Haliburton Forest and Wild Life Reserve Ltd.

Permanent Sample Plot Report 2010

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Introduction

Haliburton Forest & Wildlife Reserve Ltd. (HF) is a 70 000 acre private land holding bordering the south-western portion of Algonquin Park, approximately 30 km northwest of Haliburton, Ontario. The property is used for snowmobiling, boating, camping, fishing, hunting, outdoor education and forestry.

In 1862, private developers bought the lands comprising Haliburton Forest from the Crown. The forests were in turn high-graded for white pine, other softwoods, and by WWII, yellow birch. A sawmill commenced operations at basecamp in 1944, and in the following 25 years, 150 million board feet of timber were cut and processed at this mill. High-grading was the norm.

Adolf Schleifenbaum, the father of the current owner, acquired the property in 1962, and in 1972, the focus of management switched to improvement of the forest resources. The first tree marking was carried out in 1976, and soon became the norm.

Today, forest management at Haliburton Forest and Wildlife Reserve is oriented towards quality improvement, mimicking natural forest dynamics and maintaining tree diversity and wildlife habitat. All cut blocks are marked prior to selection harvesting by cut and skid operators. Harvesting is carried out in summer, fall and winter, and logs trucked to 2 nearby sawmills. In 1998, Haliburton Forest became the first forestry operation in Canada to achieve Forest Stewardship Council certification as an ecologically, economically and socially sustainable forestry operation.

Peter Schleifenbaum, the owner and manager of HF, has adopted a different management approach from that advocated by the Ontario Ministry of Natural Resources for central Ontario. Schleifenbaum is using shorter rotations (15 years instead of the 20-25 year rotations practiced on Crown land), and with each entry, taking basal areas down to 16-18 m^2/ha. The intent is to optimize tree growth by optimizing crown growth. As crowns close in, stands are re-entered and crop trees given space to grow.

Schleifenbaum has engaged academic researchers from German and Canadian universities to monitor the growth and dynamics of HF's forests and to test the success of HF's management approach. Four different Permanent Sample Plot (PSP) systems have been established. In 1998 Haliburton Forest initiated its own system using OMNR's 1995 field manual for establishing and measuring Permanent Sample Plots.

In its first year, 5 PSPs were established. Twelve more were added in 1999, 3 in 2000, 2 in 2003 and one more in 2007. One was abandoned after being destroyed by a downburst in 2006. For each PSP, field staff collected data on ground cover, herbaceous vegetation, shrubs, tree regeneration, soils, wildlife habitat, and timber growth and yield.

Treatments

PSPs were selected to represent the different forest types at HF, as well as different disturbances within similar forest types. Three PSPs were set up in stands severely damaged by a storm in 1995; another in an area that was clearcut in 1983; 10 in tolerant hardwood stands with varying (and sometimes vague) histories of harvesting, 2 in hemlock stands (one recently harvested); one in a unusual red spruce stand; and 5 in early- or mid-tolerant stands.

"Control plots" were placed in areas of the forest that had not been logged for at least 20 years prior to the study. They were intended to serve as baselines for comparisons with other treatments. When these plots were established, however, no effort was made to indicate which plots were the "control" plots and which ones weren't.

The 1995 storm mentioned above was a tornado with extensive downbursts. Masses of cold air, generated by extensive thunderstorms 'smashed' the forest with an impact similar to a water-balloon smashing onto a long grassy lawn. It was estimated that Haliburton Forest lost approximately 5000 acres of forest, half of which incurred 90% damage, and the remainder, 50%. The storm had a trajectory from the northwest, entering HF south west of Stocking lake, crossing Kennisis Lake due west of Kelly Lake, over basecamp, west of Blue Lake and across Pelaw Lake. There was no significant damage north or south of Haliburton Forest. Tembec carried out a large salvage operation in storm-damaged areas, with 13 skidder crews operating into the winter to salvage downed timber.

Methods

PSP planning

The protocol and procedures for the selection, establishment and measurement of the 22 Haliburton Forest PSPs are outlined in “Ontario Forest Growth and Yield Program Field Manual for Establishing and Measuring Permanent Sample Plots” (1995 edition). In lieu of regurgitating this book, this section of the report will outline general methodology, critical steps, specific methods adopted by HF data collectors, and lessons learned.

Baseline introductory information about each PSP is on the Main PSP Information Form and inserted at the front of every PSP file. If there is logging in a PSP, information about harvesting treatments should be entered on the second page of this form.

UTM coordinates were taken at the centre of every PSP. Centres were also marked with a 3-foot long wooden stake, painted orange, as well as a shorter and more permanent aluminium stake. UTM coordinates, access instructions, sampling schedule and logging history for every PSP are summarized in Appendix I.

PSPs are circular in design, with a 45.14 m radius (Figure 1). There are 3 growth plots within a PSP, each with an 11.28 m radius. Wooden stakes, painted blue, are at the centre of each growth plot, along with aluminium stakes. Researchers should have a stock of freshly cut and painted stakes to replace lost or rotten stakes, and use permanent marker to label each stake.

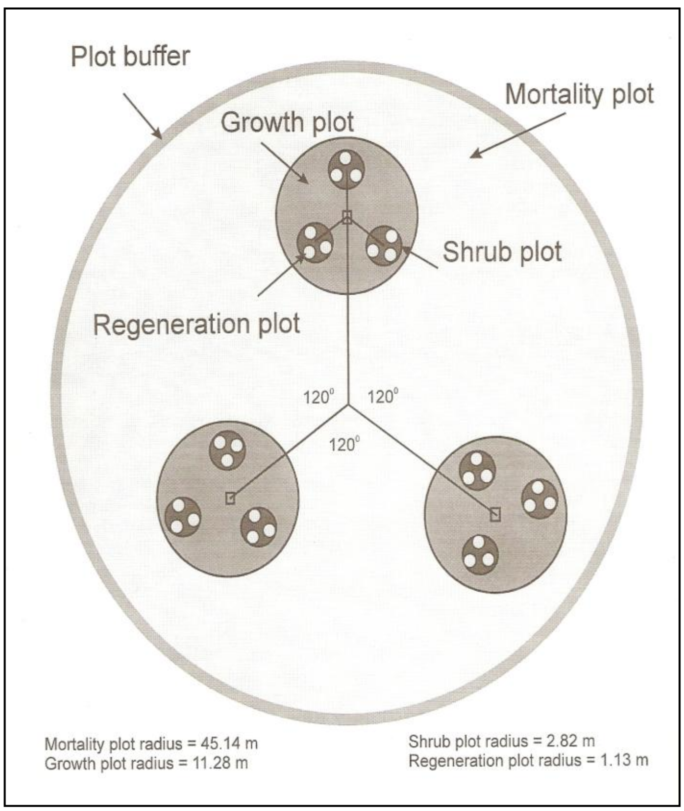

Figure 1. Layout of a Permanent Sample Plot (Hayden *et al.* 1995).

Each growth plot has 3 shrub plots, for a total of 9 x 2.82-m-radius shrub plots per PSP. Some shrub plots have small red stakes indicating their centre; most don't. The centres of each shrub plot are located using azimuths and distances from the growth plot centre. It is important not to trample these areas, and to collect data during the growing season. It is also important to establish accurate declination on your compass. For Haliburton Forest, declination was 11^o33' West in 1996, and 12^o16' in 2010.

Materials needed

Locating plots: Access instructions, UTM coordinates, GPS, compass
Numbering trees: Blue Nelson tube paint; and as a back-up, hammer, aluminum nails, aluminum tree tags and tag punch
Height measurements: Altimeter, meter tape
Dead tree and downed woody debris measurements: 50 meter tape, smaller tape or ruler
Basal area: prism or dendrometer
Shrub plots: meter stick, 8 flags, meter tape
Growth Plot Tree Data: diameter tape, densiometer

Essentials: Clipboard, pencils, PSP data forms, laminated instructions from PSP manual, meter tape, compass, field version of PSP protocol manual, tree and plant ID book, GPS

Other: bug dope, raingear, waterproof footwear, warm clothing, knife

Office: calculator, Excel software

Measurements

In growth plots, every tree over 2.5cm DBH and within an 11.28m radius of the stake is considered inside the plot and given a number. Numbering is done in a clockwise order starting at North (0^o).

A complicated system of numbering was developed as plots were resampled and new trees passed the 2.5 cm threshold. New trees in plots being remeasured in 2003 and 2004 were described according to their position between existing trees, and given a letter after a number. For example, "2a" was a new tree that had grown between trees 2 and 3. "10b" was the second new tree between trees 10 and 11. The enormous number of new trees in several storm-damaged plots made this system very cumbersome.

By 2008, researchers decided to renumber these 'new' trees starting at the last number on the original 1998 & 1999 data forms. If, for example, in the original year of sampling there were 40 trees in a plot, then 1a became 41. This changeover has been cross-referenced, on paper and in the excel spreadsheets, to ensure that tree "1a" has not 'disappeared'.

In the 2008 season it was also decided that all *new* trees - appearing in the third sampling year – had numbers starting at the next 100 series. The plot mentioned above may now have trees 1-40 from the first sampling year, 41-59 from the second sampling year, and 100-108 from the third sampling year. For this plot, there will never be trees numbered 60-99.

OMNR simply numbers trees starting at 1, and in new sampling years, continues the numbering from the last year's final number. Thus, in clockwise order, they may have tree 1, then 41 (added in second sampling year), then 2, 3, 4, 5, then 42, then 56 (added in third sampling year), then 6, 7, 8, etc.

We cannot retroactively change our system at HF, as this would take too long, and jeopardize too much data. However, into the future, we should adopt OMNR's approach for numbering new trees. Thus, if the last tree in the previous sampling year was 145, then the first new tree in the next sampling year should be 146.

Over the past 12 years, trees have been numbered with paint, flagging tape or aluminium tags - nailed or wired. Paint was applied with stencils, and took too long. Flagging tape was too short-lived, and the wires and nails attaching aluminium tags were causing injury and mortality to young trees. Part way through the 2009 sampling season (precipitated by the loss of the number stamp), researchers switched to blue Nelson tube recommended by OMNR for numbering trees and establishing a height for DBH measurements. This also had its drawbacks, as a heavy rainfall several days after applying paint in November washed paint off many trees in one plot. After this, paint was applied in a thin bead that dried more rapidly. Continued and careful use of tube paint is recommended as it can last many years, does not injure trees, and is highly visible. To speed up the drying process, application in summer months is suggested. Tube paint should be thoroughly kneaded prior to use.

In the field, trees are identified using two letter abbreviations. The 1995 OMNR PSP manual provides these abbreviations. However, OMNR now uses an updated set of abbreviations. For example, in 1995, "Ba" meant basswood. Now "Bd" means basswood. A November, 2009 list of tree abbreviations has been acquired from OMNR. This more current list was utilized in this report. It is recommended that future researchers acquire the most recent lists from OMNR. Consistency with naming tree species is vital, and it is highly recommended that data collectors bring a current list of tree abbreviations to the field. If the species cannot be identified, collect leaves and twigs from the tree, identify in the office, and fill in the appropriate tree species abbreviation.

Accurate and consistent measurements of tree diameter are a critical step in data collection. The PSP manual provides many pages of illustrations that help the data recorder with the multiplicity of situations encountered in the field. As well, OMNR have provided HF with more details in the document "Measuring DBH". Here are some of the most important pointers when measuring DBH:

- Be sure tape is straight and level around the tree for accuracy
- When on a slope, measure DBH on the uphill side of the tree
- If there is a bulge or other deformity that makes measuring diameter at 1.3 m unrepresentative, measure above or below the deformity and record at what height diameter was measured
- If the tree is forked below DBH, and both forks are alive, measure each fork *as a separate tree*
- If the tree is forked above DBH, measure as one tree.

Towards the end of the 2009 sampling season, it was learned that OMNR uses blue tube paint to mark a horizontal line where DBH is measured, so that diameter is consistently measured in the same place each sampling year. This approach was adopted, but only implemented in several PSPs. It is recommended that a blue DBH line be painted on all trees in every growth plot. The line need only be several inches in length – the point is to indicate where to measure DBH.

Collecting tree data for the “Growth Plot Tree Data Form” requires a description of crown class (e.g. dominant/codominant/intermediate, etc), as well as height tree designation. Trees that have been selected as “Yes” height trees may become part of a subset that will be measured for height. For PSPs established in storm plots, there has been a great deal of inconsistency with these designations. According to a PSP specialist at OMNR, trees that are generally stunted should be designated as “No” trees. If “No” trees are the only ones available for height measurements, they can still be measured for height.

Collecting data in the growth plots also requires an assessment of tree quality. In 2009, it was decided that the system could be simplified to AGS/UGS designations. Thus for data analysis purposes, all trees previously assessed as A1 and B1 by previous data collectors were called AGS, and all other quality class categories UGS. The OMNR treemarking guide should be used for consistent assessments of quality.

The Growth Plot Tree Data Form requires estimating canopy closure. This was not done in 2009 due to the time of year data was collected. Sampling began in mid-September, and the initial priority was to measure ground vegetation, regeneration and shrubs. No leaves were on the trees by the time tree data was collected.

Basal area was estimated for the PSP Assessment Form using a German dendrometer. For experimental purposes, factor 1 and 2 were used to assess the same growth plot. The results were found to vary significantly. They also had little resemblance to basal area calculations from diameter measurements. Growth plot #3 in PSP MDL was first measured with the factor 1 dendrometer, and had a BA of 31 m^2/ha. With the factor 2 dendrometer, it had a BA of 42 m^2/ha. BA derived from diameter measurements indicated a BA of 55.9 m^2/ha. A prism was not available for further comparison.

For the purposes of measuring ground vegetation, regeneration, and shrubs, full shrub plots were measured, not nested regeneration plots. Flags placed 2.82-m from the shrub plot center marked the perimeter of the circular plot. Estimates of percent cover included herbaceous vegetation, shrubs and regeneration that are not rooted in the plot but extend over the plot. If a shrub or tree is just over 50 cm, but the bulk of its leaf area is below 50 cm, it should be tallied in the 50 cm-130cm height class.

Regeneration measurements required estimations of percent cover for ferns and allies, grasses, sedges, feather, sphagnum and other mosses, cladonia lichens and other bryophytes and fungi. The 1995 PSP manual provided little guidance on what species should be included under each of these groupings. OMNR provided the following guidance:

Feather mosses include :

- Ptilium crista-castrensis – plume moss
- Hypnum pallascens – stump pigtail moss
- Sanionia unicanta – sickle moss
- Callicladium haldanainumi – beautiful branch moss
- Thudium delicatulum – common fern moss

- Hylocomium splendens – stair-step moss
- Rhytidelphus triquetrus – shaggy moss
- Pleurozium schreberi – Schreber's moss
- Tomenthypnum nitens – golden fuzzy fen moss
- Bracythecium spp. – ragged moss
- Neckera pennata – feathery neckera moss

'Other Bryophytes and Fungi' include liverworts and hornworts

Fern allies include :

- Horsetails – Equisetum spp.
- Club-Moss – Lycopodium spp., Huperzia spp., Diphasiastrum spp.
- Quillworts – Isoetes spp.
- Spikemoss – Selaginella spp.

When measuring all the dead standing trees in the PSP (Mortality Plot Data Form), be sure *not* to include trees within the 3 growth plots. If a tree is hung up, and partially supported by other trees, stumps, rocks, or by its own branches (one end is supported by the ground directly or via roots or an incomplete stem break), and has a lean of 45 degrees or less, it is tallied on the mortality form. It is tallied on the downed woody debris data form if the lean is > 45 degrees or there is a complete break from the stump end. After recording data for species, DBH and decay class, snags should be painted red or blue (if paint still visible from previous sampling year, repaint with different colour or add a second circle). This helps data recorders know which trees have been tallied.

Record wildlife observations with every visit to the PSP, and transcribe notes to the Nesting/Feeding/Escape Cavity data form.

Careful, accurate, and tidy data recording is essential. Data sheets are originals, and will be perused, checked and cross-referenced for many years into the future. Every page should be filled out completely, including *full* names of all crew members, *full* date, PSP name, growth plot number, and azimuth and distance to growth plot. If there is more than one page for a form (e.g. Figure 8), note the current page out of the total number of pages (e.g. Page 2 of 10). PSP files are rearranged many times, and it is essential that basic information is *on every page, <u>and legible</u>.*

Recording data must be done consistently and accurately. Species names must not be made up – they need to correspond to OMNR's list of species abbreviations. Shifting data recorders can help reduce monotony, but it can also have major impacts on the quality of the data collected. New recorders should be give clear instructions, encouraged to ask questions for clarification, and their records double and triple checked by the primary PSP person. Questions that cannot be answered by consulting the PSP manual can be written down, and answers sought from OMNR PSP specialists.

Fresh one-sided paper should be used for all data entry. Though good for the environment, scrap paper *should not be used for data collection*. It is simply too confusing for people consulting this data in future years. If the forecast in any way suggests rain, waterproof paper should be used. It will hold up much longer, though in heavy rain even waterproof paper will deteriorate. All wet forms need to be dried upon return to the office. This is also essential for all mensuration equipment, including meter and diameter tapes (pull them all the way out, and dry the entire length of tape).

Researchers need to photocopy the previous sampling year's data sheets and bring them to the field (especially Figure 8). *Do not take the originals from previous surveys into the field, and do not use the backsides of photocopies for data recording*. Photocopies of the 2009 Growth Plot Tree data forms have already been made.

Data analysis

The most recent data files have been "tidied" up with considerable care and effort, with many mistakes corrected. For example, in previous years, the diameter of all trees had been entered in the "Tree Diameter" Excel spreadsheet for every PSP, regardless if the tree was dead or not. The diameters of these dead trees were included in calculations of basal area, diameter growth, and species composition.

These 'tidied' files are located in the electronic folder "PSP Report Winter 2010". Researchers will need to create a new folder with copies of all these PSP files, and use them for data entry.

Sapling and tree data (data forms 6 and 8) were entered into Excel spreadsheets for each PSP. Accurate entry of species and diameter data is critical. The data entry person must be given clear instructions. Diameters of dead trees should *not* be recorded in the "Tree Diameter" worksheet of every PSP – the tree should be noted as "DEAD" in the DBH column. If a tree has been cut, it should be noted as "harvested" – both on the data sheets and in the DBH column of the tree diameter worksheet. The data entry person can also help identify anomalies in the dataset, and bring these to the attention of the PSP researcher. For example, some trees appear to 'shrink'; others grow at unusually fast rates. The PSP researcher may be able to remeasure these trees, or make a note on the data forms and Excel files that a particular tree may be skewing the data, and needs to be remeasured.

The "tree diameter" Excel worksheet is the foundation of most of the data analysis. This data is used to calculate basal area ($BA = 0.00007854 \times (DBH)^2$) by species and by size class, and tree abundance by species and by size class.

Basal area and tree abundance, by species, was calculated by hand, with Excel spreadsheets and with Excel pivot tables (pivot tables were the fastest and most accurate). Pivot tables were also used to generate size class distributions (the set up of the "Size class" worksheets was used to generate the pivot tables in the "Pivot table" worksheets).

PSP canopy height was estimated by selecting the highest 3-4 trees per growth plot, and calculating the average for all 3 growth plots.

Quadratic mean diameter at breast height was calculated with the following formula:
Mean DBH = sqrt ((G/N) x 40000/PI)
G = is the sum of the basal areas of all living trees in square meters. G = 0.0000785398 x d^2 (d is DBH in cm)
N = Number of trees in the stand

Results

Each of the 22 PSPs is described, including stand history, sampling years, location, forest type and dominant tree species, ecosite, basal area by species and by growth plot, tree species composition, sapling abundance by species, basal area by size class and quality, species abundance by size class and quality, canopy height, and mean diameter.

PSPs have been grouped by similarities in disturbance history (Table 1). Four of the PSPs have had fairly recent, stand replacing disturbances, including a tornado with extensive downbursts in 1995, and clearcutting with standards in 1983. Three PSPs appear to be the product of stand replacing disturbances of unknown origin and age. Two have experienced patch-replacing disturbances.

Eight PSPs are in stands with relatively recent histories of selection and/or salvage harvesting. This may also be the case for TLI, TLII and KLII, but no trees were harvested from the growth plots, and harvesting history is vague. PSP NT and PSP RSR are dominated by many large-diameter climax species, with gap disturbance as the dominant agent of regeneration.

Table 1: List of PSPs, disturbance history, and sampling years

Disturbance Type	PSP	Sampling Years
1995 Tornado with extensive downbursts & salvage harvest	T3 PSP1	1998/1999, 2004, 2009
	T4 PSP2	1998, 2003, 2008
1995 Tornado with extensive downbursts	PSP DT	1999, 2004, 2009
1983 Clearcut	PSP KLRT	2007
Stand-replacing disturbance – either fire or heavy cutting; date unknown	PSP ER	1999, 2004, 2009
	PSP RL	1999, 2005
	PSP RT	1999, 2004, 2009
Patch-replacing disturbance – spruce budworm epidemic or otherwise. One tree harvested	PSP DL	1999, 2004, 2009
	PSP L'Azure	2000, 2005
Selection Cut and salvage harvest	T1 PSP1	1998, 2003, 2008
	T2 PSP1	1999, 2004, 2009
Selection Cut [stand harvested, though trees in growth plots may not have been cut]	T5 PSP1	1999, 2004, 2009
	T6 PSP1	1998, 2003, 2008
	T6 PSP2	1998, 2003, 2008
	PSP HT	1999, 2004, 2009
	PSP KLI	2003, 2008
	PSP MDL	1999, 2004, 2009
Gap disturbance	PSP KLII	2003, 2008
	PSP NT	1999, 2004, 2009
	PSP RSR	1999, 2004, 2009
	PSP TL1	1999/2000, 2005
	PSP TL2	2000, 2005

T1PSP1

Site description

This plot represents an uneven-aged, tolerant hardwood forest on fresh, moderately deep unsorted till. The stand is about 1.5 km due north of basecamp, accessed from the North Rd and the Kennisis Bridge Trail (Figure 2). It is located on level terrain and was harvested in 1987 (diameter limit cut) and 1995 (post storm salvage cut).

Figure 2: Map of Haliburton Forest with arrow showing location of T1PSP1

T1PSP1 is a very productive, sugar maple and beech dominated stand (Figure 3). Basal area has increased rapidly since 1998, from 11.6 m^2/ha in 1998, to 15.6 m^2/ha in 2003 and 19.6 m^2/ha in 2008. These basal area estimates include “trees” (or “large saplings”) 2.5 cm -9.9 cm DBH, which accounted for 2.4 m^2/ha in basal area in 2008. The overall 10-year basal area increase was 8.0 m^2/ha (0.8 m^2/ha/year), with strong growth exhibited for both major species, as well as across all growth plots (Figure 4).

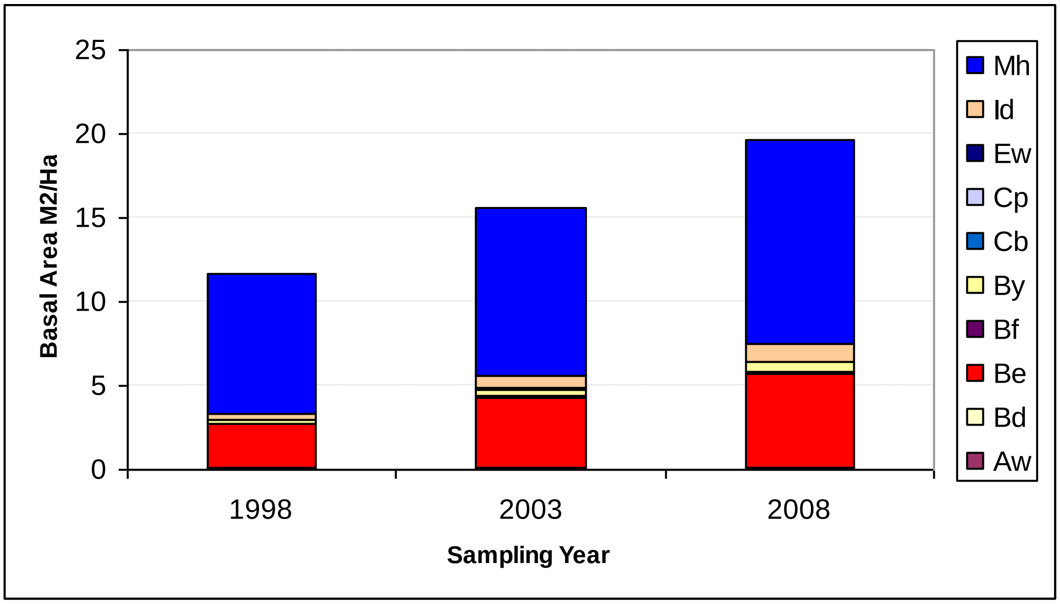

Figure 3: Total basal area/hectare, by species, over 3 sampling years for T1PSP1.

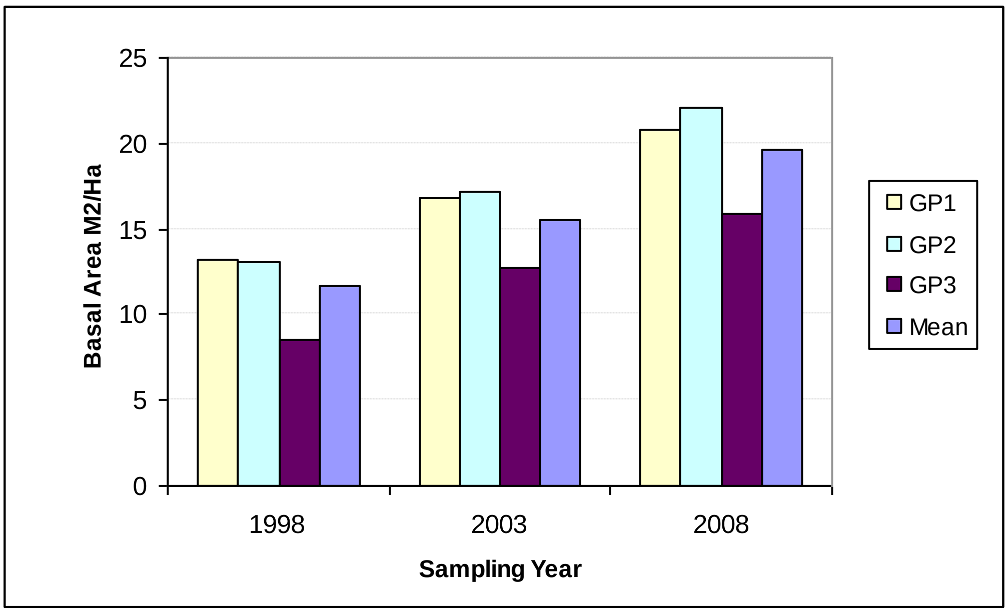

Figure 4: Total basal area/hectare, by growth plot, over 3 sampling years, for T1PSP1.

Tree and small sapling abundance

Total stem count increased from 817/ha to 1392/ha between 1998 and 2008. Sugar maple is the most common tree species in this plot (392), followed by beech (375) and ironwood (350), with a lesser component of yellow birch (183), basswood (50), balsam fir (17) and black cherry (17) (Figure 5).

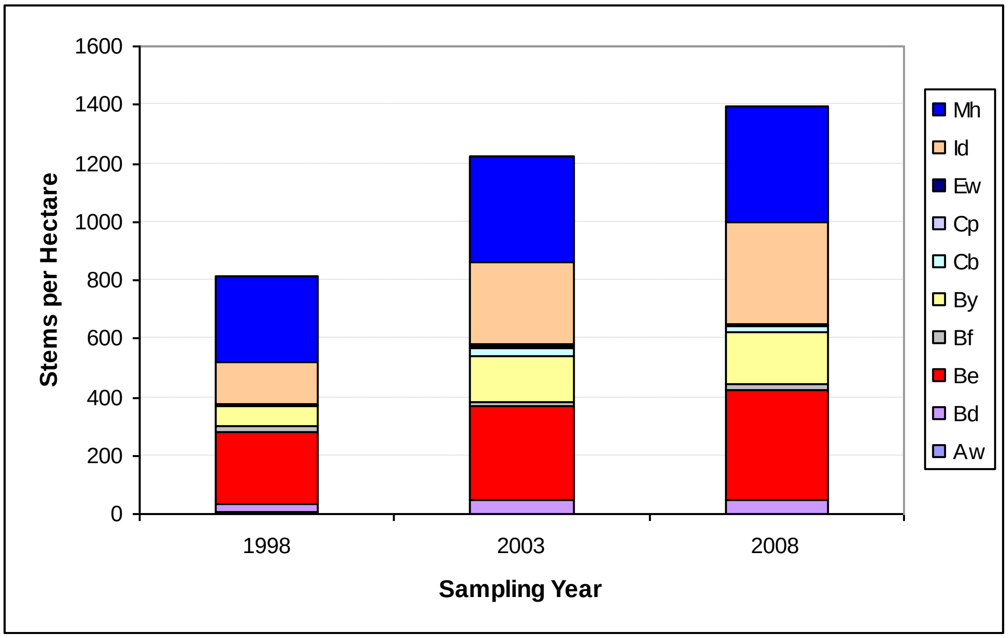

Figure 5: Number of stems/hectare, by species, over 3 sampling years for T1PSP1.

In 2008, 75 of the 76 saplings (>1.3 m high and <2.5 cm DBH) in this plot were sugar maple, beech and ironwood (Figure 6). Yellow birch was the most common regeneration in 1998, and nearly disappeared by 2008 (likely due to the reduction in light levels at ground level as the canopy closed in). Beech was a common sapling species in 1998, almost disappeared from the plot in 2003, and was again common in 2008. This anomaly may be due to inaccurate data collection.

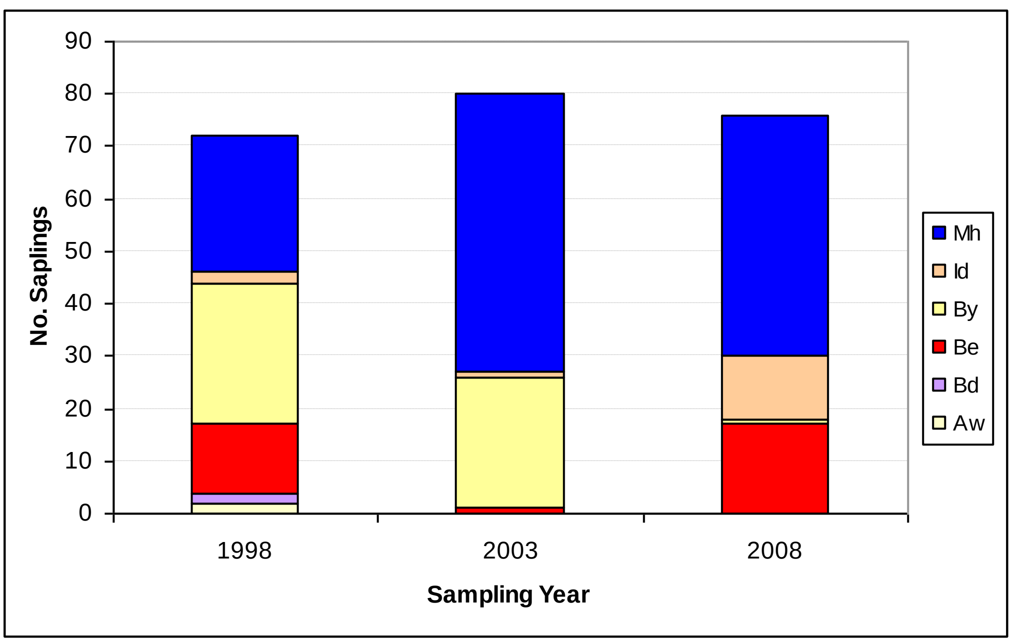

Figure 6: Sapling abundance, by species, over 3 sampling years for T1PSP1.

Size class distribution

In 2009, basal area distribution in this stand was 5-8-2-2 (polewood-small sawlog-medium sawlog-large sawlog). Of the total basal area of 19.6 m^2/ha in 2008, 39% was concentrated in the small sawlog size class, followed by polewood-sized trees (27%) (Figure 7). Medium and large sawlog sized-trees comprised 22% of basal area.

52% of basal area (10.2 m^2/ha) was UGS, including all the large diameter sawlogs and the majority of the polewood-sized trees.

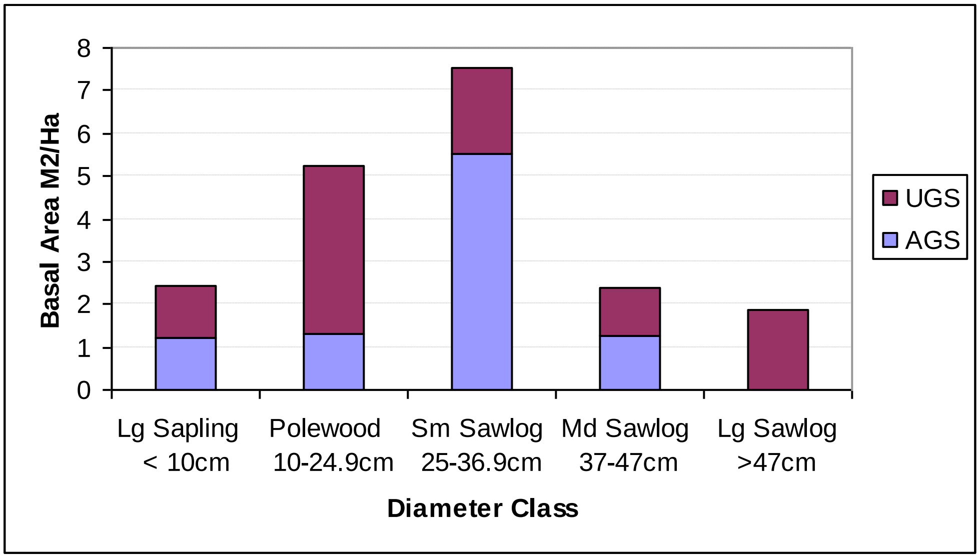

Figure 7: Basal area by size class and quality for T1PSP1 (2008 data).

Most of the trees in this plot are polewood-sized, with abundance declining rapidly in the larger size classes (Figure 8). Mean DBH is relatively low, at 12.8 cm, which is in part a result of the high proportion of "large saplings" (2.5-9.9 cm DBH). The distribution of stems by size class resembles the reverse-J-shaped curve recommended for selection management in the Algonquin Region (312-81-33-14), though the abundance of polewood-sized stems is lower than recommended to ensure adequate recruitment to larger size classes. This may be especially important in this stand, as over 75% of the polewood-sized trees have been characterized as UGS, suggesting that harvesting of quality timber may be problematic in the future.

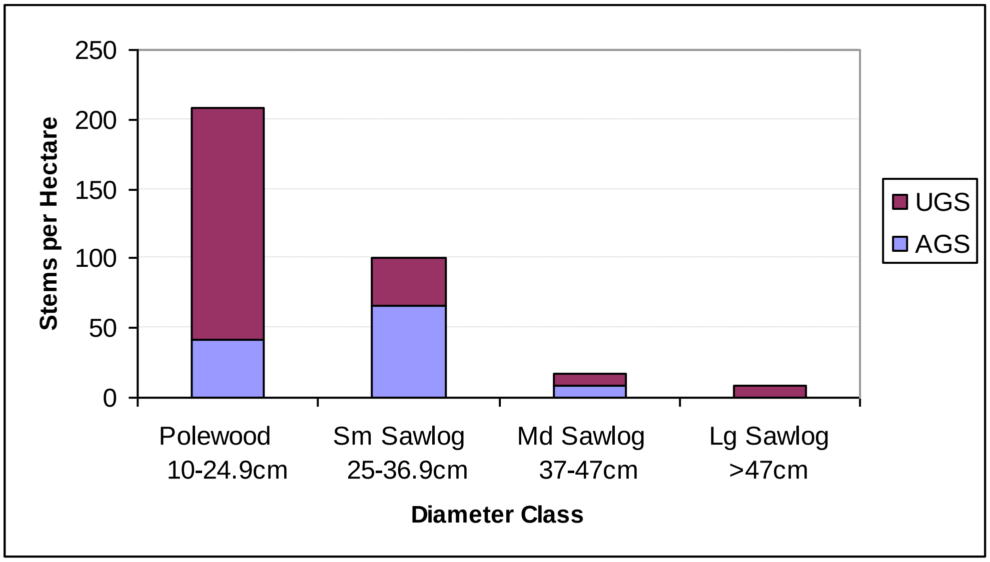

Figure 8: Tree abundance by size class and quality for T1PSP1 (2008 data).

Table 2: Summary of T1PSP1 results

T1 PSP1	
Forest type	Hard maple dominated, level terrain
Dominant Tree Species	Mh6Be3OH1
Regeneration Species	Mh6Be2Iw2
Disturbance type	Salvage cut in1995; harvest (possibly diameter cut) in 1987
FEC classification	ES 25.2 (Mh-Be-Or; fresh to moist)
Basal area (>2.5cm dbh)	19.6 m^2/ha (2008)
Canopy height	24 m
Mean DBH	12.8 cm
Location	West side of North Rd, ½ km north of intersection with East Rd

T2PSP1

Site Description

This plot represents a multi-aged, tolerant hardwood forest on fresh, moderately well-drained, loamy sand. It is located along a gentle slope, with a northeast exposure. The stand was salvage harvested in 1995 (post storm) and selection harvested in 2004. No trees have been cut from the 3 growth plots since establishment of the PSP in 1999. The stand is about 1 km NNE of basecamp, close to East Rd. (Figure 9).

Figure 9: Map of Haliburton Forest with arrow showing position of T2PSP2

T2PSP1 is a productive sugar maple and beech stand. Basal area increased from 21.5 m^2/ha in 1999, to 26 m^2/ha in 2009 (Figure 10). Basal area estimates include “trees” (or “large saplings”) 2.5 cm -9.9 cm DBH. For this PSP, large saplings accounted for 1.3 m^2/ha of basal area in 2009. The overall 10-year basal area increase was 4.5 m^2/ha (0.45 m^2/ha/yr), with good growth exhibited for the 2 major species, as well as across all growth plots (Figure 11).

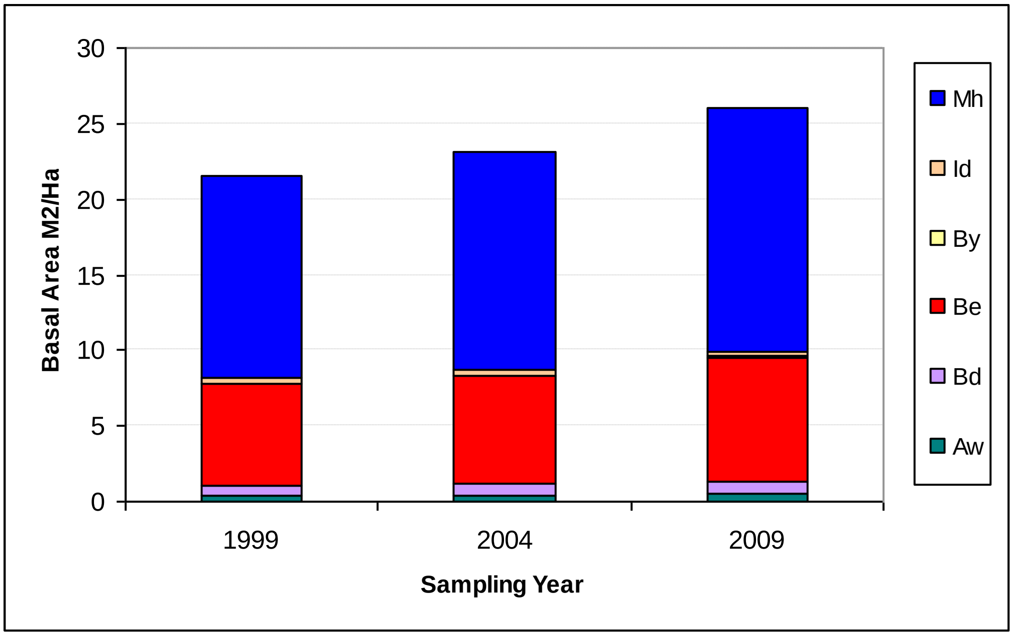

Figure 10: Total basal area/hectare, by species, over 3 sampling years for T2PSP1.

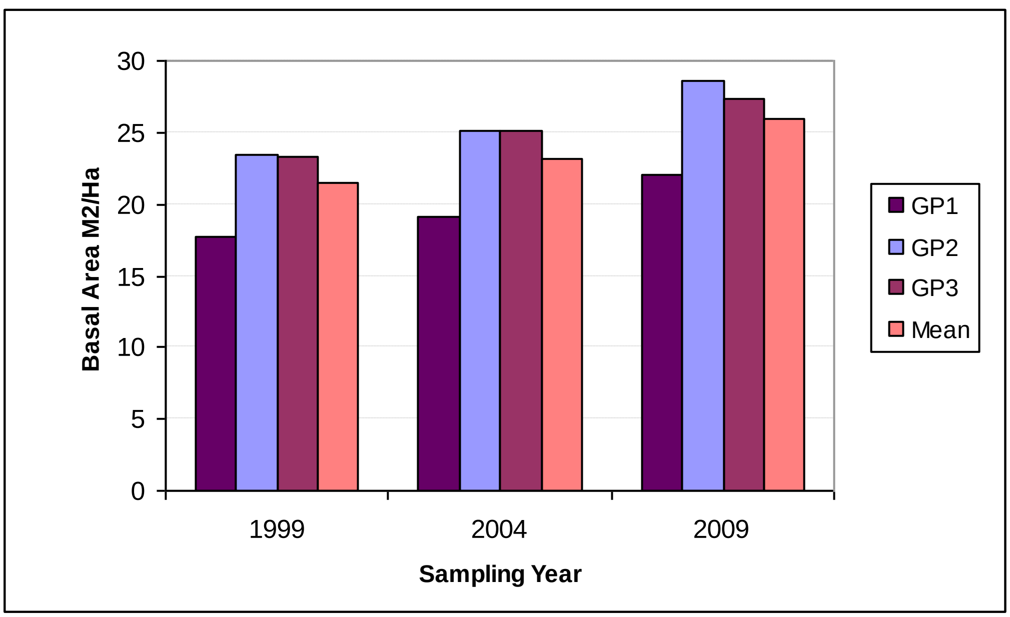

Figure 11: Total basal area/hectare, by growth plot, over 3 sampling years, for T2PSP1.

Tree and small sapling abundance

Total stem count increased from 900/ha to 983/ha between 1999 and 2009. Sugar maple is the most common tree species in this plot, followed by beech, with much smaller amounts of ironwood, yellow birch, basswood, and white ash (Figure 12). Beech increased in volume by 19% over the 10 year sampling period, while sugar maple increased 17%.

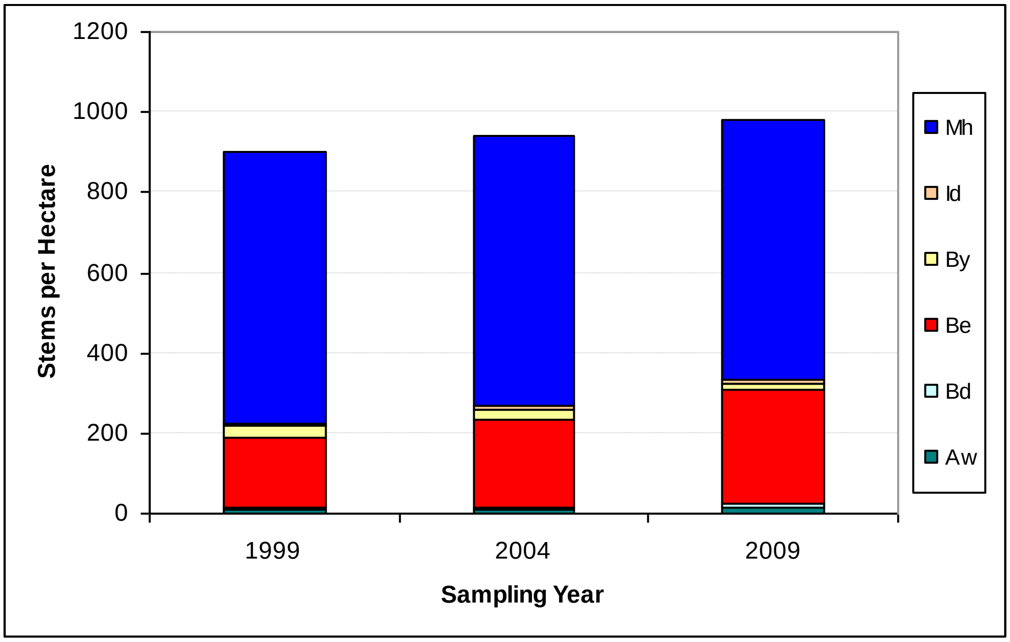

Figure 12: Number of stems/hectare, by species, over 3 sampling years for T2PSP1.

For every sampling year, sugar maple and beech comprised the majority of saplings for this plot (Figure 13). Yellow birch, white ash and basswood all made brief and fleeting appearances.

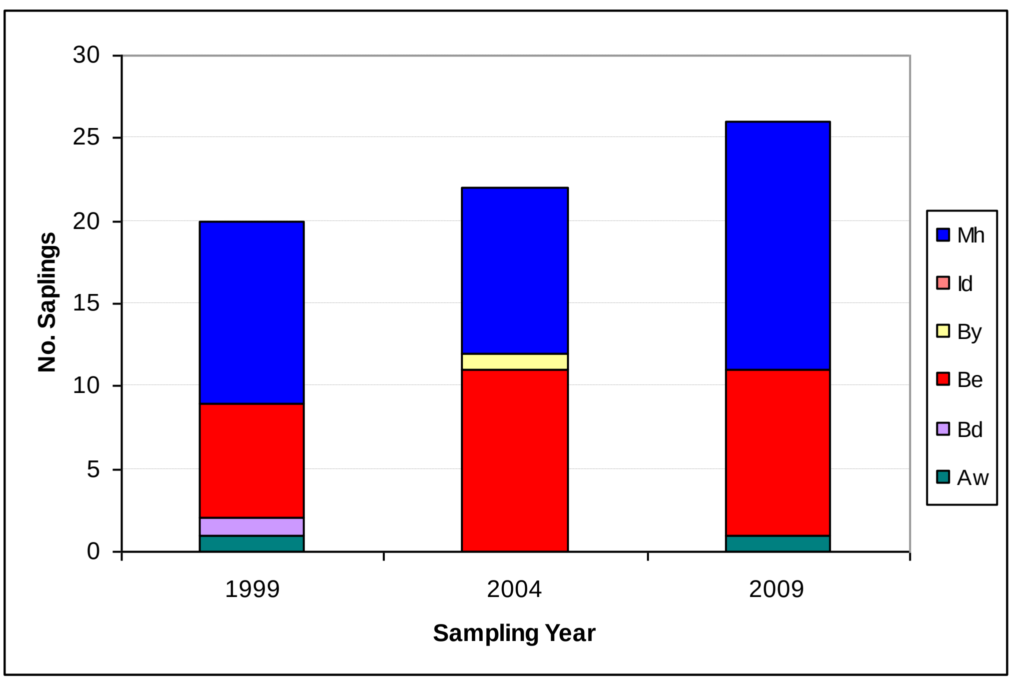

Figure 13: Sapling abundance, by species, over 3 sampling years for T2PSP1.

Size class distribution

Basal area distribution for this plot is 4-6-12-3 (polewood-small sawlog-medium sawlog-large sawlog). 46% (12/26 m^2/ha) of the basal area in this plot is concentrated in the medium sawlog size class, followed by small sawlog-sized trees (23%) (Figure 14). Polewood and large sawlog-sized trees comprise 26% of basal area. 15.4 m^2/ha, or 59% of basal area, is AGS, including all the large diameter sawlogs and the majority of the polewood and small sawlog-sized trees. The majority of UGS trees are in the medium sawlog size class.

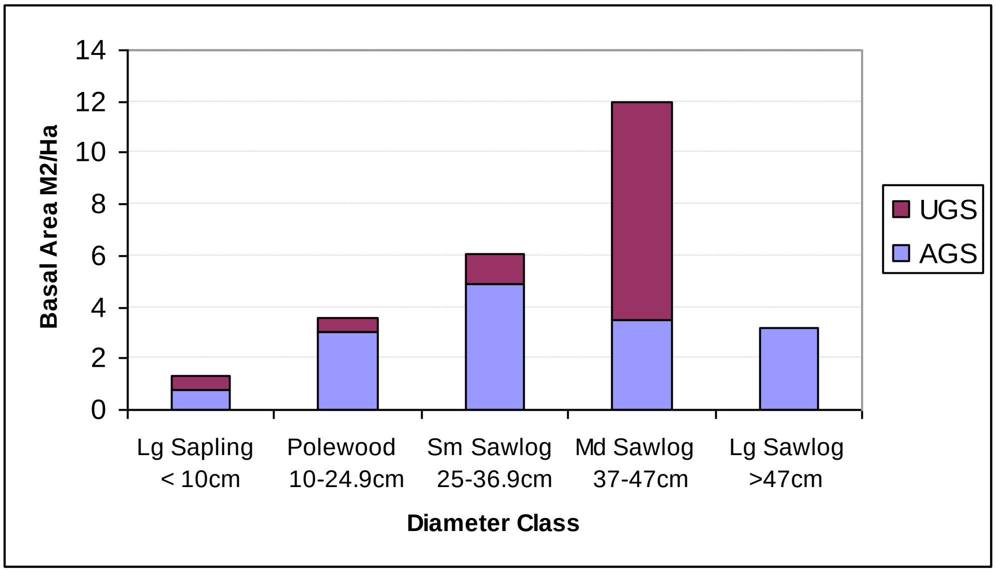

Figure 14: Basal area by size class and quality for T2PSP1 (2009 data).

As to be expected, most of the trees in this plot are polewood-sized, though abundance is lower than suggested to ensure adequate recruitment of larger size classes into the future (Figure 15). The abundance of medium-sized sawlogs is relatively high, with 70% characterized as UGS. Mean stem diameter is 18.35 cm.

