-	-	-	-	-	-	-	-	573
		Saplings**	≥ 4 cm dbh	Control	99	99	99	-	-	-	-	198	-	-	-	-	-	494	-	-	-	-	-	-	-	-	-	-	-	494	
				20% BAR	99	148	395	-	-	49	99	148	-	939	-	-	-	-	-	148	49	-	-	-	-	-	49	98	-	-	1,283
				40% BAR	29	414	191	12	-	-	-	166	-	812	-	-	-	-	-	121	212	-	-	-	-	-	-	87	-	-	1,232
				60% BAR	-	277	79	-	-	-	79	59	99	593	-	20	-	-	-	59	297	-	-	-	-	-	-	-	-	-	969
		Seedlings	1.3 m tall - 3.9 cm dbh	Control	-	99	-	-	-	-	-	198	-	-	-	-	-	297	-	-	-	-	-	-	-	-	-	-	99	396	
				20% BAR	-	99	148	-	-	-	49	544	-	840	49	-	-	-	-	395	99	-	-	-	-	-	49	99	-	-	1,532
				40% BAR	25	17	63	37	-	-	74	104	132	452	-	-	-	-	-	211	84	-	-	-	-	-	-	87	-	133	967
				60% BAR	59	20	40	-	40	257	79	119	-	613	-	-	-	-	-	99	237	-	-	-	-	-	40	-	-	20	1,008
	Seedlings	0.3 m tall - 1.2 m tall	Control	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
			20% BAR	-	-	198	-	-	-	-	247	-	445	-	-	-	-	-	99	-	-	-	-	-	-	-	-	-	-	544	
			40% BAR	17	-	58	-	-	-	63	63	-	201	12	-	-	-	-	137	-	-	-	-	-	-	-	12	-	117	479	
			60% BAR	40	-	40	-	20	20	-	-	-	119	-	-	-	-	-	20	-	-	-	-	-	-	-	59	-	237	435	
Springhill JCT. 0511	97	Original*	≥ 4 cm dbh	Control	-	-	-	-	-	-	-	-	-	-	-	-	-	25	173	-	420	-	-	-	-	-	-	-	618		
				20% BAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	198	-	568	-	-	-	-	-	-	-	-	766
				40% BAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	211	-	262	-	-	-	-	-	-	-	-	473
				60% BAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	51	-	266	-	-	-	-	-	-	-	-	316
		Saplings**	≥ 4 cm dbh	Control	-	-	-	124	-	-	-	-	-	-	-	-	-	124	25	544	-	49	-	-	-	-	-	148	-	890	
				20% BAR	-	-	49	198	-	-	-	-	-	247	99	791	25	74	-	49	-	-	-	-	-	-	25	-	-	1,310	
				40% BAR	56	-	9	138	-	-	-	-	9	10	221	203	777	44	261	-	43	-	-	-	-	-	418	-	-	1,967	
				60% BAR	15	-	-	95	-	-	-	-	7	-	117	67	205	121	819	26	-	-	-	-	-	-	340	-	-	1,696	
		Seedlings	1.3 m tall - 3.9 cm dbh	Control	-	-	-	74	-	-	-	-	-	-	-	-	74	99	222	-	-	-	-	-	-	74	-	-	469		
				20% BAR	-	-	-	25	-	-	-	-	-	25	74	420	-	198	-	25	-	-	-	-	-	25	-	-	766		
				40% BAR	-	-	-	-	-	-	-	35	-	35	87	323	167	83	-	9	-	-	-	-	-	251	-	-	953		
				60% BAR	-	-	-	38	-	-	-	7	-	46	33	99	138	221	15	-	-	-	-	-	-	47	-	-	599		
	Seedlings	0.3 m tall - 1.2 m tall	Control	-	-	25	124	-	-	-	-	-	-	-	-	148	321	445	-	-	-	-	-	-	-	-	-	914			
			20% BAR	-	-	25	-	25	-	-	-	25	-	74	99	469	25	-	-	-	-	-	-	-	-	-	-	-	667		
			40% BAR	-	-	-	-	-	-	-	-	17	-	17	106	313	173	-	-	-	-	-	-	-	-	-	-	-	609		
			60% BAR	-	-	-	6	-	-	-	-	-	-	6	64	54	-	-	-	-	-	-	-	-	-	-	-	-	125		

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## 2015 Density

Appendix 8. Density (# stems/ha) by size class in 2015.