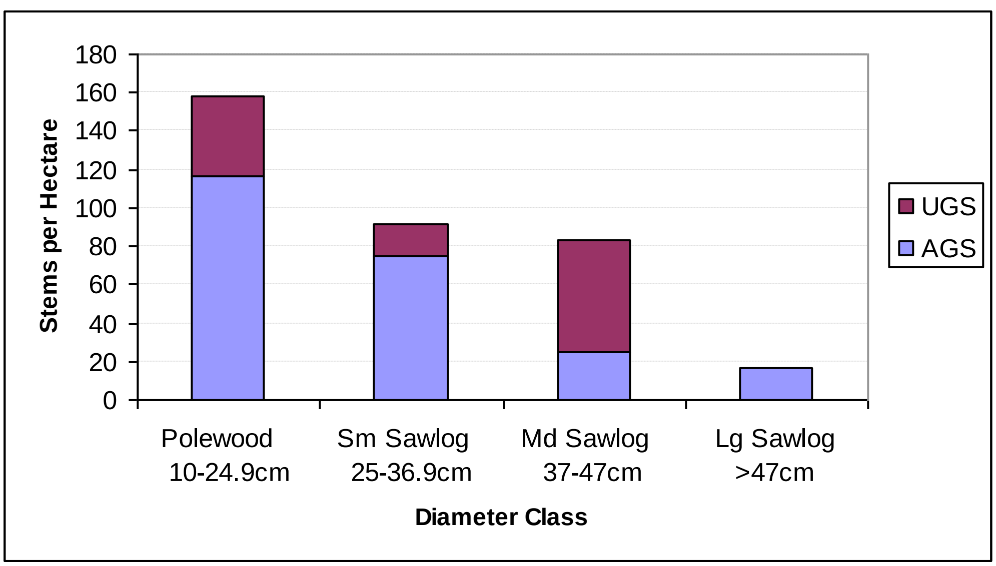

Figure 15: Tree abundance by size class and quality for T2PSP1 (2009 data).

Table 3: Summary of T2PSP1 results

T2 PSP1	
Forest type	Sugar maple dominated, mid-slope, northeast exposure
Dominant Tree Species	Mh6Be3
Regeneration Species	Mh6Be4
Disturbance type	Selection cut in 2004; salvage harvest in 1995; no trees cut in growth plots since 1999
FEC classification	ES 25.2 (Mh-Be-Or; fresh to moist)
Basal area	25.6 m^2/ha
Canopy height	23 m
Mean DBH	18.35 cm
Location	South off East Rd, about 50 m past beginning of Normac Trail

T3PSP1

Site description

T3PSP1 represents a young, post-disturbance sapling dominated stand on deep sandy loam. The plot is on level terrain, with parts of it inundated after heavy rains. A microburst in 1995 levelled much of the stand, which was later salvage harvested by Tembec. This plot is located just east of basecamp and Redkenn Road (Figure 16). It was chosen for sampling in 1998/99 to study forest regeneration after a natural disturbance.

Figure 16: Map of Haliburton Forest with arrow showing location of T3PSP1

Before the 1995 microburst, T3PSP1 was a tolerant hardwood stand. Today it is mostly an early successional stand of balsam fir, poplar, red maple and cherry (Figure 17). Basal area has increased in all 3 growth plots, from 6.2 m^2/ha in 1999, to 10.2 m^2/ha in 2004 and 13.7 m^2/ha in 2009 (Figure 18). Total basal area increased 7.5 m^2/ha over the ten year sampling period, or 0.75 m^2/ha/yr. Large saplings comprise the majority of basal area. One very large diameter (79 cm DBH) white pine persisted in growth plot 2 for the first 2 sampling years, which accounts for the relatively large proportion of basal area dominated by white pine before 2009.

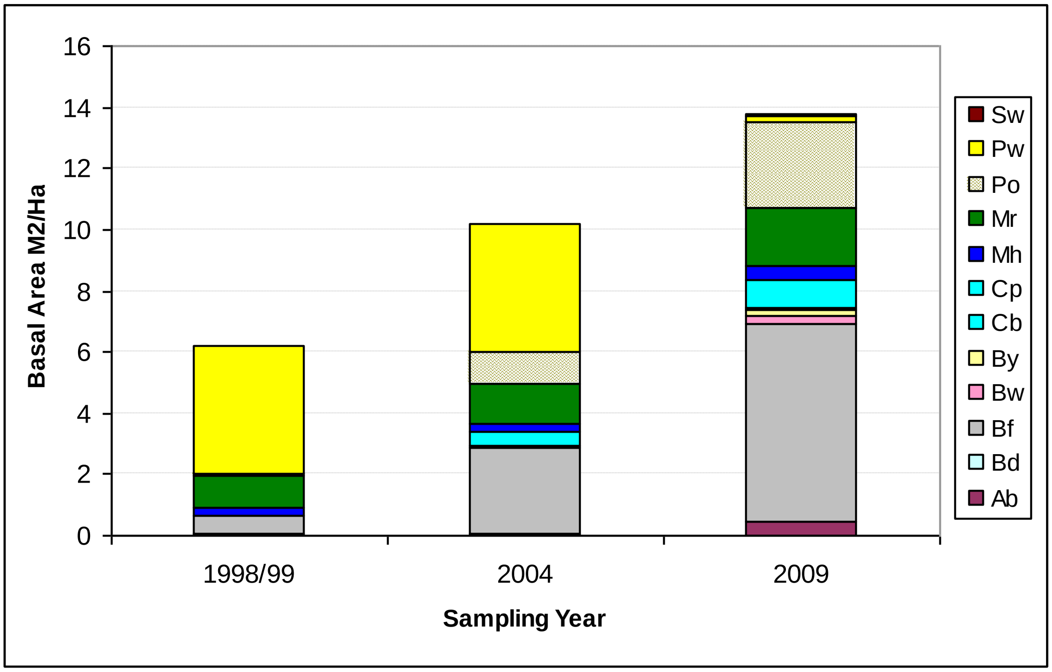

Figure 17: Total basal area/hectare, by species, over 3 sampling years for T3PSP1.

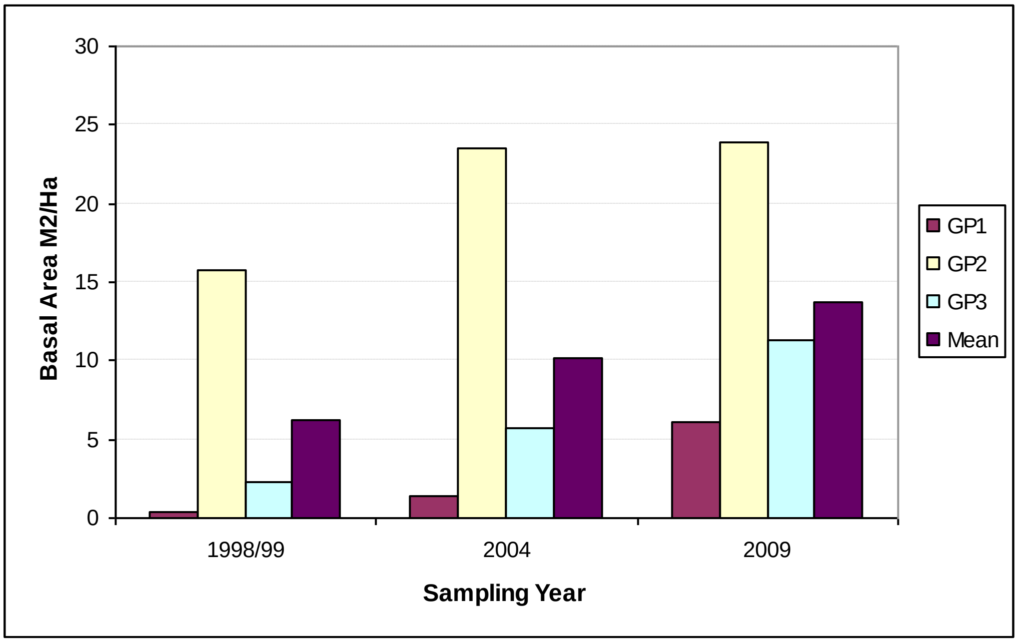

Figure 18: Total basal area/hectare, by growth plot, over 3 sampling years, for T3PSP1.

Tree and small sapling abundance

Total stem count increased from 617/ha to 5,358/ha between 1999 and 2009 (Figure 19). In 2009, balsam fir was the most common tree species (2,142), followed by poplar (1,058), red maple (1000), and pin cherry (508). There were also small amounts of white pine, black ash, white and yellow birch, and sugar maple. Like the other 2 storm damaged PSPs, the post storm residual species composition influenced current stand composition. While sugar maple has done poorly, residual red maple and balsam fir, along with shade intolerant poplar, cherry, and white birch, have done very well.

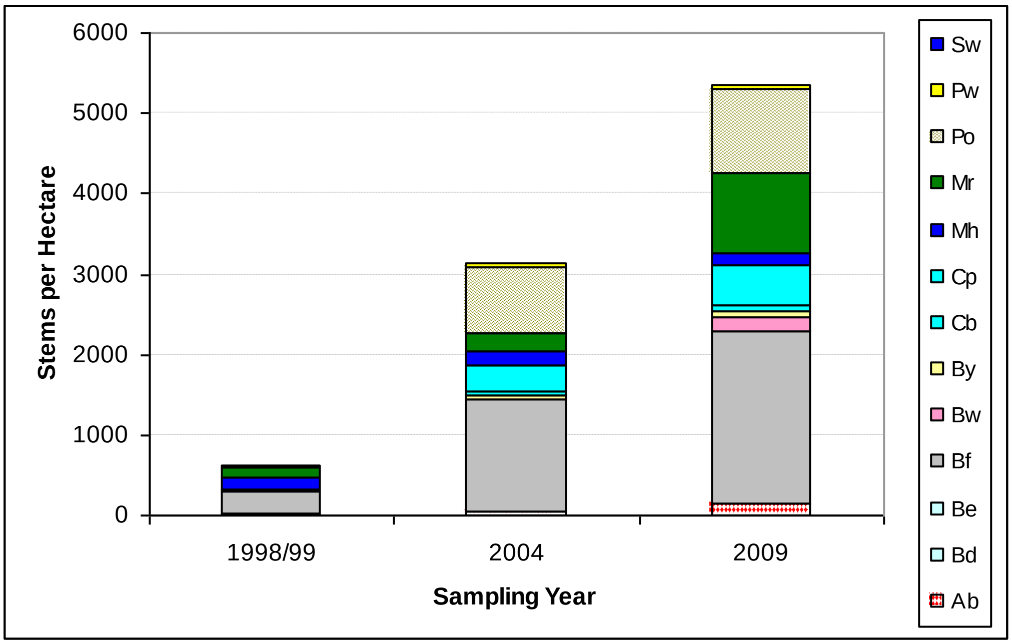

Figure 19: Number of stems/hectare, by species, over 3 sampling years for T3PSP1.

In 2009, balsam fir, white birch and red maple comprised the majority of saplings (>1.3 m high and <2.5 cm DBH) for this plot (Figure 20). Sapling abundance dropped from 142 to 62 between 2004 and 2009. This is likely because many saplings have grown into the next size class (2.5-10 cm DBH), and the canopy is closing in. Sapling abundance can be expected to drop further in future sampling years.

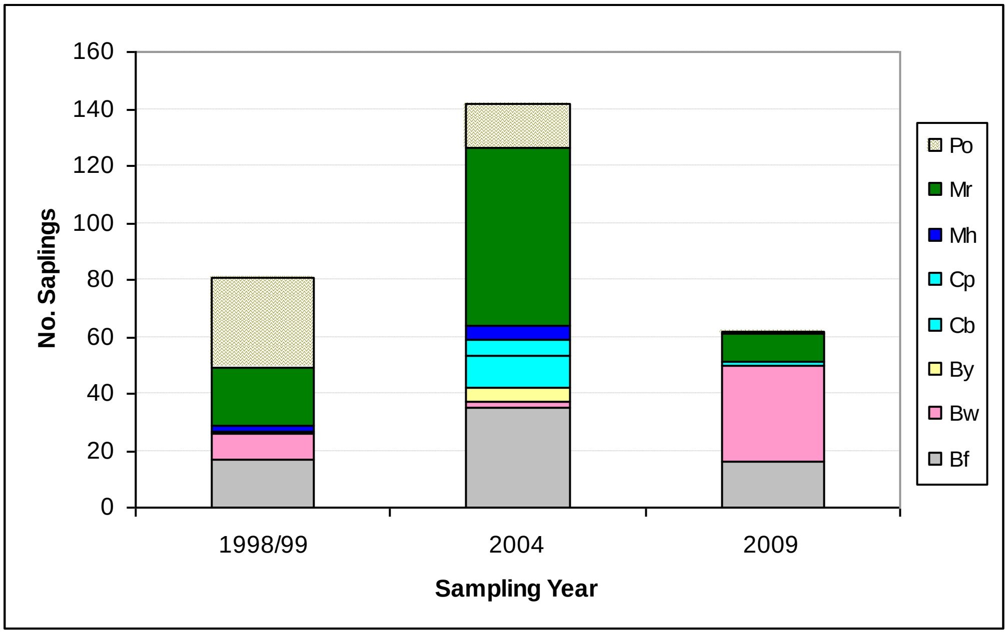

Figure 20: Sapling abundance, by species, over 3 sampling years for T3PSP1.

Size class distribution

The basal area of large saplings (2.5 cm-9.9 cm DBH) accounted for 81% of total basal area in 2009, with the remainder made up of polewood-sized trees (Figure 21). Due to the storm and salvage harvest, very few trees were left standing, and those that were died. Due to the very high number of young, sapling-sized trees, it was decided that characterizing them as AGS/UGS would be premature.

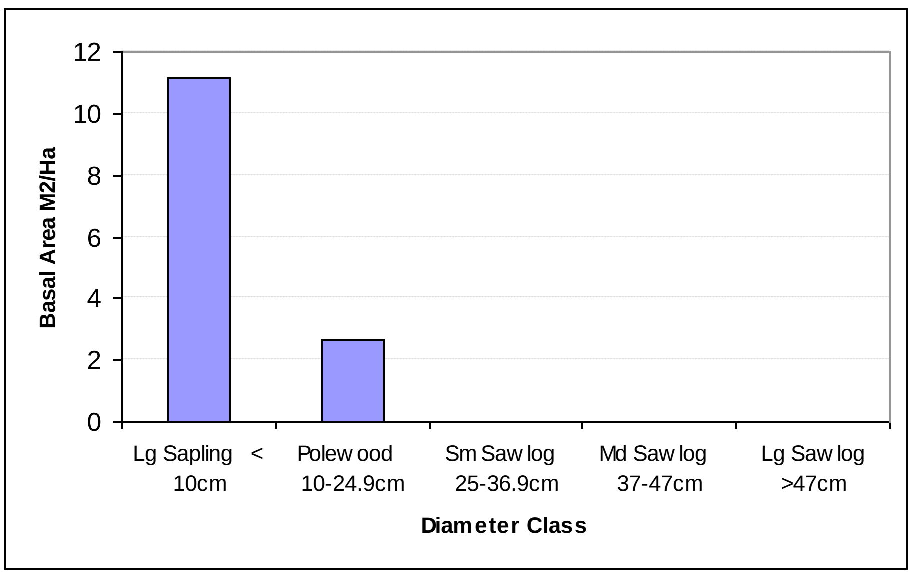

Figure 21: Basal area by size class and quality for T3PSP1 (2009 data).

The vast majority (96%) of trees in T3PSP1 are "large saplings" (Figure 22). The remaining 4% are polewood-sized trees. Mean stem diameter is very low, at 5.7 cm.

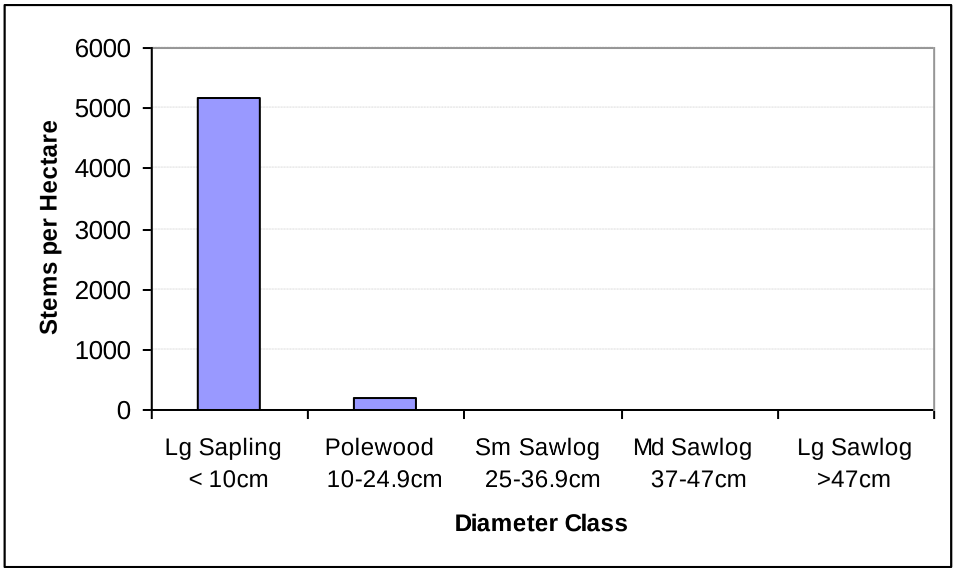

Figure 22: Tree abundance by size class and quality for T3PSP1 (2009 data).

Table 4: Summary of T3PSP1 results

T3 PSP1	
Forest type	Early successional, 14-year-old stand, level terrain
Dominant Tree Species	Bf5Po2OH3
Regeneration Species	Bw5Bf3OH2
Disturbance type	Micro-burst in 1995; salvage harvest winter 1995
FEC classification	Too young to classify
Basal area	13.8 m^2/ha
Canopy height	10.9 m
Mean DBH	5.7 cm
Location	East off Redkenn Rd, 20-m south of driveway to Astronomy Ctr.

T4PSP2

Site Description

T4PSP2 is a multi-aged, post-disturbance sapling dominated stand located 200 m east of the main office at basecamp (Figure 23). The plot is on level terrain with imperfectly drained sandy loam. A microburst in 1995 levelled much of the plot, which was then salvage harvested. It was selected as a PSP to study forest regeneration after a large-scale natural disturbance.

Figure 23: Map of Haliburton Forest with arrow showing position of T4PSP2.

T4PSP1 has both a significant component of shade tolerant and mid-tolerant hardwoods and softwoods (sugar maple, yellow birch, beech and hemlock) as well as a major component of young, early-successional species like cherry and balsam fir (Figure 24). This reflects the stand's history. During the microburst and salvage harvest of 1995, a large number of the dominant trees were removed. Some survived, and have responded well to release, while others died. Young vigorous regeneration has filled in the gaps. Basal area has increased rapidly, from 6.9 m^2/ha in 1998, to 9.9 m^2/ha in 2003 and 14.4 m^2/ha in 2008. These basal area estimates include "trees" (or "large saplings") 2.5 -9.9 cm DBH, which accounted for 5.2 m^2/ha of basal area in 2009. The overall 10-year basal area increase was 7.5 m^2/ha (0.75 m^2/ha/yr), which was concentrated in growth plots 1 and 2 (Figure 25). Growth plot 3 has a large amount of regeneration but total growth was reduced by the death of 5 polewood-sized trees and 1 small sawlog-sized tree.

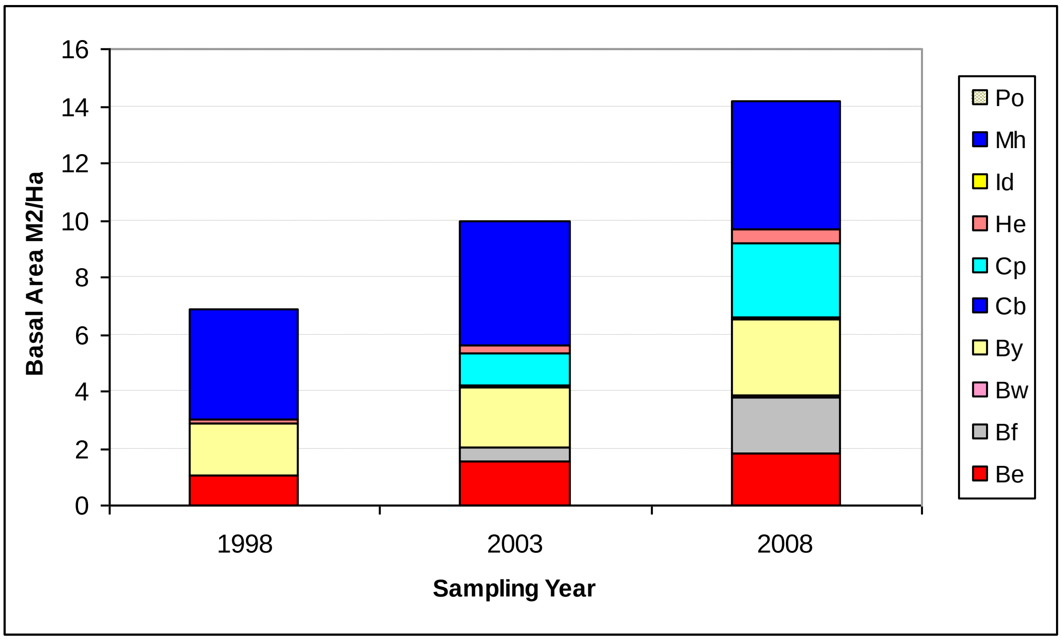

Figure 24: Total basal area/hectare, by species, over 3 sampling years for T4PSP1.

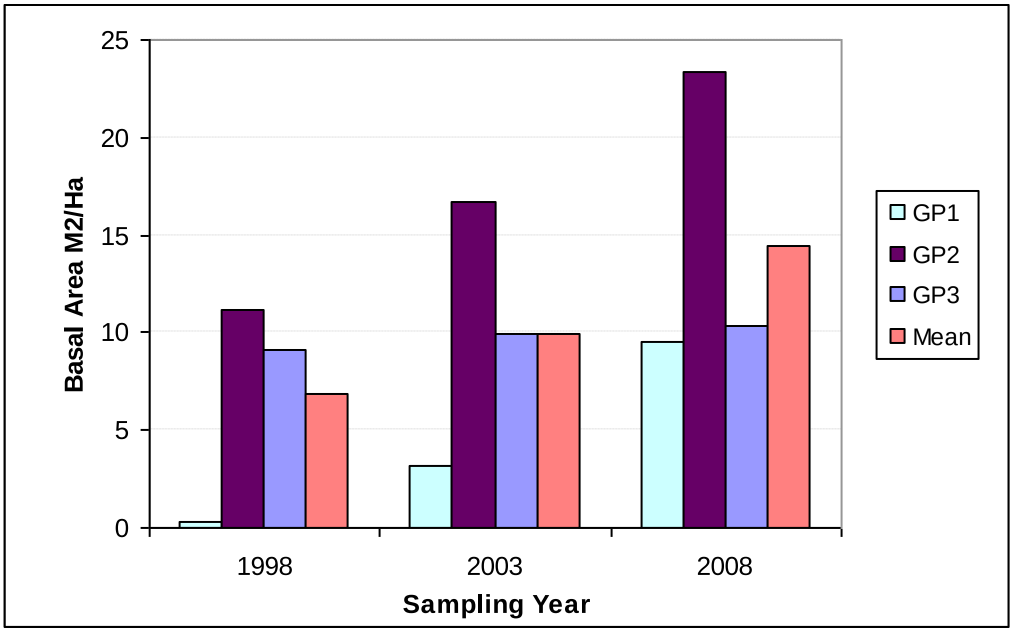

Figure 25: Total basal area/hectare, by growth plot, over 3 sampling years, for T4PSP1.

Tree and small sapling abundance

Total stem count increased from 217/ha to 3,908/ha between 1998 and 2008. Cherry has been very successful in regenerating this stand : by 2008, pin cherry was the most common tree species (2,325), followed by sugar maple (492), yellow birch (417), balsam fir (283) and beech (200) (Figure 26).

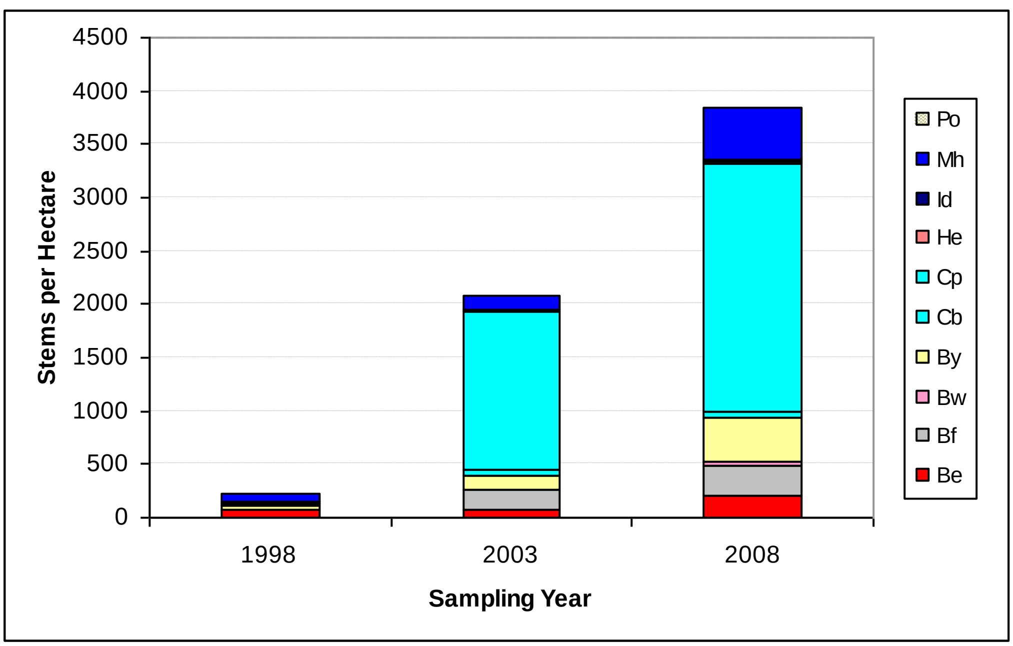

Figure 26: Number of stems/hectare, by species, over 3 sampling years for T4PSP1.

In 2008, cherry, sugar maple, beech and yellow birch made up the majority of saplings (>1.3 m high and <2.5 cm DBH) for this plot (Figure 27). The total number of saplings has ranged between 160 and 202 since 1998. While the results indicate that black cherry was dominant in 1998 and absent in 2008, and vica versa for pin cherry, this 'change' may be due to inaccurate identification of cherry species.

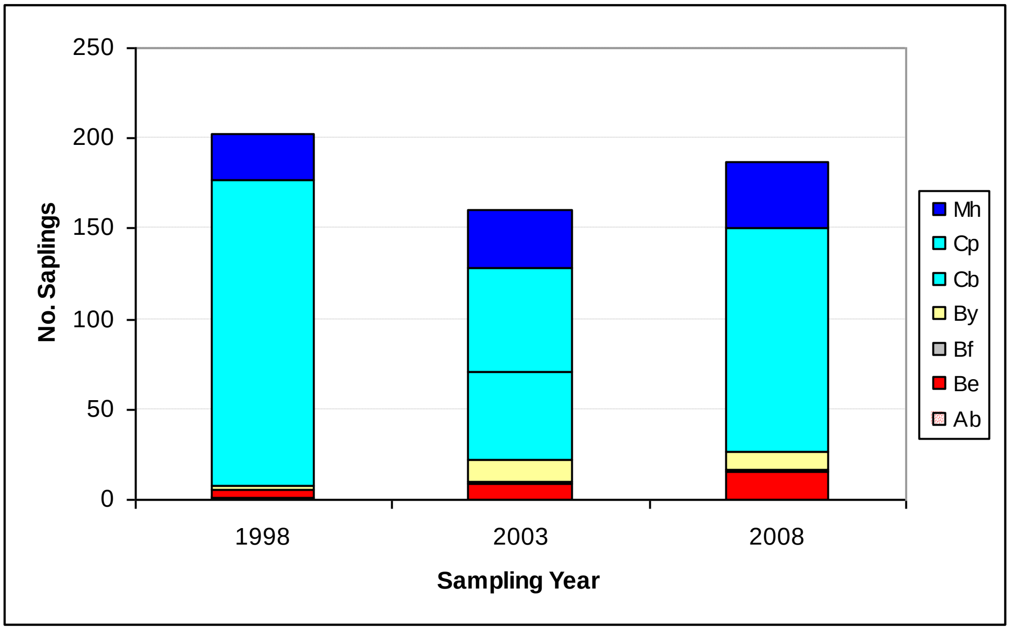

Figure 27: Sapling abundance, by species, over 3 sampling years for T4PSP1.

Size class distribution

Basal area distribution of this stand is 4-2-3-0. This does not include large saplings, which comprise 36% of basal area in this plot (Figure 28). Large saplings make up the majority of stems (93%) while medium sawlogs make up less than 1% (but comprise 22% of basal area) (Figure). Mean stem diameter is 6.8 cm.

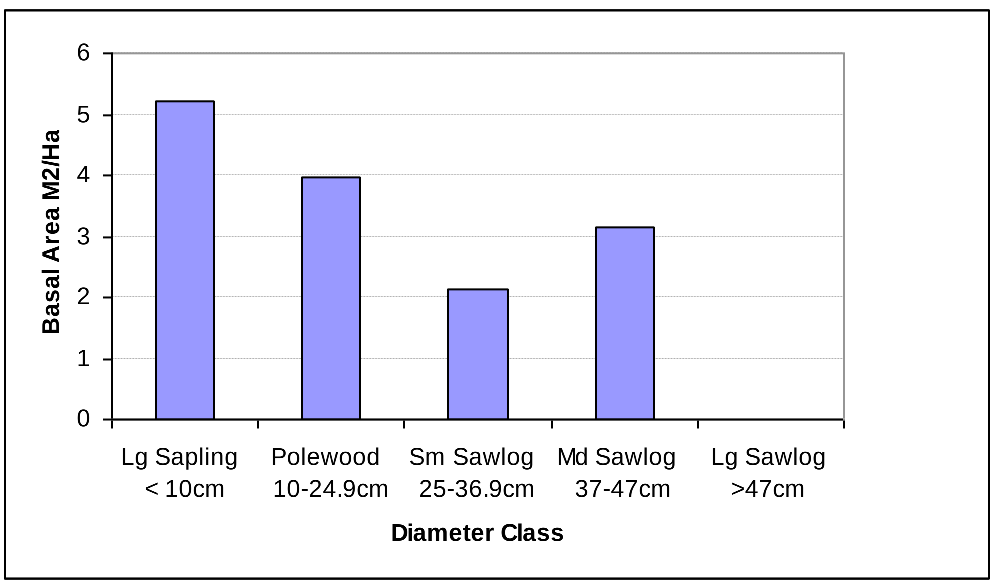

Figure 28: Basal area by size class and quality for T4PSP1 (2008 data).

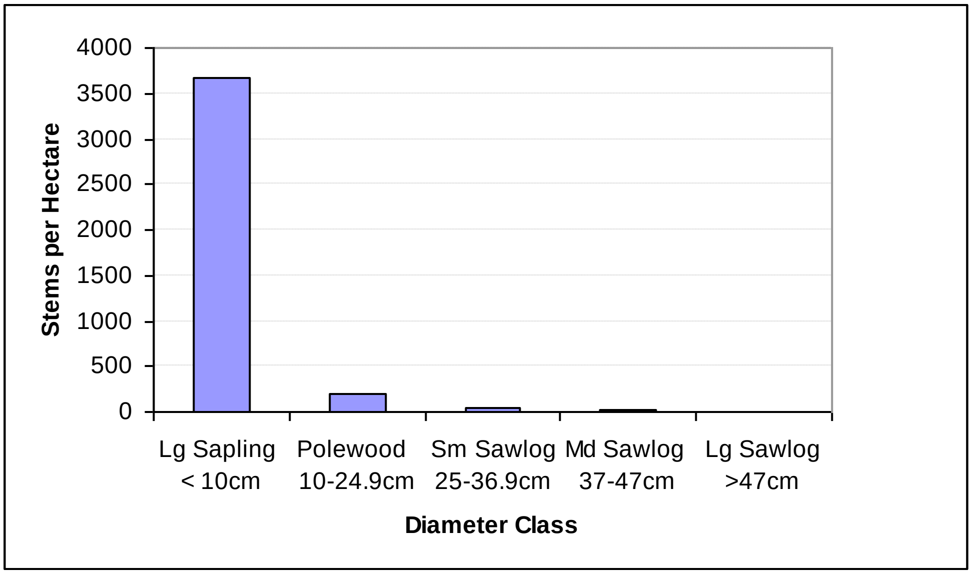

Figure 29: Tree abundance by size class and quality for T4PSP1 (2008 data).

Table 5: Summary of T4PSP1 results

T4 PSP1	
Forest type	Remnant tolerant hardwood forest interspersed with early successional species, level terrain
Dominant Tree Species	Mh3Cp2By2OC2Be1
Regeneration Species	Cp7Mh2OH1
Disturbance type	Micro-burst in 1995; salvage harvest winter 1995
FEC classification	Pre-1995 tolerant hardwood forest; now too disturbed to classify
Basal area	14.4 m^2/ha
Canopy height	13.9 m
Mean DBH	6.8 cm
Location	200 m at 90^o from main office at basecamp

T5PSP1

Site Description

T5PSP1 represents a multi-aged, beech and sugar maple dominated hardwood forest on well-drained sandy loams ½ km due south of basecamp (Figure 30). It is on level terrain. The stand was selection harvested in 2007, though according to the PSP records, a medium-sized beech was cut between 1999 and 2004. With the exception of the beech, the only trees cut in the growth plots in 2007 were less than 5.2 cm DBH (to clear a skid trail).

Figure 30: Haliburton Forest map with arrow showing location of T5PSP1.

Site description

Basal area increased from 23.4 in 1999 to 25 m^2/ha in 2009 in T5PSP1 (Figure 31). The total increase over the 10 year period was only 1.6 m^2/ha, or 0.16 m^2/ha/yr. Of the total basal area, large saplings comprised 1.2 m^2/ha in 2009. Below average growth rates occurred in all 3 growth plots (Figure 32).

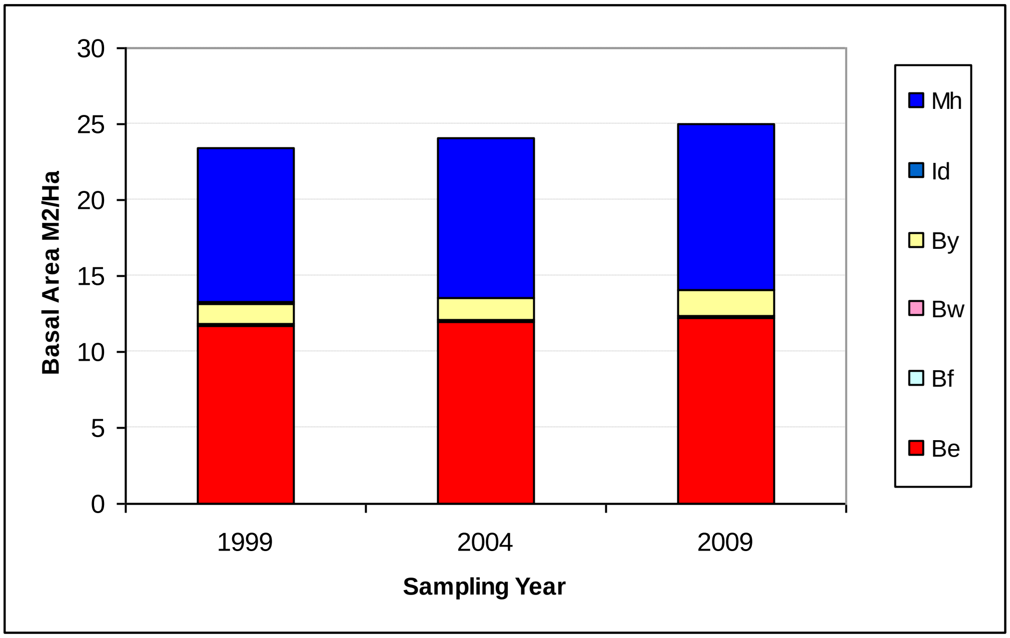

Figure 31: Total basal area/hectare, by species, over 3 sampling years for T5PSP1.

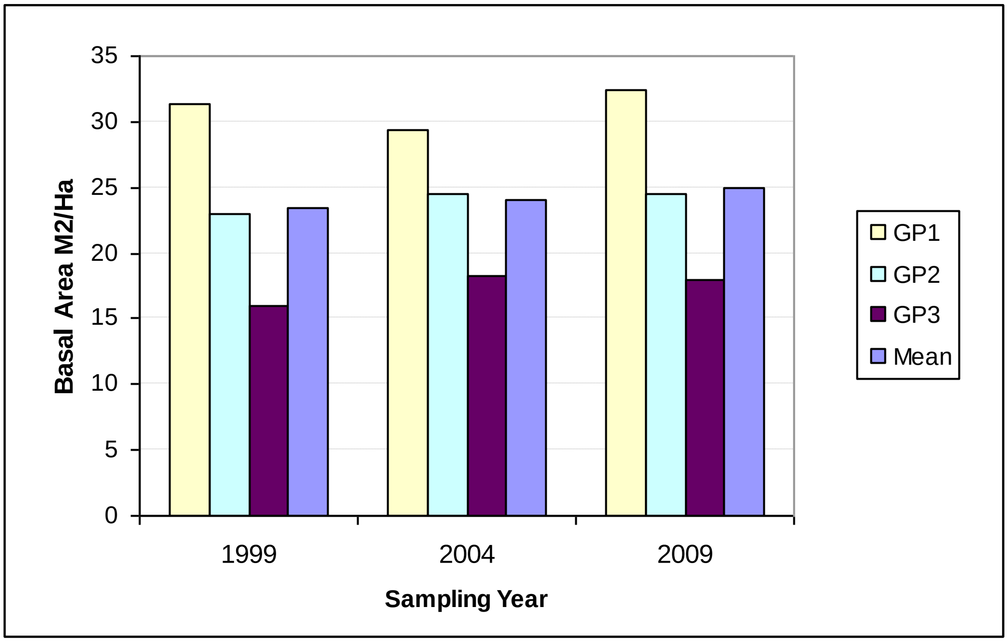

Figure 32: Total basal area/ha, by growth plot, over 3 sampling years, for T5PSP1.

Tree and small sapling abundance

Total stem count decreased from 875/ha to 817/ha between 1999 and 2009 (Figure 33). Reductions in yellow birch (133 => 83) and sugar maple (417 => 367) stems accounted for this decline. Beech abundance increased from 292 in 1999 to 333 in 2009. In 2009, sugar maple was the most common tree species in this plot (367/ha), followed by beech (333/ha) and yellow birch (83/ha).

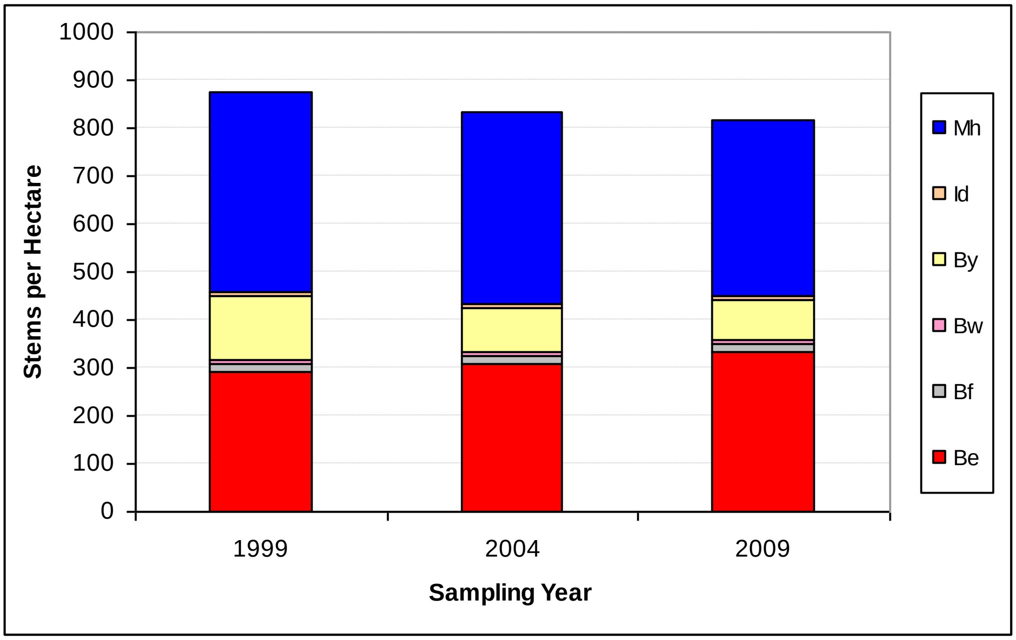

Figure 33: Number of stems/hectare, by species, over 3 sampling years for T5PSP1.

For all 3 sampling years, sugar maple and beech comprised the majority of saplings (>1.3 m high and <2.5 cm DBH) in this plot (Figure 34). Sapling abundance increased slightly between 1999 and 2004 (137 to 147), then dropped 44% by 2009 to 82. This is likely due to sapling damage from felling and skidding during the 2007 harvest.

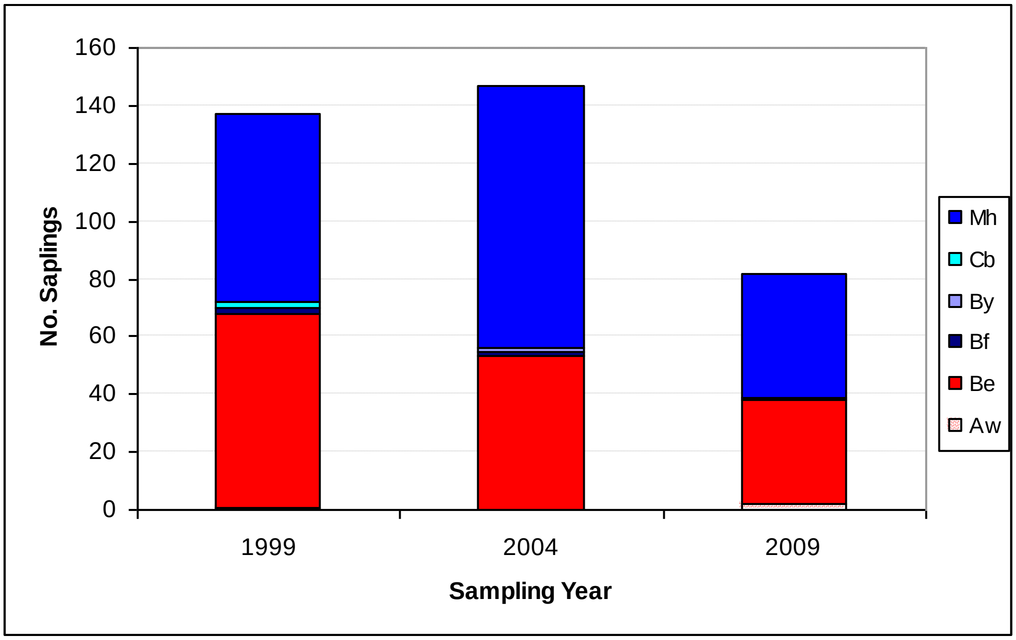

Figure 34: Sapling abundance, by species, over 3 sampling years for T5PSP1.

Size class distribution

Basal area distribution in this PSP was 4-5-7-7 in 2009 (polewood-small sawlog-medium sawlog-large sawlog). 57% of the basal area in this plot was concentrated in the medium to large sawlog size classes. Polewood basal area is quite low, at 4 m^2/ha (Figure 35). Overall, 69% of basal area is UGS, with particularly high proportions in the medium and large sawlog size classes.

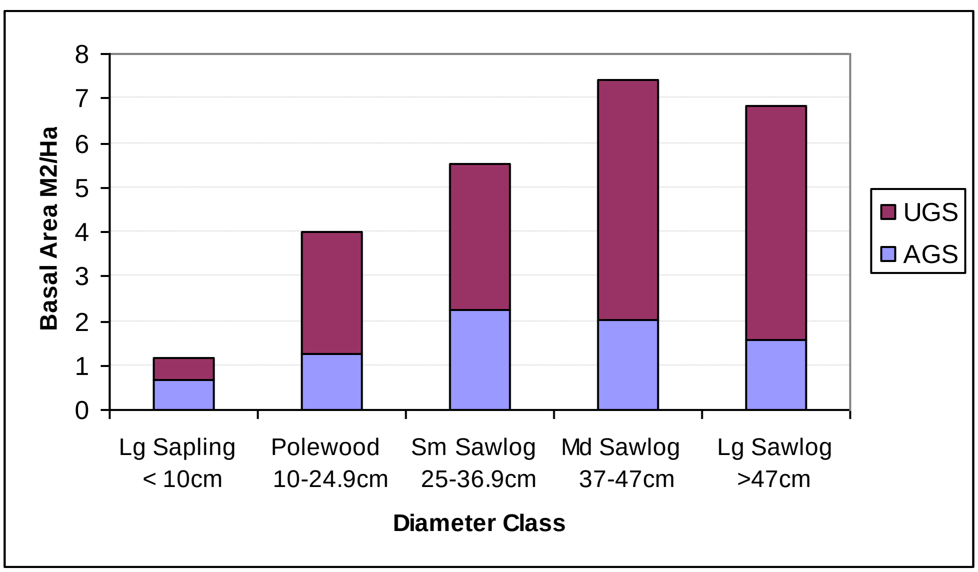

Figure 35: Basal area by size class and quality for T5PSP1 (2009 data).

Most of the trees in this plot are polewood-sized, with abundance declining in the larger size classes (Figure 36). The total number of polewood-sized stems should be higher to ensure adequate recruitment to larger size classes. Almost 75% of polewood-sized trees have been characterized as UGS, suggesting that harvesting of quality timber may be problematic in the future. Mean stem diameter is 20.1 cm.

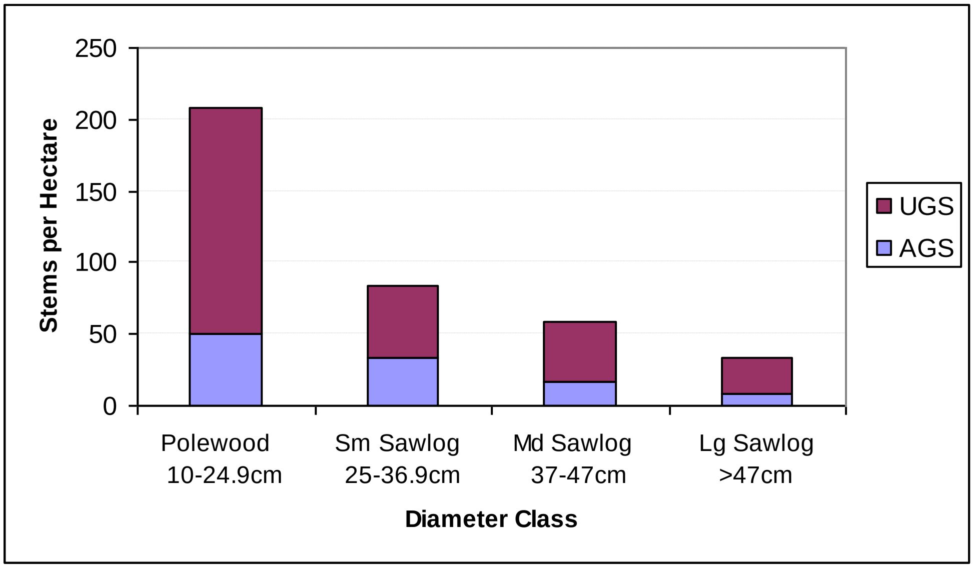

Figure 36: Tree abundance by size class and quality for T5PSP1 (2009 data).

Table 6: Summary of T5PSP1 results

T5 PSP1	
Forest type	Beech and hard maple dominated, level terrain
Dominant Tree Species	Be5Mh4By1
Regeneration Species	Mh5Be4
Disturbance type	Selection harvest in 2007, possibly other harvesting since 1999
FEC classification	ES 25.2 (Mh-Be-Or; fresh to moist)
Basal area	25.8 m^2/ha
Canopy height	23.4 m
Mean DBH	20.1 cm
Location	East off Redkenn Rd, near intersection with Kennisis Lake Rd.

T6PSP1

Site description

T6PSP1 represents an uneven-aged, sugar maple dominated stand on fresh, loamy sand located ½ km southeast of basecamp (Figure 37). The terrain is level to gently undulating. It was horse logged in 2007, and there may have been some salvage harvesting in 1995. Between 3-5 small and medium sawlog-sized trees were harvested from growth plots, and a few sapling-sized trees may have been knocked down during harvesting operations. Poor record keeping has made it difficult to determine whether several trees in growth plots were cut or died from natural causes.

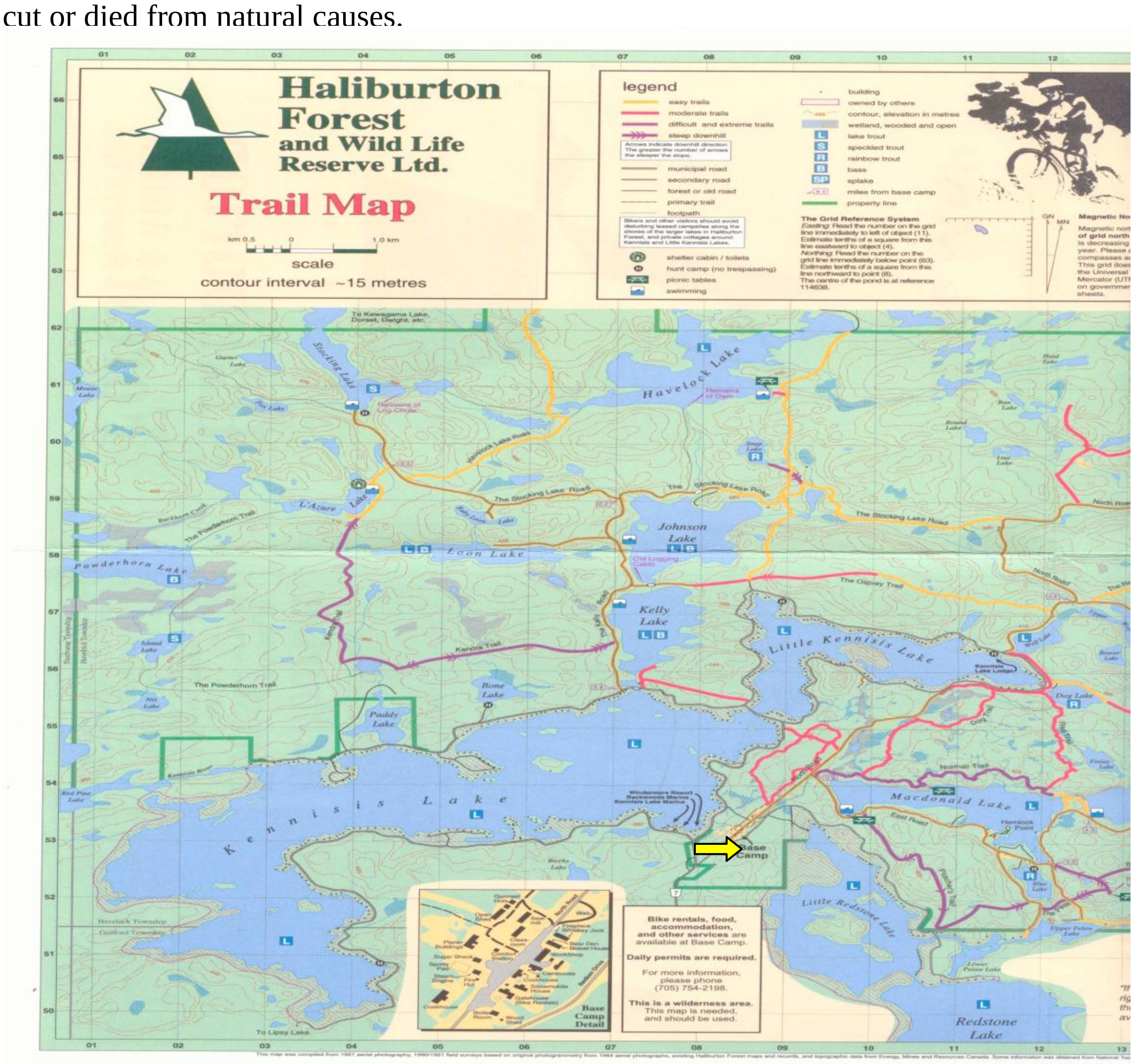

Figure 37: Map of Haliburton Forest with arrow showing location of T6PSP1

T6PSP1 is dominated by sugar maple (56%), beech (29%), and yellow birch (15%) (Figure 38). Basal area increased slightly from 27.1 m^2/ha in 1998, to 27.8 m^2/ha in 2003, then decreased in all growth plots to 23.7 m^2/ha in 2008 (Figure 39). The 2007 harvest removed sugar maple only (Mh basal area decreased from 17.4 to 13.3 m^2/ha between 2003 and 2008, while the basal area of beech remained the same, at 6.7 m^2/ha over the same period).