Location/ Stand #	Stump Age (2015)	Strata	Size Class	Spacing / Basal Area Removed (BAR)	Long-Lived, Intermediate to Tolerant (LIT) Species										Other Softwoods		Other Hardwoods					Non-Commercial			Total					
					Red spruce	Hem- lock	White Pine	White Spruce	Sugar Maple (Seed)	Sugar Maple (Sprout)	Yellow Birch	Red Oak	White Ash	Total LIT Species	Balsam Fir	Black Spruce	Red Maple (Seed)	Red Maple (Sprout)	White Birch	T. Aspen	LT. Aspen	Striped Beech	Grey Maple	M. Birch						
																										Maple	Maple	White	T.	LT.
Maybee Rd. 0911	81	Original*	≥ 4 cm dbh	Control	37	-	-	-	-	-	19	-	-	56	-	-	420	-	80	-	-	-	-	-	-	-	-	556		
				20% BAR	-	-	-	37	-	-	-	-	-	-	-	37	-	-	408	-	222	-	-	-	-	-	-	-	667	
				40% BAR	-	-	-	-	106	-	-	-	-	-	12	119	-	-	321	-	104	-	-	-	-	-	-	-	-	544
				60% BAR	-	-	-	-	62	-	-	-	-	-	-	62	-	-	457	-	49	-	-	-	-	-	-	-	-	568
		Saplings**	≥ 4 cm dbh	Control	1,569	-	-	-	-	-	-	-	-	1,569	-	-	-	19	-	-	-	-	-	-	408	-	-	-	1,995	
				20% BAR	2,743	-	-	-	-	-	-	-	-	-	2,743	-	-	-	111	-	-	-	-	-	74	371	-	-	3,299	
				40% BAR	717	-	-	99	-	-	-	-	-	-	815	-	-	37	65	-	-	-	-	-	10	885	-	-	1,811	
				60% BAR	1,050	-	62	49	-	25	-	-	-	-	1,186	-	12	62	161	-	-	-	-	-	-	210	-	-	1,631	
		Seedlings	1.3 m tall - 3.9 cm dbh	Control	890	-	-	-	-	-	-	-	-	890	25	-	-	-	-	-	-	-	-	-	328	-	-	-	1,242	
				20% BAR	1,891	-	-	-	-	-	-	-	-	-	1,891	37	-	-	37	-	-	-	-	-	667	-	-	-	2,632	
				40% BAR	645	-	-	67	12	20	12	-	-	-	756	20	-	12	13	-	-	-	-	-	625	-	-	-	1,426	
				60% BAR	803	-	37	12	-	13	-	-	-	-	865	-	-	25	13	12	-	-	-	-	-	111	-	-	-	1,026
	Seedlings	0.3 m tall - 1.2 m tall	Control	531	-	-	-	-	-	-	-	-	531	19	-	-	-	-	-	-	-	-	-	111	-	-	-	661		
			20% BAR	334	-	-	-	-	-	-	-	-	-	334	-	-	-	-	-	-	-	-	-	-	-	-	-	334		
			40% BAR	262	-	-	12	-	-	-	-	-	-	274	-	-	-	-	-	-	-	-	-	-	198	-	-	-	472	
			60% BAR	432	-	12	-	-	-	-	-	-	-	445	-	-	-	-	-	-	-	-	-	-	-	-	-	-	445	
Upper Sixty Lake 3311	99	Original*	≥ 4 cm dbh	Control	-	-	-	-	395	-	148	-	148	692	-	-	74	-	371	-	-	-	-	-	-	-	-	1,137		
				20% BAR	-	-	-	-	37	-	-	-	-	-	37	-	-	148	-	426	-	-	-	-	-	-	-	-	612	
				40% BAR	-	-	-	-	31	-	-	-	-	-	31	-	-	154	-	395	-	-	-	-	-	-	-	-	-	581
				60% BAR	-	-	-	-	14	-	14	-	-	-	27	-	-	27	-	597	-	-	-	-	-	-	-	-	-	651
		Saplings**	≥ 4 cm dbh	Control	-	-	-	-	25	-	-	-	-	25	124	-	-	99	-	-	-	-	-	-	74	49	-	-	371	
				20% BAR	19	-	-	-	-	-	-	-	-	-	19	19	-	130	149	-	-	-	-	-	56	630	-	-	1,001	
				40% BAR	-	-	12	-	99	550	-	-	-	-	661	56	-	62	556	-	-	-	-	-	49	161	-	-	1,545	
				60% BAR	-	-	-	-	141	409	-	69	59	678	-	-	222	367	-	19	-	-	-	-	82	-	-	-	1,368	
		Seedlings	1.3 m tall - 3.9 cm dbh	Control	-	-	-	-	99	25	-	-	371	494	99	49	247	99	-	-	-	-	-	148	272	-	-	-	1,408	
				20% BAR	74	-	-	-	19	315	-	37	371	816	93	-	334	223	-	-	-	-	-	-	779	-	-	-	2,243	
				40% BAR	37	-	-	-	920	649	-	-	49	1,655	12	-	111	37	-	-	-	-	-	173	396	-	-	-	2,385	
				60% BAR	37	-	-	-	603	567	19	56	818	2,099	-	-	408	41	-	-	-	-	-	41	895	-	-	-	3,483	
	Seedlings	0.3 m tall - 1.2 m tall	Control	-	-	-	-	247	99	49	148	1,631	2,175	148	148	1,334	297	-	-	-	-	-	25	148	-	-	-	4,275		
			20% BAR	-	-	-	-	185	241	-	19	1,186	1,631	56	-	19	149	-	-	-	-	-	-	389	-	-	-	2,242		
			40% BAR	43	-	-	-	321	37	-	12	914	1,328	43	-	12	-	12	-	-	-	-	80	421	-	-	-	1,897		
			60% BAR	111	-	-	-	568	141	-	-	2,302	3,122	74	-	-	56	-	-	-	-	-	27	255	-	-	-	3,534		

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Simpson's Corner 2211	79	Original*	≥ 4 cm dbh	Control	-	-	-	-	-	-	-	-	-	-	-	-	-	1,359	-	-	-	914	-	-	-	-	2,273		
				20% BAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	49	-	-	395	865	-	-	-	-	1,310
				40% BAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	83	-	-	23	1,070	-	-	-	-	1,177
				60% BAR	-	-	-	-	-	-	-	-	93	-	-	-	-	-	-	74	-	-	-	593	-	-	-	-	760
		Saplings**	≥ 4 cm dbh	Control	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
				20% BAR	-	-	-	-	-	-	-	-	-	-	-	-	-	25	-	-	939	-	-	-	-	-	-	964	
				40% BAR	-	-	23	-	-	-	-	-	-	-	-	-	-	-	60	-	908	-	-	-	-	-	-	991	
				60% BAR	-	-	19	-	-	-	-	-	-	-	-	-	-	-	19	-	983	-	-	-	-	-	-	1,020	
		Seedlings	1.3 m tall - 3.9 cm dbh	Control	-	-	-	-	-	-	-	-	-	-	-	-	-	-	643	-	-	-	-	-	-	643			
				20% BAR	-	-	49	-	-	-	-	-	99	-	-	-	-	-	49	-	470	-	-	-	-	-	-	667	
				40% BAR	-	-	-	-	-	-	-	-	278	-	-	-	-	-	23	-	399	-	-	-	-	-	-	700	
				60% BAR	-	-	167	-	-	-	-	-	130	-	-	-	-	19	-	74	-	946	-	-	-	-	-	1,335	
		Seedlings	0.3 m tall - 1.2 m tall	Control	-	-	124	-	-	-	-	2,570	-	-	-	-	470	-	-	1,112	-	-	-	-	-	-	4,275		
				20% BAR	-	-	148	-	-	-	-	-	1,384	-	-	-	-	99	-	494	-	1,063	-	-	-	-	-	3,188	
				40% BAR	-	-	23	-	-	-	-	-	843	-	-	-	-	46	-	741	-	23	-	-	-	-	-	1,677	
				60% BAR	-	-	93	-	-	-	-	-	723	-	-	-	-	19	-	-	56	-	-	-	-	-	-	890	
All Sites	Original*	≥ 4 cm dbh	Control	5	-	-	-	56	-	116	-	21	199	-	-	4	388	-	620	-	131	-	-	-	-	1,341			
			20% BAR	-	-	-	5	5	-	14	-	-	25	-	-	-	136	-	575	56	124	-	-	-	-	916			
			40% BAR	-	-	-	-	20	-	23	-	2	44	-	-	-	130	-	497	3	153	-	-	4	-	-	831		
			60% BAR	-	-	-	-	14	-	42	16	-	71	-	-	-	107	-	425	-	85	-	-	-	-	-	688		
		Saplings**	≥ 4 cm dbh	Control	352	14	28	18	4	-	14	28	-	458	106	78	-	24	-	-	-	-	11	86	-	-	762		
				20% BAR	582	21	88	28	-	7	14	21	-	762	65	120	43	189	-	7	-	-	26	160	-	-	1,372		
				40% BAR	429	59	48	36	14	79	4	25	1	694	115	136	85	307	-	6	-	8	225	-	-	-	1,576		
				60% BAR	240	40	26	21	20	73	8	25	8	461	159	40	144	490	75	3	-	12	79	1	-	-	1,463		
		Seedlings	1.3 m tall - 3.9 cm dbh	Control	282	14	-	11	14	4	-	28	53	406	96	53	49	106	-	-	-	21	96	-	14	841			
				20% BAR	318	14	28	4	3	45	7	97	53	568	163	116	164	150	34	4	-	7	224	18	-	1,449			
				40% BAR	186	2	16	15	133	106	20	64	7	549	31	60	93	98	7	1	-	25	194	-	19	1,078			
				60% BAR	159	3	45	7	92	120	14	45	117	601	39	34	168	221	24	-	-	11	150	-	3	1,252			
		Seedlings	0.3 m tall - 1.2 m tall	Control	360	-	35	18	35	14	7	388	233	1,090	413	85	699	201	-	-	-	4	37	-	-	2,529			
				20% BAR	138	-	132	-	30	34	-	239	169	743	279	88	299	173	-	-	-	-	56	-	-	-	1,638		
				40% BAR	60	-	40	2	46	5	9	134	131	426	47	73	392	3	2	-	4	11	90	-	17	1,065			
				60% BAR	120	-	42	1	84	23	-	103	329	702	121	29	301	18	-	-	-	4	45	-	34	1,254			

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