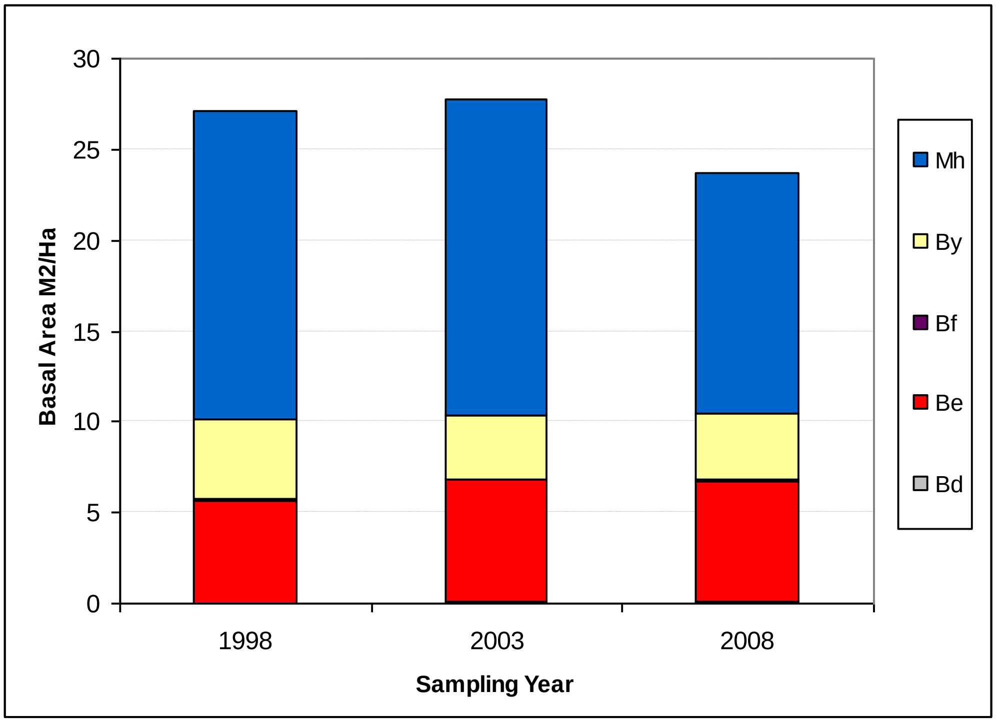

Figure 38: Total basal area/hectare, by species, over 3 sampling years for T6PSP1.

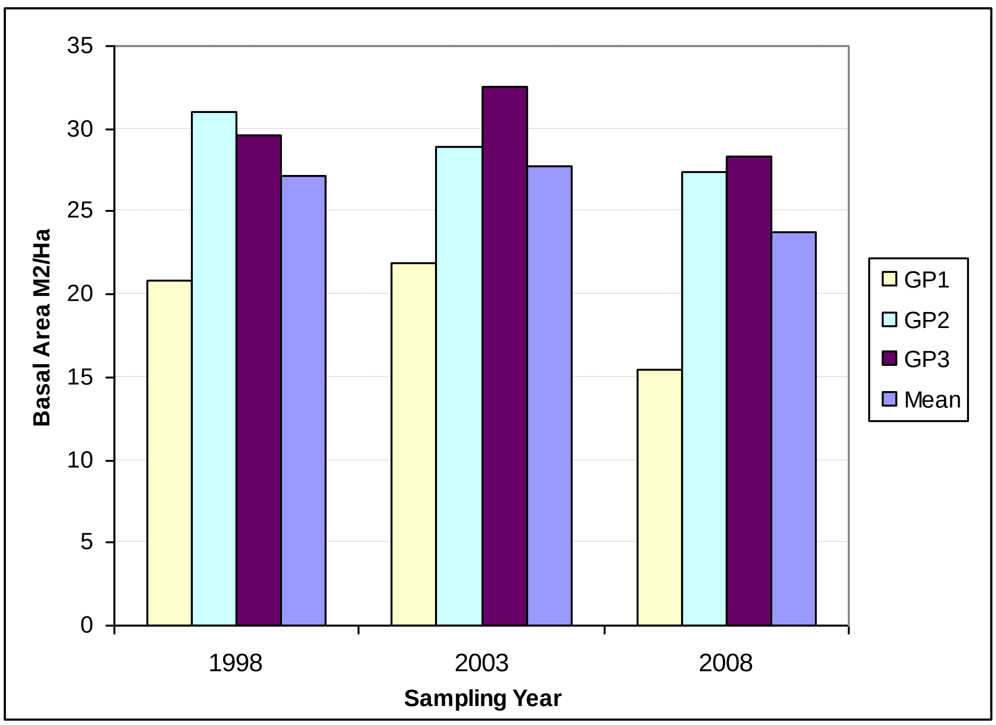

Figure 39: Total basal area/hectare, by growth plot, over 3 sampling years, for T6PSP1.

Tree and small sapling abundance

Total stem count increased from 667/ha to 783/ha between 1998 and 2003, then decreased to 775/ha by 2008 (Figure 40). Within the 10 year sampling period, the relative abundance of sugar maple to beech changed significantly. In 1998, there was a 4:1 ratio of sugar maple to beech. By 2008 the ratio was closer to 1:1. Yellow birch, basswood and balsam fir persisted in the stand throughout the sampling period.

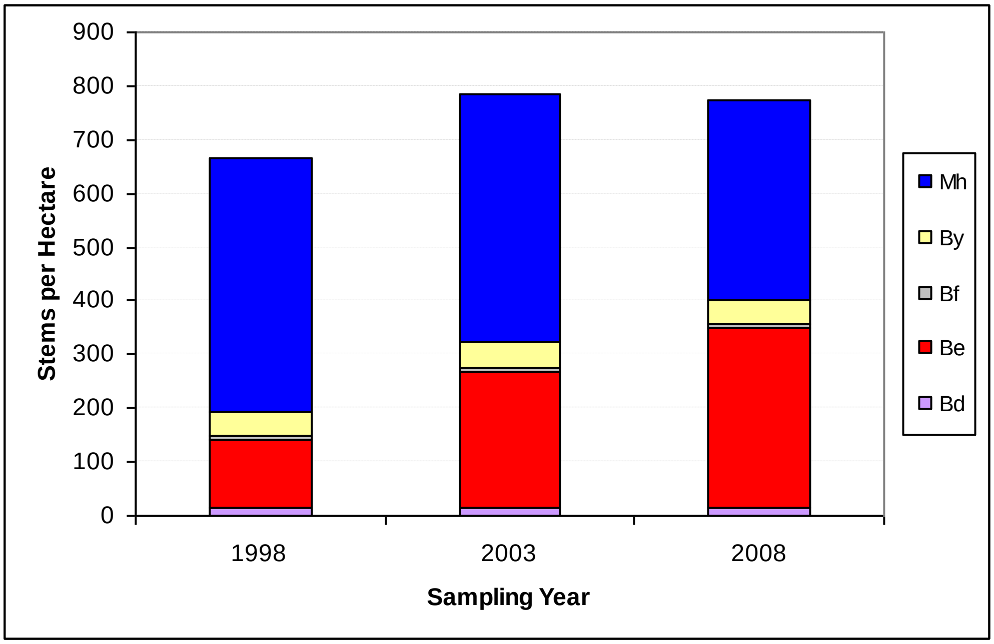

Figure 40: Number of stems/hectare, by species, over 3 sampling years for T6PSP1.

In 2008, sapling species included beech, sugar maple, yellow birch and white ash (Figure 41). Sapling abundance almost doubled over the sampling period (42 in 1998 to 77 in 2008). The increase was especially pronounced for sugar maple (from 7 in 1998 to 12 in 2003, and 31 in 2008).

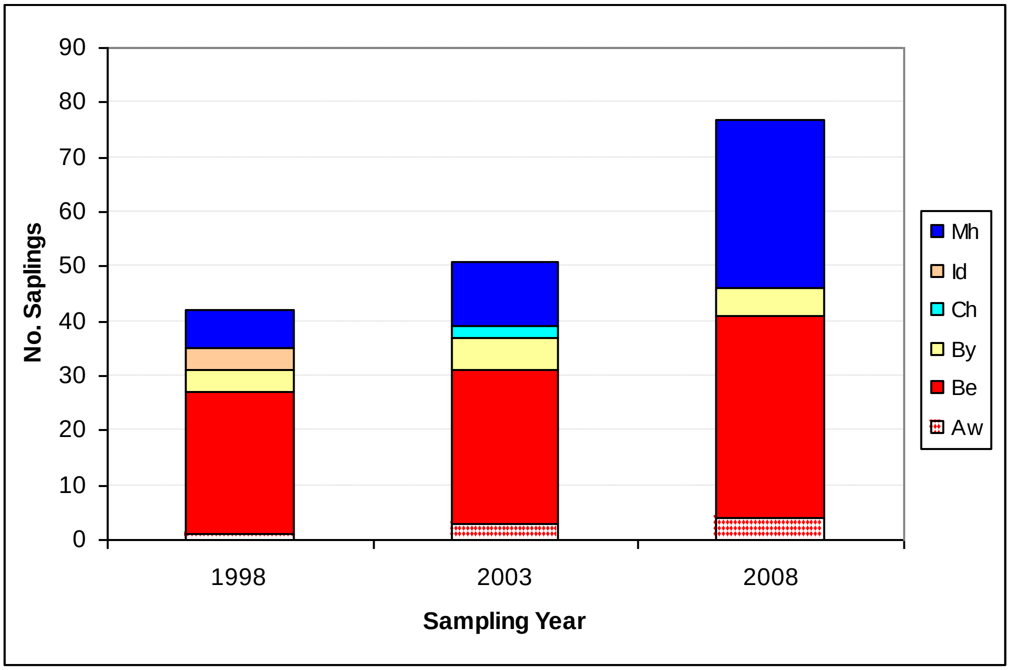

Figure 41: Sapling abundance, by species, over 3 sampling years for T6PSP1.

Size class distribution

Basal area distribution in this stand was 2-7-12-5 in 2003, and 2-2-10-8 in 2008 (Figures 42 and 43). This is a significant change over a 5-year period – in part a consequence of trees growing into larger size classes, but also due to the harvesting of several small sawlog-sized and 1 medium sawlog-sized trees. In 2003, small sawlog-sized trees accounted for 7.3 m^2/ha, and in 2008, 2.3 m^2/ha. In both sampling years, polewood-sized trees had low basal areas (2.5 m^2/ha in 2003 and 2 m^2/ha in 2008). By 2008, basal area in this plot was concentrated in the medium to large sawlog size classes, with a very low proportion in the polewood and small sawlog size classes. After logging, the proportion of AGS:UGS decreased very slightly, from 85% to 80%, though this change could be a product of differing assessments of vigour by data recorders.

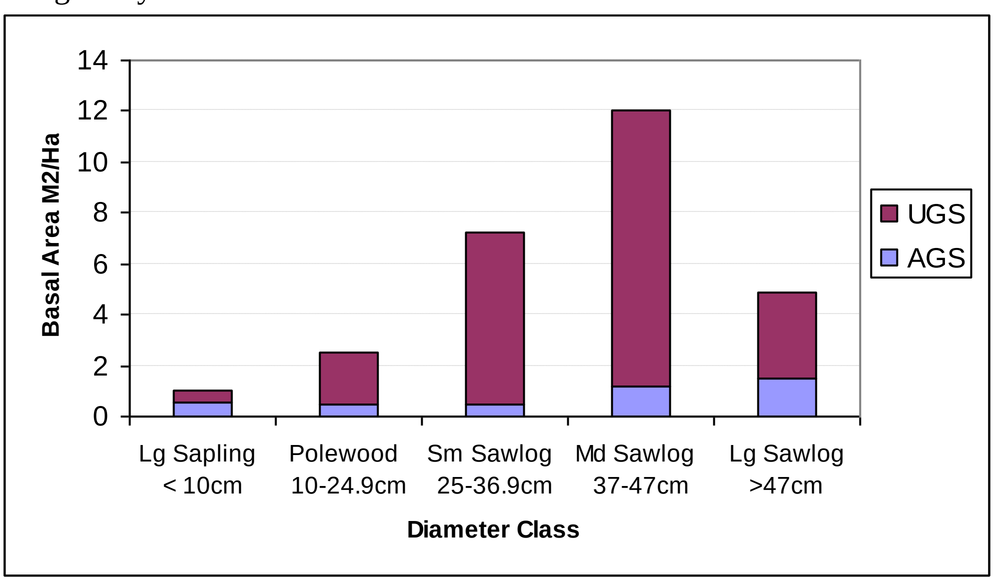

Figure 42: Basal area by size class and quality for T6PSP1 (2003 data).

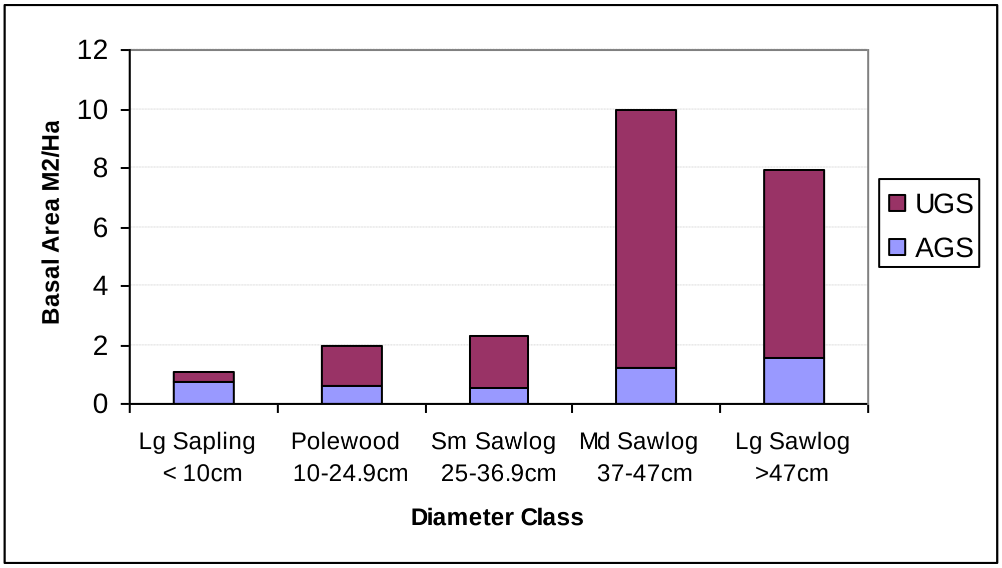

Figure 43: Basal area by size class and quality for T6PSP1 (2008 data).

A relatively small proportion of the trees in this plot are polewood and small sawlog- sized, while the proportion of medium and large trees is relatively high (Figures 44 and 45). The low abundance and basal area of polewood and small sawlog size classes, especially in 2008, as well as the high proportion of UGS trees (80%), suggests there may be problems with recruitment of high quality, larger-sized trees in the future. Mean stem diameter for this plot is 19.8 cm.

Figure 44: Tree abundance by size class and quality for T6PSP1 (2003 data).

Figure 45: Tree abundance by size class and quality for T6PSP1 (2008 data).

Table 7: Summary of T6PSP1 results

T6 PSP1	
Forest type	Hard maple, Beech and Yellow birch dominated, level to gently undulating terrain
Dominant Tree Species	Mh6Be3By1
Regeneration Species	Be5Mh4OH1
Disturbance type	Selection harvest in 2007; salvage harvest in 1995
FEC classification	ES 25.2 (Mh-Be-Or; fresh to moist)
Basal area	23.7 m^2/ha
Canopy height	28.6 m
Mean DBH	19.8 cm
Location	From Forest Walk trail, Redkenn Rd side of dog kennels

T6PSP2

Site description

T6PSP2 represents a multi-aged, tolerant hardwood/hemlock forest on deep, sandy loam. The stand is north-facing on gently undulating terrain. It is located off the Forestry Walk, southeast of basecamp (Figure 46). This stand was selection harvested in the early 1990s, and possibly salvage harvested in 1995. There has been no cutting in this stand since the establishment of this PSP.

Figure 46: Haliburton Forest map with arrow showing location of T6PSP2.

T6PSP2 is a productive tolerant hardwood/hemlock site. Basal area was 26.8 m^2/ha in 1998, the same in 2003, and increased to 29.4 m^2/ha in 2008 (0.26 m^2/ha/yr) (Figure 47). Most of this increase came from vigorous growth of sugar maple and hemlock. One large beech (48 cm DBH) died between 1998 and 2003, accounting for a large drop in basal area in growth plot 2 (Figure 48). Sugar maple (51%), hemlock (24%) and beech (21%) comprised the majority of basal area. Large saplings made up a small proportion of total basal area (0.8 m^2/ha)

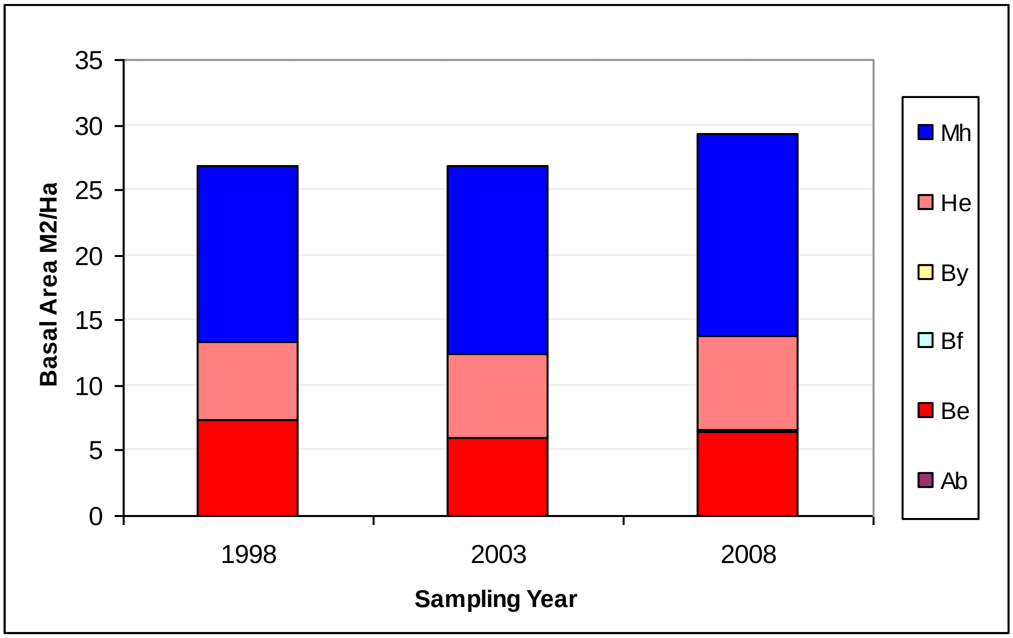

Figure 47: Total basal area/hectare, by species, over 3 sampling years for T6PSP2.

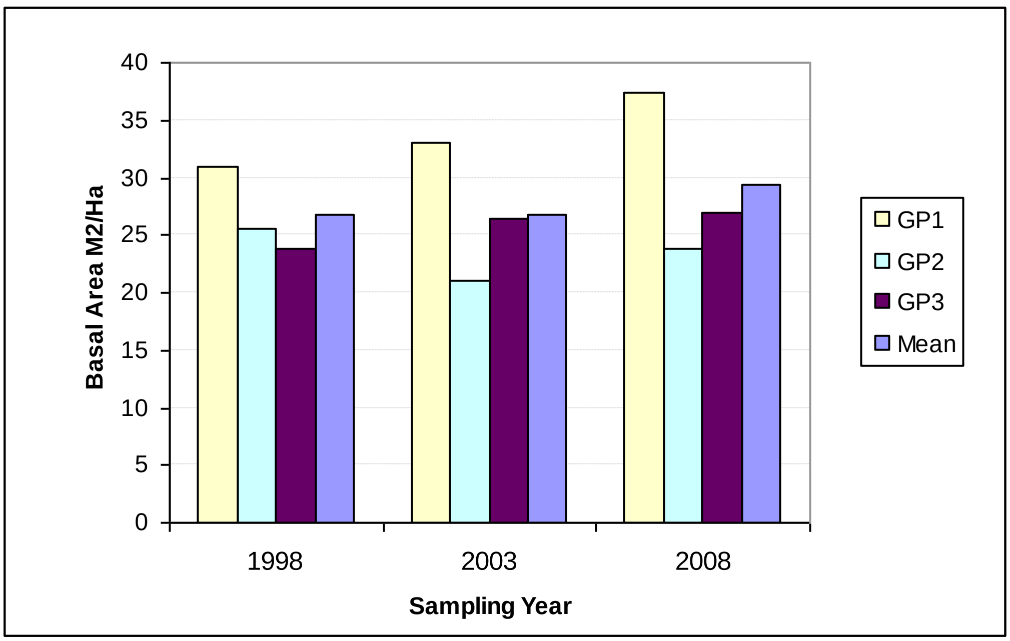

Figure 48: Total basal area/hectare, by growth plot, over 3 sampling years, for T6PSP2.

Tree and small sapling abundance

The total number of trees increased from 592/ha to 683/ha between 2003 and 2008. Beech, balsam fir and yellow birch accounted for this increase. In 2008, sugar maple was the most common tree species in this plot (392 per hectare), followed by beech (158 per hectare), hemlock (42), yellow birch (42) and balsam fir (42) (Figure 49). There were 5 hemlocks in the 3 growth plots, 3 of which were greater than 50 cm DBH (accounting for a relatively large proportion of basal area). The 5 yellow birch in the 3 growth plots had an average diameter of 3 cm DBH.

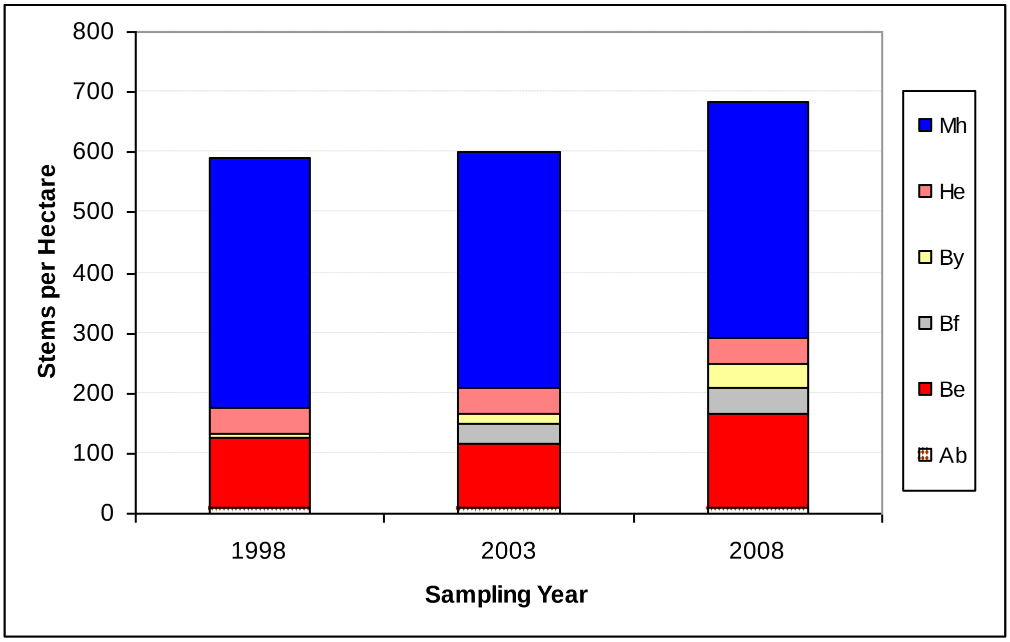

Figure 49: Number of stems/hectare, by species, over 3 sampling years for T6PSP2.

In 2008, beech, sugar maple, yellow birch comprised the majority of saplings (>1.3 m high and <2.5 cm DBH) in this plot (Figure 50). The abundance of beech saplings fluctuated wildly among sampling years, from 16 in 1998, to 61 in 2003 and 44 in 2008. Within growth plot 2, 47 beech saplings were recorded in 2003, but only 13 in 2008. It is not clear why.

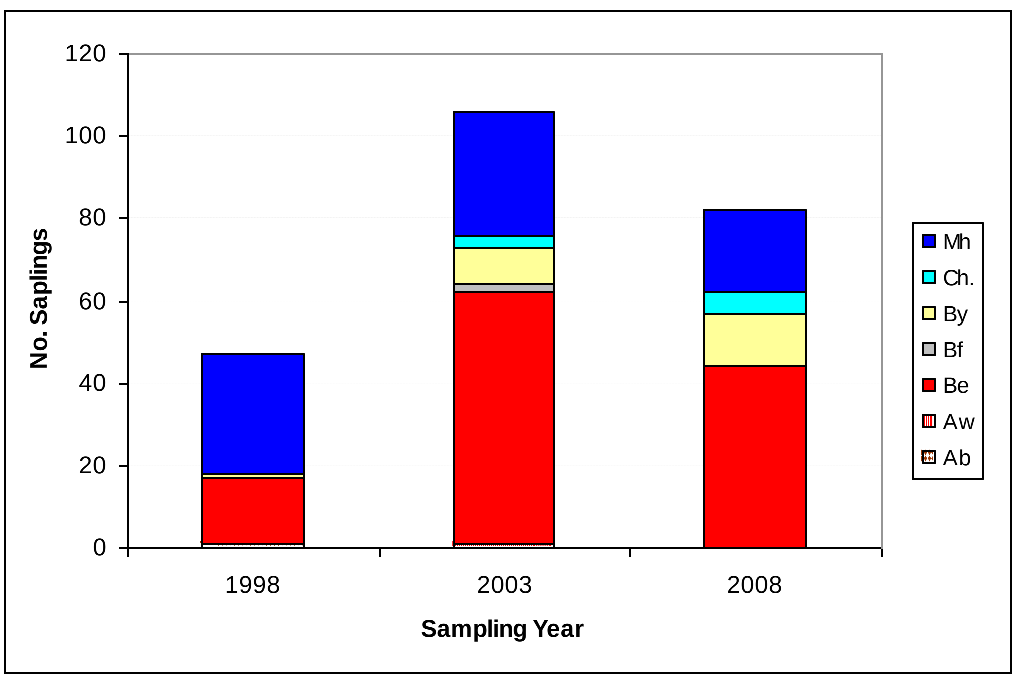

Figure 50: Sapling abundance, by species, over 3 sampling years for T6PSP2.

Size class distribution

Basal area distribution in this plot was 4-7-7-10 in 2008. Many medium and large-sized trees accounted for 59% of basal area (Figure 51). Polewood and small sawlog-sized trees comprised 38% of basal area. In 2008, 15.2 m^2/ha was AGS, with most of that in the small and large sawlog size classes.

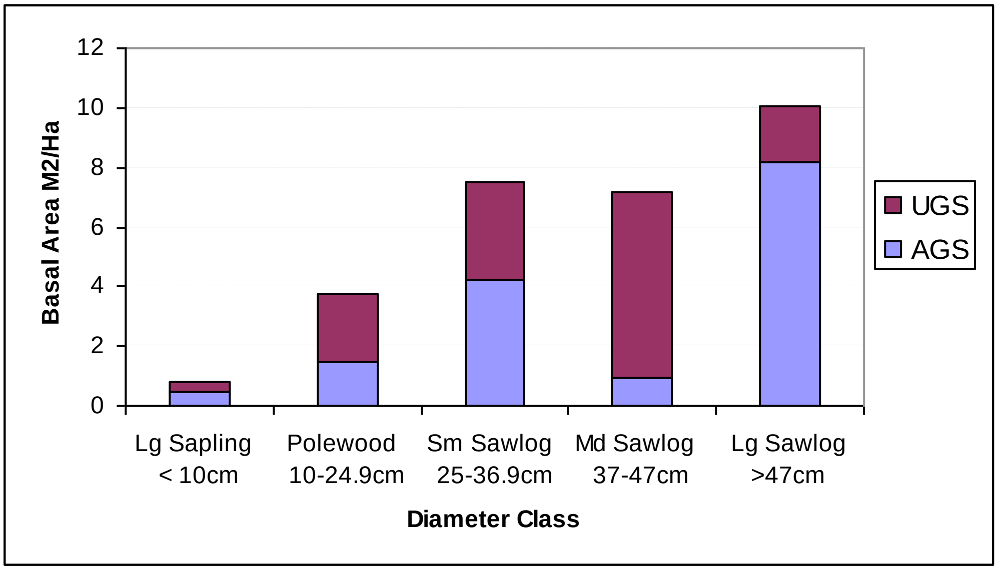

Figure 51: Basal area by size class and quality for T6PSP2 (2008 data).

Over 160 trees per hectare are in the polewood size class, 92 in the small sawlog size class, 50 in the medium and 42 in the large diameter size class (Figure 52). Quadratic mean DBH for this plot is 24.1 cm – higher than all but 1 other PSP, including 2 hemlock-dominated stands with basal areas between 40-50 m^2/ha. This indicates the relatively low number of large saplings and the concentration of stems in the larger size classes.

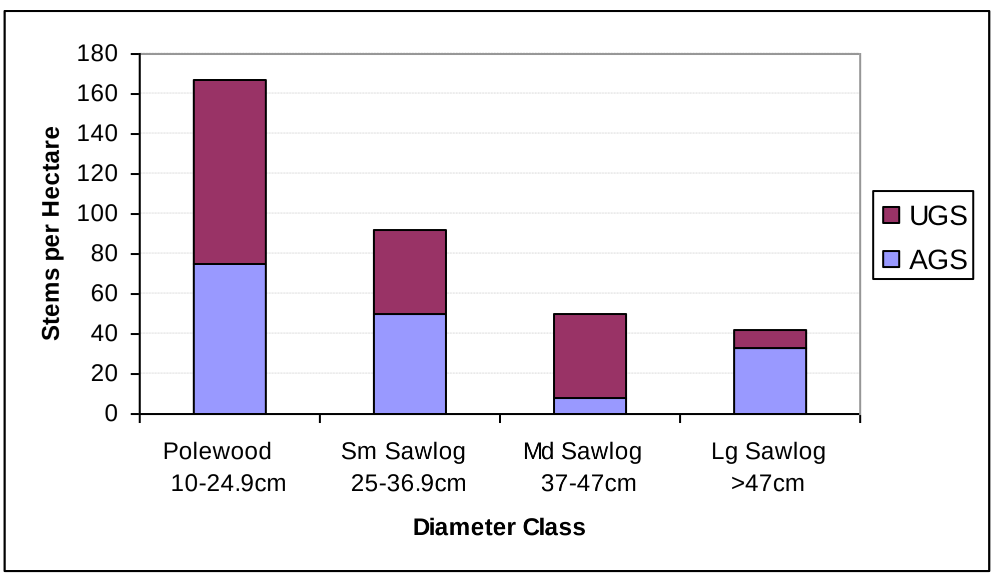

Figure 52: Tree abundance by size class and quality for T6PSP2 (2008 data).

Table 8: Summary of T6PSP2 results

T6 PSP2	
Forest type	Hard maple, Hemlock and Beech dominated, level to gently undulating terrain
Dominant Tree Species	Mh5He2Be2
Regeneration Species	Be5Mh2OH2
Disturbance type	Selection cut in early 1990s; may have been salvage harvest in 1995
FEC classification	ES 25.2 (Mh-Be-Or; fresh to moist)
Basal area	30.6 m^2/ha
Canopy height	32.4 m
Mean DBH	23.7 cm
Location	From Forest Walk trail, Redkenn Rd side of dog kennels

PSP DL

Site Description

PSP DL has a mixed history, with the lower portion, on the edge of a forest swamp, dominated by large-diameter eastern white cedar, white pine, white birch and white spruce. This was likely the original forest type for this stand. The rest of this PSP is located on an east-facing, gentle slope and was heavily cut roughly a century ago, grew back in spruce, balsam fir and yellow birch, much of the mature balsam fir died in the late 1970s (during the spruce budworm epidemic that swept across eastern North America), and is now deadfall or snags. The soils are wet, poorly drained sandy loam. This plot is ½ km north of Depot Lake, accessed from the Red Trail (Figure 53).

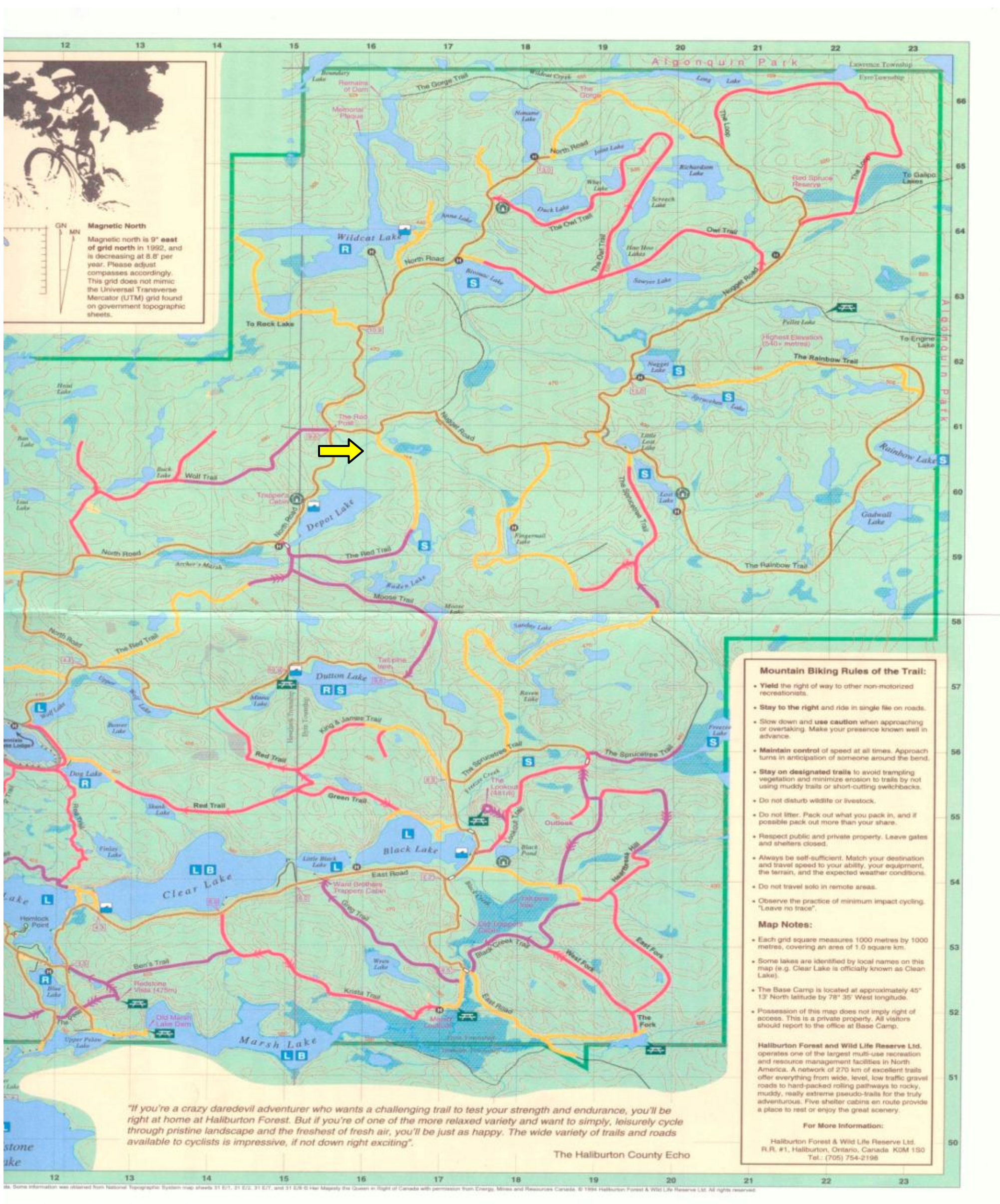

Figure 53: Haliburton Forest map with arrow showing location of PSP DL.

Basal area in PSP DL has hovered close to 50 m^2/ha since 1999, varying from as little as 30.7 m^2/ha in growth plot 2 to 68.1 m^2/ha in growth plot 3 (Figure 54). Cedar, yellow birch, white spruce, and balsam fir comprise the majority (77%) of basal area. Over the last 10 years, basal area has declined from 38.6 to 30.7 m^2/ha in growth plot 2, largely a consequence of balsam fir and white birch mortality (Figure 55). White spruce and yellow birch increased in basal area in growth plot 2, and will likely respond well to the reduced competition. Growth plot 3 has a remarkably high basal area due to many medium- and large-sized cedars, a large white pine and 2 medium-sized yellow birch. Over the 10-year sampling period, basal area in this highly-stocked growth plot decreased from 67.6 m^2/ha to 64.8 m^2/ha then increased to 68 m^2/ha. These variations may have more to do with inconsistencies in measurements, especially of larger trees, though it is clear that there is still good growth in this growth plot.

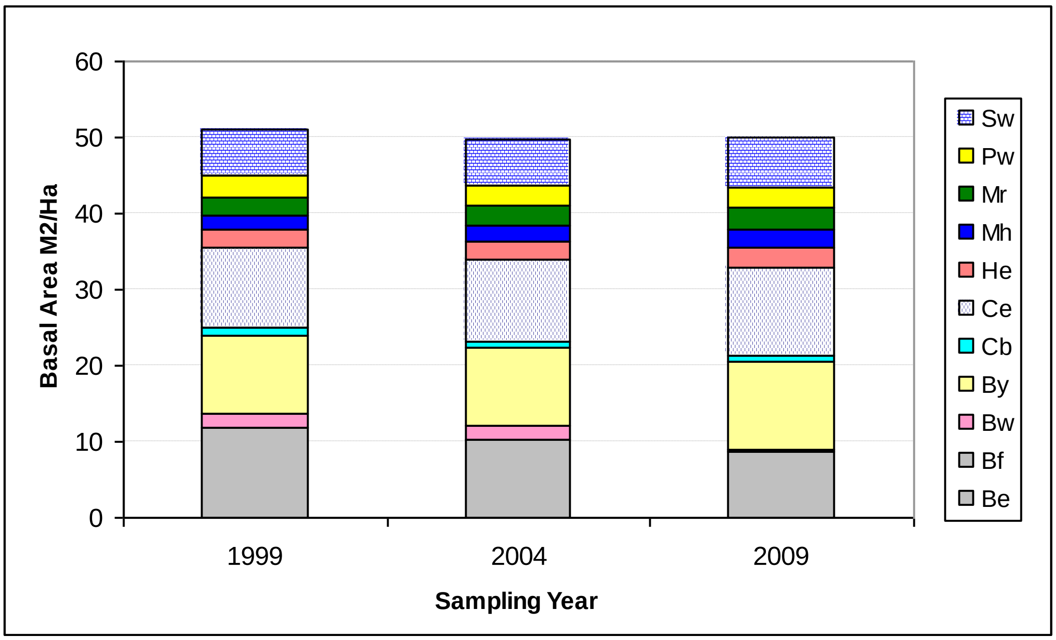

Figure 54: Total basal area/hectare, by species, over 3 sampling years for PSP DL.

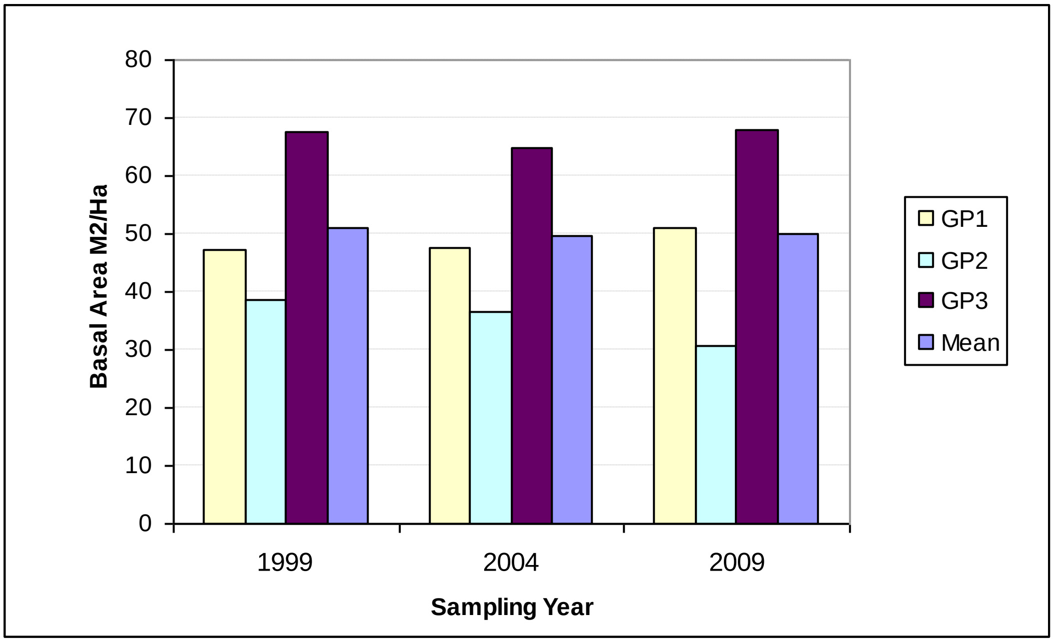

Figure 55: Total basal area/hectare, by growth plot, over 3 sampling years, for PSP DL.

Tree and small sapling abundance

Total stem count decreased from 2,025/ha to 1,467/ha between 1999 and 2009, with balsam fir accounting for 70% of that decline, and sugar and red maple accounting for 12% (Figure 56). Balsam fir and red maple comprise the majority of stems (68%), followed by white spruce (7.4%), sugar maple (7.4%), cedar (5.7%) and yellow birch (5.7%). Tree abundance declined in all 3 growth plots, but was most pronounced for growth plot 2.

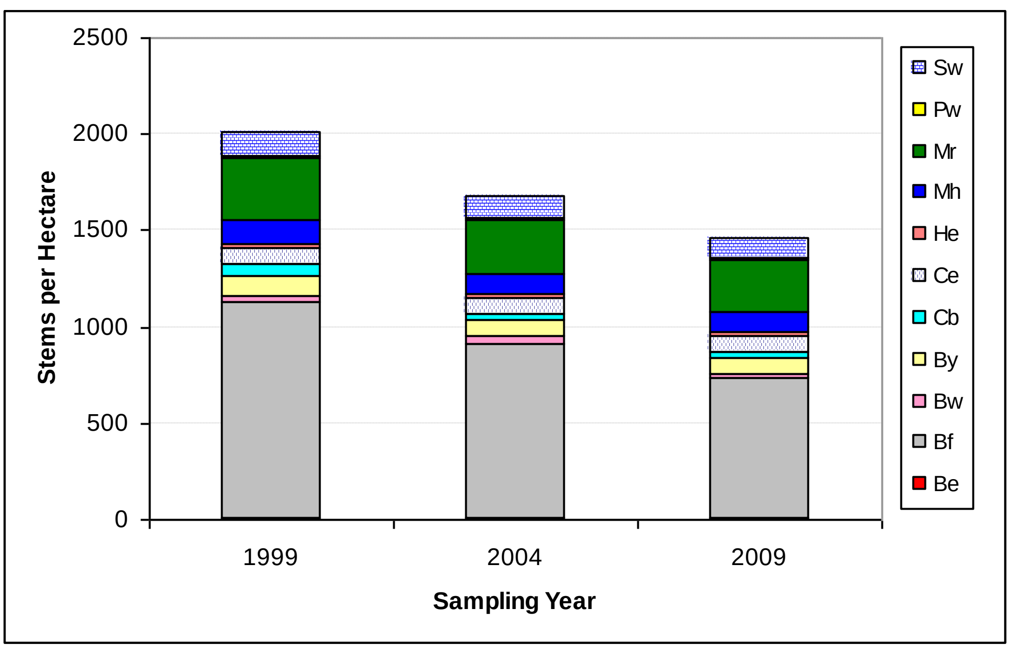

Figure 56: Number of stems/hectare, by species, over 3 sampling years for PSP DL.

Sapling abundance is very low in this plot – a total of 4 in 2009 (Figure 57). Growth plot 1, which is going through a thinning phase, had no saplings. Growth plot 2 is gradually opening up as basal area declines, so we can expect an increasing abundance of saplings in future sampling years. Growth plot 3, already very dense and shaded, had a few balsam fir saplings.

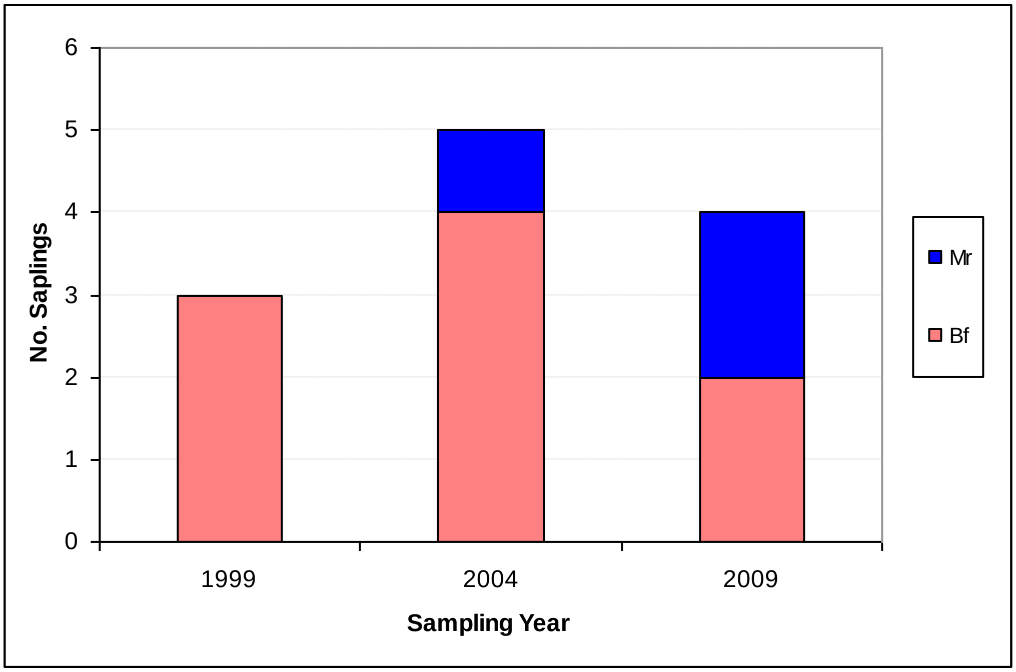

Figure 57: Sapling abundance, by species, over 3 sampling years for PSP DL.

Size class distribution

The high basal area in this plot is found across all size classes (11-10-13-14), with the highest in the large sawlog-sized trees (Figure 58). A very high proportion of basal area is AGS (77%), which is not unusual in a confer-dominated stand. Interestingly, all the large sawlog-sized trees are AGS.

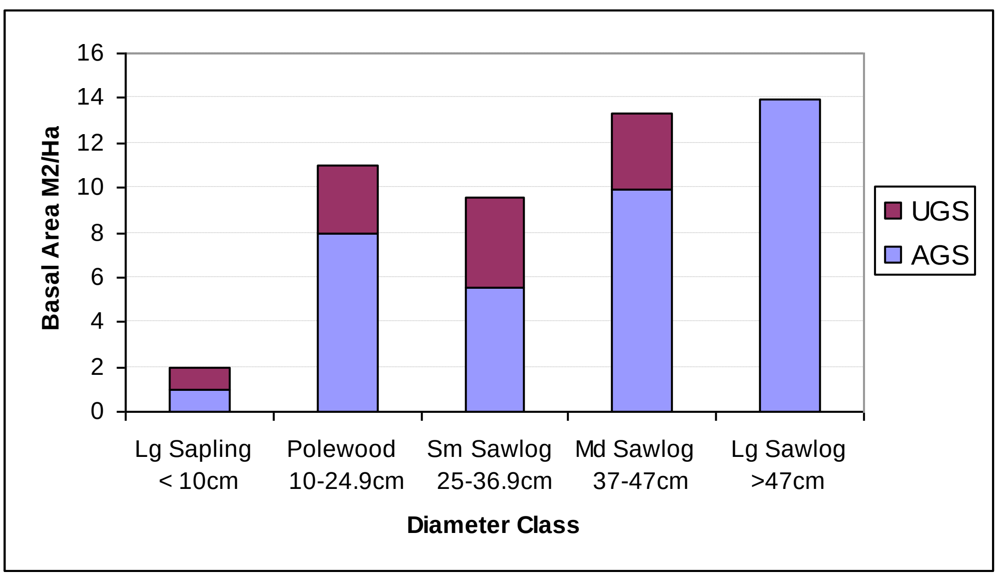

Figure 58: Basal area by size class and quality for PSP DL (2009 data).

Polewood-sized trees account for the majority of stems (525), followed in decreasing quantity by sawlog-sized trees (142), medium-sized trees (100) and large-sized trees (50) (Figure 59). The total number of stems in the polewood to large sawlog size classes is twice that of most other PSPs. Despite the high basal areas (not unusual in a conifer-dominated stand), there appears to be no problem with recruitment in this plot. There are relatively few small and medium-sized UGS trees, with 64% of UGS trees concentrated in the polewood size class. The high number of polewood-sized stems, combined with the relatively high number of medium and large-sized stems resulted
in a mean stem diameter of 20.7 cm.

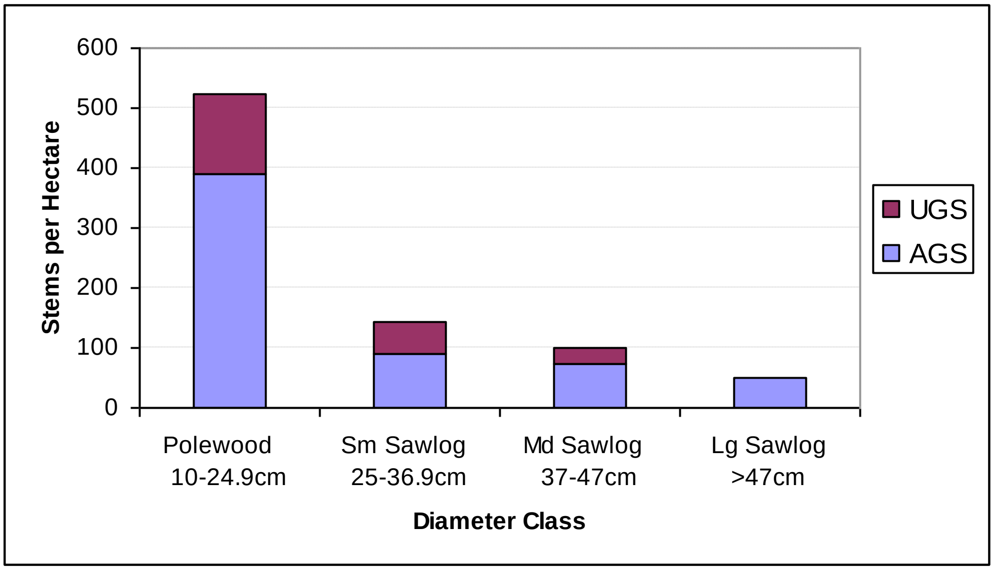

Figure 59: Tree abundance by size class and quality for PSP DL (2009 data).

Table 9: Summary of PSP DL results

PSP DL	
Forest type	Cedar, spruce and fir dominated, lower slope, east exposure
Dominant Tree Species	Cw2By2Sw2Bf2MX1
Regeneration Species	Bf5Mr5
Disturbance type	Spruce budworm infestation in 1970s, many fallen & dead fir
FEC classification	ES 21.2 (Cw-Pw-Bw-Sw; fresh to moist)
Basal area	49.22 m^2/ha
Canopy height	23.3 m
Mean DBH	20.67cm
Location	About ½ km north of Depot Lake, off Red Trail

PSP DT

Site Description

PSP DT is a multi-aged, post-disturbance sapling dominated stand similar to T4PSP1. It is located off the Dog Trail, about ½ km past the intersection with Normac Trail (Figure 60). The plot is on poorly drained, level terrain, with the occasional boulder, and many large downed trees. A microburst in 1995 levelled much of the plot, but it was not salvage harvested. It was selected as a PSP to study forest regeneration after a large-scale natural disturbance.

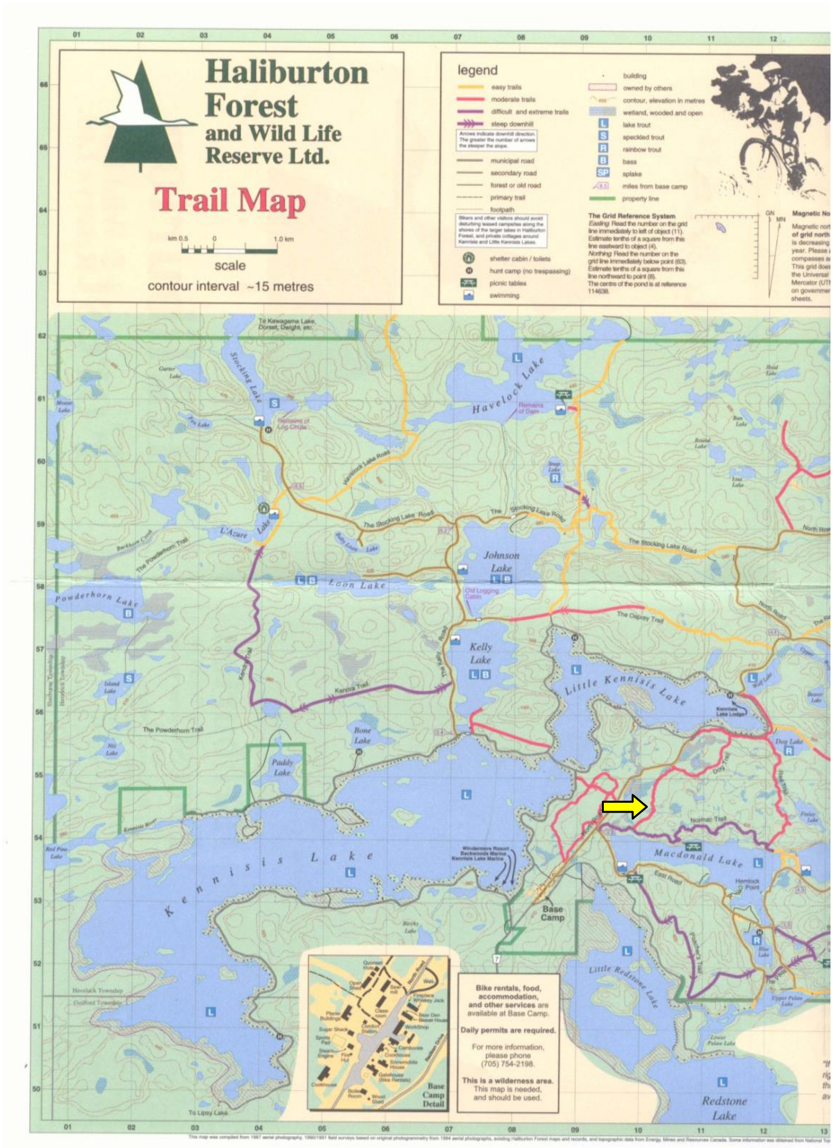

Figure 60: Haliburton Forest map with arrow showing location of PSP DT

T4PSP1 has both a significant component of shade tolerant and mid-tolerant hardwoods and softwoods (hemlock, yellow birch, beech and cedar) as well as young, early-successional species like red maple, balsam fir and cherry (Figure 61). This reflects the stand's history. During the microburst of 1995, a large number of the dominant trees were blown down. A few survived, and have responded well to release. Young vigorous regeneration - including a great deal of coppiced stems – has filled in the large gaps. Hemlock, balsam fir, yellow birch and beech have been the most successful.

Basal area has increased rapidly, from 9.2 m^2/ha in 1999, to 9.9 m^2/ha in 2004 and 18.5 m^2/ha in 2009. These basal area estimates include "trees" (or "large saplings") 2.5 -9.9 cm DBH. Without large saplings, basal area in 2009 was 13 m^2/ha. The 10-year basal area increase was 9.3 m^2/ha, which occurred primarily between 2004 and 2009 in all 3 growth plots (Figure 62). Continued mortality after the microburst, combined with shock of exposure for those trees that survived likely depressed basal area for the first 10 years after the storm.

The inconsistent impacts of the microburst are shown in Figure 62, in which growth plot 1 lost relatively few trees, and had a basal area of 19.8 m^2/ha in 1999, while growth plots 2 and 3, only metres away, were reduced to 1.7 m^2/ha and 6.2 m^2/ha.

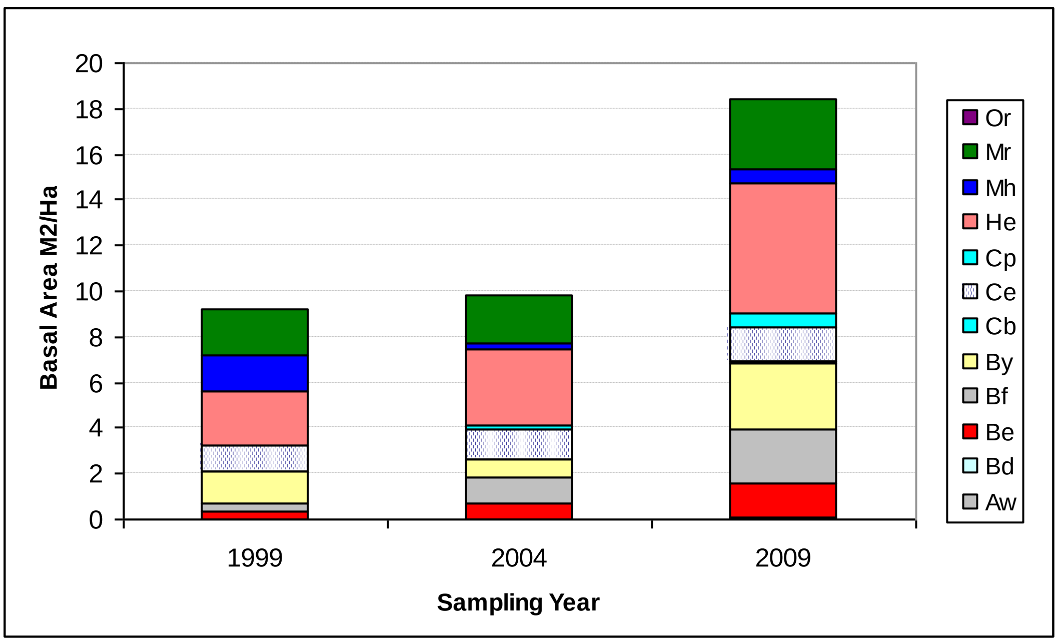

Figure 61: Total basal area/hectare, by species, over 3 sampling years for PSP DT.

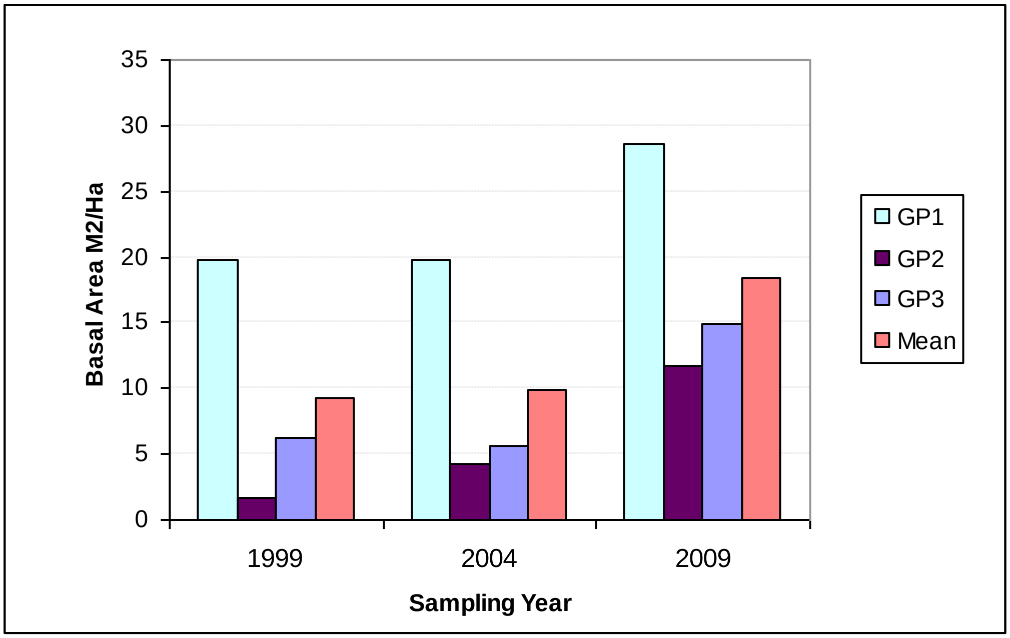

Figure 62: Total basal area/hectare, by growth plot, over 3 sampling years, for PSP DT.

Tree and small sapling abundance

Like the other storm damaged plots, total stem count increased dramatically, from 567/ha to 2,900/ha between 1999 and 2009. By 2009, yellow birch was the most common tree species (792), followed by hemlock (617), red maple (433), beech (317) and balsam fir (283) (Figure 63). As noted above, many of the new stems were coppiced. Species composition in 2009 was very similar to species composition in 1999, suggesting that the post-storm residual forest had a very significant influence on future regeneration.

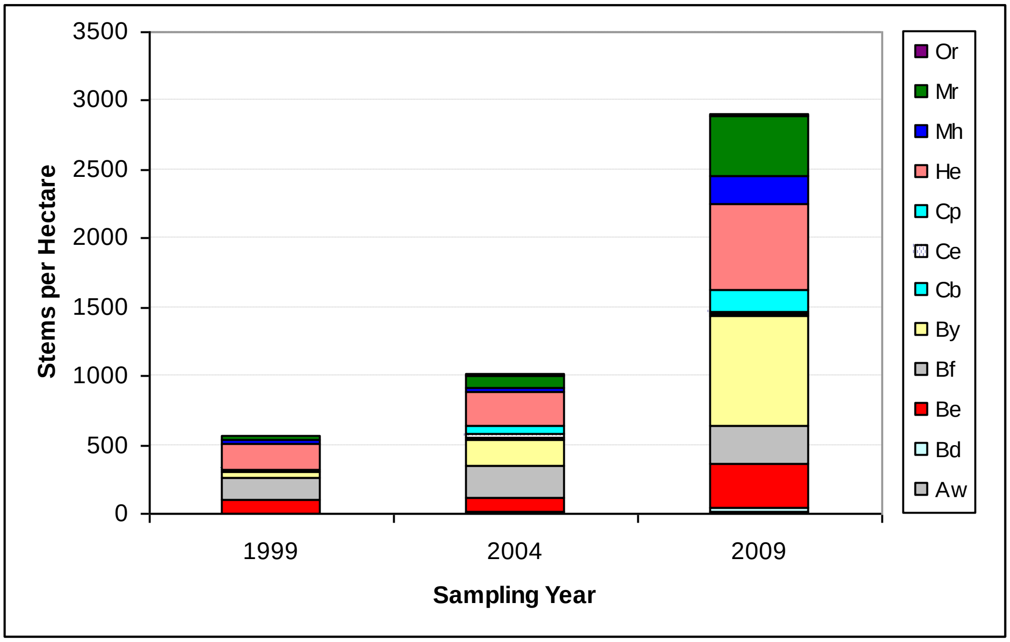

Figure 63: Number of stems/hectare, by species, over 3 sampling years for PSP DT.

In 2009, red maple, sugar maple and beech made up the majority of saplings (>1.3 m high and <2.5 cm DBH) for this plot (Figure 64). The total number of saplings peaked in 2004, with 76, and declined to 42 by 2009. This is likely due to many of these stems becoming tree-sized (>2.5 cm DBH) by 2009. Also, 14 years after the microburst, there was strong competition for sunlight at ground level.

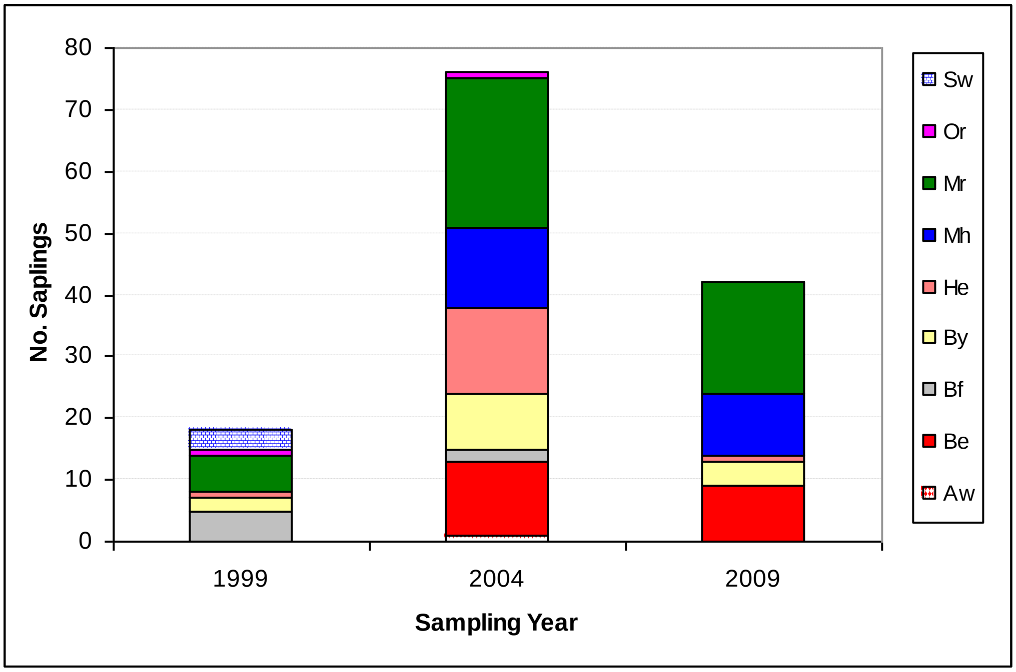

Figure 64: Sapling abundance, by species, over 3 sampling years for PSP DT.

Size class distribution

Basal area distribution in this plot was 7-1-2-2 in 2009, with large saplings (2.5 cm DBH to < 10 cm DBH) and polewood-sized trees comprising 69% of basal area (Figure 65). As for T4PSP1, post storm legacy trees, while low in number, comprised a significant proportion of basal area in 2009.

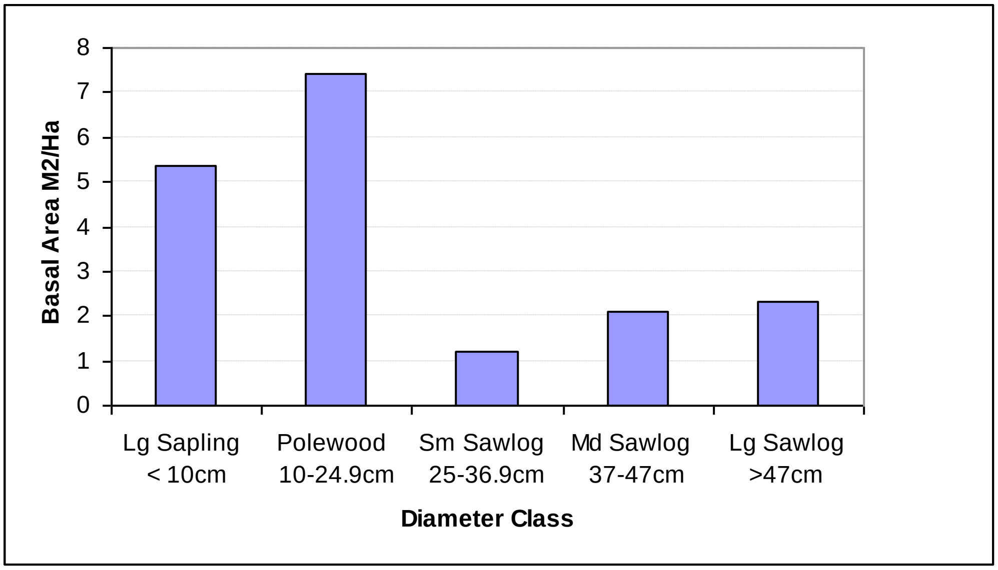

Figure 65: Basal area by size class and quality for PSP DT (2009 data).

Large sapling abundance is very high, at 2,408 per hectare, as is polewood abundance, at 450 per hectare (Figure 66). The number of larger-sized trees was small and concentrated in growth plot 1. Mean tree diameter for this plot was low, at 8.7 cm.

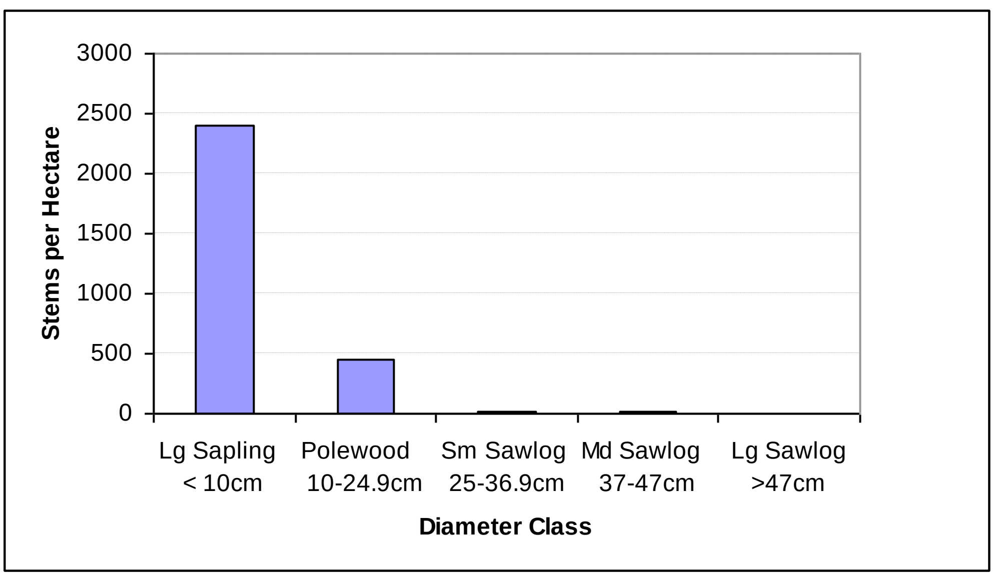

Figure 66: Tree abundance by size class and quality for PSP DT (2009 data).

Table 10: Summary of PSP DT results

PSP DT	
Forest type	Remnant mixed forest interspersed with rapid regeneration, often by coppicing, of mostly tolerant species (He, Cw, Be, By, Bf); level terrain,
Dominant Tree Species	He3Mr2By1Bf1Be1Cw1
Regeneration Species	Mr4Mh2Be2By1
Disturbance type	Micro-burst in 1995; no salvage harvest
FEC classification	Too young to classify
Basal area	17.4 m^2/ha
Canopy height	10.75 m
Mean DBH	8.75 cm
Location	East off Dog Trail, about ½ km past intersection with Normac Tr

PSP ER

Site Description

PSP ER represents a very unusual stand for HF. The plot is mid-slope on a hill of gravel located between MacDonald and Clear Lakes (Figure 67), with a southern exposure and dry to moderately fresh soils. The 2 dominant tree species are red oak and white pine, but there are no pine or oak saplings, and very few polewood-sized trees of either species.

Both these species are of intermediate shade tolerance, and tend to regenerate well after fire. They also tolerate drier sites. It is possible this is mostly an even-aged stand, regenerated roughly 100 years ago after a fire. However, there are 2 large-sized hemlocks in this plot (52 and 67 cm DBH), and hemlock does not usually survive fire. So, either the hemlocks regenerated after a fire, which is unlikely, as they are so old, or there was no fire, but heavy cutting of the previous stand (likely pine).

Figure 67: Map of Haliburton Forest with arrow showing location of PSP ER

The basal area of this stand has changed little over the last 10 years, ranging between 48 and 49.7 m^2/ha (Figure 68). In 2009, PSP ER was dominated by white pine (40%), red oak (31%) and hemlock (13%). Basal area in the individual growth plots has changed little, with small drops between 1999 and 2004 attributable to mortality of one medium-sized oak and several polewood-sized trees (Figure 69). Overall, net growth in this well-stocked stand is close to zero, with sapling regeneration bearing little semblance to the dominant overstorey species.

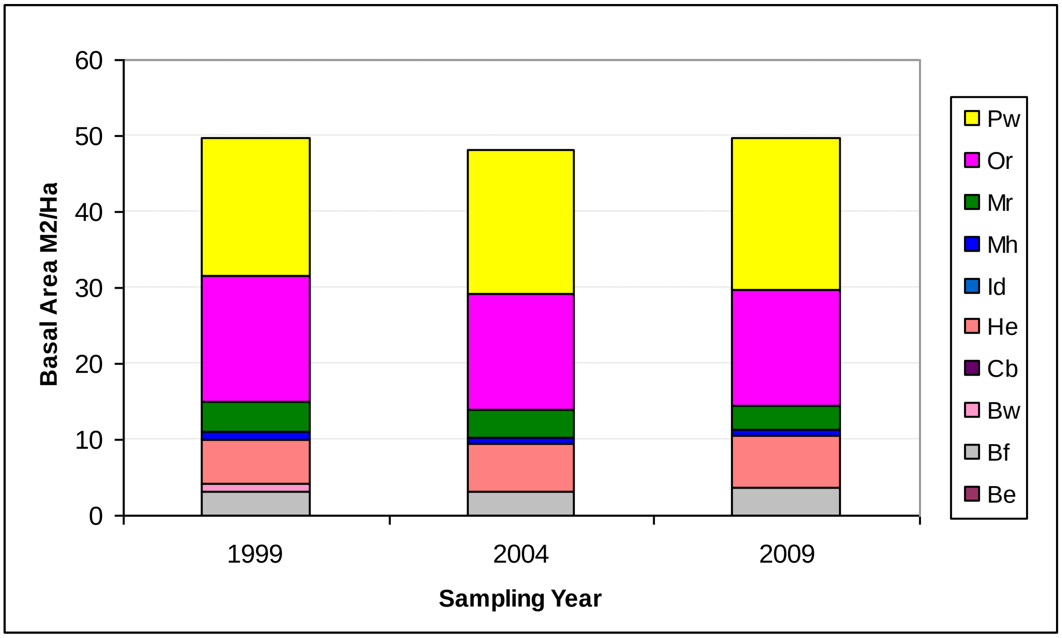

Figure 68: Total basal area/hectare, by species, over 3 sampling years for PSP ER .

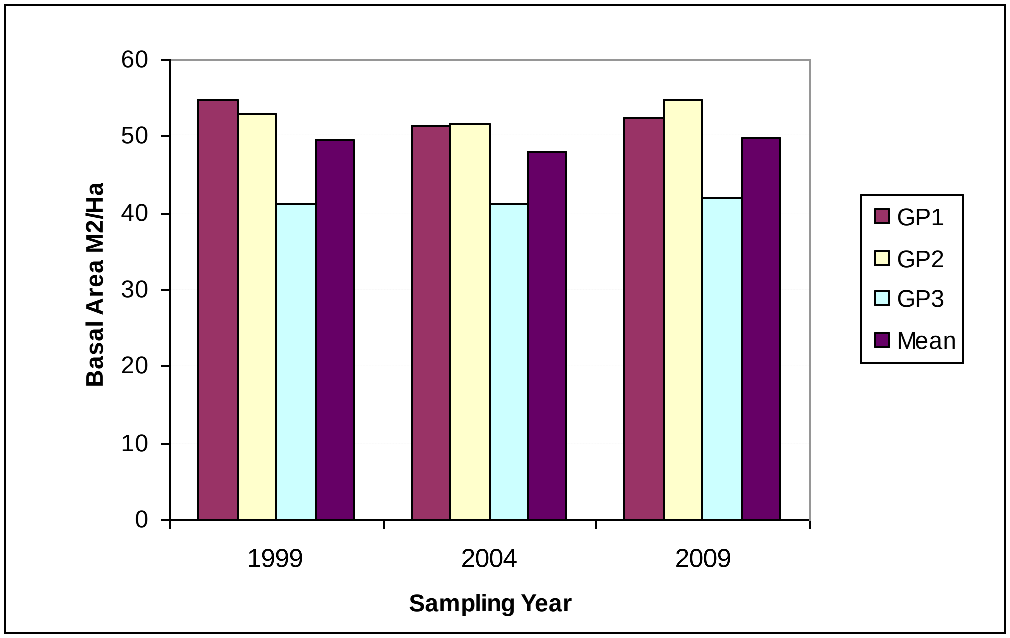

Figure 69: Total basal area/hectare, by growth plot, over 3 sampling years, for PSP ER.

Tree and small sapling abundance

The total number of trees increased from 1,417/ha to 1,700/ha between 1999 and 2009. Despite dominance of the overstorey by white pine and red oak, balsam fir was the most common tree species in this plot (750 per hectare), followed by red maple (317 per hectare), hemlock (233), white pine (158) and red oak (108) (Figure 70). Interestingly, in 2009 black cherry comprised 2% of stems in this plot.

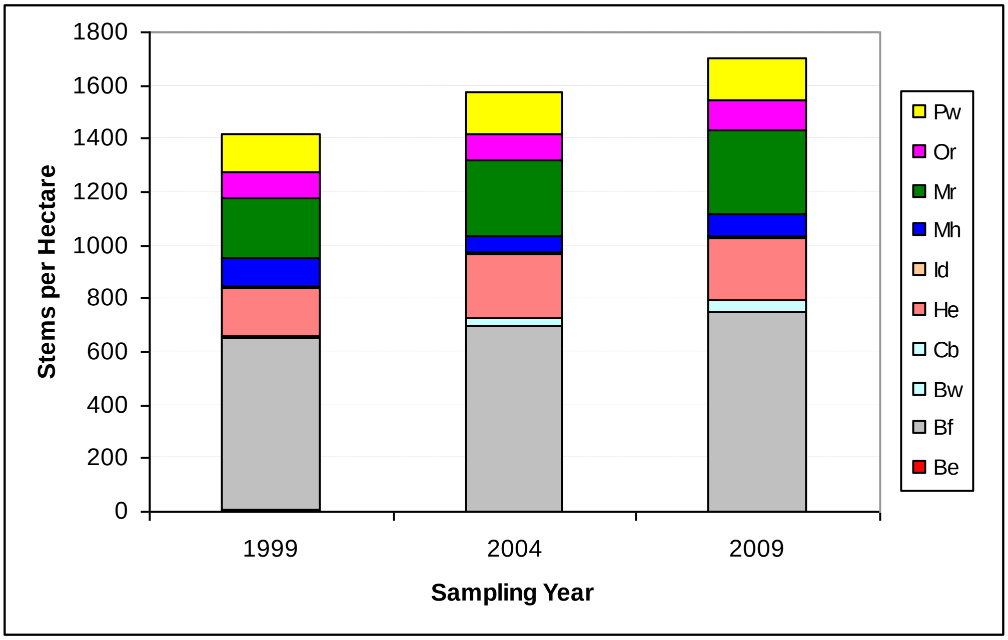

Figure 70: Number of stems/hectare, by species, over 3 sampling years for PSP ER.

In 2009, the only saplings in the 9 x 25 m^2 shrub plots were red maple, sugar maple and balsam fir (Figure 71). There were a total of 11 saplings in 2009, 22 in 2004 and 17 in 1999.

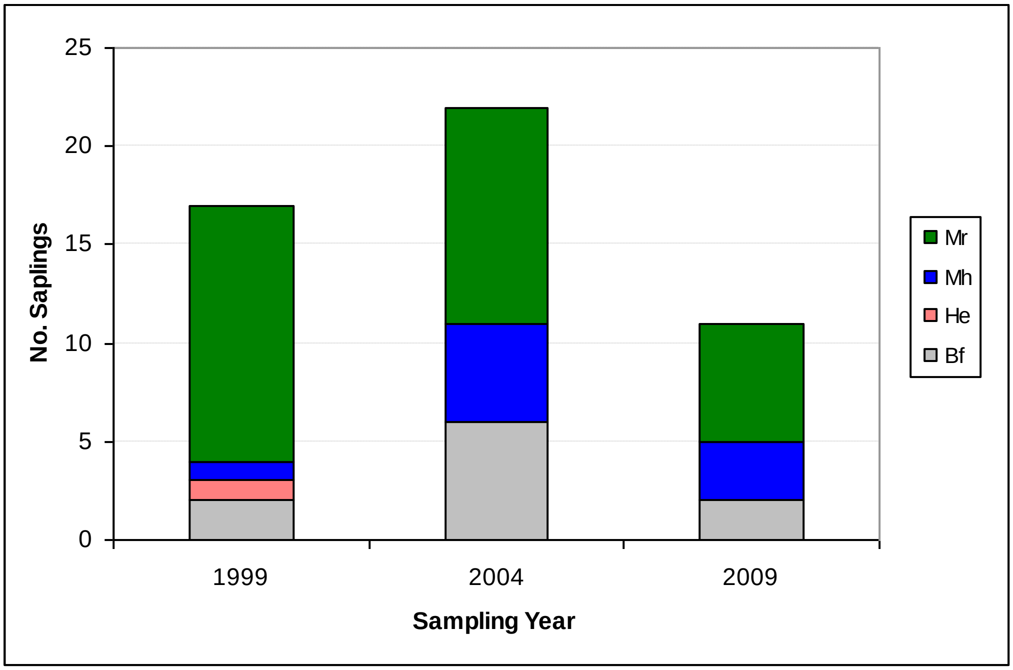

Figure 71: Sapling abundance, by species, over 3 sampling years for PSP ER.

Size class distribution

In 2009, basal area distribution in this plot was 7-6-14-21, with medium and large-sized trees accounting for 70% of basal area (Figure 72). Polewood and small sawlog-sized trees comprised 25% of basal area. Overall, 77% of basal area is AGS. As little as 10% of medium sawlog-sized trees are UGS, with the greatest proportion of UGS in small sawlog-sized trees (40%).

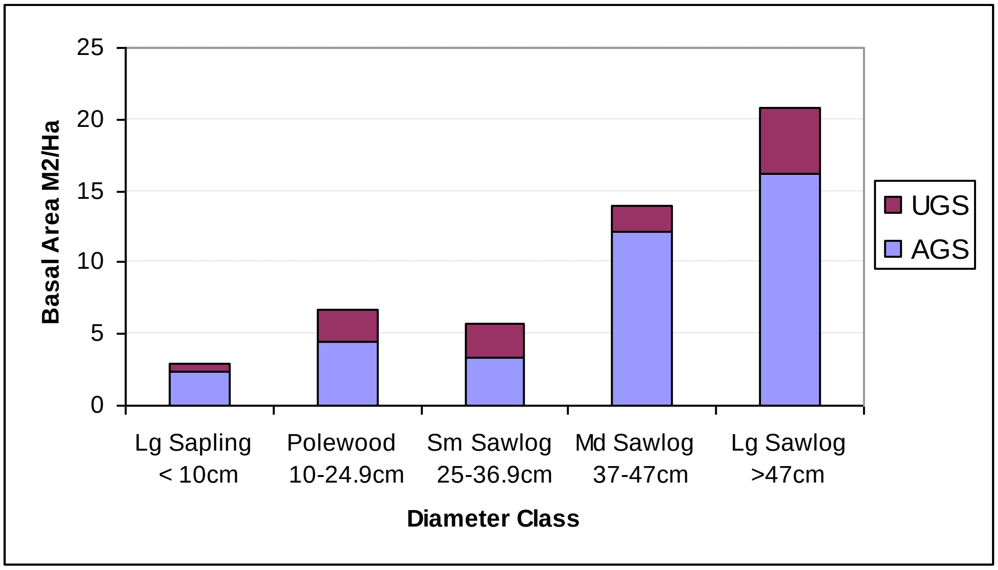

Figure 72: Basal area by size class and quality for PSP ER (2009 data).

Almost 400 trees per hectare are in the polewood size class, 75 in the small sawlog size class, 108 in the medium and 92 in the large diameter size class (Figure 73). A quarter of polewood-sized trees and 44% of small sawlog-sized trees are UGS. Mean stem diameter is fairly average (19.4 cm).

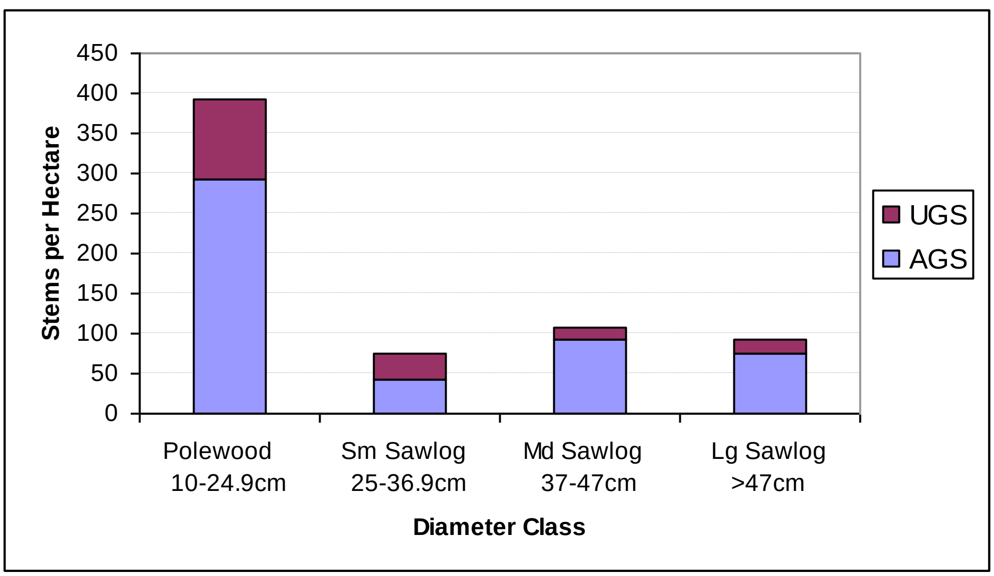

Figure 73: Tree abundance by size class and quality for PSP ER (2009 data).

Table 11: Summary of PSP ER results

PSP ER	
Forest type	Mid-successional, pine/oak dominated; gravel outwash between Clear and MacDonald Lakes; mid-slope, southern exposure
Dominant Tree Species	Pw4Or3He1Bf1MX1
Regeneration Species	Mr5Mh3Bf2
Disturbance type	Currently, gap disturbance, though stand may have been initiated by fire about ~ 100 years ago
FEC classification	ES 14.1 (Pw-Pg-Or; dry to moderately fresh)
Basal area	49.7 m^2/ha
Canopy height	27.5 m
Mean DBH	19.4 cm
Location	About 100-m east of mile marker 4.3 on East Rd

PSP HT

Site Description

PSP HT represents a sugar maple dominated hardwood stand on dry, well-drained loamy sand, with a southwest exposure. Two of the growth plots are on the crest of a gentle slope, and the third in a depression part way down the slope. This site is located north of Stocking Lake Road off the Havelock Trail (Figure 74). It was selection harvested in 2005.

Figure 74: Map of Haliburton Forest with arrow showing location of PSP HT.

Basal area increased between 1999 and 2004, from 20.7 m^2/ha in 1999 to 23.2 m^2/ha in 2004, and decreased after harvesting to 16.7 m^2/ha by 2009 (Figure 75). Of the 16.7 m^2/ha, 2.2 m^2/ha were large saplings (2.5-9.9 cm DBH). Sugar and red maple were harvested from this plot. Basal area declined in all 3 growth plots, but the drop was most pronounced in growth plot 2 (from 26.2 m^2/ha to 16.9 m^2/ha) (Figure 76). In 2009 sugar maple dominated this stand (64%), followed by yellow birch (11.2%), balsam fir (6.3%), beech (5.4%) and red maple (5.3%).

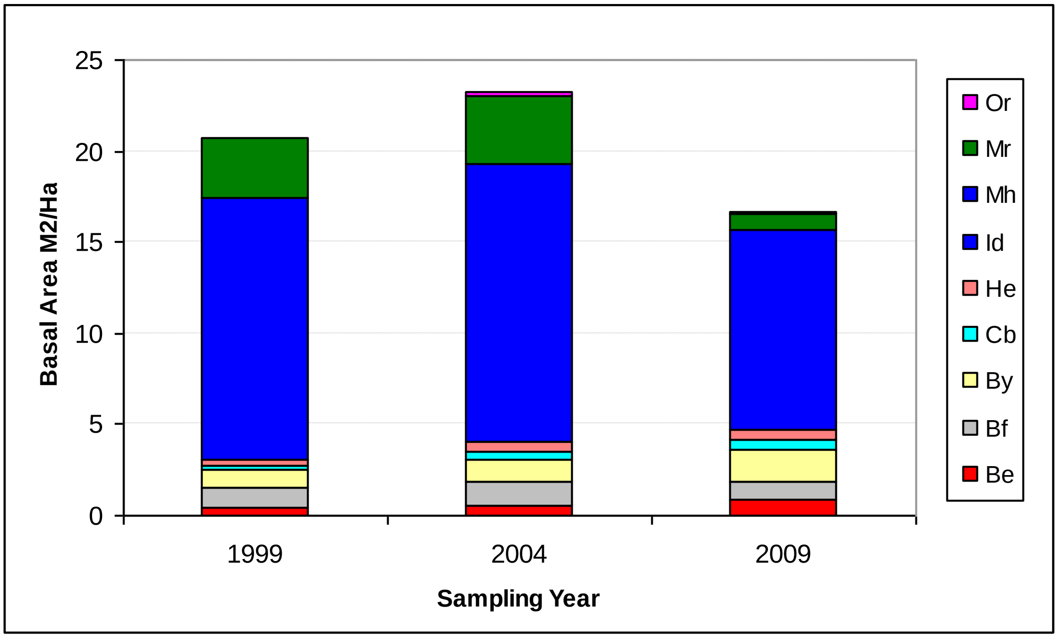

Figure 75: Total basal area/hectare, by species, over 3 sampling years for PSP HT.

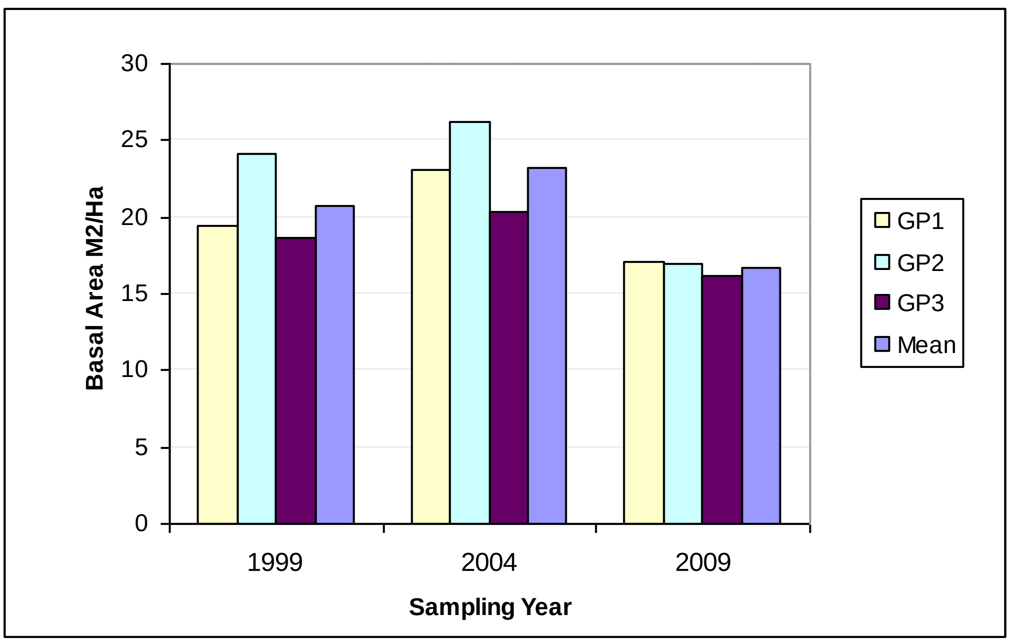

Figure 76: Total basal area/hectare, by growth plot, over 3 sampling years, for PSP HT.

Tree and small sapling abundance

Total stem count increased from 1,617/ha in 1999 to 1,908/ha in 2004. After harvesting, the total number of stems decreased to 1,533/ha (Figure 77). Sugar maple, yellow birch, cherry and balsam fir abundance declined between 2004 and 2009, while red maple abundance increased. By 2009, sugar maple comprised 32% of stems, red maple 20%, yellow birch 15%, balsam fir 10%, and hemlock and cherry 8% each. Red oak also had a small presence in this stand.

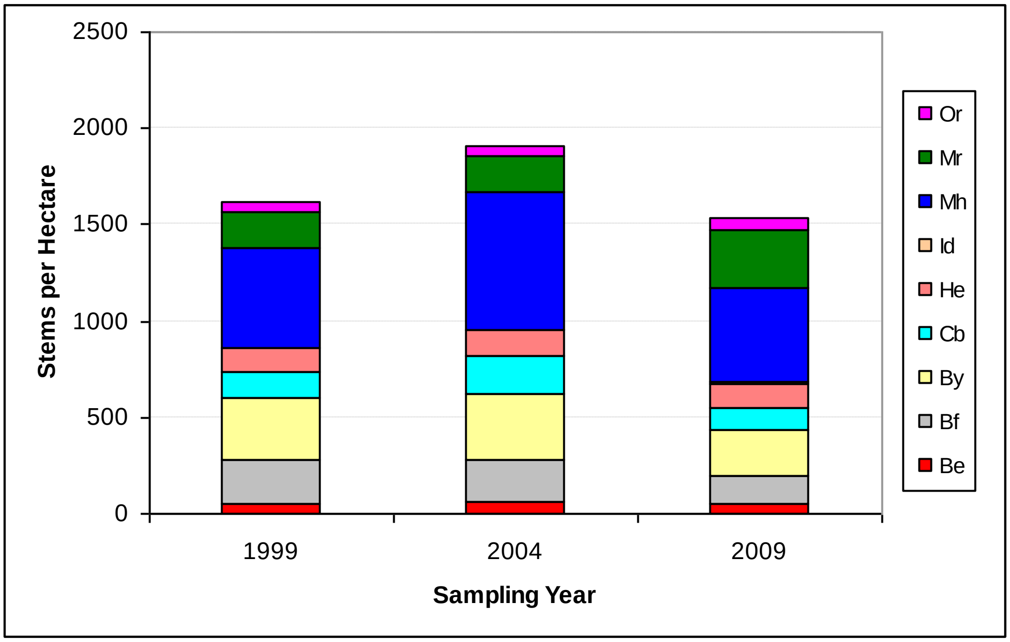

Figure 77: Number of stems/hectare, by species, over 3 sampling years for PSP HT.

The number of saplings in the 9 shrub plots declined dramatically post harvest, from 62 in 2004 to 11 in 2009 (Figure 78). This is likely due to damage during harvesting operations. Yellow birch and cherry disappeared entirely, and red maple declined from 29 saplings in 2004 to 2 in 2009 (though it is very likely some of these red maples grew to "tree"-size (>2.5 cm DBH).

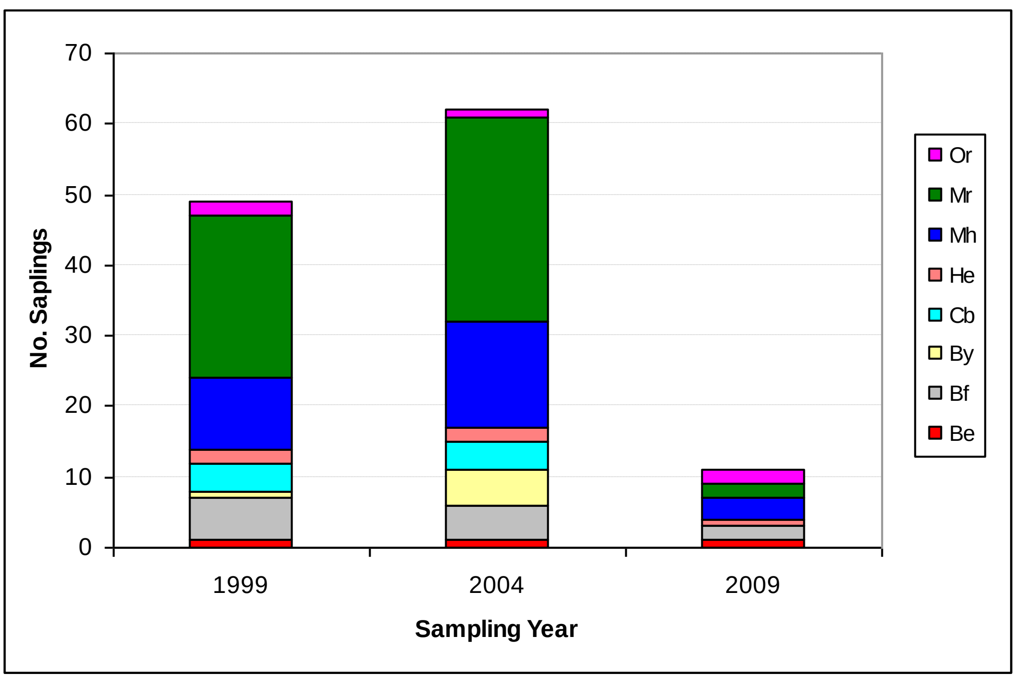

Figure 78: Sapling abundance, by species, over 3 sampling years for PSP HT.

Size class distribution

In 2004, the size class distribution in this plot was 8-8-3-2, 44% (or 10 m^2/ha) AGS (Figure 79). By 2009, after harvesting, the distribution was 9-6-0-0 (Figure 80). Harvesting of trees in the PSP focussed on removing UGS and medium and large-sized sawlogs. 79% of residual trees were AGS. This in interesting, because a great deal of crown dieback was observed in maple trees along a skid trail in the PSP.

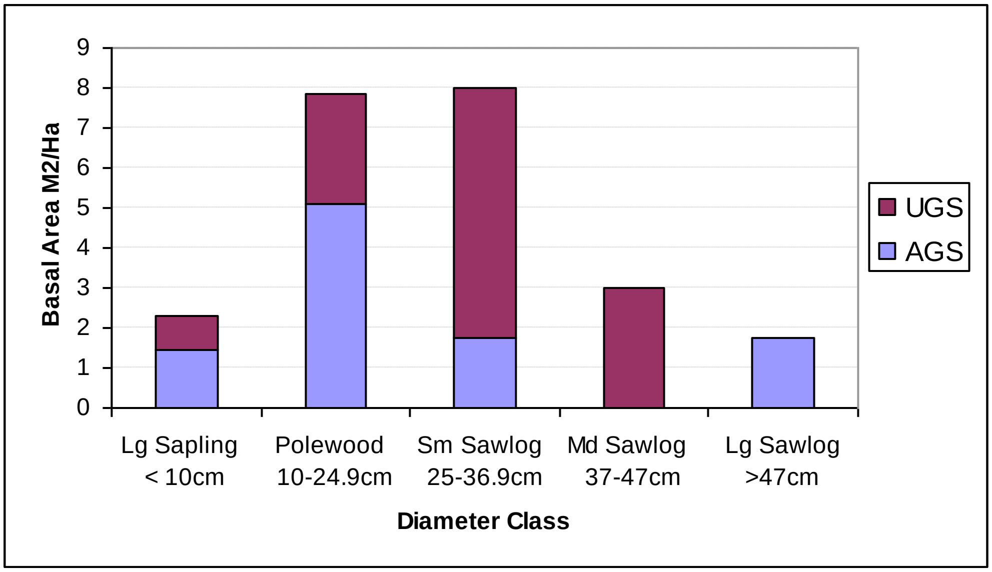

Figure 79: Basal area by size class and quality for PSP HT (2004 data).

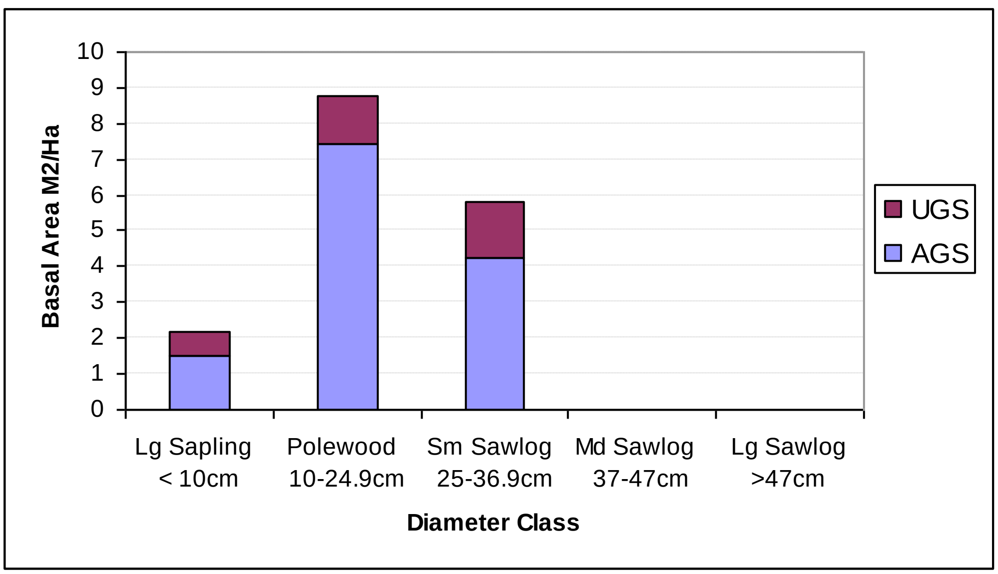

Figure 80: Basal area by size class and quality for PSP HT (2009 data).

In 2004, the distribution of stems across size classes was 425-117-25-8 (Figure 81). This distribution is fairly close to that recommended by OMNR for maximizing sawlog production. 51% of stems were AGS. By 2009, after harvesting, stem distribution was 450-

75-0-0, 82% of which were AGS (Figure 82). With the absence of medium and large-sized trees, mean tree diameter was 11.5 cm.

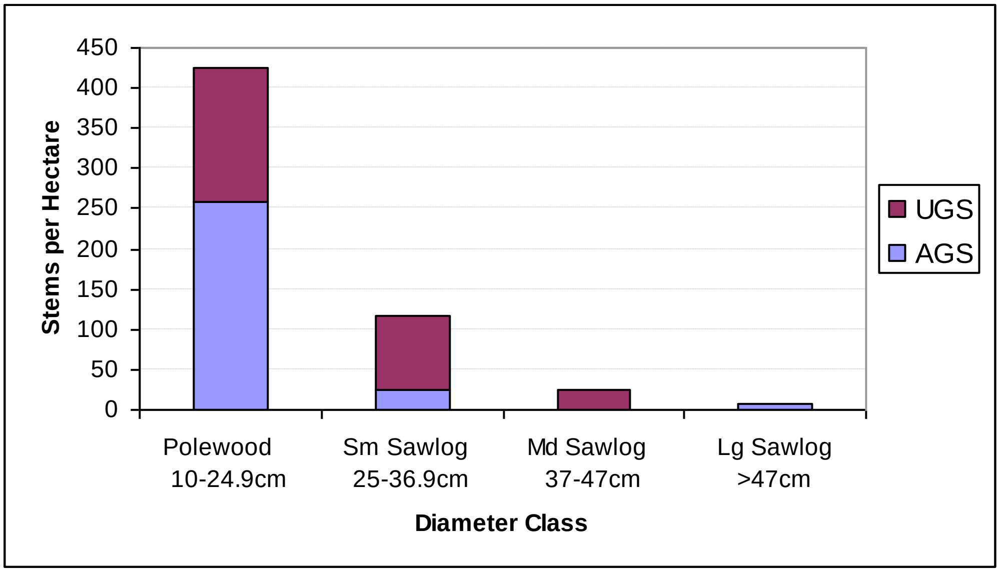

Figure 81: Tree abundance by size class and quality for PSP HT (2004 data).

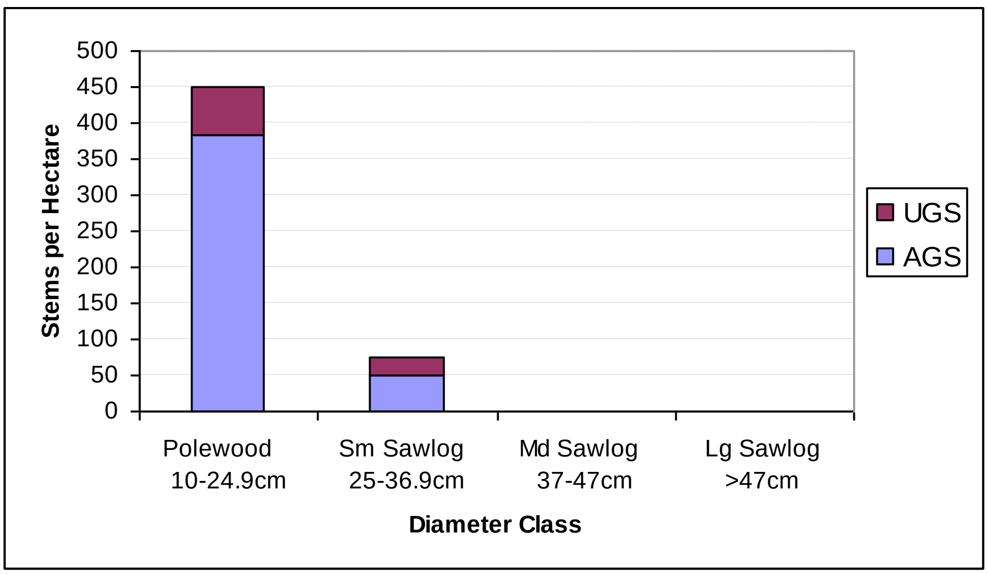

Figure 82: Tree abundance by size class and quality for PSP HT (2009 data).

Table 12: Summary of PSP HT results

PSP HT	
Forest type	Hard maple dominated, southwest exposure, complex terrain
Dominant Tree Species	Mh6OH2By1OC1
Regeneration Species	Mh3Mr2Or2Bf2Be1
Disturbance type	Selection cut in 2005
FEC classification	ES 25.1 (Mh-Be-Or; dry to moderately fresh)
Basal area	15.8 m^2/ha
Canopy height	19.7 m
Mean DBH	11.53 cm
Location	North off Stocking Lake Road after exit for Baby Loon Lake.

PSP KL1

Site Description

PSP KL1 represents a multi-aged, sugar maple dominated hardwood stand on moist, sandy loam. It has a western exposure, and is located at the toe of a slope on the west side of Kelly Lake, about 200-m north of Kendra Trail (Figure 83). The stand was selection harvested in 2005, but no trees were cut from the growth plots. Unlike the majority of PSPs, this plot has only been sampled twice – in 2003 and 2008.

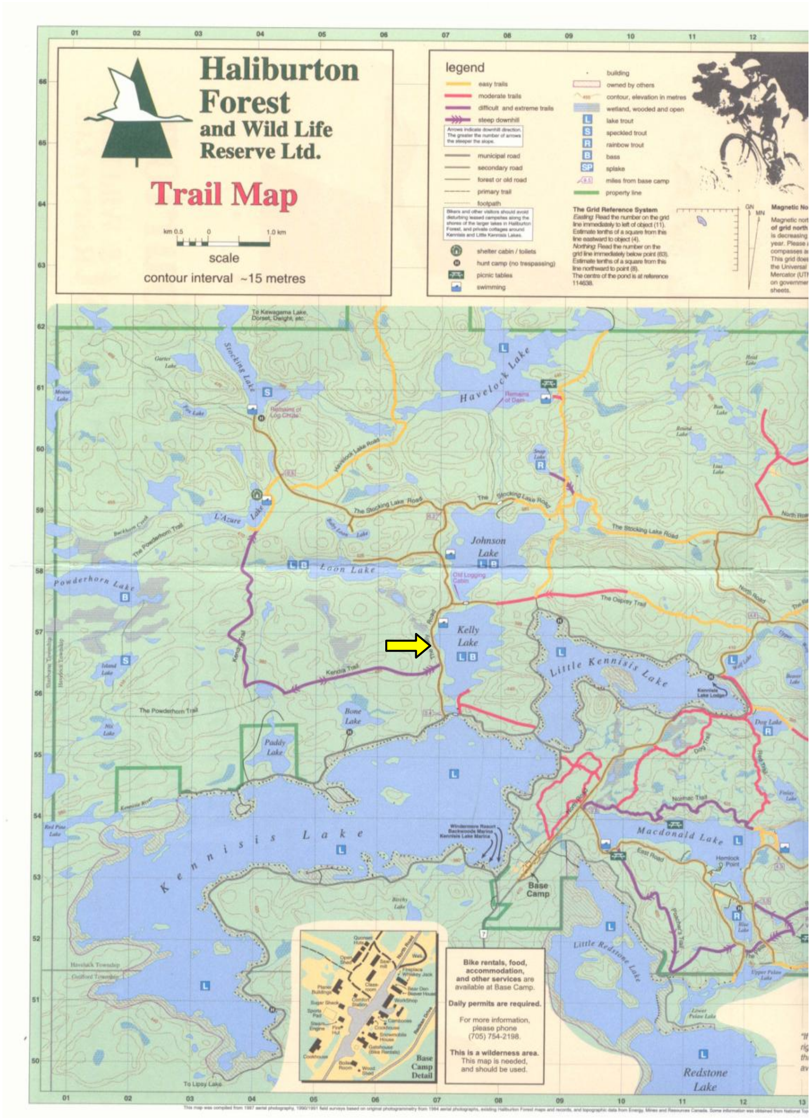

Figure 83: Haliburton Forest map with arrow showing location of PSP KLI.

PSP KLI is a moderately productive hardwood stand. Between 2003 and 2008, basal area increased from 19 m^2/ha to 21 m^2/ha, or 0.4 m^2/ha/yr (Figure 84). Of the total 2008 basal area of 21 m^2/ha, 0.8 m^2/ha was large saplings. In 2008, basal area was dominated by sugar maple (77%) and beech (16%). It also had a component of basswood (6%). All 3 growth plots increased in basal area over the sampling period (Figure 85).

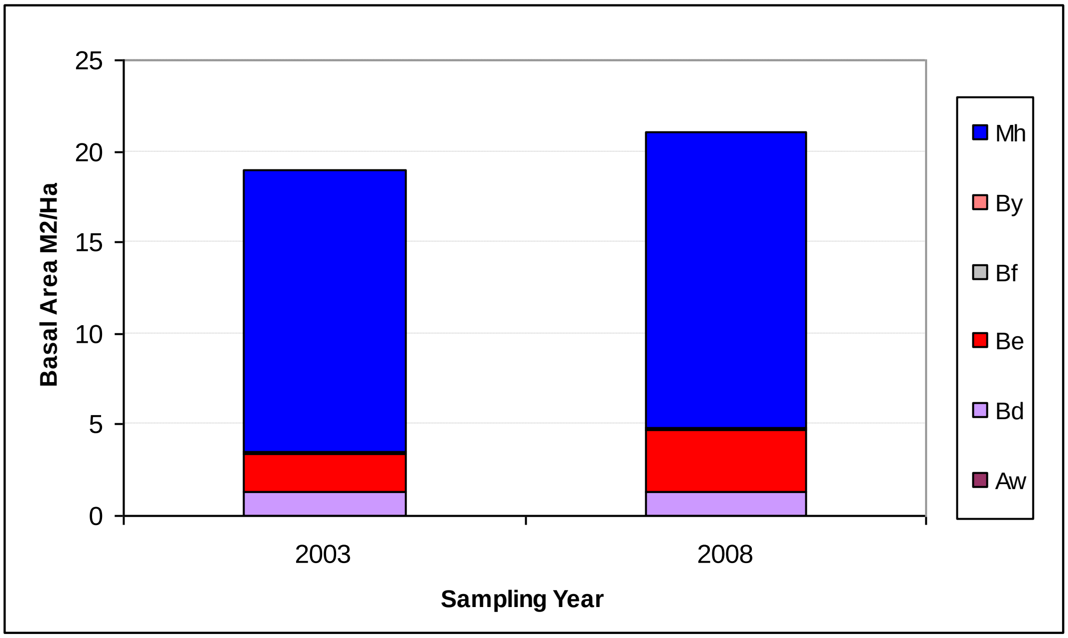

Figure 84: Total basal area/hectare, by species, over 2 sampling years for PSP KLI.

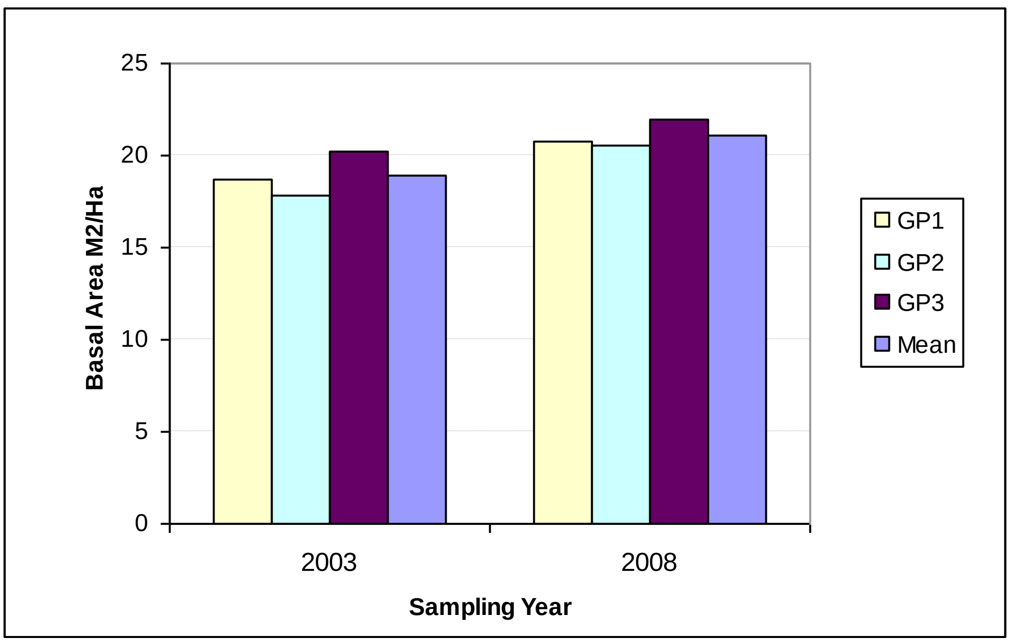

Figure 85: Total basal area/hectare, by growth plot, over 2 sampling years, for PSP KLI.

Tree and small sapling abundance

Total stem count increased from 342/ha to 625/ha between 2003 and 2008. Compared to the other PSPs representing tolerant hardwood stands, these numbers are quite low. By 2008, beech was the most common tree species in this plot (333/ha), followed by sugar maple (233/ha), with much smaller amounts of yellow birch, basswood, white ash and balsam fir (Figure 86).

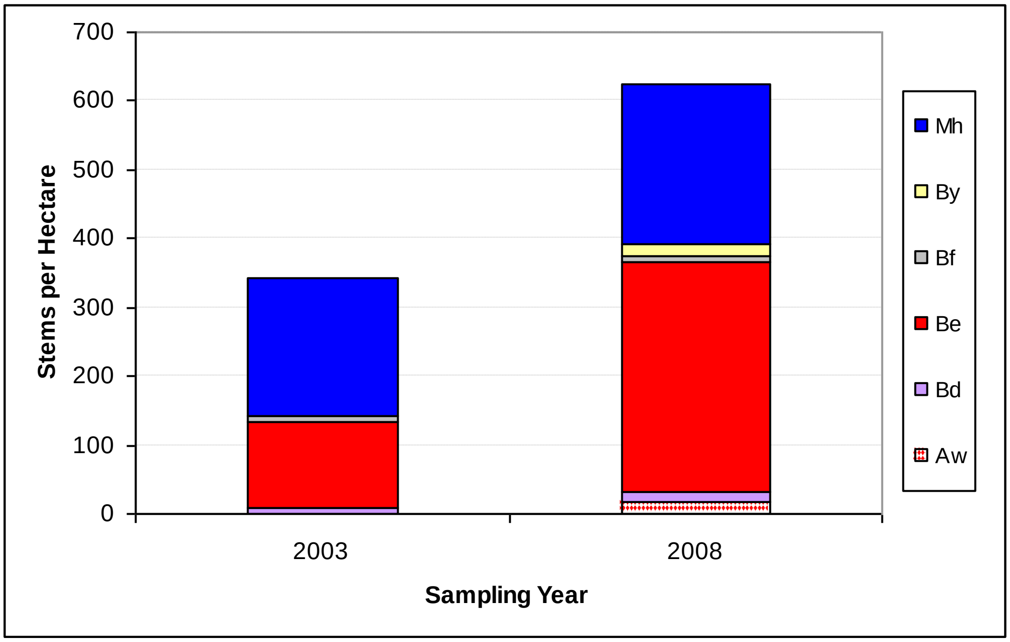

Figure 86: Number of stems/hectare, by species, over 2 sampling years for PSP KLI.

In both sampling years, sugar maple and beech comprised the majority of saplings for this plot (Figure 87). Both increased after harvesting operations in 2005, though balsam fir declined from 9 to 0 between 2003 and 2008. Small components of ironwood and yellow birch were present in 2008.

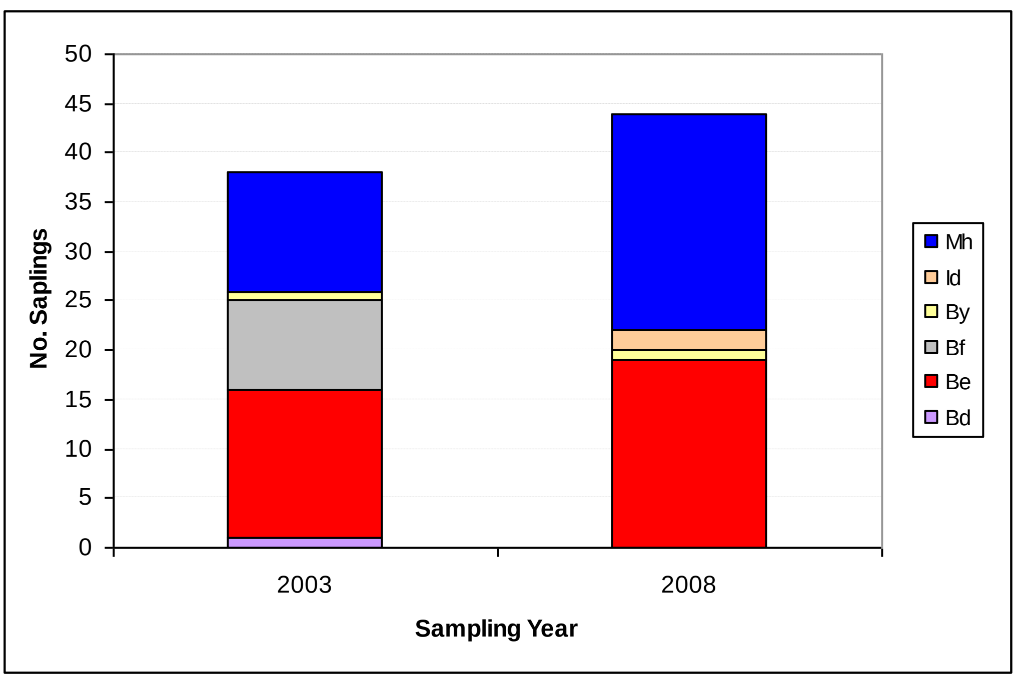

Figure 87: Sapling abundance, by species, over 2 sampling years for PSP KLI.

Size class distribution

Basal area distribution in this plot was 2-3-5-9. Large trees comprise 44% of basal area, medium-sized trees 26%, and polewood and small trees another 26% (Figure 88). Overall, 79% of basal area was UGS, with a high proportion of UGS in all size classes. The low basal area of polewood and small sawlog-sized trees, and the high proportion of UGS trees may suggest problems with the long-term recruitment of quality sawlogs.

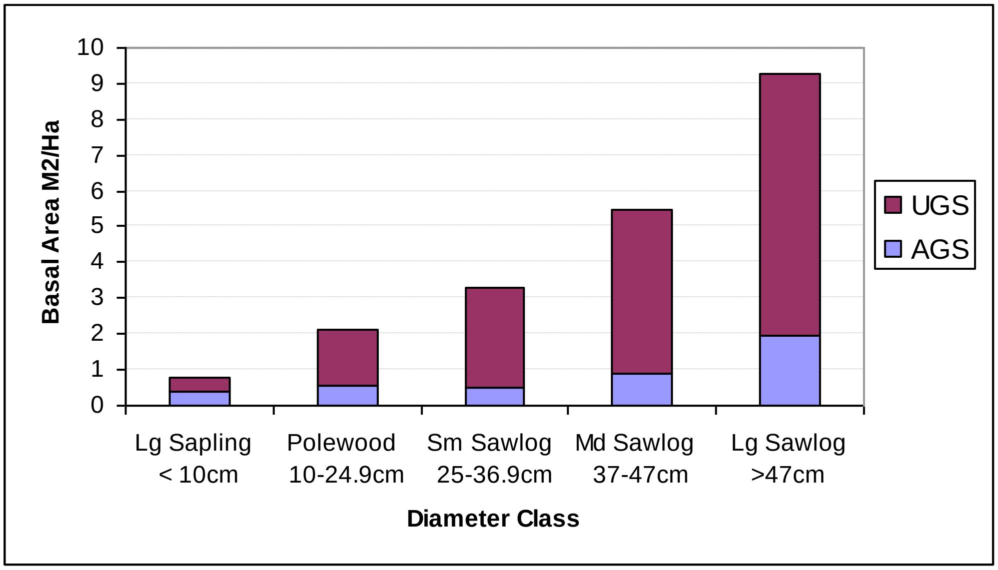

Figure 88: Basal area by size class and quality for PSP KLI (2008 data).

This plot has low stocking, with tree abundance - especially in the polewood and small sawlog size classes - much lower than suggested for the long-term recruitment of larger size classes (OMNR recommends residual stocking of 312 stems/ha in the polewood size class, and 81 stems/ha in the small sawlog size class) (Figure 89). Abundance of medium and large sawlog-sized trees is relatively high. Mean stem diameter in this plot is fairly average, at 20.7 cm.

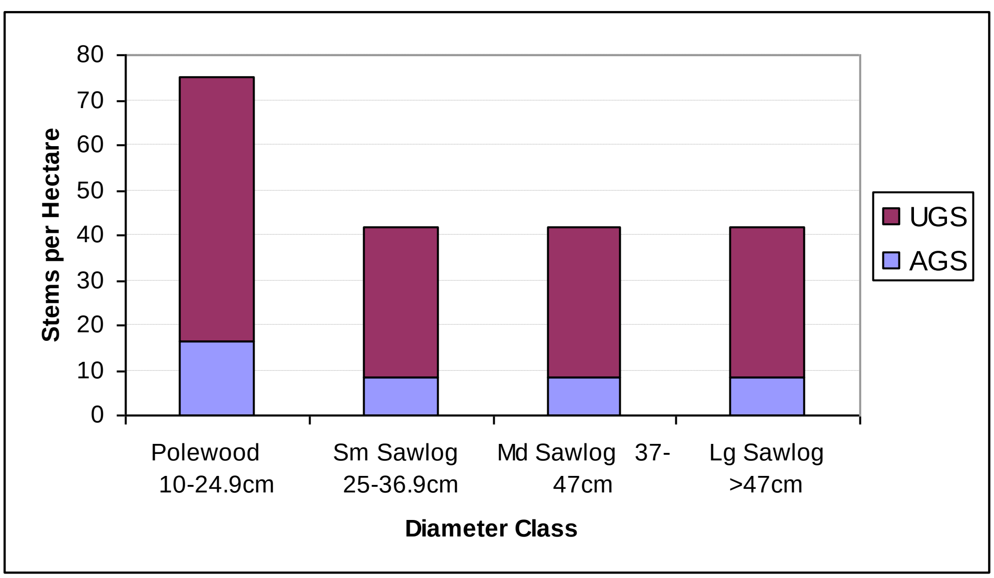

Figure 89: Tree abundance by size class and quality for PSP KLI (2008 data).

Table 13: Summary of PSP KLI results

PSP KLI	
Forest type	Hard maple dominated, western exposure, toe of slope
Dominant Tree Species	Mh8Be2
Regeneration Species	Mh5Be4OH1
Disturbance type	Selection harvest in 2005; no trees cut from growth plots
FEC classification	ES 25.2 (Mh-Be-Or; fresh to moist)
Basal area	21.1 m^2/ha
Canopy height	29.6 m
Mean DBH	20.7 cm
Location	Left side of Kelly Lake Rd, about 200-m north of Kendra Trail.

PSP KL2

Site Description

PSP KLI1 represents a multi-aged, tolerant hardwood stand on well-drained, fresh loam. It is located mid-slope, with a western exposure, west of PSP KLI and Kelly Lake (Figure 90). The stand was harvested with single tree selection in 2005, but no trees within the PSP growth plots were cut. This plot was sampled twice – in 2003 and 2008.

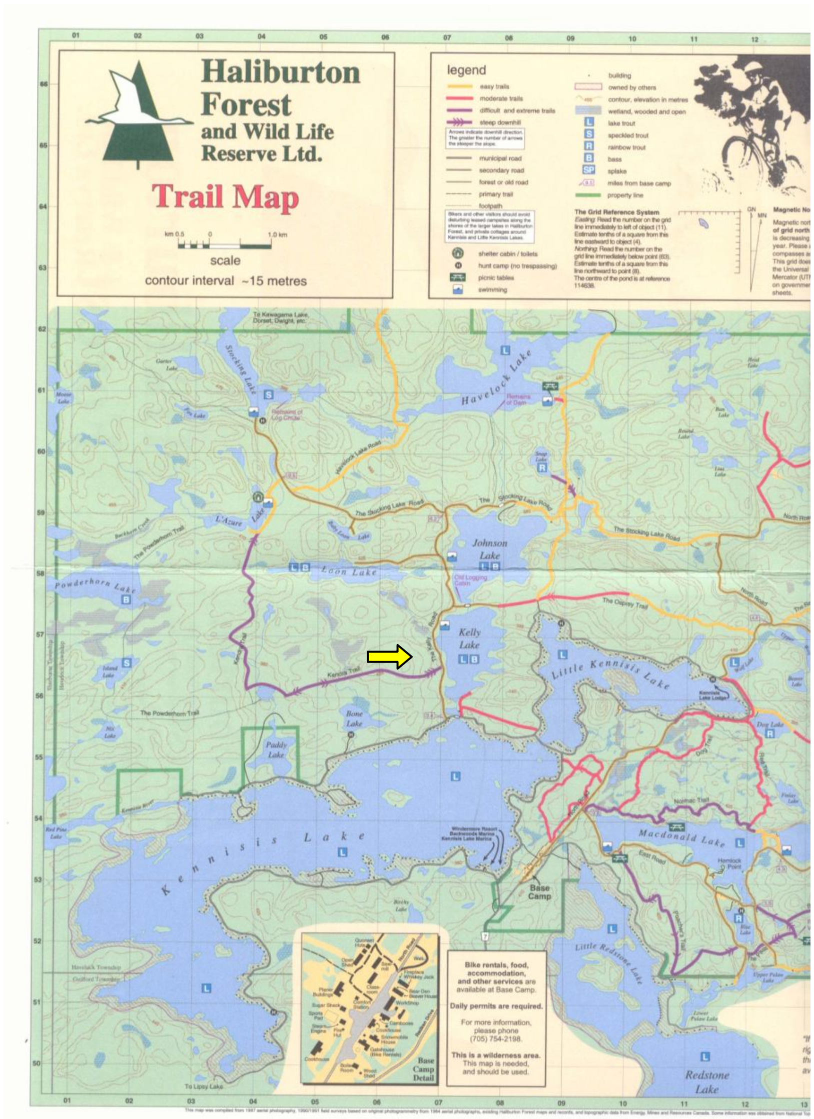

Figure 90: Haliburton Forest map with arrow showing location of PSP KLII.

Between 2003 and 2008, basal area increased from 17.4 m^2/ha to 20.3 m^2/ha, of which 3.9 m^2/ha was large saplings (Figure 91). Sugar maple and beech were the most dominant tree species in 2008 (52% & 45%). The plot also had a very small component of cherry, basswood, yellow birch, balsam fir and white ash. Net growth was measured in all 3 growth plots, with the greatest gains in growth plot 3 (Figure 92).

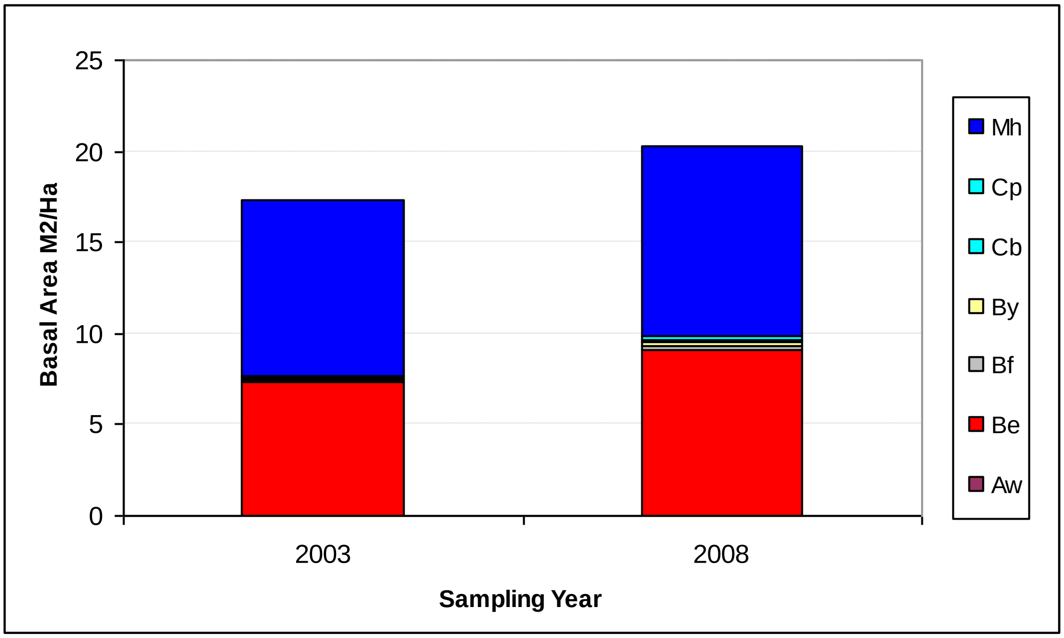

Figure 91: Total basal area/hectare, by species, over 2 sampling years for PSP KLII.

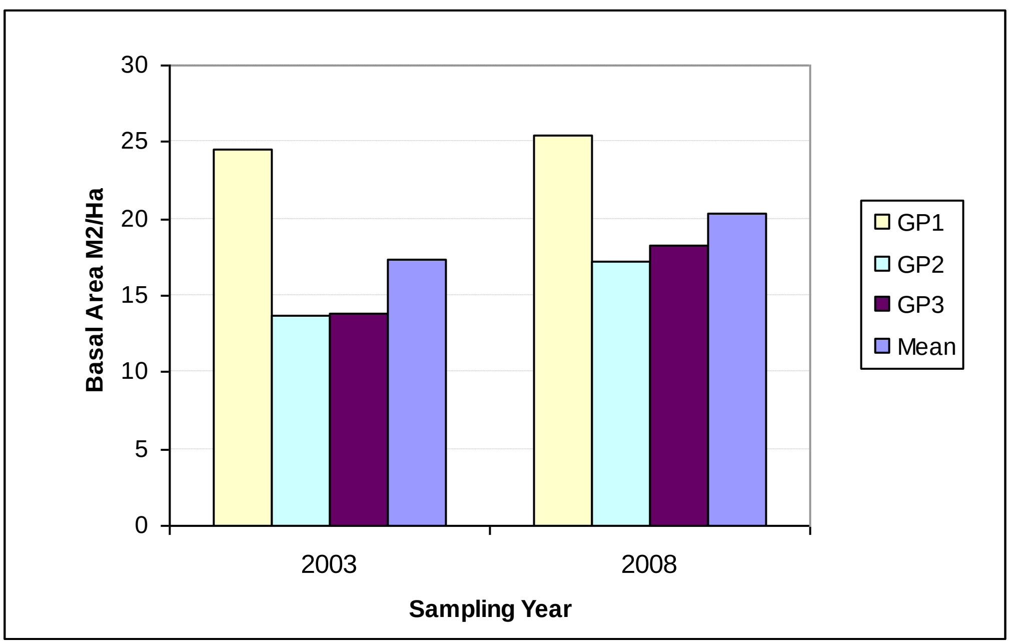

Figure 92: Total basal area/hectare, by growth plot, over 2 sampling years, for PSP KLII.

Tree and small sapling abundance

Total stem count in PSP KL2 increased from 1,983/ha to 2,175/ha between 2003 and 2008 (Figure 93). Compared to the other PSPs representing tolerant hardwood stands – especially PSP KL1, which is very close to this growth plot, these numbers are quite high. By 2008, beech was the most common tree species in this plot (1,058/ha), followed by sugar maple (808/ha), with smaller amounts of cherry (158), yellow birch (92), and balsam fir (50).

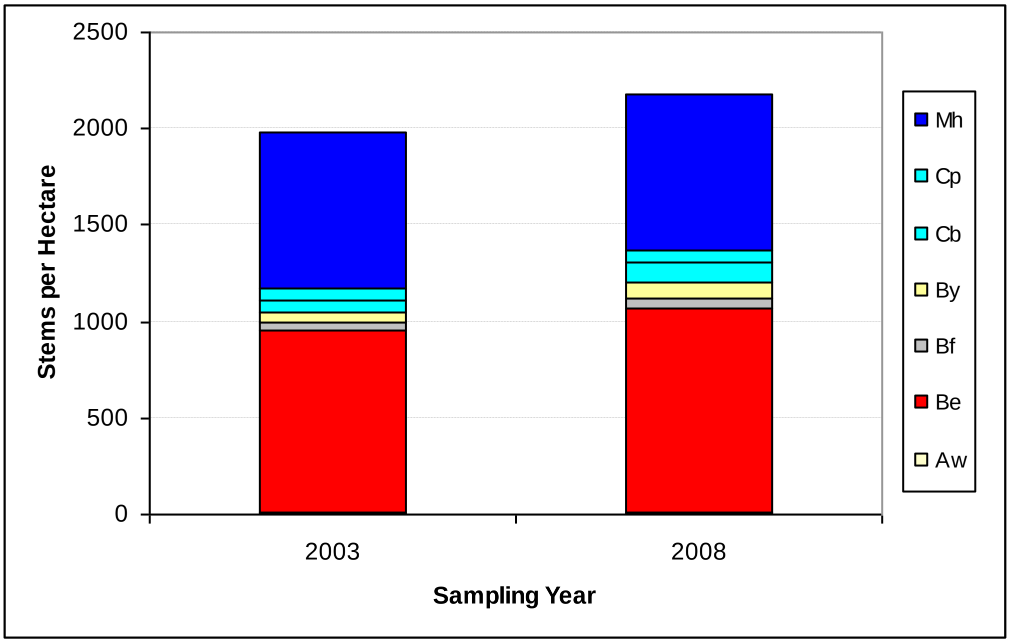

Figure 93: Number of stems/hectare, by species, over 2 sampling years for PSP KLII.

In both sampling years, sugar maple and beech comprised the majority of saplings for this plot (Figure 94). The total number of saplings changed little, though the proportion of beech increased moderately while sugar maple decreased, and the number of cherries doubled (from 3 to 6).

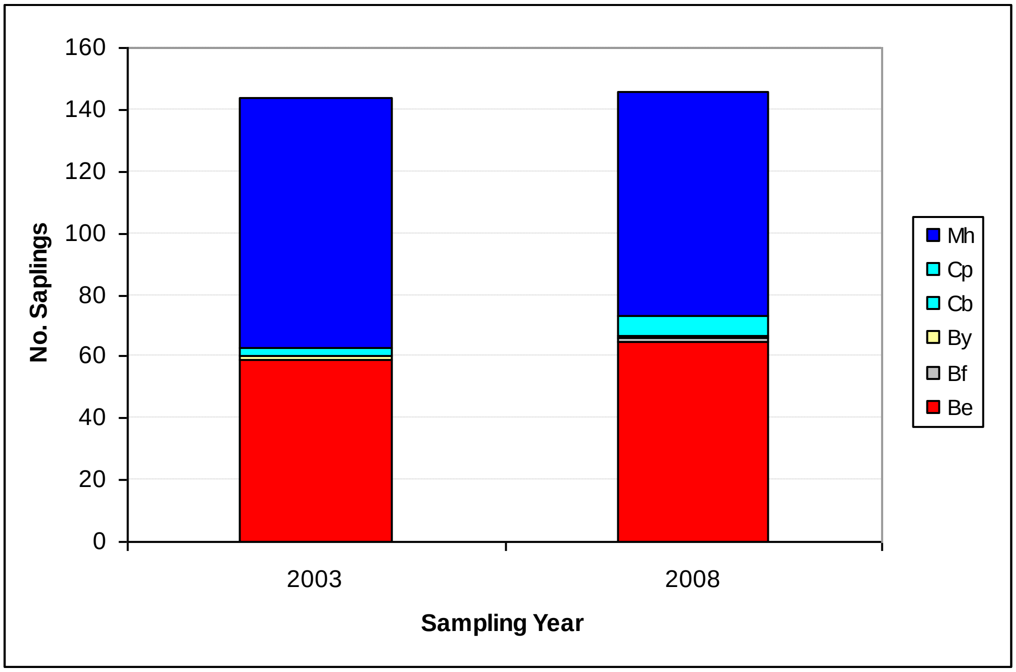

Figure 94: Sapling abundance, by species, over 2 sampling years for PSP KLII.

Size class distribution

Basal area distribution for this stand is 5-6-1-4 (Figure 95). Polewood and small sawlog-sized trees comprise the majority of basal area (58%). Without large saplings, total basal area was 16.4 m^2/ha. Thus recruitment to larger size classes is not a concern, even though, currently, there are very few medium-sized trees.

Overall, 7.6 m^2/ha is AGS (37%). Almost all the small sawlog class is UGS (94%), all the medium sized trees, half the large-sized trees, and roughly 40% of polewood and large saplings.

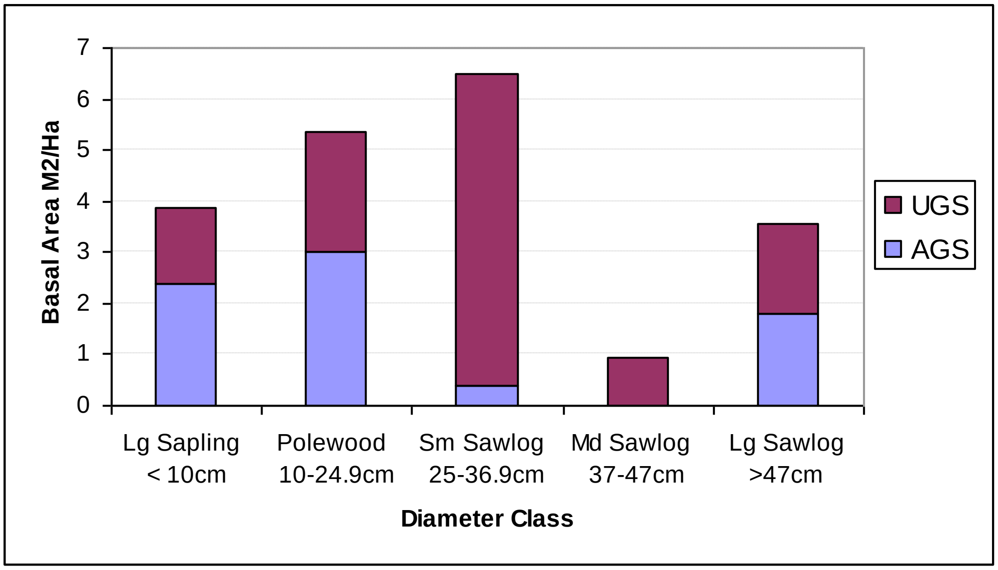

Figure 95: Basal area by size class and quality for PSP KLII (2008 data).

This plot has good stocking, with a stem distribution of 283-83-8-17 (Figure 96). These proportions are close to OMNR's residual stand structure for single tree selection. 57% of trees in this plot are UGS.

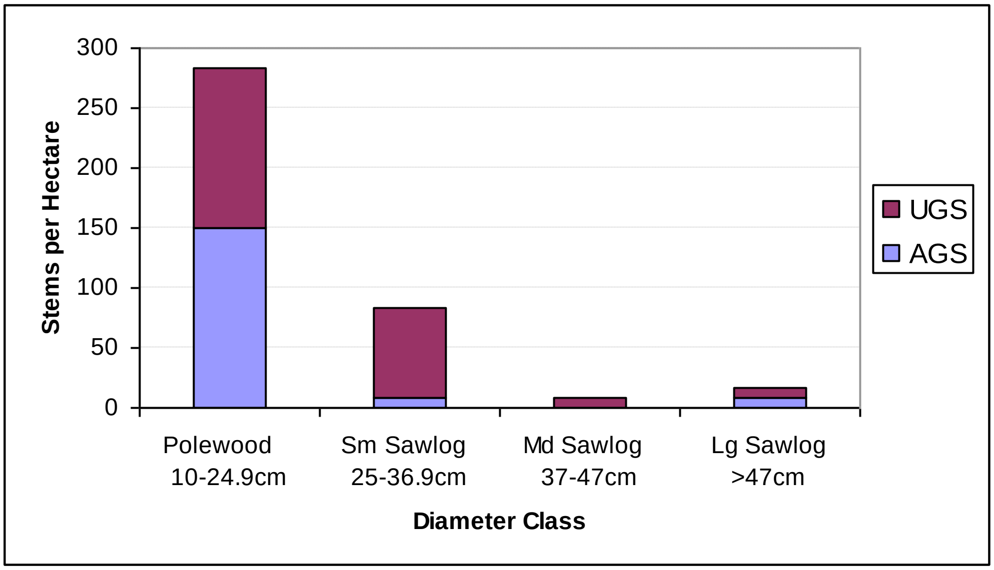

Figure 96: Tree abundance by size class and quality for PSP KLII (2008 data).

Table 14: Summary of PSP KLII results

PSP KLII	
Forest type	Hard maple and beech dominated, western exposure, mid slope
Dominant Tree Species	Mh5Be4
Regeneration Species	Mh5Be4
Disturbance type	Currently, gap disturbance
FEC classification	ES 25.1 (Mh-Be-Or; dry to moderately fresh)
Basal area	20.5 m^2/ha
Canopy height	25.6 m
Mean DBH	10.9 cm
Location	~ 200 m uphill and west of PSP KI

PSP KLRT

Site Description

PSP KLRT is a young, early successional hardwood dominated stand. It is mid-slope, with a western aspect, located about ½ km north of Wilkinson Lake Rd and 300-m past Kelly Lake Rd (Figure 97). The stand was “clearcut with standards” in 1983. Most of the trees left standing at that time have since died. The PSP was initiated in 2007, but not completely established, and lacks information on soils, regeneration, mortality and wildlife usage.

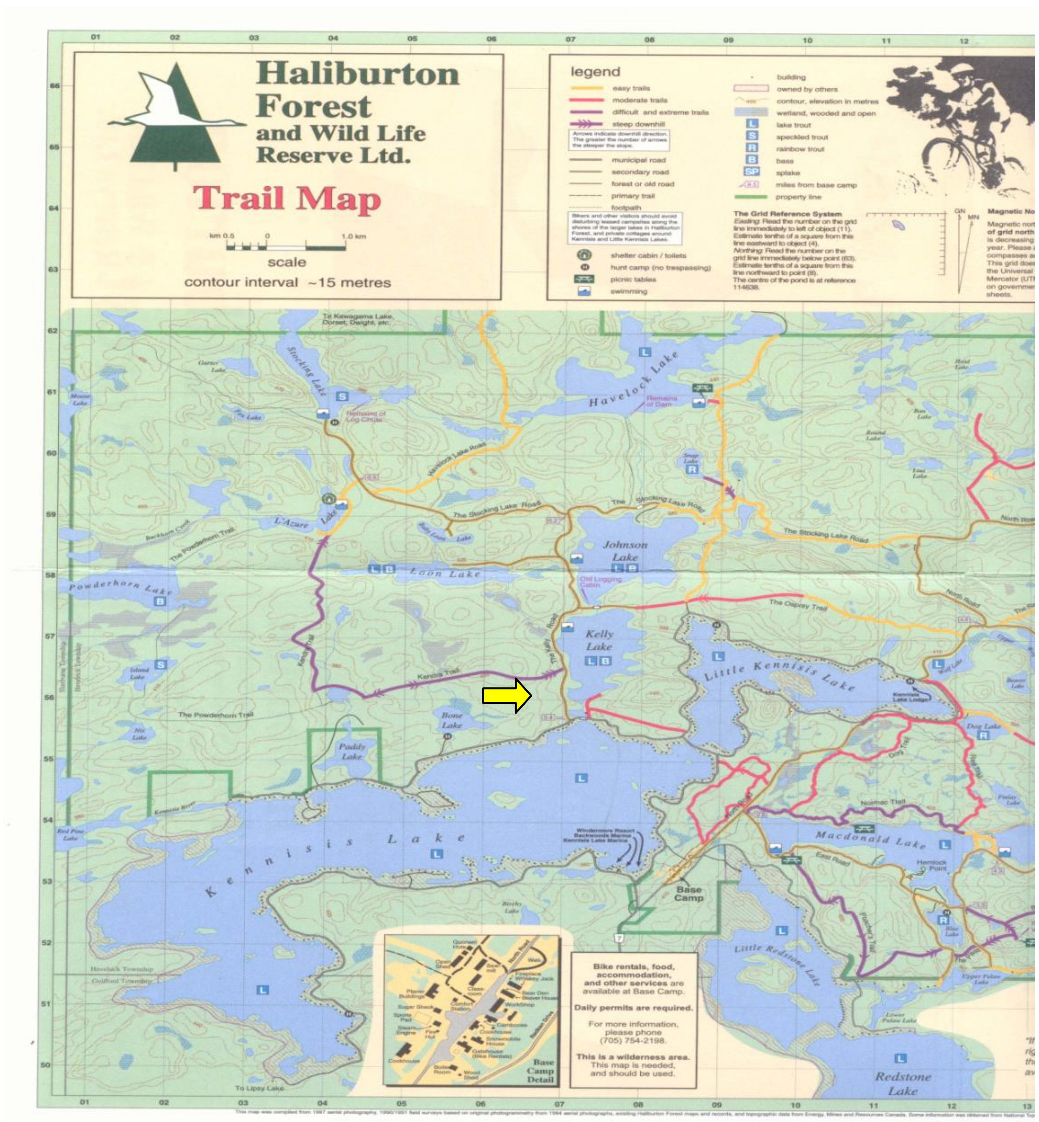

Figure 97: Haliburton Forest map with arrow showing location of PSP KLRT.

Before clearcutting in 1983, this was a tolerant hardwood stand. It is now an early successional stand with a basal area of 24 m^2/ha in 2007, dominated by large saplings and polewood-sized trees, including hard maple (30%), poplar (23%), yellow and white birch (25% and 5.5%), beech (7.6%), basswood (4%) and cherry (1.5%) (Figure 98). All 3 growth plots were similar in basal area – ranging from 21.9 to 25.7 m^2/ha (Figure 99).

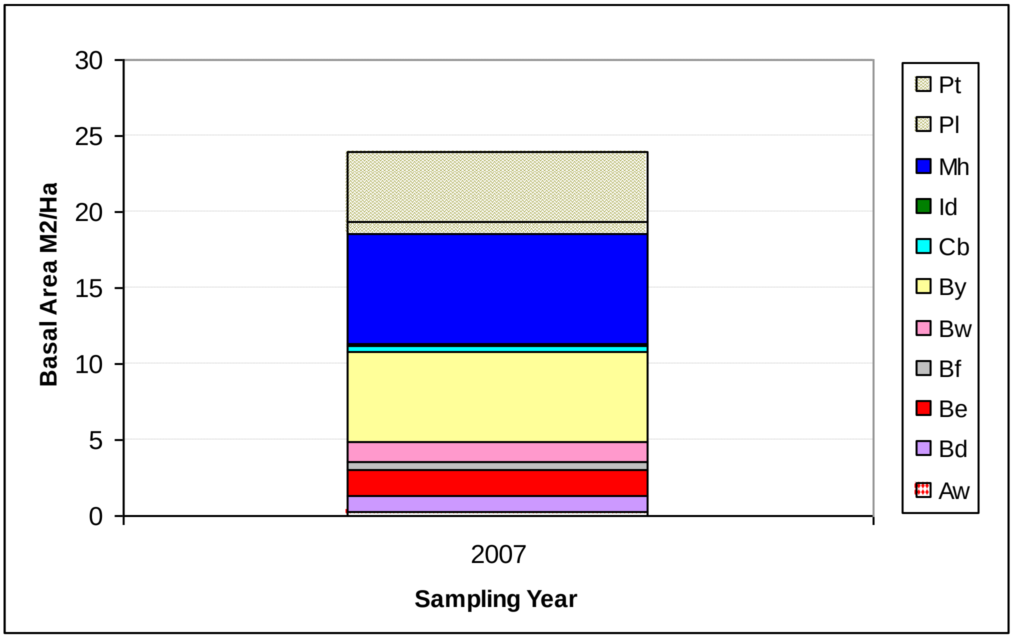

Figure 98: Total basal area/hectare, by species, for PSP KLRT.

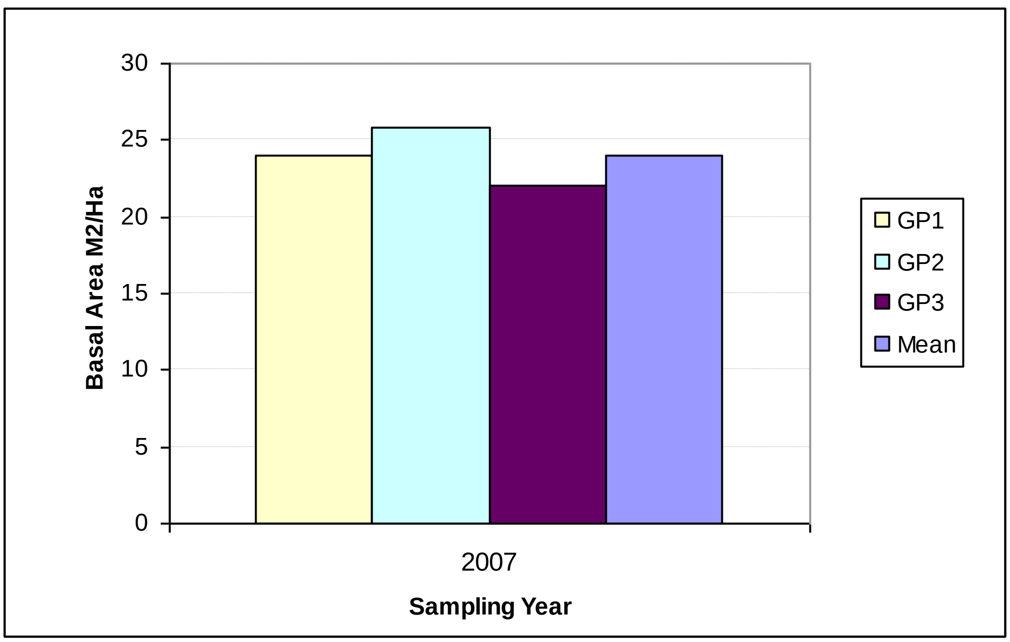

Figure 99: Total basal area/hectare, by growth plot, for PSP KLRT.

Tree and small sapling abundance

Total stem count was 3,192/ha in 2007 (Figure 100). Hard maple was the most common species (1,275), followed by yellow birch (900), poplar (391), and beech (192). There was also white birch, basswood, white ash, balsam fir, cherry and ironwood.

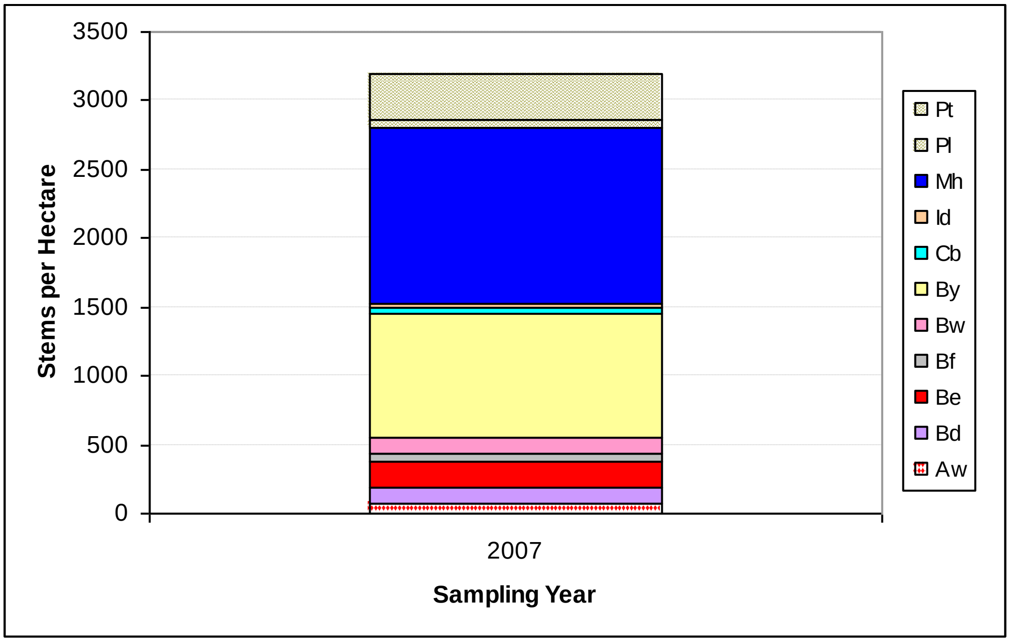

Figure 100: Number of stems/hectare, by species, for PSP KLRT.

No sapling data was collected for this PSP.

Size class distribution

Basal area distribution in this plot is 16-1-1-0 (Figure 101). Polewood accounted for 65% of basal area, with large saplings accounting for most of the remainder (26%). Very few trees survived the "clearcut with standards" carried out in 1983. Small and medium sized trees accounted for 8% of basal area in 2007, though they probably had a very significant influence on regeneration, as sugar maple now makes up 40% of stems, followed closely by yellow birch. 46% of basal area is AGS, with most of that in the polewood and large sapling size classes.

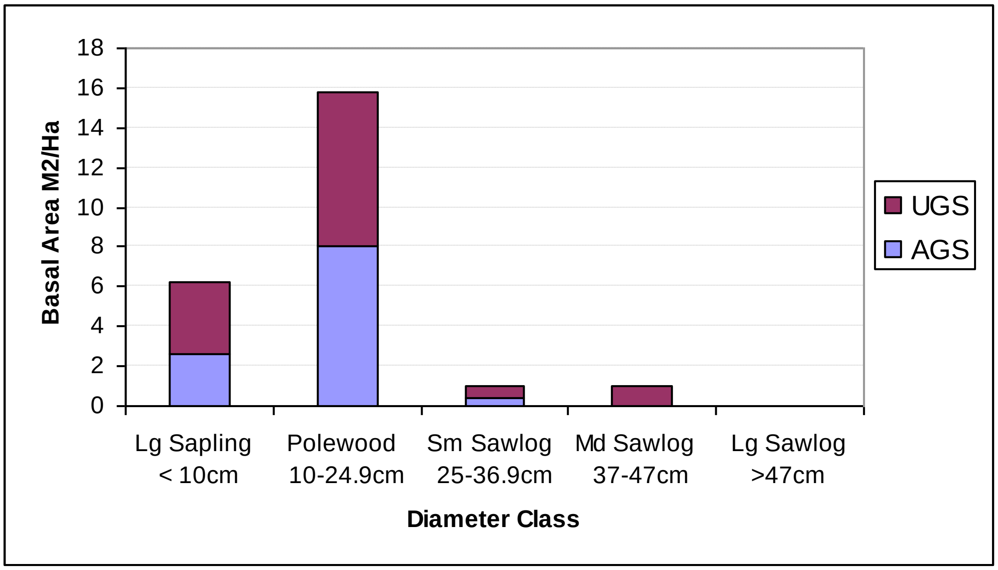

Figure 101: Basal area by size class and quality for PSP KLRT (2007 data).

The majority of trees in PSP KLRT are either large saplings (2,208/ha) or polewood sized (975/ha) (Figure 102). Less than half the stems (42%) are AGS.

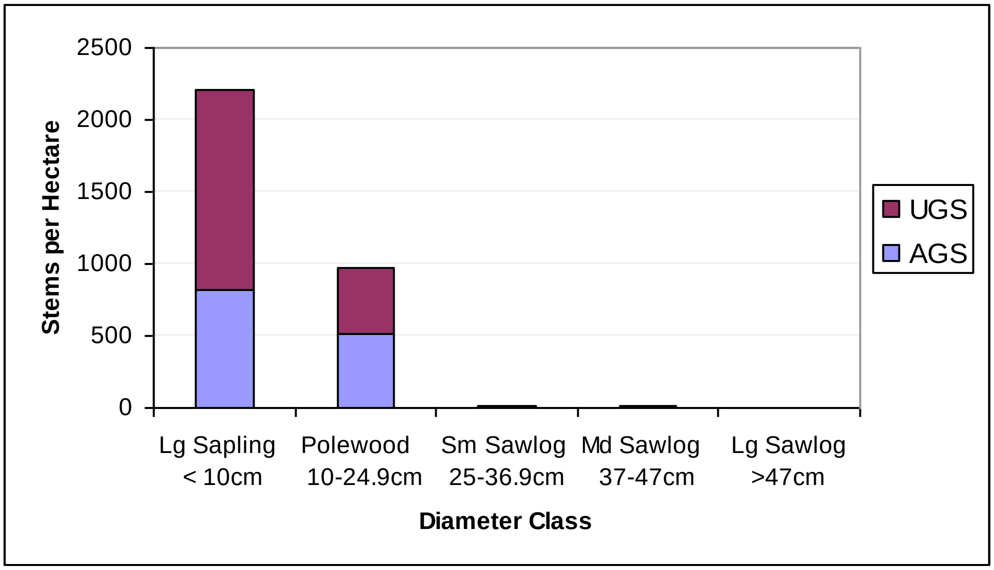

Figure 102: Tree abundance by size class and quality for PSP KLRT (2007 data).

Table 15: Summary of PSP KLRT results

PSP KLRT	
Forest type	Young, early successional, hardwood dominated stand, mid-slope, western exposure
Dominant Tree Species	Mh3By2Pt2OH2
Regeneration Species	No data collected
Disturbance type	Clearcut with standards in 1983
FEC classification	Too young to classify
Basal area	23.2 m^2/ha
Canopy height	Data not usable
Mean DBH	9.76 cm
Location	½ km north of Wilkinson Rd, ~300 m past Kelly Lake Rd

PSP L'Azure

Site Description

PSP L'Azure represents a wet, poorly drained mixed hardwood and softwood stand on the southeast side of L'Azure Lake. It is partly located in a wet depression as well as on a very gentle slope. White birch veneer was harvested from this stand in 2003, but only one tree (Mh) was cut from the growth plots.

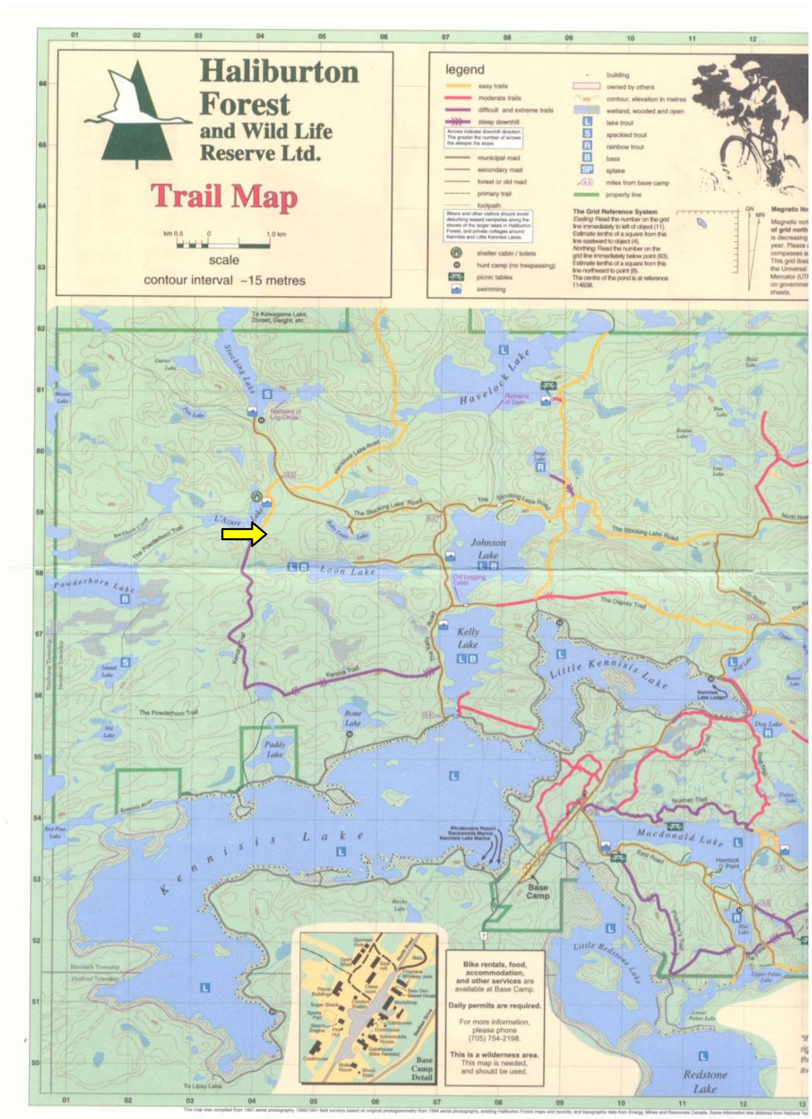

Figure 103: Haliburton Forest map with arrow showing location of PSP L'Azure.

In 2005, PSP L'Azure had a relatively high basal area of 33.1 m^2/ha, which was less than the 33.8 m^2/ha in 2000 (Figure 104). The site is dominated by yellow birch (30%), sugar maple (19.7%), black ash (19.7%) and hemlock (13.7%). Growth plot 3 (26.1 m^2/ha in 2005) had a significantly lower basal area than growth plot 2 (38.8 m^2/ha in 2005) (Figure 105). Basal area of large saplings accounted for 2.3 m^2/ha. The high proportion of black ash in this PSP distinguishes it from other PSPs. It is the wettest PSP, with water depths reaching several feet in places.

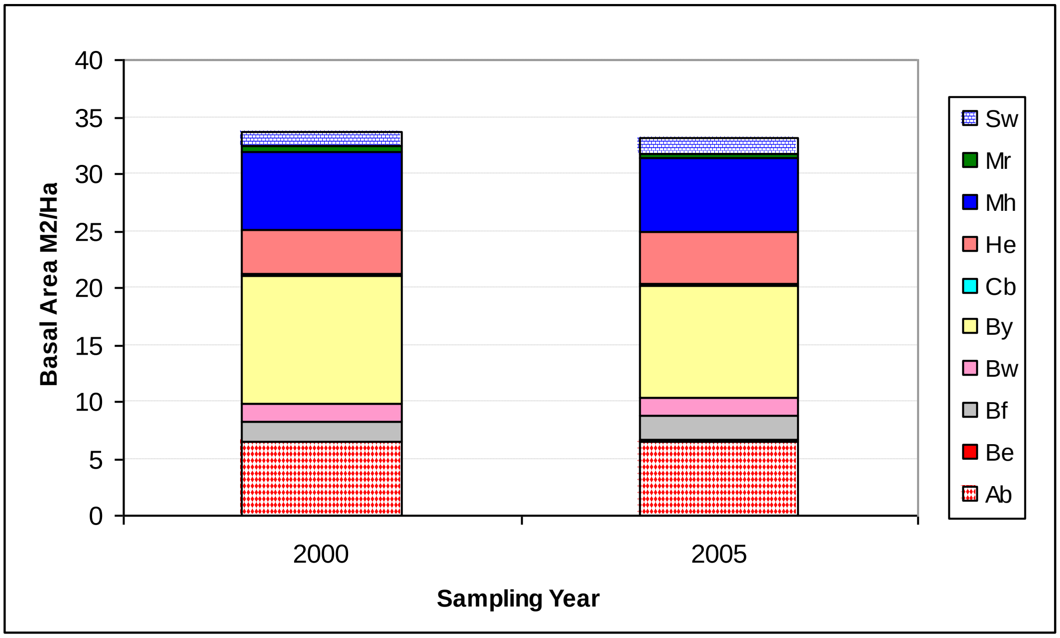

Figure 104: Total basal area/hectare, by species, over 2 sampling years for PSP L'Azure.

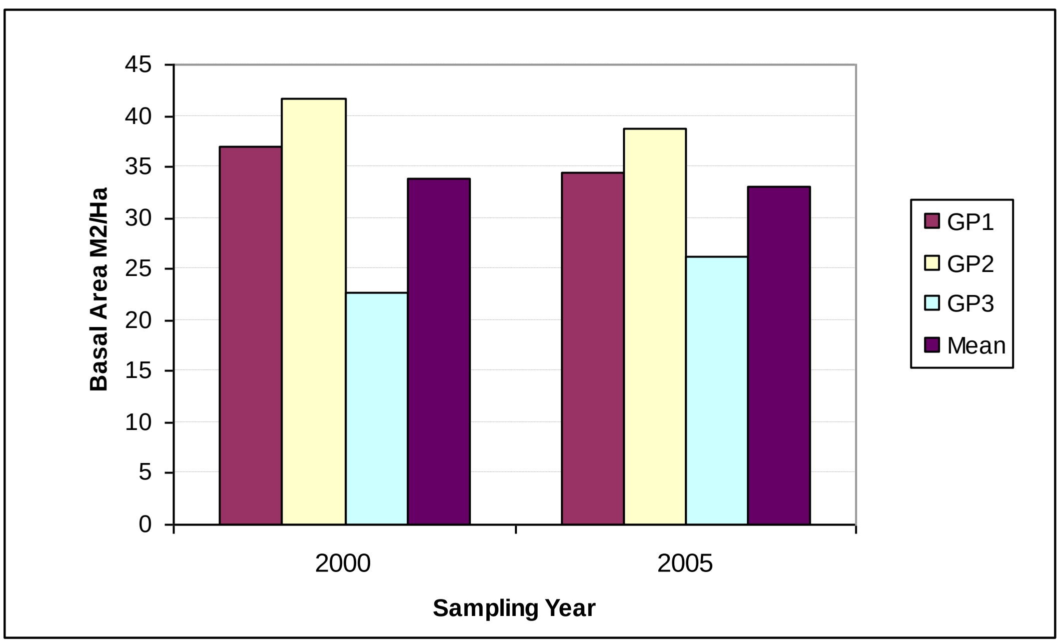

Figure 105: Total basal area/ha, by growth plot, over 2 sampling years, for PSP L'Azure.

Tree and small sapling abundance

Balsam fir, sugar maple and yellow birch comprise the majority of stems (76%), followed by black ash, beech, hemlock, and white spruce (Figure 106). Total stem count increased from 1,675/ha to 1,825/ha between 2000 and 2005. Balsam fir, beech, hemlock and white spruce accounted for this.

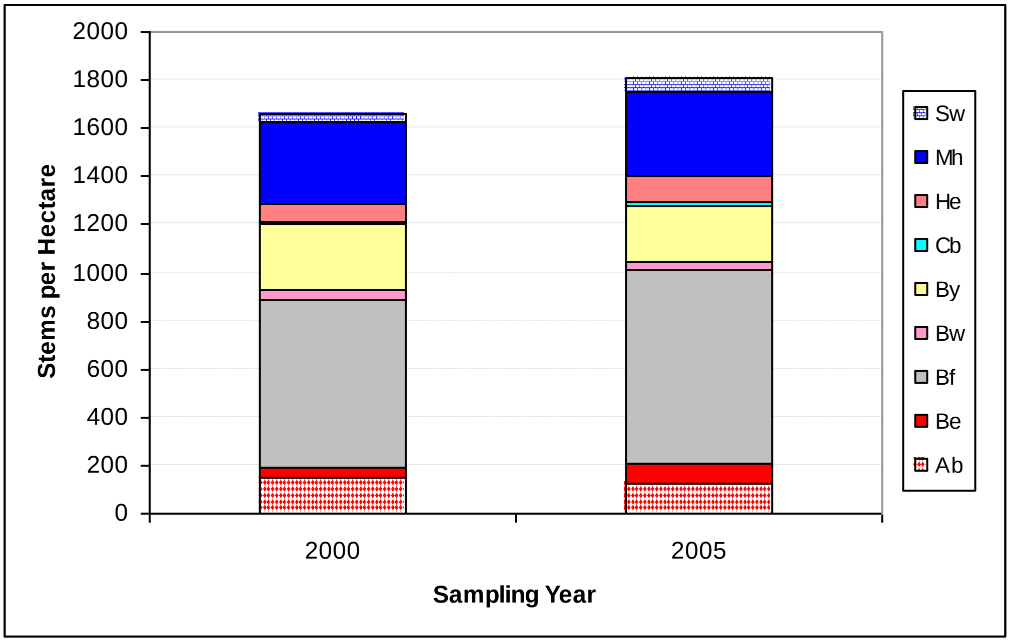

Figure 106: Number of stems/hectare, by species, over 2 sampling years for PSP L'Azure.

Sapling abundance decreased from 48 to 39 between 2000 and 2005 (Figure 107). White birch, red maple, white spruce, cherry and beech were all saplings in 2000, but not in 2005. By 2005, sugar maple, balsam fir and hemlock were the dominant sapling regeneration.

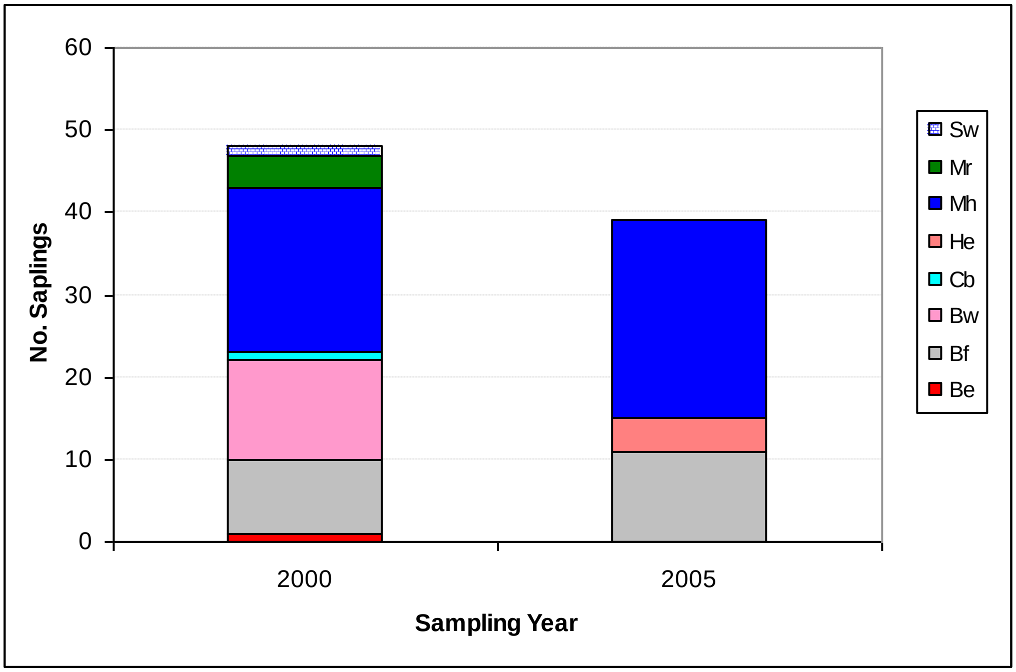

Figure 107: Sapling abundance, by species, over 2 sampling years for PSP L'Azure.

Size class distribution

In 2005, basal area distribution in this plot was 10-11-5-4. The high basal area in this plot is found across all size classes, with the highest in the polewood (10 m^2/ha) and small sawlog (10.9 m^2/ha) size classes (Figure 108). Medium and large sawlog-sized trees accounted for 8.8 m^2/ha in basal area. 44% of basal area was UGS. Polewood and medium-sized trees in particular had fairly high proportions of UGS. Interestingly, all the large sawlog-sized trees were AGS.

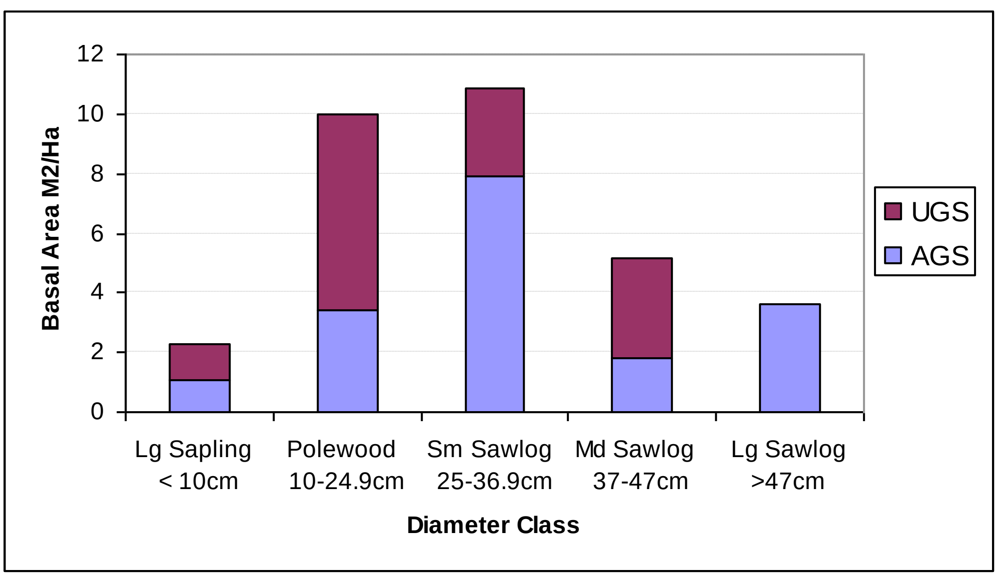

Figure 108: Basal area by size class and quality for PSP L'Azure (2005 data).

Polewood-sized trees account for the majority of stems (375), followed in decreasing abundance by sawlog-sized trees (158), medium-sized trees (42) and large-sized trees (17) (Figure 109). The distribution of stems across size classes closely resembles the distribution recommended by MNR for single tree selection (333-100-21-12). Overall, 58% of stems were UGS, with much of that in the polewood size class (73%).

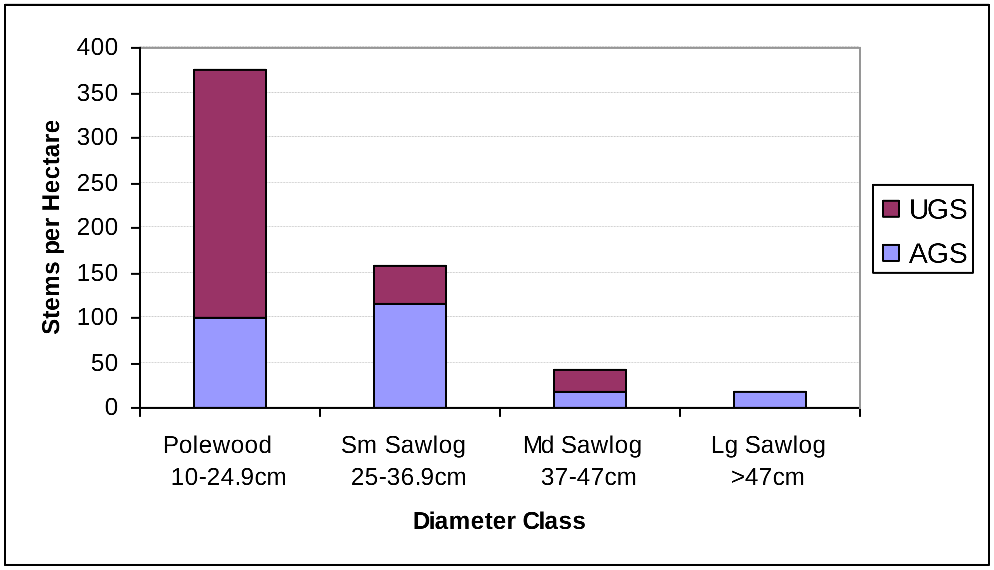

Figure 109: Tree abundance by size class and quality for PSP L'Azure (2005 data).

Table 16: Summary of PSP L'Azure results

PSP L'Azure	
Forest type	Very wet low-lying areas dominated by Ab; He, Mh and By dominant along toe of slope
Dominant Tree Species	By3Ab2Mh2He1Bw1Bf1
Regeneration Species	Mh6Bf3He1
Disturbance type	Light cutting of stand for Bw veneer in 2003, one Mh harvested from growth plots
FEC classification	ES 35 (Lowland hardwood; fresh to very moist)
Basal area	33.2 m^2/ha
Canopy height	19.3 m
Mean DBH	15.4 cm
Location	East off L'Azure Lake Rd., 100m before Kendra trail

PSP MDL

Site Description

PSP MDL represents a late successional hemlock forest as well as a hemlock/yellow birch forest on well-drained, dry to fresh loamy sand. The plot is on a north-facing slope on the south side of MacDonald Lake, as well as on level ground above this slope. It is accessed from East Rd, before Hemlock Point (Figure 110). The stand was harvested with horses in 2006. A total of 3-4 trees were cut from the 3 growth plots.

Figure 110: Haliburton Forest map with arrow showing location of PSP MDL.

Total basal area increased slightly between 1999 and 2004, from 43.1 in 1999 to 44.7 m^2/ha in 2004. In 2006, 3-4 large diameter trees were harvested, resulting in a small decrease in basal area (down to 42.4 m^2/ha in 2009). In 2009, hemlock accounted for the majority of basal area (78%), followed by yellow birch (9%), beech (5%) and balsam fir (3%) and cedar (3%). One small and one medium-sized sugar maple were harvested from growth plot 2, resulting in the near disappearance of sugar maple from this plot.

Variability among growth plots is very significant (Figure 111). In 2009, growth plot 2 had a relatively low basal area of 23.3 m^2/ha, and was dominated by yellow birch. Growth plots 1 and 3 were dominated by hemlock, and had basal areas of 48-56 m^2/ha. Despite harvesting 8% of basal area in growth plot 3 in 2006, basal area actually increased slightly between 2004 and 2009.

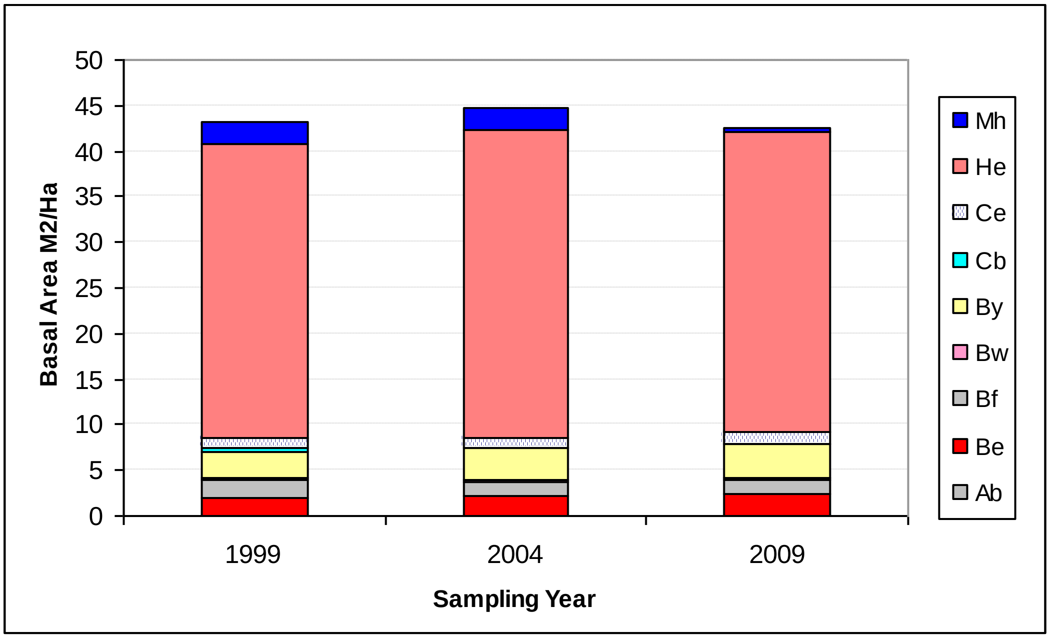

Figure 111: Total basal area/hectare, by species, over 3 sampling years for PSP MDL.

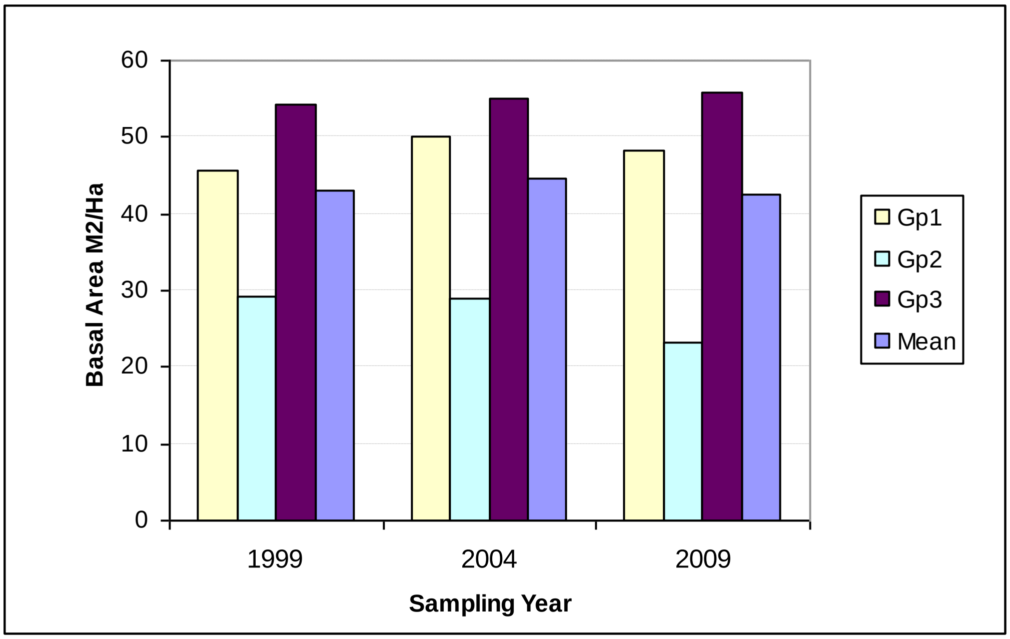

Figure 112: Total basal area/ha, by growth plot, over 3 sampling years, for PSP MDL.

Tree and small sapling abundance

In 2009, hemlock, balsam fir, yellow birch and beech comprised the majority of stems (96%) (Figure 113). Total stem count has varied among sampling years, from 1,575/ha in 1999 to 1,733/ha in 2004 to 1,367/ha in 2009. The bulk of the decline was in growth plot 2, which was harvested in 2007.

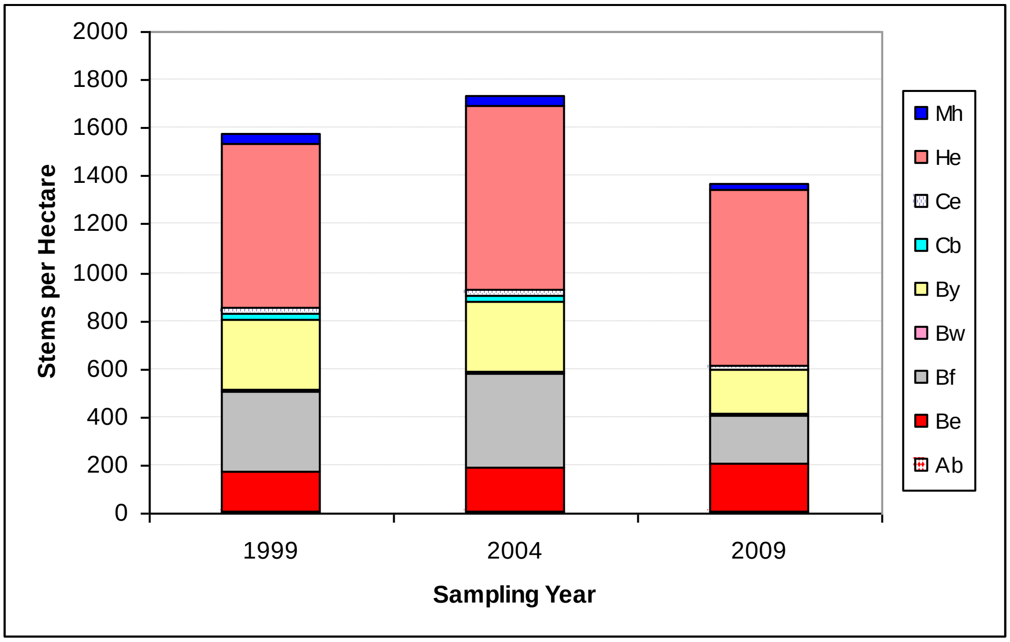

Figure 113: Number of stems/hectare, by species, over 3 sampling years for PSP MDL.

Between 2004 and 2009, sapling abundance fell dramatically in the 9 shrub plots – from 27 in 1999 and 2004 to 5 in 2009 (Figure 114). This decline was in growth plots 1 and 3 only. There has been some blowdown as well as logging in each of the growth plots, which may have crushed some saplings. Otherwise it is unclear what has caused this decline.

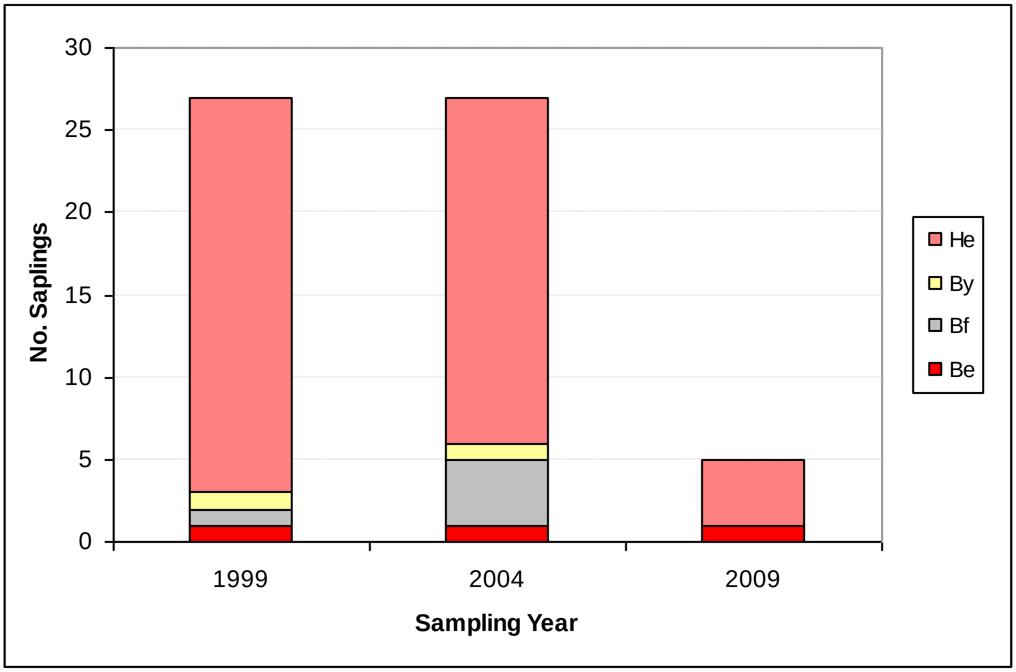

Figure 114: Sapling abundance, by species, over 3 sampling years for PSP MDL.

Size class distribution

In 2009, basal area distribution in this plot was 5-7-16-13. Most of the basal area was in the medium (15.9 m^2/ha) and large (12.9 m^2/ha) sized trees (Figure 115). A very high proportion of basal area is AGS (92%), which is not unusual in conifer-dominated stands. All the large sawlog-sized trees are AGS.

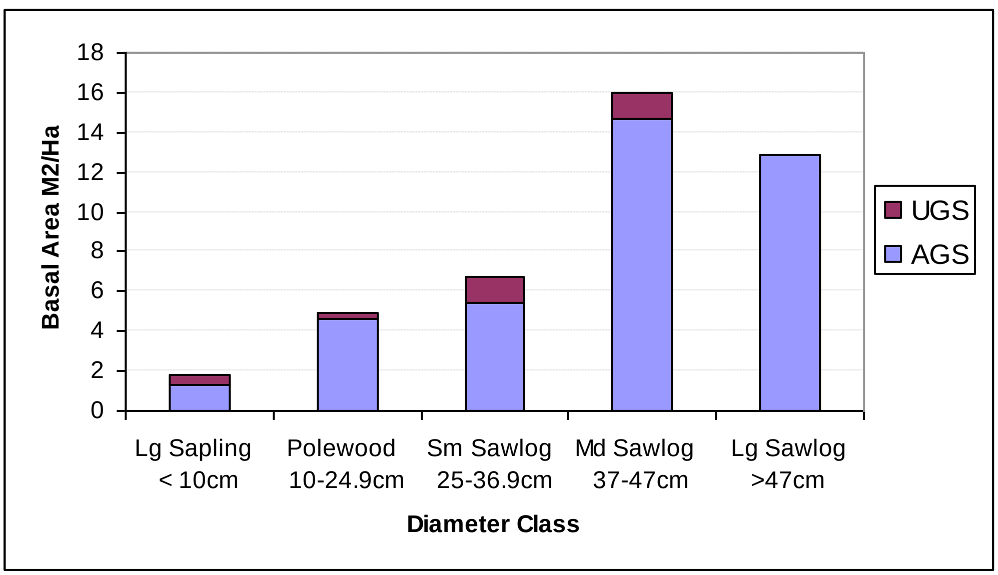

Figure 115: Basal area by size class and quality for PSP MDL (2009 data).

Polewood-sized trees account for the majority of stems (275), followed by medium-sized trees (117), small-sized trees (100), and large-sized trees (50) (Figure 116). Despite the high basal area, recruitment is strong. There are also relatively few UGS trees in all size classes. Mean stem diameter is 19.8 cm, which reflects both the abundance of small, medium and large trees, as well as the abundance of large saplings and polewood sized trees.

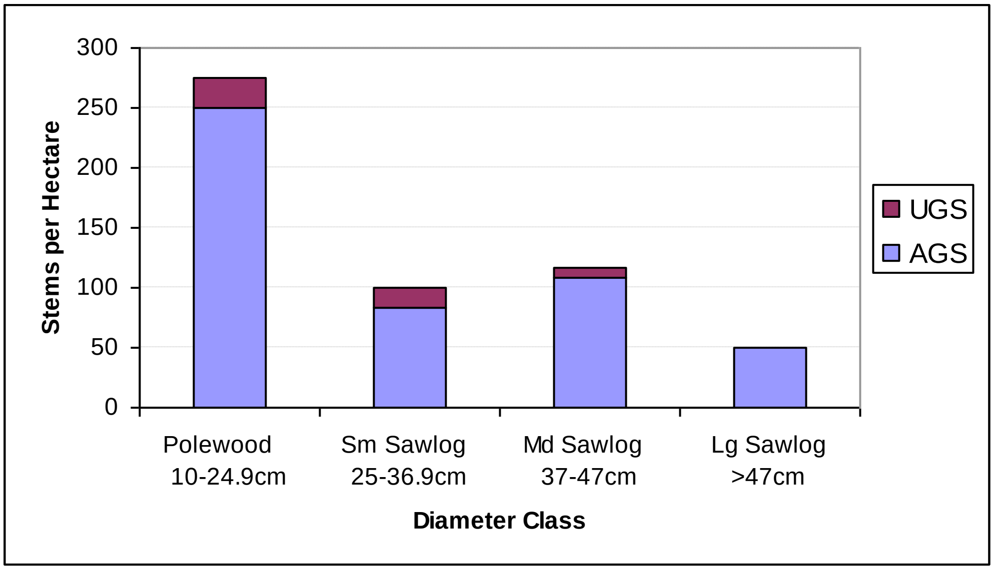

Figure 116: Tree abundance by size class and quality for PSP MDL (2009 data).

Table 17: Summary of PSP MDL results

PSP MDL	
Forest type	Hemlock dominated forest along north-facing slopes down to Lake; Yellow birch dominated forest along top of slope (where horse logging occurred)
Dominant Tree Species	He8By1
Regeneration Species	He8Be2
Disturbance type	PSP horse-logged in 2006; total of 4 trees cut from growth plots
FEC classification	ES 30.2 (He-By; fresh to moist)
Basal area	41.8 m^2/ha
Canopy height	24.7 m
Mean DBH	19.8 cm
Location	North side of East Rd. (mile marker 2.4), close to shore of MacDonald Lake.

PSP NT

Site Description

PSP NT represents a late-successional hemlock forest on well-drained, loamy sand. The plot is on a south-facing slope on the north side of MacDonald Lake, and is accessed from the Normac trail (Figure 117). There has been no harvesting in this plot in recent times.

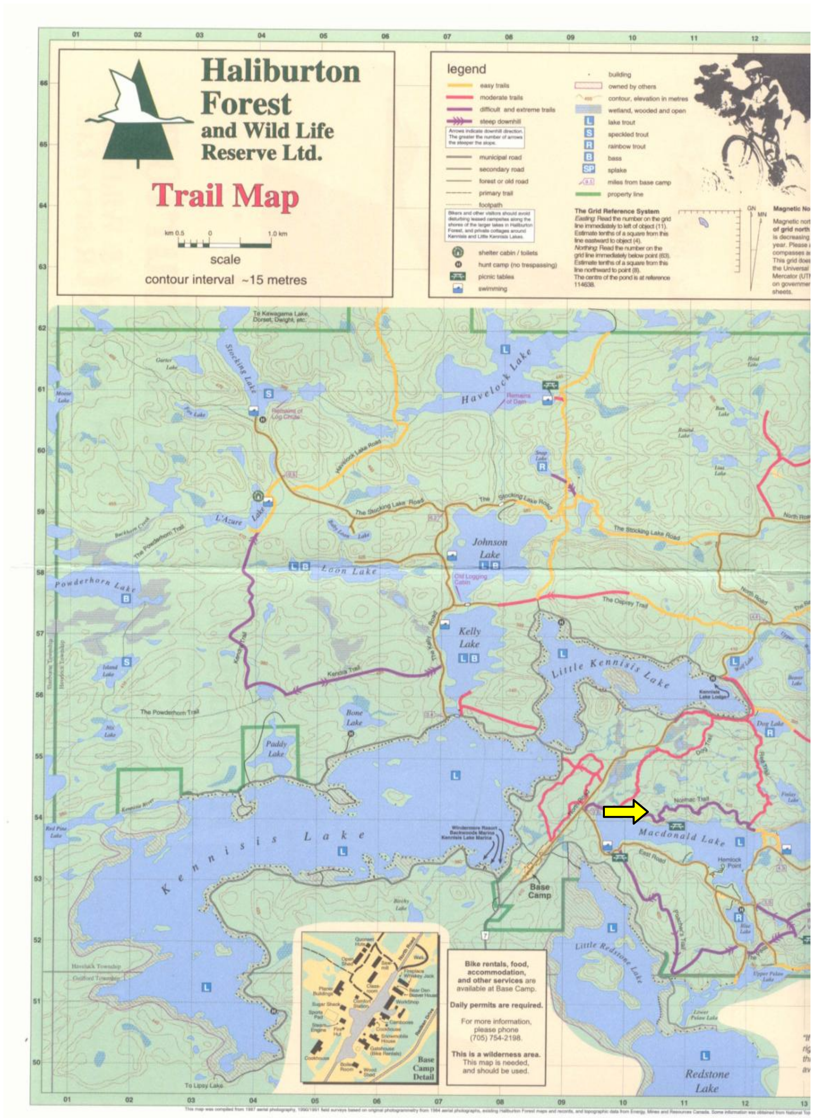

Figure 117: Map of Haliburton Forest with arrow showing location of PSP NT.

Basal area declined from 51.2 m^2/ha (1999) to 47.8 m^2/ha (2009) (Figure 118). Most of this decline was in growth plot 3, in which a single large diameter hemlock (68 cm DBH) blew down, knocking a few other trees down (Figure 119). Hemlock accounted for the majority of basal area (80%), followed by white birch (10%) and sugar maple (5.5%). Red oak, red maple and yellow birch were also present. Hemlock is maintaining its dominance in this plot, while sugar maple and yellow birch are declining.

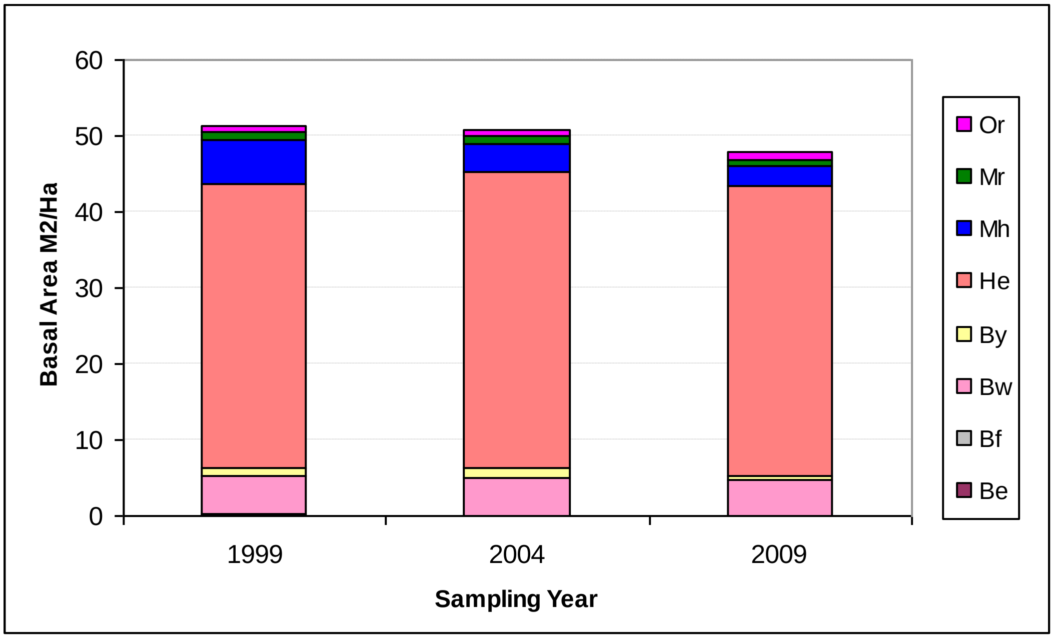

Figure 118: Total basal area/hectare, by species, over 3 sampling years for PSP NT.

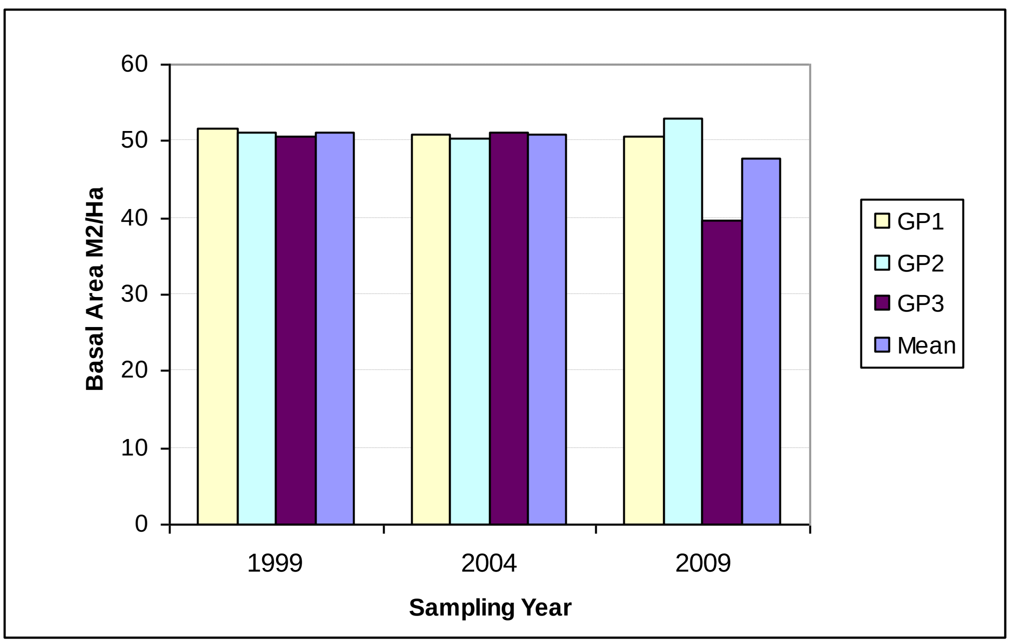

Figure 119: Total basal area/hectare, by growth plot, over 3 sampling years, for PSP NT.

Tree and small sapling abundance

In all sampling years, hemlock made up the majority of stems (88% in 2009) (Figure 120). White birch and sugar maple comprise most of the remainder (8%). Total stem count increased slightly since 1999, from 1,100/ha in 1999 to 1,158/ha in 2009.

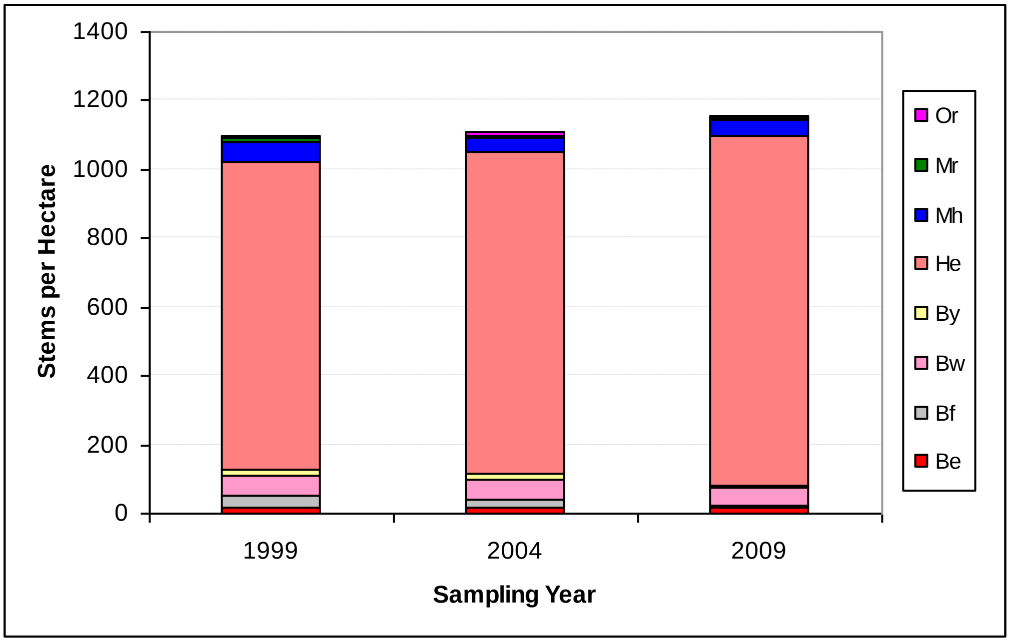

Figure 120: Number of stems/hectare, by species, over 3 sampling years for PSP NT.

Sapling abundance has fluctuated in the 9 shrub plots. Between 1999 and 2004, the total number of saplings increased from 24 to 40, then dropped to 16 in 2009 (Figure 121). In 2009, hemlock made up the majority of saplings (81%), followed by balsam fir (12.5%) and yellow birch (6.3%). The total number of hemlock saplings fell from 37 to 13 between 2004 and 2009. This decline happened in all 3 growth plots. It is unclear what caused this decline, though the high basal area and heavy shade of the hemlock overstorey may be a contributing factor.

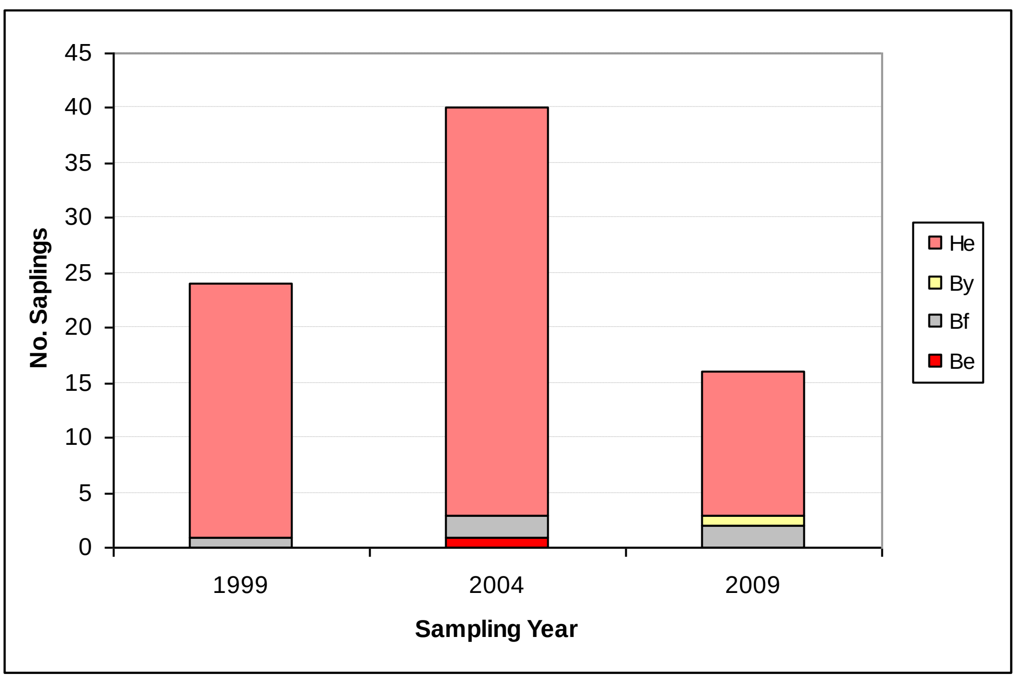

Figure 121: Sapling abundance, by species, over 3 sampling years for PSP NT.

Size class distribution

In 2009, basal area distribution in this PSP plot was 9-17-18-4. Most of the basal area in this plot was in the small (17 m^2/ha) and medium (18.4 m^2/ha) sized trees (Figure 122). A very high proportion of basal area is AGS (93%). All the medium and large sawlog-sized trees were AGS.

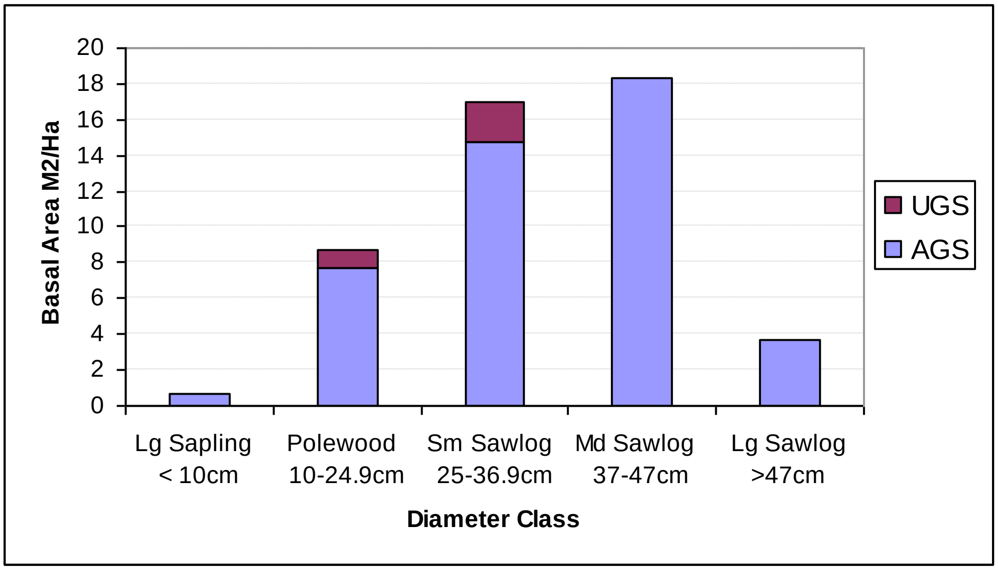

Figure 122: Basal area by size class and quality for PSP NT (2009 data).

Polewood-sized trees account for the majority of stems (325), followed by small-sized trees (217), medium-sized trees (150), and large-sized trees (17) (Figure 123). Recruitment of healthy polewood-sized trees is strong, even with basal areas in the 50 m^2/ha range. There are relatively few UGS trees overall (67 out of 708 stems/ha). Mean stem diameter is relatively high (23 cm).

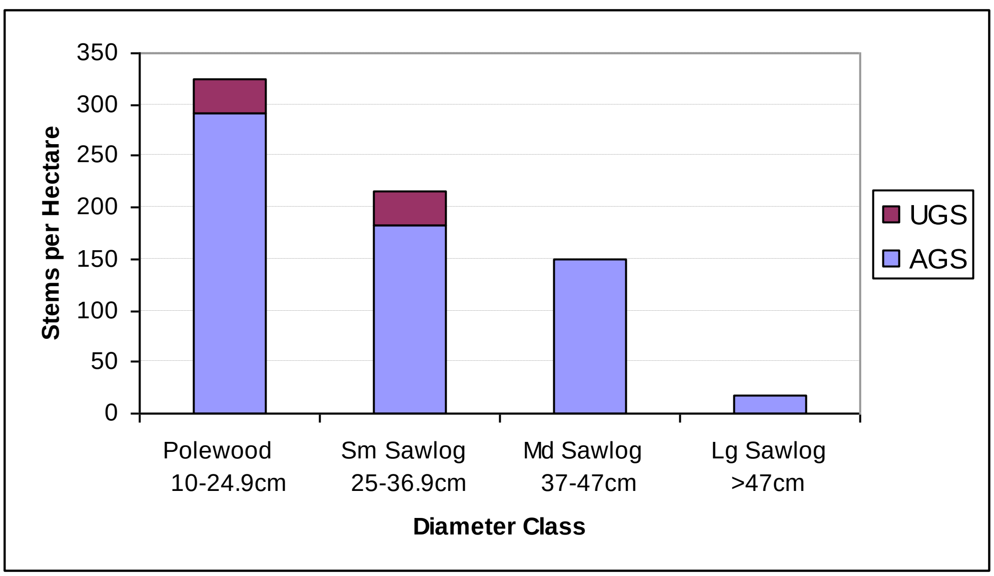

Figure 123: Tree abundance by size class and quality for PSP NT (2009 data).

Table 18: Summary of PSP NT results

PSP NT	
Forest type	Hemlock dominated forest on south-facing slope down to MacDonald Lake
Dominant Tree Species	He8Bw1
Regeneration Species	He8Bf1By1
Disturbance type	Gap disturbance
FEC classification	ES 30.2 (He-By; fresh to moist)
Basal area	47.8 m^2/ha
Canopy height	26 m
Mean DBH	23 cm
Location	Between Normac Trail and MacDonald Lake, ~1 km from intersection of North and East roads

PSP RL

Site Description

PSP RL represents a mid-successional mixedwood stand dominated by poplar, fir, white birch and spruce, with some remnant white pine. It is located mid slope, with a southern exposure, about 1 km ESE of Rainbow Lake (Figure 124). The stand was initiated after a major disturbance, such as heavy cutting or windstorm.

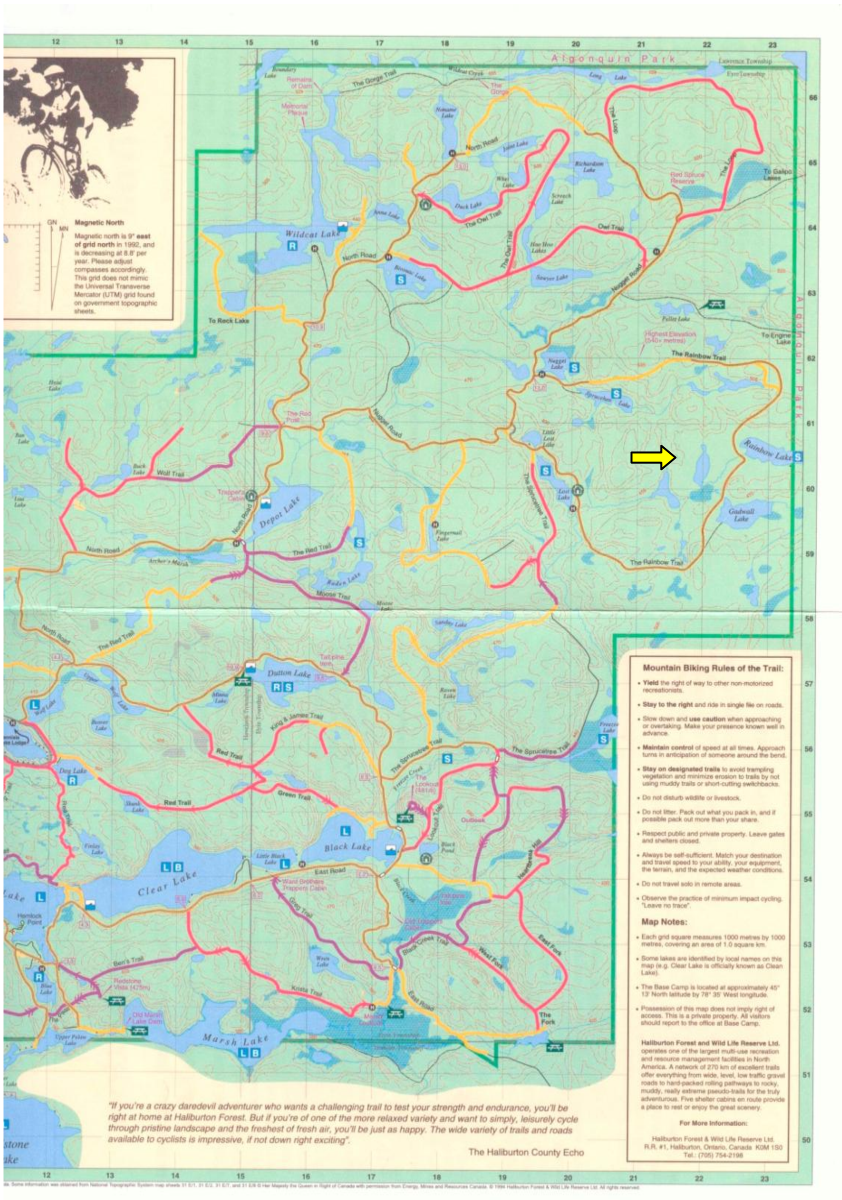

Figure 124: Haliburton Forest map with arrow showing location of PSP RL.

In 2005, early successional species like poplar (25%), balsam fir (18%), white spruce (15%), white birch (14%) and red maple (6%) dominated PSP RL. There were also a few mid- to late-successional species, including white pine (14%) and sugar maple (7%) (Figure 125). Basal area varied little between sampling years – 32.6 m^2/ha in 1999, and 32.7 m^2/ha in 2005. Basal area in growth plot 1 is lower than for the other 2 growth plots: 26.6 m^2/ha in 2005, compared to 36.2 m^2/ha in growth plot 2 and 34.9 m^2/ha in growth plot 3 (Figure 126).

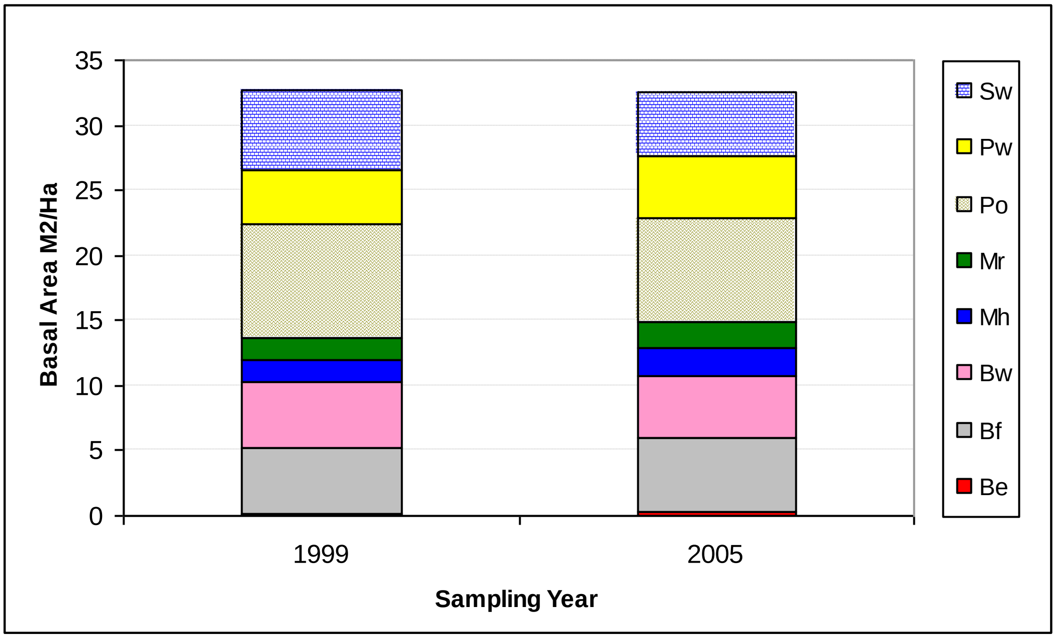

Figure 125: Total basal area/hectare, by species, over 2 sampling years for PSP RL.

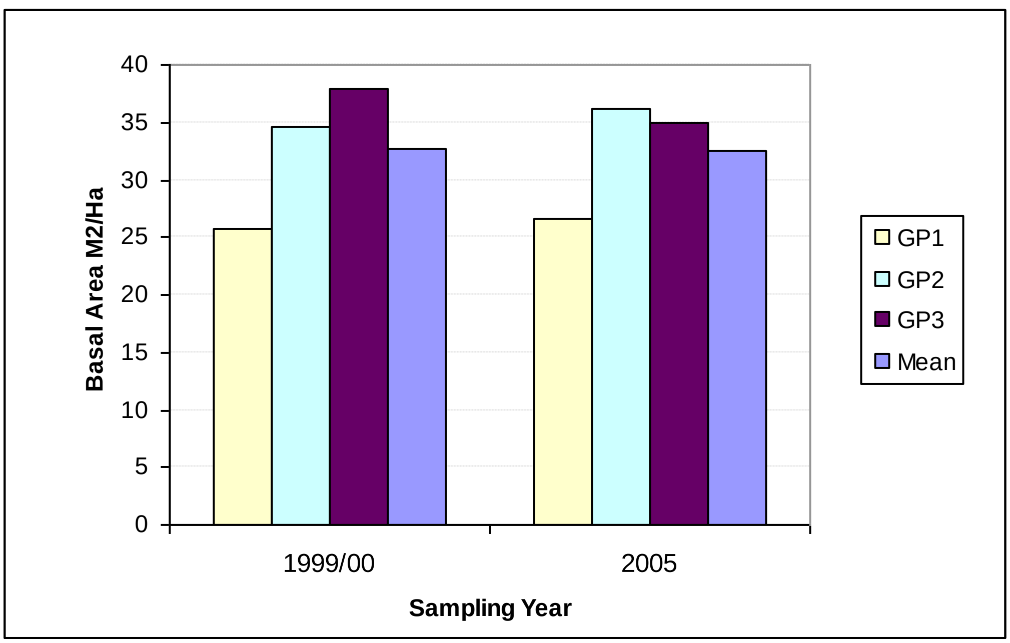

Figure 126: Total basal area/ha, by growth plot, over 2 sampling years, for PSP RL.

Tree and small sapling abundance

In 2005, balsam fir, sugar and red maple comprised the majority of stems (86%), followed by white birch (4.5%), white spruce (3.9%), poplar (2.4%) and beech (2.1%) (Figure 127). Between 1999 and 2005, total stem count decreased from 3,217/ha to 2,758/ha. Most of this decline can be attributed to balsam fir.

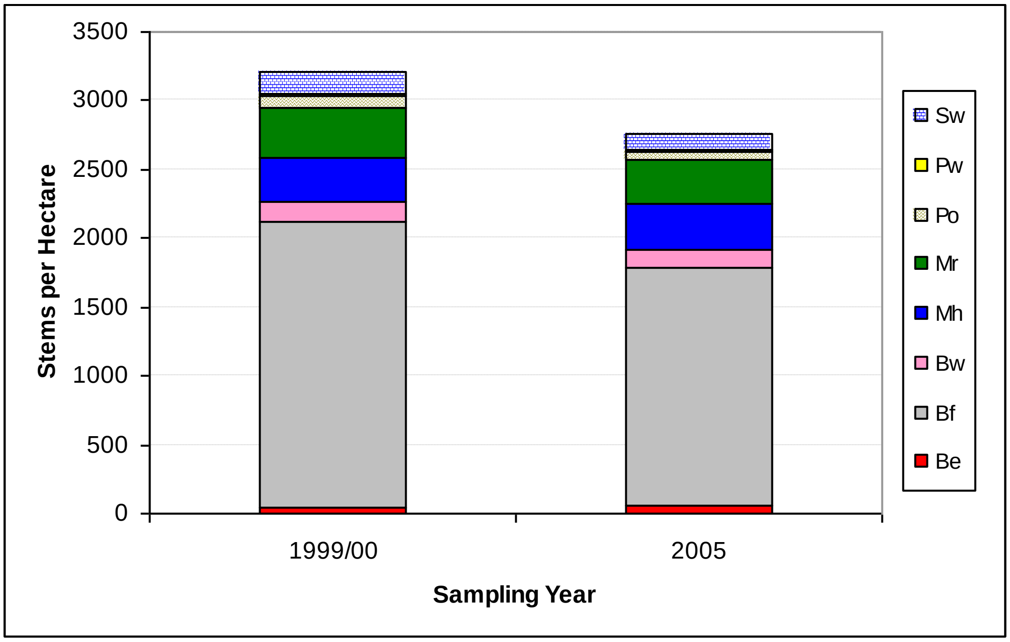

Figure 127: Number of stems/hectare, by species, over 2 sampling years for PSP RL.

Sapling abundance also declined between sampling years - from 51 in 1999 to 28 in 2005 (Figure 128). Balsam fir and red maple accounted for most of this decline. It is very likely that many of these small saplings (>1.3 m high and < 2.5 cm DBH) became "large saplings".

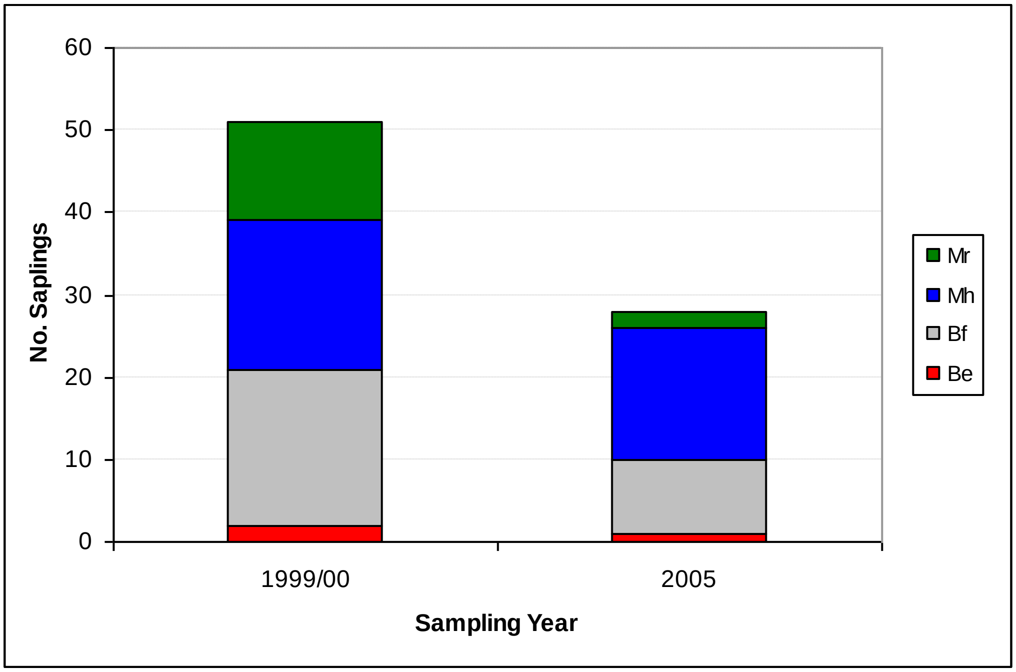

Figure 128: Sapling abundance, by species, over 2 sampling years for PSP RL.

Size class distribution

In 2005, basal area distribution in this plot was 7-10-2-8. It was distributed fairly evenly across all size classes, with the exception of medium-sized trees (Figure 129). Large saplings also had an unusually high basal area of 5.3 m^2/ha. Overall, 42% (13.8 m^2/ha) of basal area was AGS. All the medium-sized trees were UGS, as well as most of the saplings.

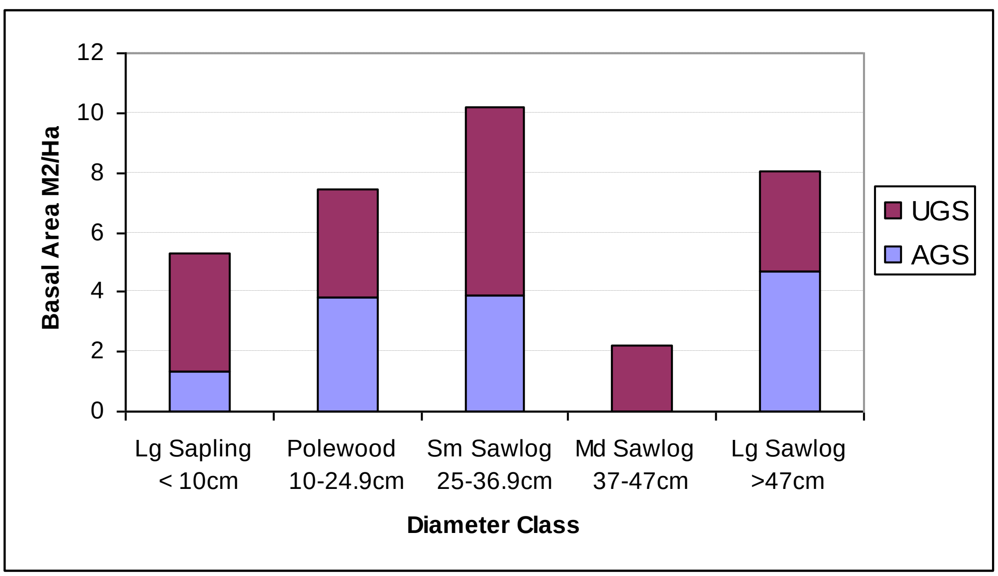

Figure 129: Basal area by size class and quality for PSP RL (2005 data).

Polewood-sized trees accounted for the majority of stems (367), followed by small sawlog-sized trees (150), large-sized trees (33) and medium-sized trees (17) (Figure 130). Recruitment of polewood stems was strong, though 54% were UGS. Mean stem diameter is quite low (12.3cm), and is a consequence of the high abundance of large saplings in this plot (2,175/ha).

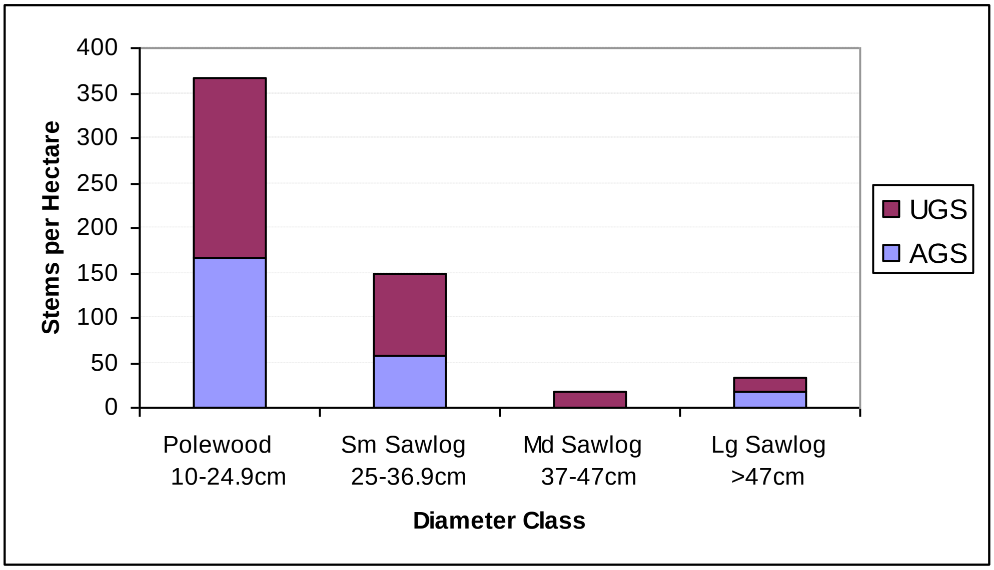

Figure 130: Tree abundance by size class and quality for PSP RL (2005 data).

Table 19: Summary of PSP RL results

PSP RL	
Forest type	Mid-successional stand dominated by poplar, fir, white birch and spruce, some remnant white pine; mid slope, southern exposure
Dominant Tree Species	Po2Bf2Sw2Pw1Bw1MX1
Regeneration Species	Mh6Bf3Mr1
Disturbance type	Stand originated after a large-scale disturbance
FEC classification	ES 18.1 (Po-Bw-Sw-Bf; dry to moderately fresh)
Basal area	32.6 m^2/ha
Canopy height	18.9 m
Mean DBH	12.3 cm
Location	~ 1 km WSW of Rainbow Lake

PSP RSR

Site Description

PSP RSR represents a late-successional red spruce stand, which is a fairly rare forest community type in eastern Ontario. The plot is level, poorly-drained, and next to a forest swamp with standing water. It is in the red spruce reserve (one of 21 forest reserves in Haliburton Forest and Wildlife Reserve), and is off limits to harvesting. The red spruce reserve is located in the northeast corner of the property, 1.5 km east of Richardson Lake, off The Loop (Figure 131).

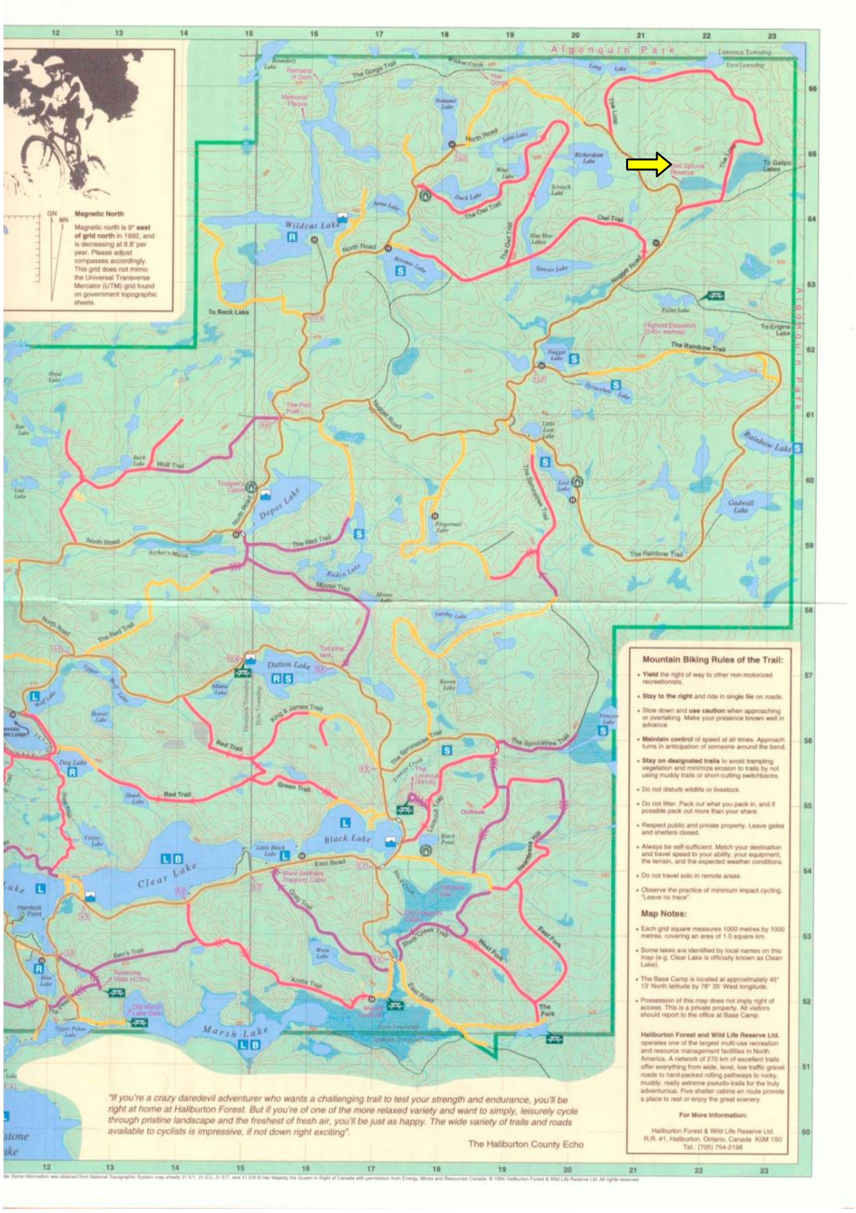

Figure 131: Haliburton Forest map with arrow showing location of PSP RSR.

Basal area declined from 47.3 m^2/ha (1999) to 41.9 m^2/ha (2009) (Figure 132). Most of the basal area was red spruce (85%), followed by balsam fir (9.4%), red maple (2.8%), and cedar (2.7%). This stand is going through a thinning phase, with very high numbers of large saplings and polewood-sized trees dying in all 3 growth plots (Figure 133).

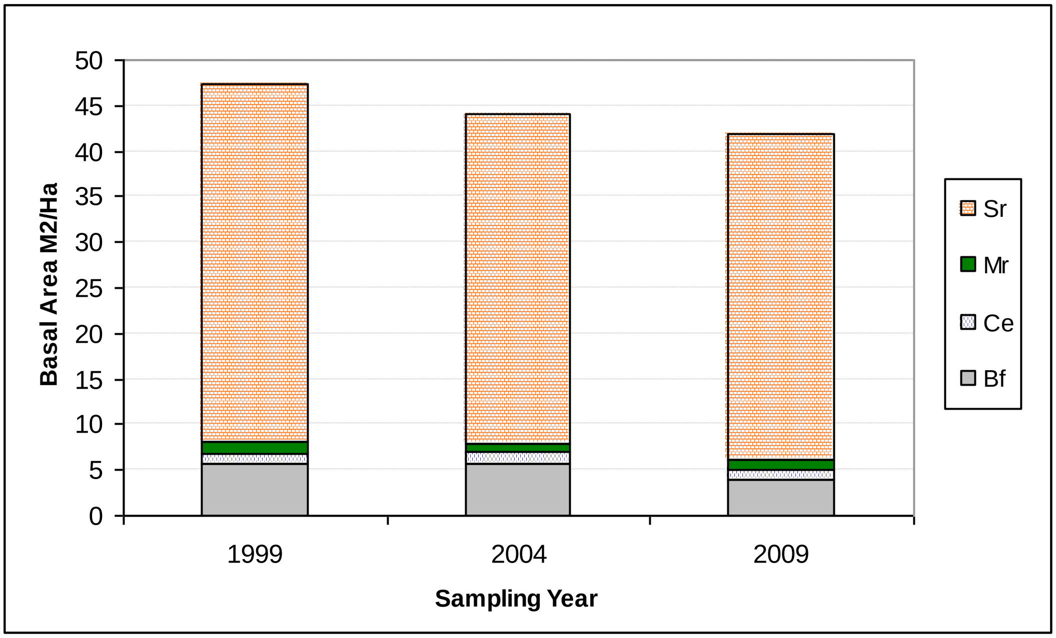

Figure 132: Total basal area/hectare, by species, over 3 sampling years for PSP RSR.

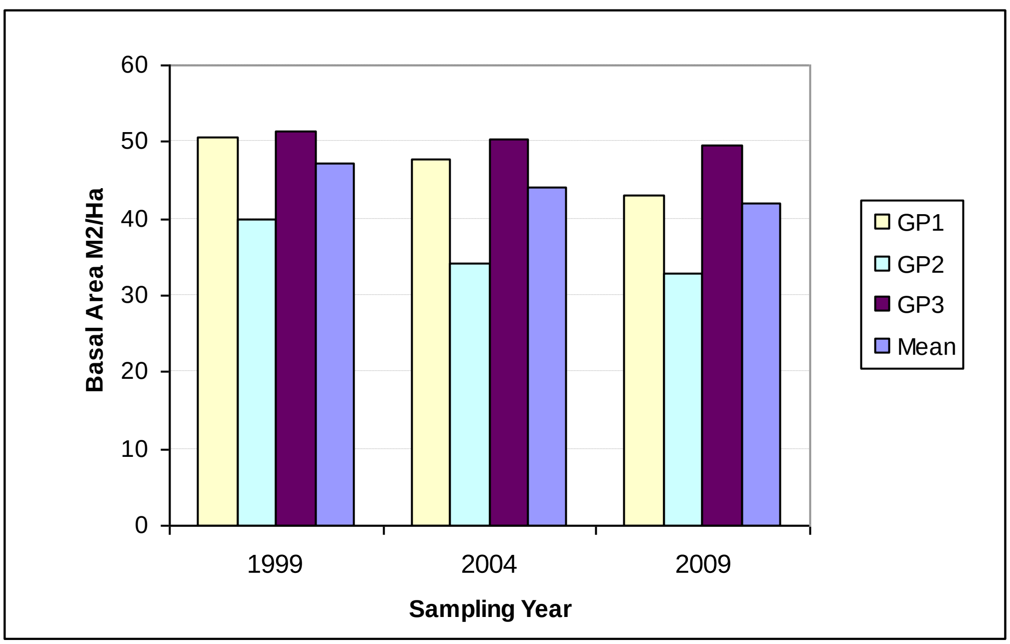

Figure 133: Total basal area/hectare, by growth plot, over 3 sampling years, for PSP RSR.

Tree and small sapling abundance

In all sampling years, red spruce made up the majority of stems (66% in 2009), followed by balsam fir (31%) (Figure 134). In 1999, total stem count was very high (3,700/ha), decreasing dramatically to 1,550/ha in 2009. As noted above, this stand is going through a thinning phase, with many of the large sapling-sized trees that were alive in 1999 now dead.

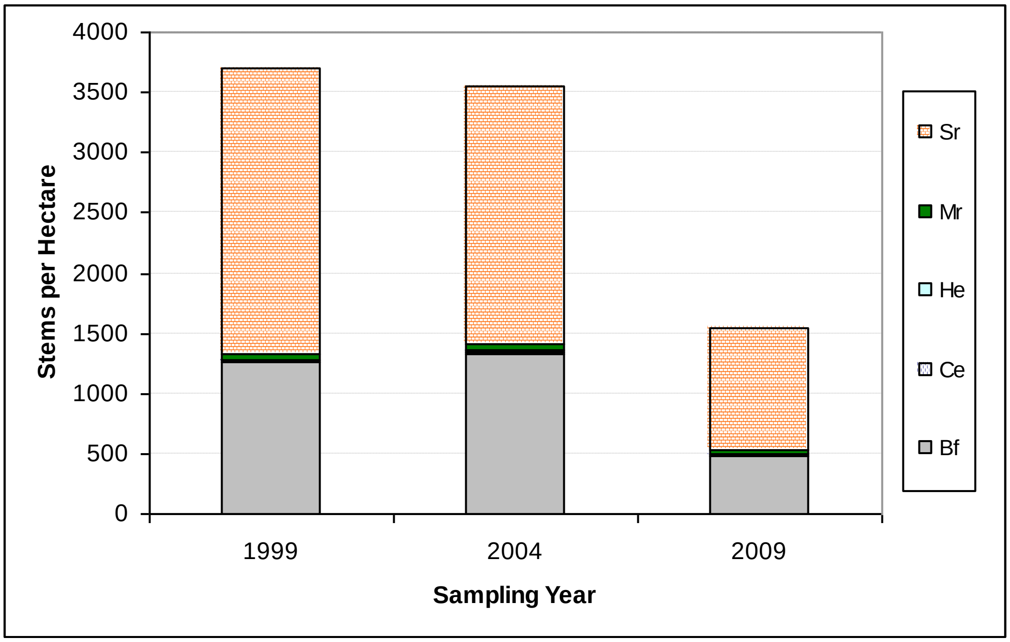

Figure 134: Number of stems/hectare, by species, over 3 sampling years for PSP RSR.

Sapling abundance is extremely low in this plot. A total of 3 saplings in 9 shrub plots were counted in 1999 (Figure 135). No saplings were found in 2009. Sapling abundance would have been extremely high in this plot 20 years ago. Now that the plot is crowded with young stems 2.5-10 cm DBH, competition for sunlight is fierce, and there is little room for new growth.

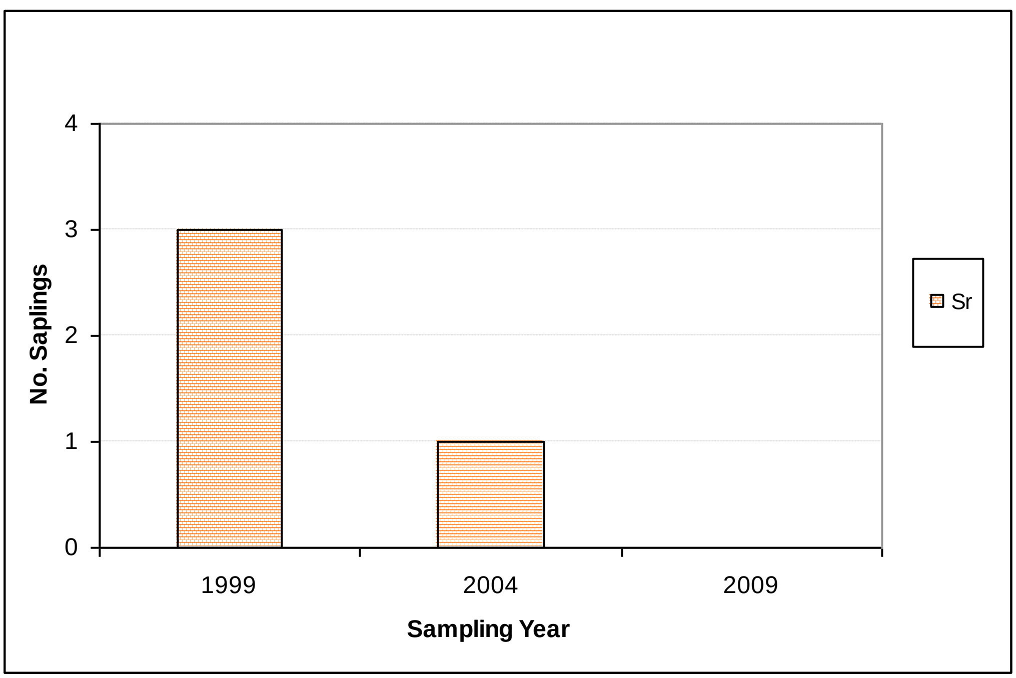

Figure 135: Sapling abundance, by species, over 3 sampling years for PSP RSR.

Size class distribution

In 2009, basal area distribution for this plot was 12-11-12-5. Polewood, small- and medium-sized trees account for the majority of basal area in this plot (35.2 m^2/ha out of a total of 42.4 m^2/ha in 2009) (Figure 136). Large sawlogs account for a relatively low proportion of basal area – likely because long-lived, shade-grown red spruce do not often have as large a girth as other species (like hemlock and maple). Overall, a high proportion of basal area is AGS (88%), and is well distributed across size classes.

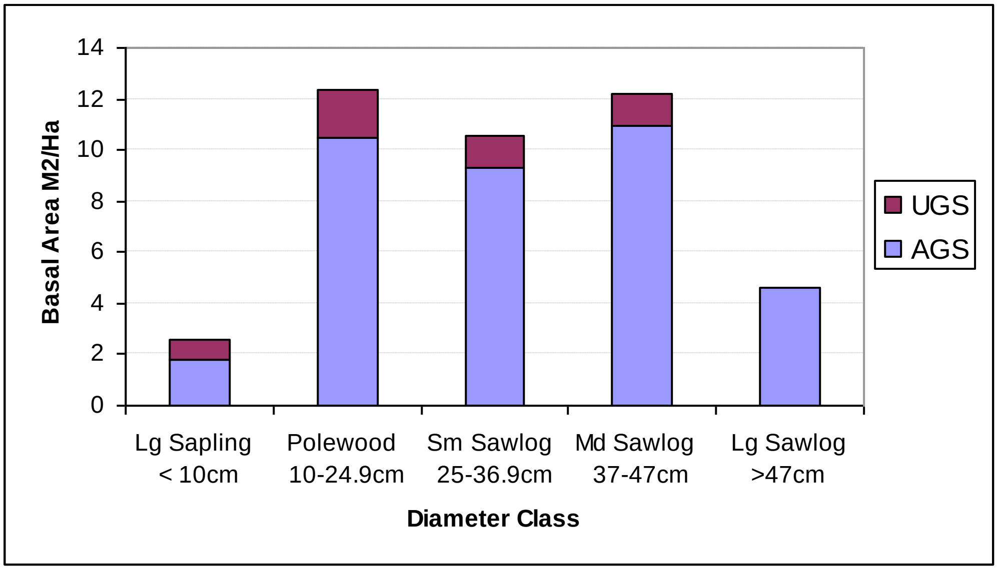

Figure 136: Basal area by size class and quality for PSP RSR (2009 data).

Polewood-sized trees account for the majority of stems (658), followed by small-sized trees (142), medium-sized trees (83), and large-sized trees (25) (Figure 137). Recruitment of healthy polewood-sized trees is very strong, with relatively few UGS trees overall (133 out of 908 stems/ha). Mean stem diameter was quite high (18.5 cm) considering the abundance of polewood-sized stems. This is because there were relatively few large saplings compared to most PSPs.

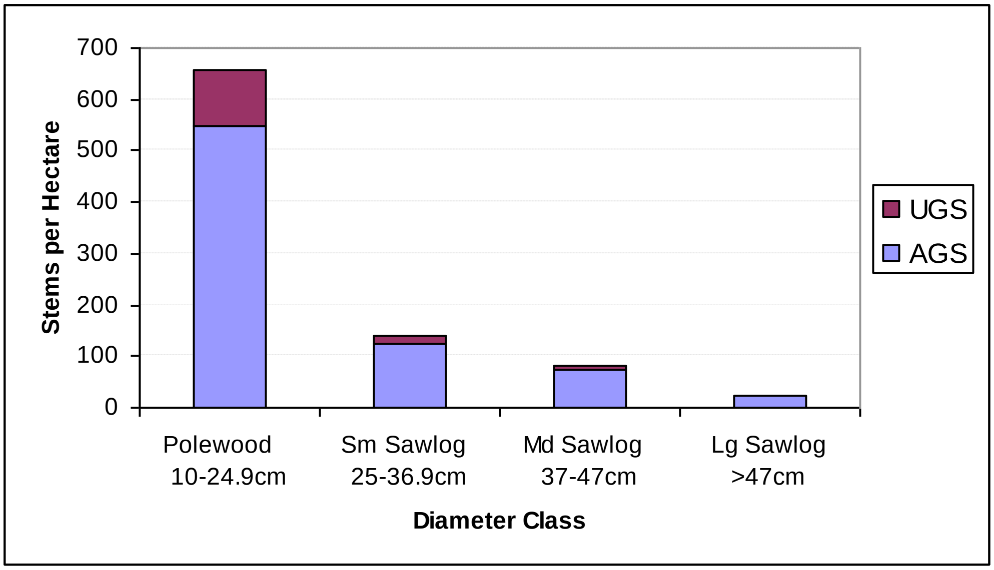

Figure 137: Tree abundance by size class and quality for PSP RSR (2009 data).

Table 20: Summary of PSP RSR results

PSP RSR	
Forest type	Red spruce dominated, level terrain, moist; many live and dead saplings (1.3-10 cm DBH) and polewood
Dominant Tree Species	Sr9Bf1
Regeneration Species	None
Disturbance type	Gap disturbance
FEC classification	No Eco-site describes stands dominated by Red spruce
Basal area	41.9 m^2/ha
Canopy height	23.25 m
Mean DBH	18.5 cm
Location	In Red Spruce Reserve, ~ 1km east of Richardson Lake

PSP RT

Site Description

PSP RT represents a dry, oak and white ash dominated forest on a southerly exposed rocky ridge overlooking MacDonald Lake. The shallow sandy loam soils on bedrock are rapidly drained and moderately fresh. The plot is located above the east end of MacDonald Lake, a short distance east of the Red Trail (Figure 138).

Both dominant species in this plot are of intermediate shade tolerance, and tend to tolerate drier sites. Sugar maple is present, but displays low vigour. Oak and white ash, on the other hand, are growing well in the dry, sunny conditions. Ironwood has unusually high prominence on this site, comprising the majority of stems. Fire has likely played a significant role in the development of this stand.

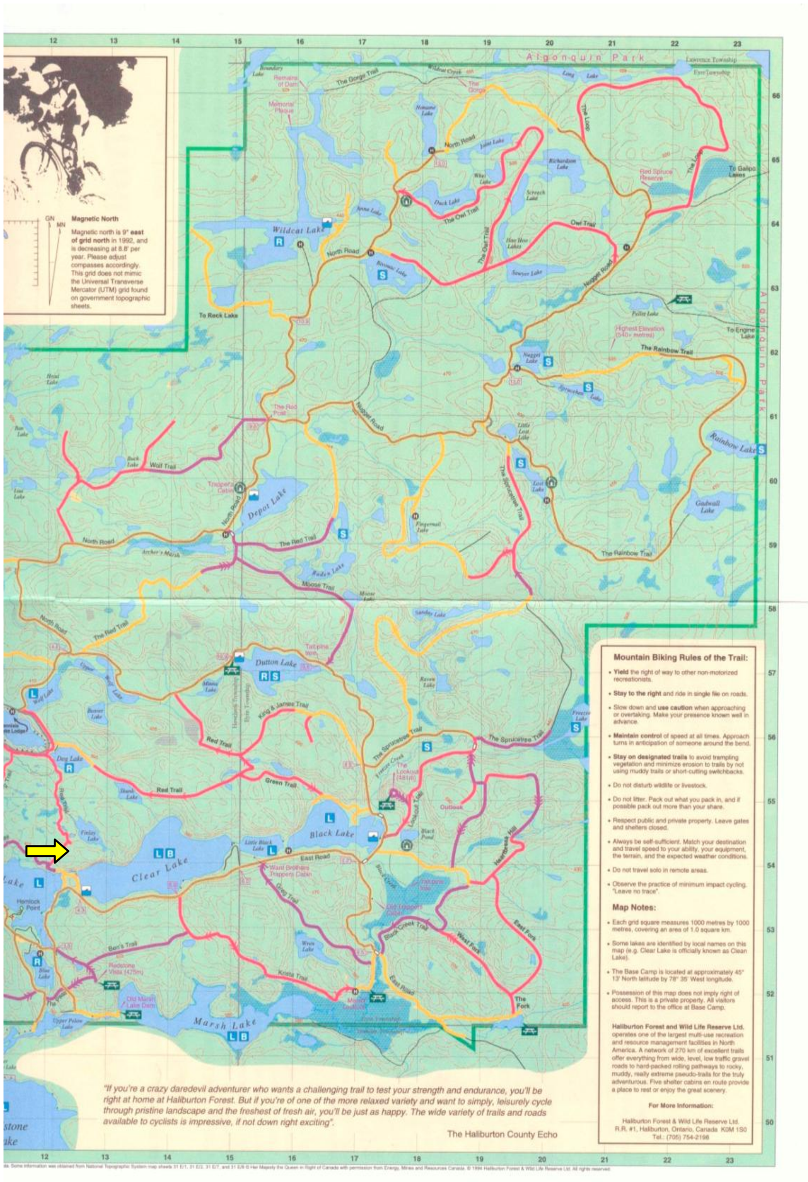

Figure 138: Haliburton Forest map with arrow showing location of PSP RT.

Given its exposure, and thin soils, PSP RT is not a productive site. Basal area has changed little over the last 10 years, from a low of 27.1 to a high of 27.9 m^2/ha (Figure 139). In 2009, PSP RT was dominated by red oak (44.5%), white ash (26.4%), ironwood (11.7%) and sugar maple (7.7%). Basswood and hemlock comprised lesser components. Basal area in the individual growth plots changed little over the 3 sampling years (Figure 140).

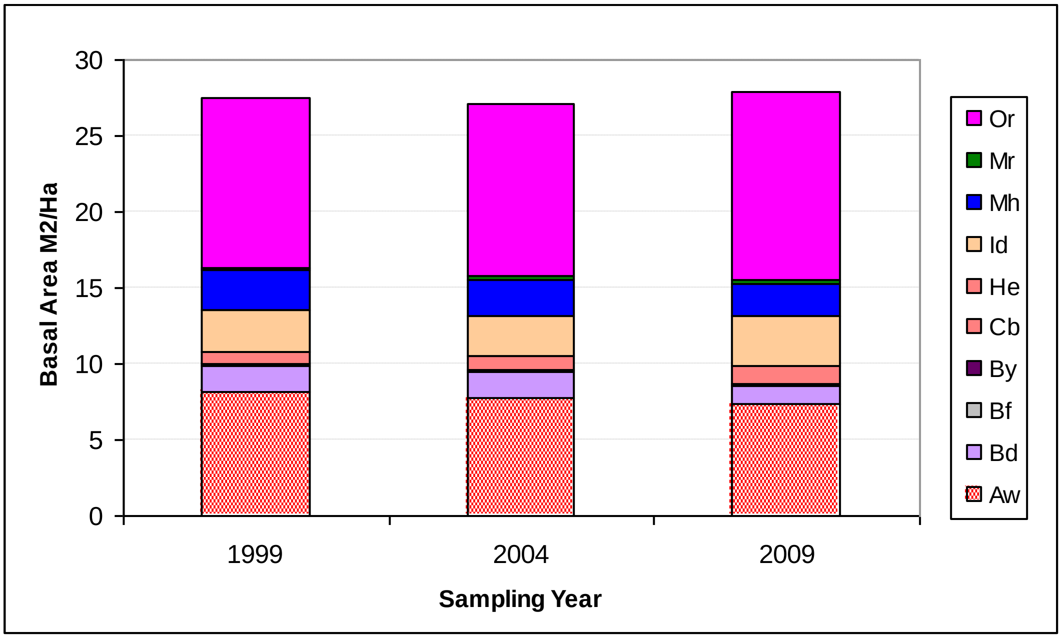

Figure 139: Total basal area/hectare, by species, over 3 sampling years for PSP RT.

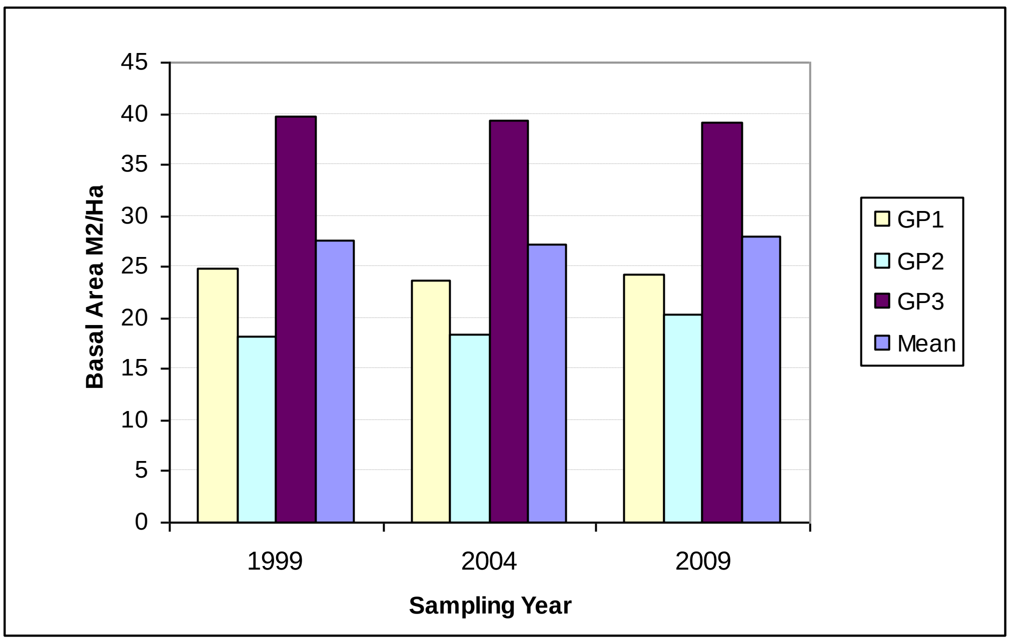

Figure 140: Total basal area/ha, by growth plot, over 3 sampling years, for PSP RT.

Tree and small sapling abundance

The total number of trees increased from 1,325/ha to 1,400/ha between 1999 and 2009. Despite dominance of the overstorey by red oak and white ash, ironwood was the most common tree species in this plot (642/ha), followed by white ash (217 per hectare), red oak (175) and basswood (142) (Figure 141). Tree species diversity in this plot is relatively high, with a total of 10 species recorded.

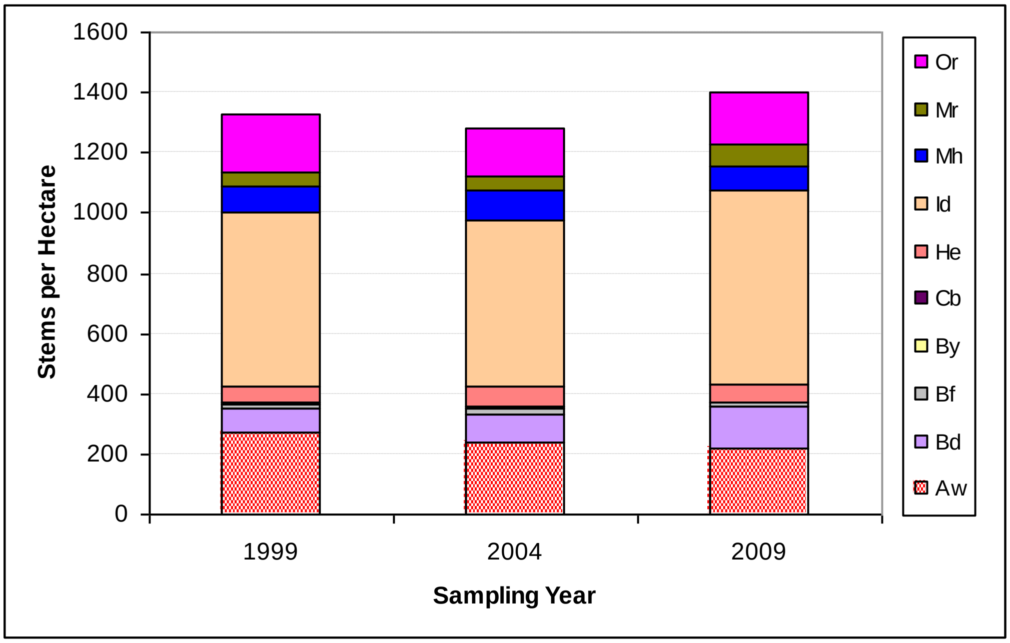

Figure 141: Number of stems/hectare, by species, over 3 sampling years for PSP RT.

There have been moderate changes in sapling abundance over the 3 sampling years. Total abundance has decreased from 42 in 1999 to 35 in 2009 (Figure 142). Ironwood and sugar maple have been the most common sapling species throughout. Poplar and red spruce were present in 1999, yet no longer present in 2004. Red maple, black cherry and white ash were new in the plot in 2004.

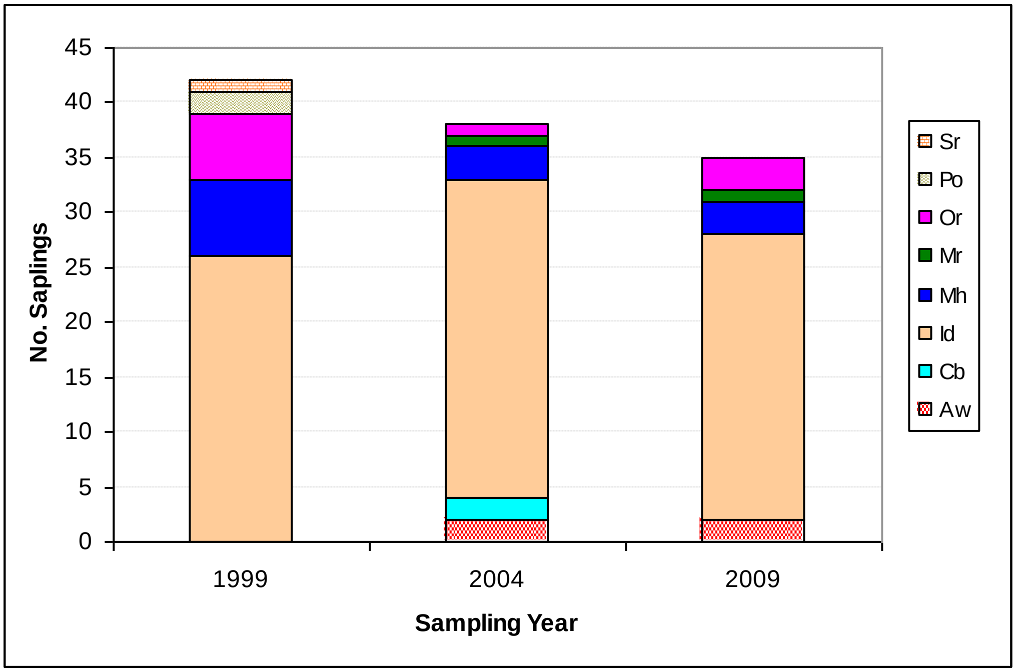

Figure 142: Sapling abundance, by species, over 3 sampling years for PSP RT.

Size class distribution

Polewood, small-sawlog and large sawlog-sized trees accounted for the majority of basal area in this plot (8.7, 7.1 and 9 m^2/ha) (Figure 143). All the large-sized trees were red oaks. Overall, 67% of basal area was AGS (18.6 m^2/ha), with the bulk of the UGS in the large diameter oaks.

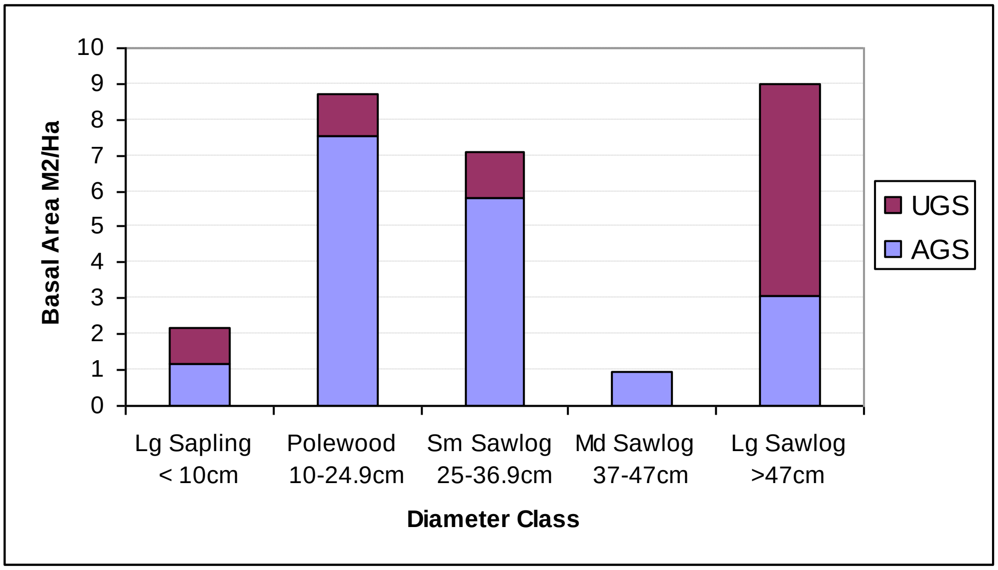

Figure 143: Basal area by size class and quality for PSP RT (2009 data).

Stem diameter distribution was 442-100-8-42 (Figure 144). Relatively low numbers of the polewood- and small sawlog-sized trees were UGS. Three of the 5 large-sized oaks in the plot were UGS. Mean stem diameter was fairly average for this site (15.9 cm).

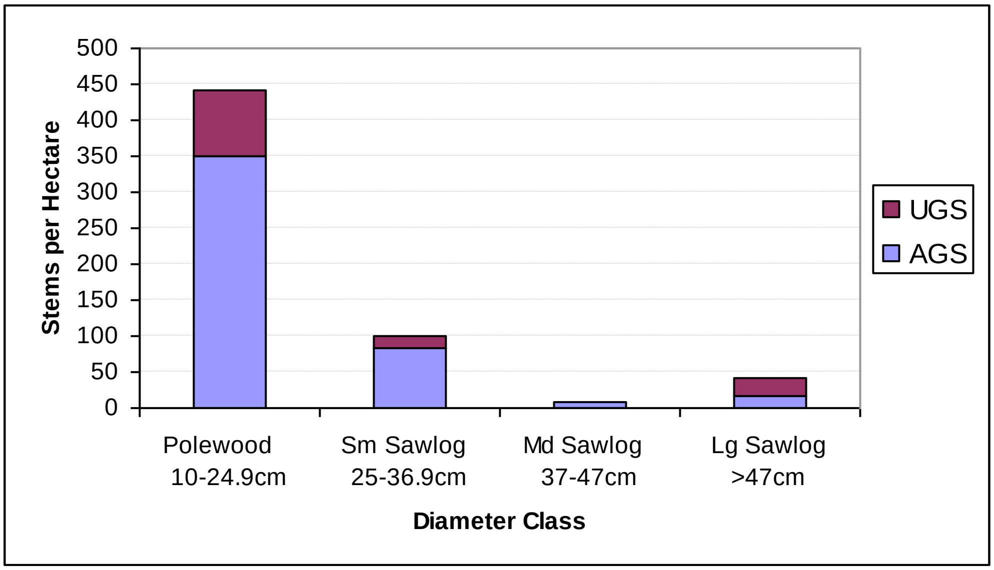

Figure 144: Tree abundance by size class and quality for PSP RT (2009 data).

Table 21: Summary of PSP RT results

PSP RT	
Forest type	Red oak and white ash dominated, upper slope of rocky ridge, southern exposure
Dominant Tree Species	Or4Aw3Iw1Mh1Bd1
Regeneration Species	Iw7Or1Mh1
Disturbance type	Fire or gap disturbance
FEC classification	ES 23.1 (Or-Hd; dry to moderately fresh)
Basal area	29.43 m^2/ha
Canopy height	18.6 m
Mean DBH	15.9cm
Location	~ ¼ km east of Red Trail, overlooking east end of MacDonald Lake

PSP TL1

Site Description

PSP TL1 represents a multi-aged sugar maple dominated hardwood forest on moderately moist, imperfectly drained sandy soils. The site is located on a lower slope with north-western exposure, near the north-eastern corner of the property, and accessed from "The Loop" (Figure 145). Since establishment of this PSP, no trees have been harvested in the growth plots.

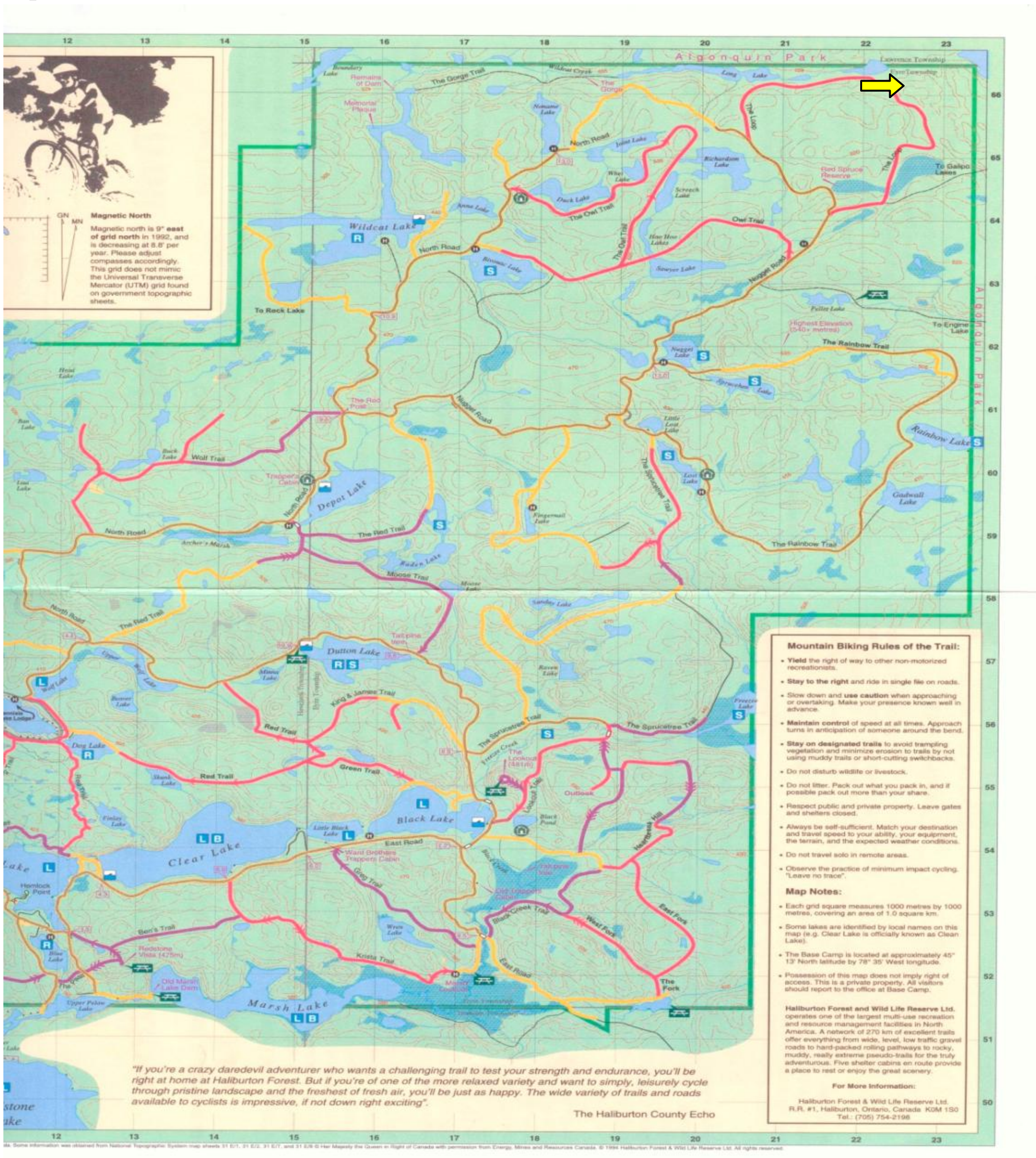

Figure 145: Map of Haliburton Forest with arrow showing location of PSP TL1.

PSP TL1 is a moderately productive sugar maple and yellow birch stand. Basal area increased from 23.4 m^2/ha in 2000, to 25.4 m^2/ha in 2005 – 0.4 m^2/ha/yr (Figure 146), mostly in sugar maple. Modest growth was recorded in all 3 growth plots (Figure 147).

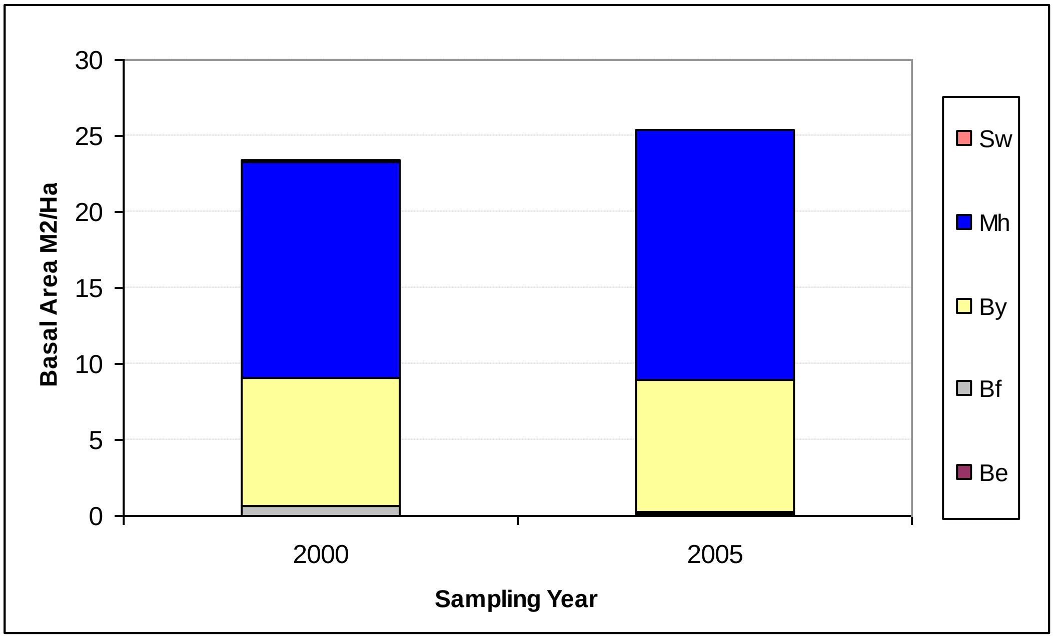

Figure 146: Total basal area/hectare, by species, over 2 sampling years for PSP TL1.

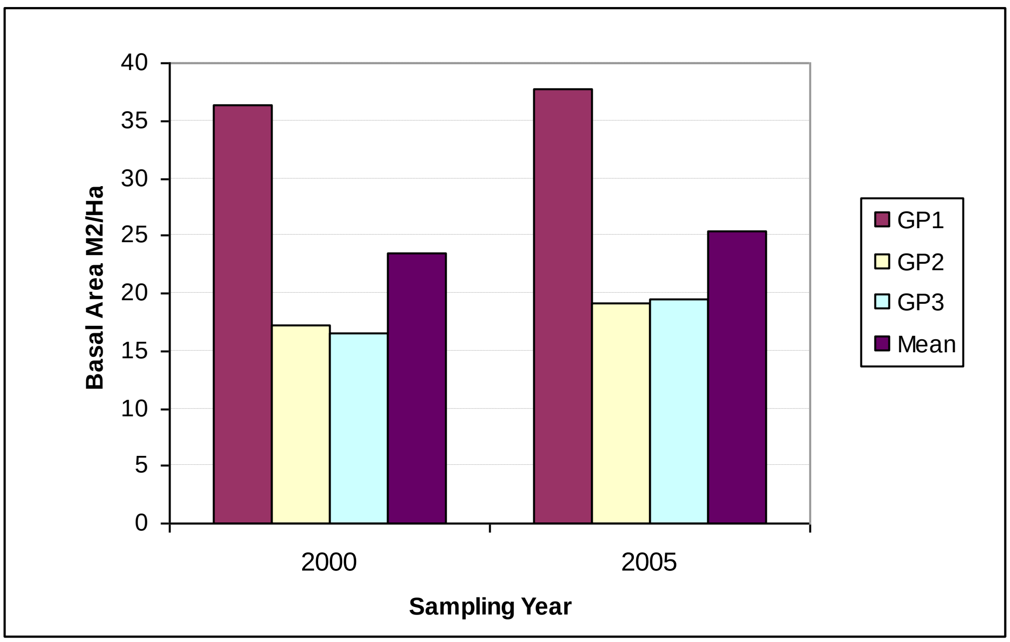

Figure 147: Total basal area/hectare, by growth plot, over 2 sampling years, for PSP TL1.

Tree and small sapling abundance

Total stem count increased from 842/ha to 883/ha between 2000 and 2005 (Figure 148). Sugar maple was the most common tree species in this plot (642), followed by yellow birch (100), beech (50), balsam fir (50) and white spruce (42).

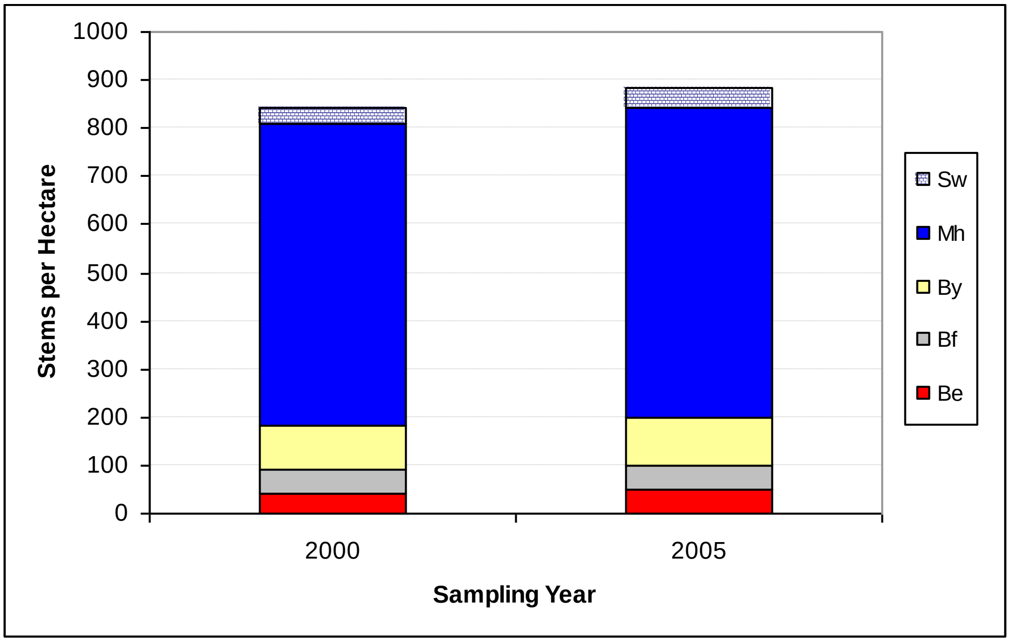

Figure 148: Number of stems/hectare, by species, over 2 sampling years for PSP TL1.

Sugar maple is the most common sapling in both sampling years, with a total of 20 in 2000 and 19 in 2005 (Figure 149). In 2000, there were 5 saplings of yellow birch and 5 of black cherry. These species were no longer present in 2005. Balsam fir, red maple, white spruce and beech comprised 49% of sapling regeneration s in 2005.

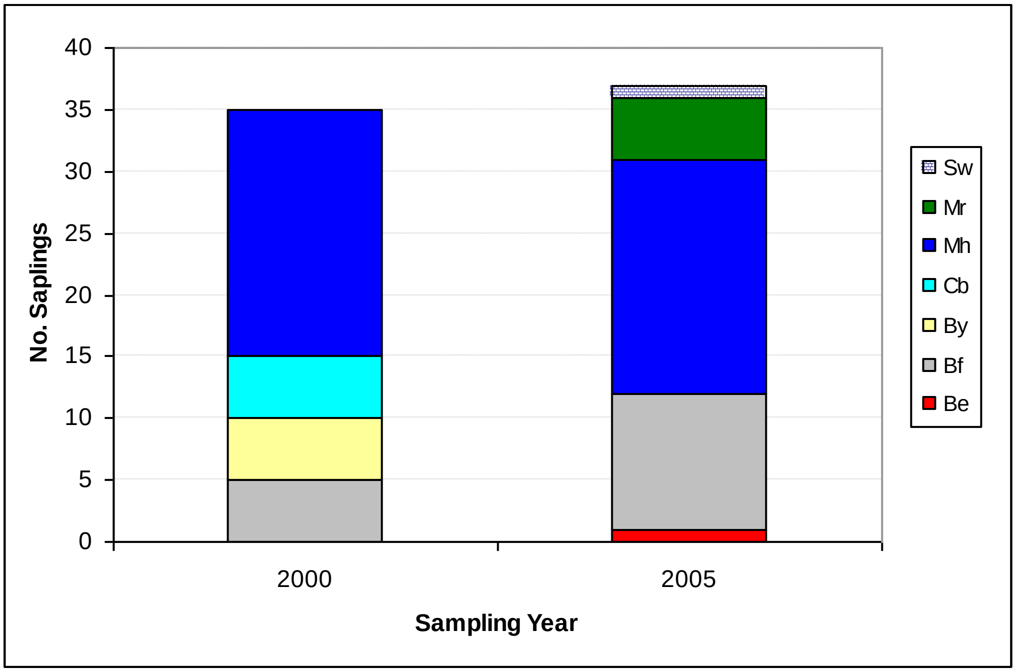

Figure 149: Sapling abundance, by species, over 2 sampling years for PSP TL1.

Size class distribution

Basal area was fairly evenly distributed across all size classes (6-7-5-6 polewood: small sawlog: medium sawlog: large sawlog) (Figure 150). Large saplings accounted for 1 m^2/ha. All the large-sized trees were UGS, with roughly half the polewood, small and medium-sized trees UGS. In 2005, there was 9.4 m^2/ha of AGS in this plot (excluding large saplings).

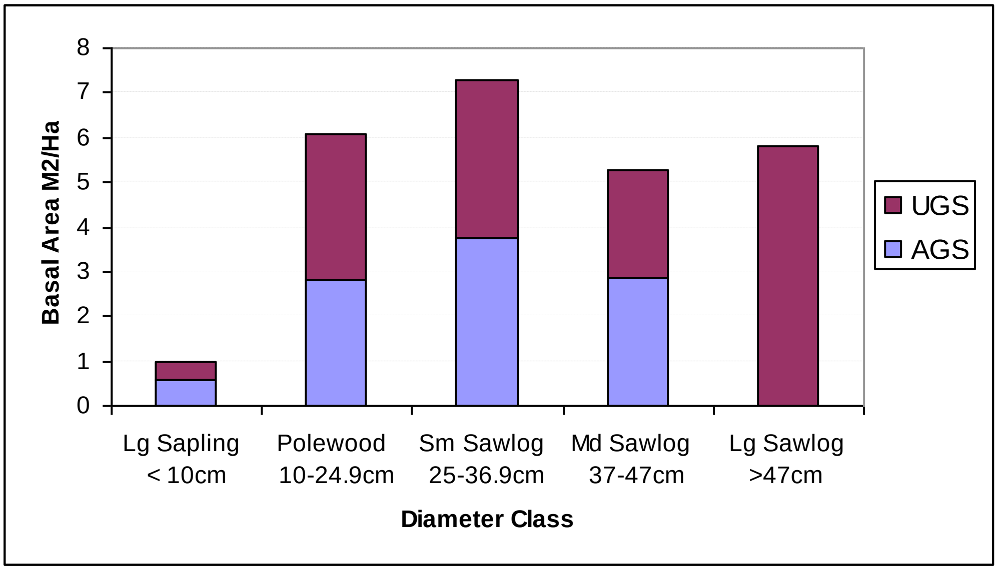

Figure 150: Basal area by size class and quality for PSP TL1 (2005 data).

There were 225 polewood-sized trees per hectare, followed by small (92), medium (42) and large (17) sized trees (Figure 151). This distribution was close to that suggested by OMNR for single tree selection, though the abundance of polewood is lower than suggested (312/ha) to ensure adequate recruitment of larger size classes into the future. 56% of stems were UGS. Mean stem diameter for this plot was 19.15 cm, which is fairly average.

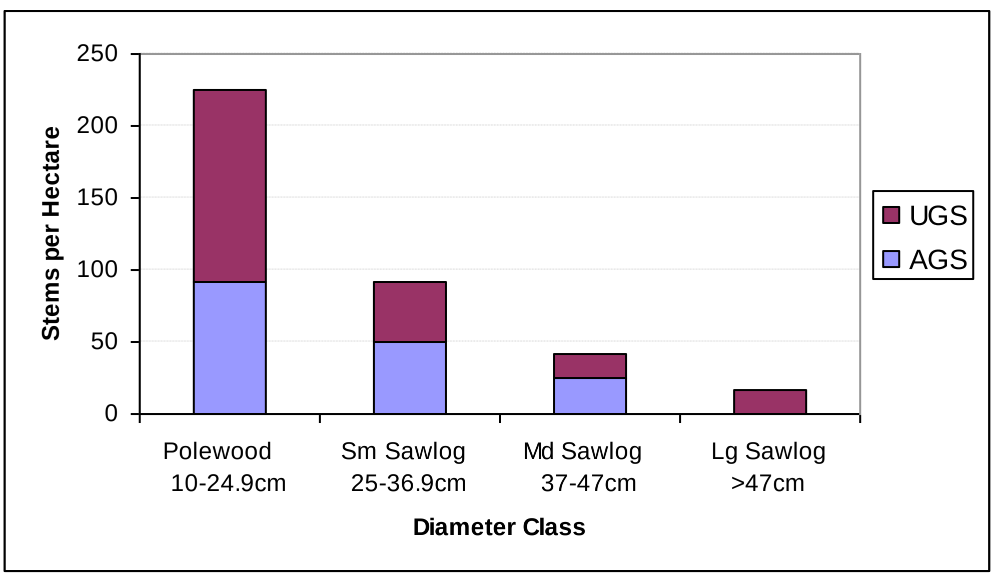

Figure 151: Tree abundance by size class and quality for PSP TL1 (2005 data).

Table 22: Summary of PSP TL1 results

PSP TLI	
Forest type	Hard maple and yellow birch dominated, mid-slope, eastern exposure
Dominant Tree Species	Mh6By3
Regeneration Species	Mh5Bf3Mr1
Disturbance type	Currently, gap disturbance; no cut stems in growth plots
FEC classification	ES 29.2 (Mh-By; fresh to moist)
Basal area	25.43 m^2/ha
Canopy height	18.29 m
Mean DBH	19.15cm
Location	NNE of The Loop, northeast corner of property

PSP TL2

Site Description

PSP TL2 represents a multi-aged sugar maple dominated hardwood forest on fresh, moderately drained sandy loam. The site is located on a lower slope with western exposure, near the north-eastern corner of the property accessed from “The Loop” (Figure 152). Since establishment of this PSP, no trees have been harvested in the growth plots.

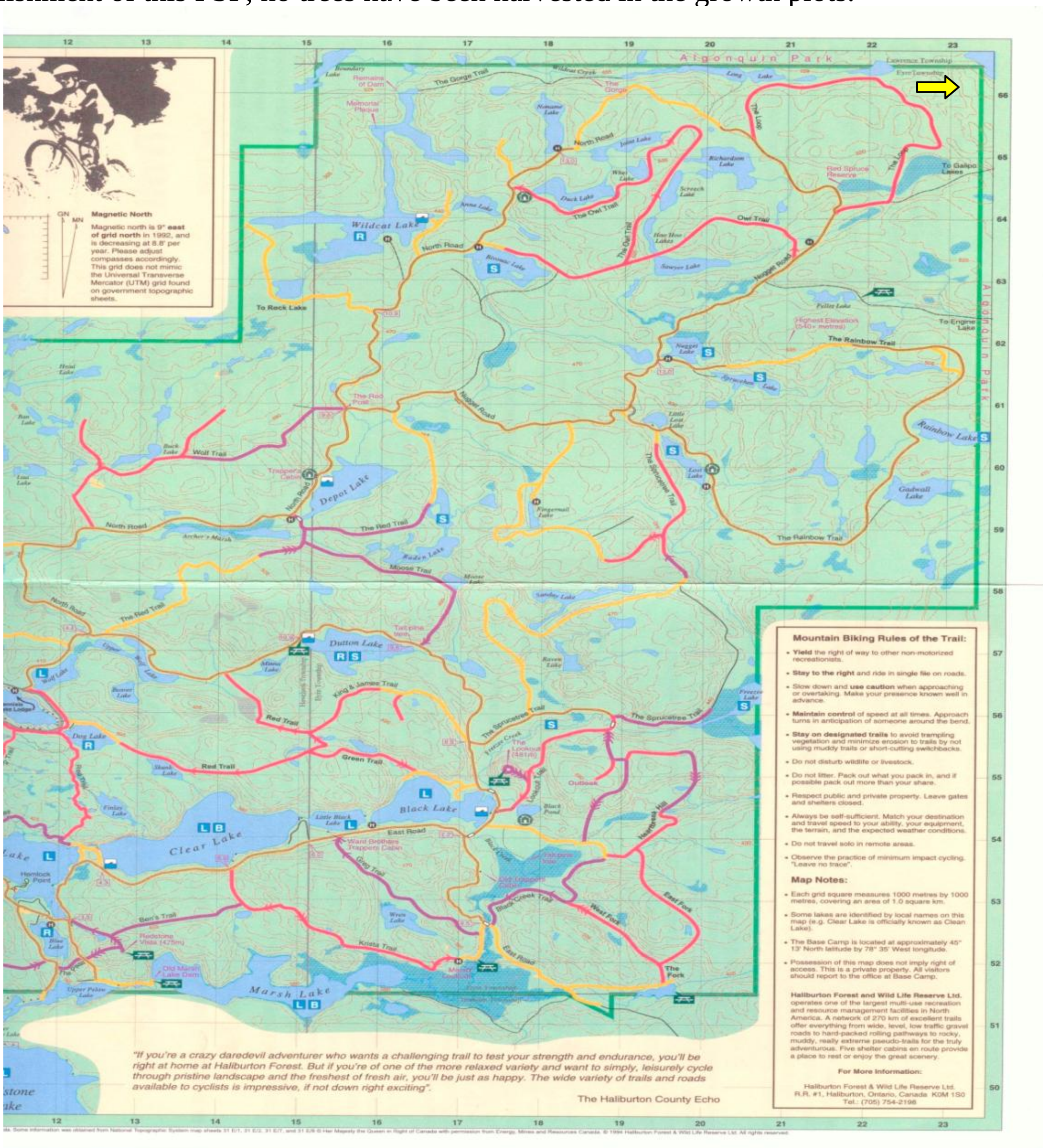

Figure 152: Map of Haliburton Forest with arrow showing location of PSP TL2.

PSP TL1 had a high basal area for a tolerant hardwood stand: 39.9 m^2/ha in 2000, and 35.9 m^2/ha in 2005. Sugar maple was dominant (17.9 m^2/ha), followed by yellow birch (10.6 m^2/ha), beech (4.1 m^2/ha) and hemlock (3.1 m^2/ha). Overall, basal area decreased 0.8

m^2/ha/yr (Figure 153). Declines in basal area occurred in growth plots 1 and 2, in which 6 maples of varying sizes died between sampling years (Figure 154).

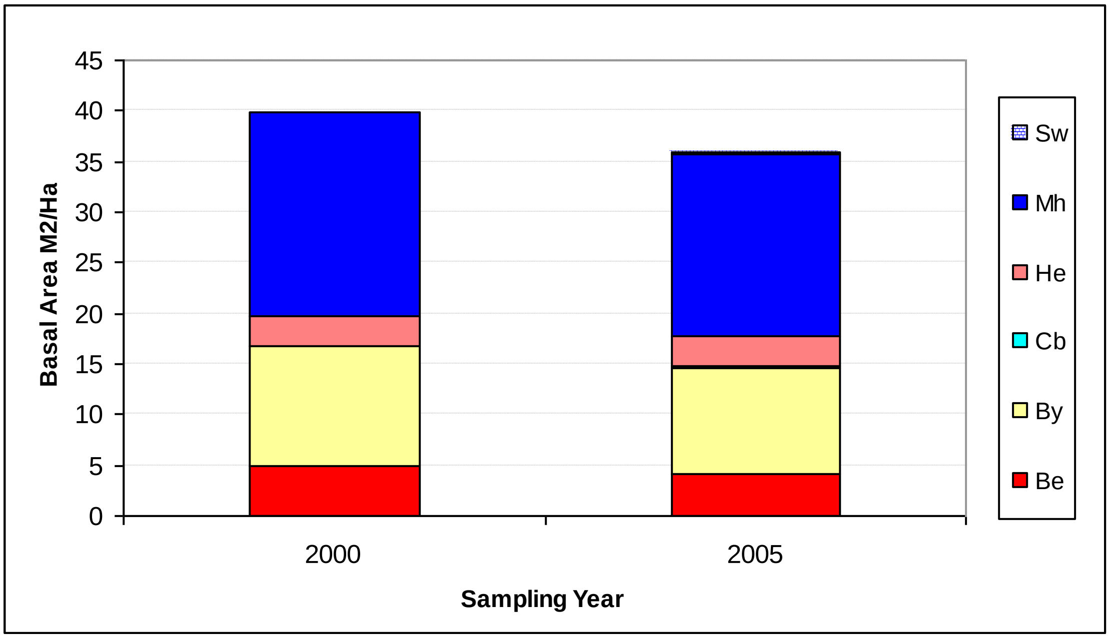

Figure 153: Total basal area/hectare, by species, over 2 sampling years for PSP TL2.

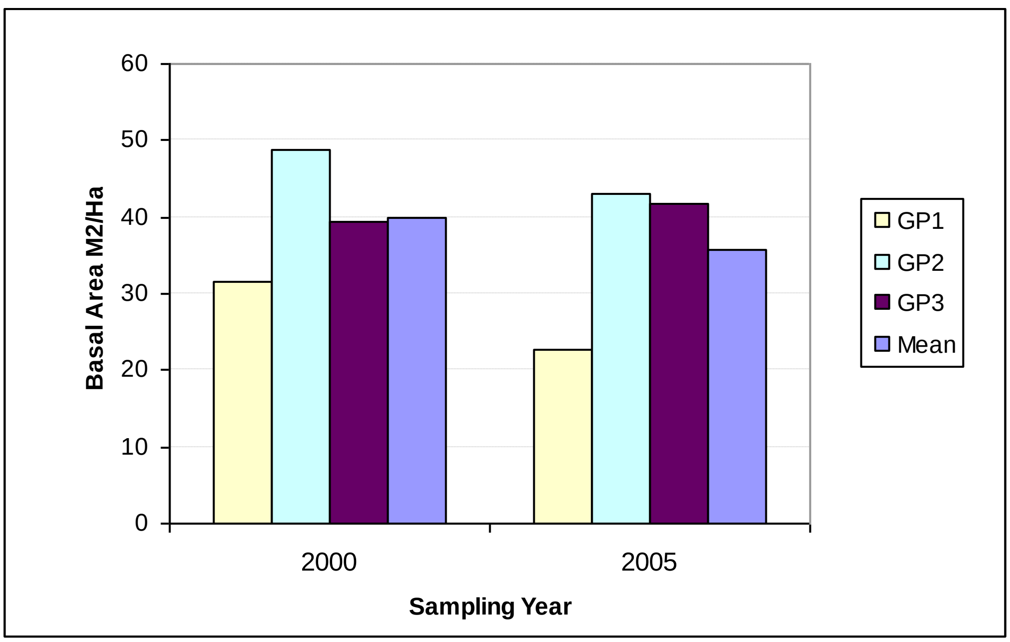

Figure 154: Total basal area/hectare, by growth plot, over 2 sampling years, for PSP TL2.

Tree and small sapling abundance

Total stem count increased very slightly from 558/ha to 575/ha between 2000 and 2005 (Figure 155). Sugar maple was the most common tree species in this plot (275), followed by beech (208), white spruce (33), hemlock (25) and. yellow birch (25). Three very large yellow birch trees in this plot accounted for the very small number of yellow birch stems (4.3% of the total) relative to their large share of basal area (29.5%).

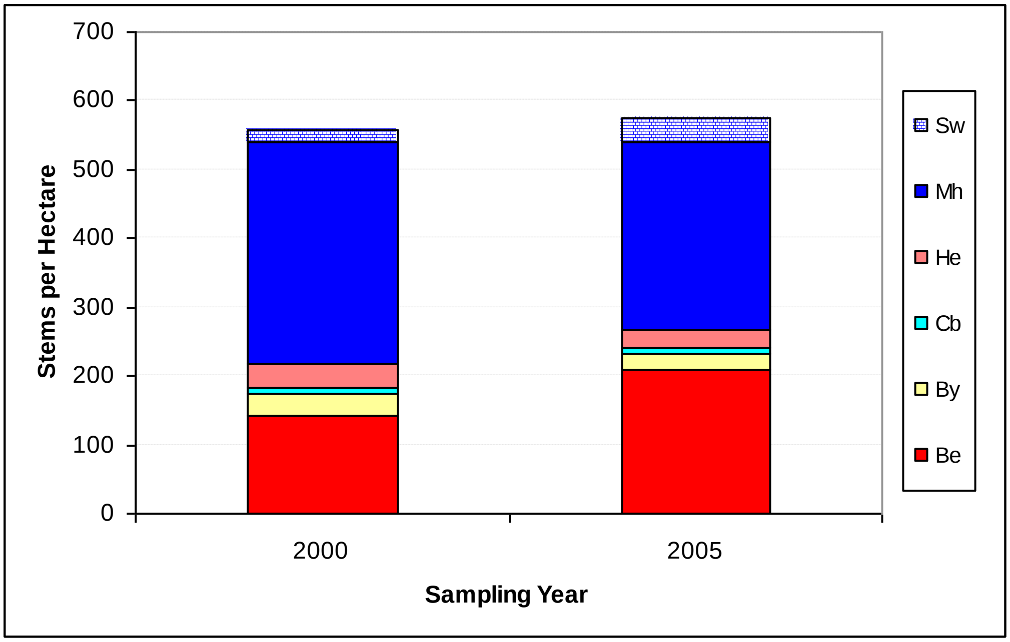

Figure 155: Number of stems/hectare, by species, over 2 sampling years for PSP TL2.

Beech was the most common sapling in both sampling years, with a total of 52 in 2005, followed by sugar maple (27), yellow birch (4) and cherry (2) (Figure 156). Total sapling abundance decreased from 99 in 2000 to 86 in 2005.

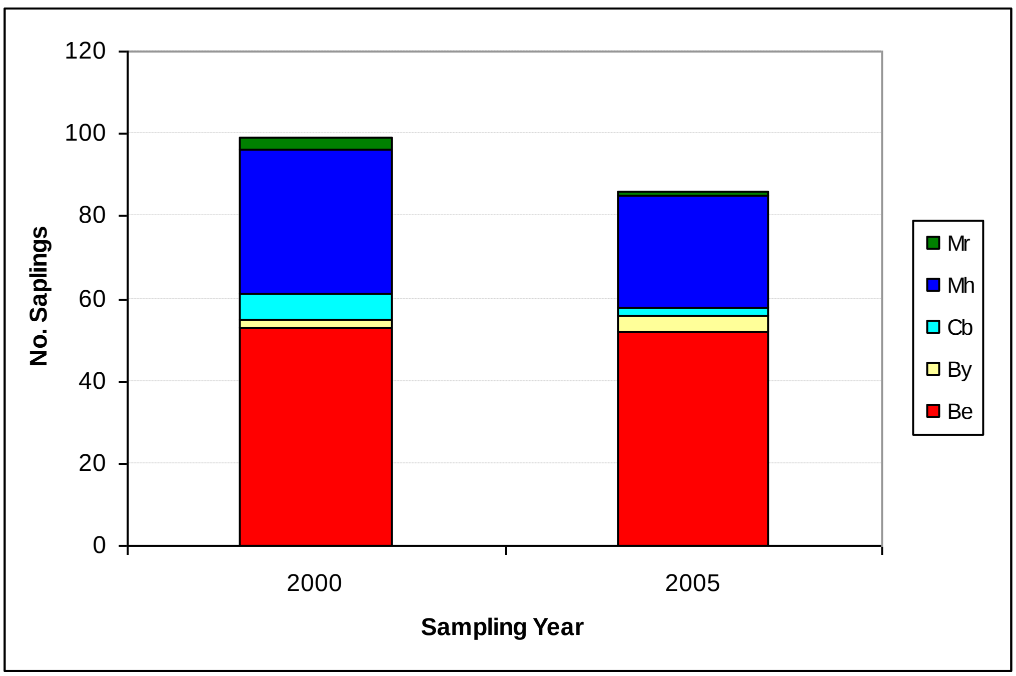

Figure 156: Sapling abundance, by species, over 2 sampling years for PSP TL2.

Size class distribution

Basal area was unevenly distributed across all size classes (5-4-6-21 polewood: small sawlog: medium sawlog: large sawlog) (Figure 157). Large sawlog-sized trees accounted for 60% of basal area. Average stem DBH was 28.2 cm - higher than any other PSP. This was a result of the relatively low number of total stems, and some very large trees in the plot (e.g. 2 yellow birch trees with diameters of 82 and 80 cm). All but 2.9 m^2/ha of total basal area was UGS.

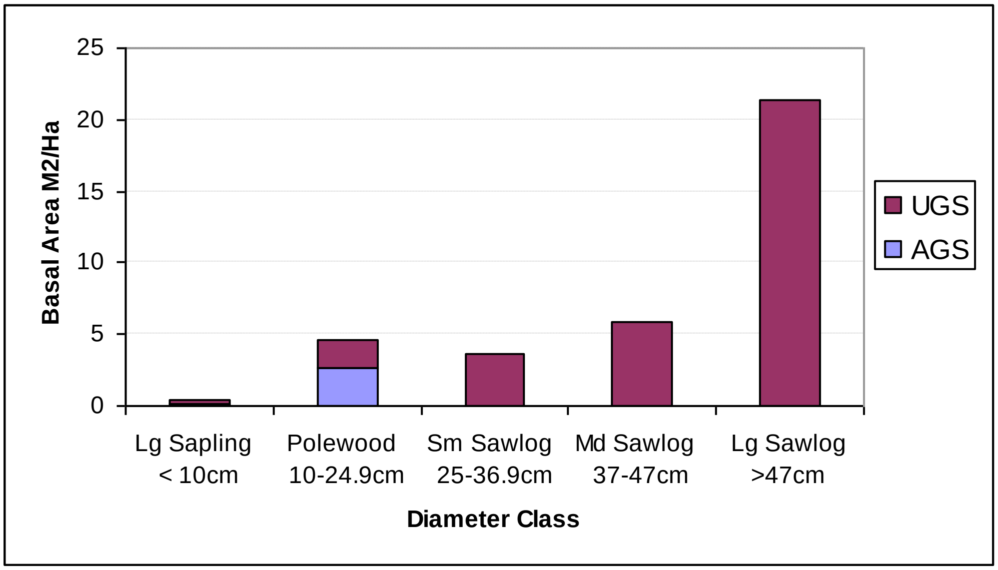

Figure 157: Basal area by size class and quality for PSP TL2 (2005 data).

This plot had 192 polewood-sized trees per hectare, 42 small sawlog-sized trees, 42 medium sawlog-sized trees, and 75 large sawlog-sized trees (Figure 158). Overall, 67% of stems were UGS, including all the trees in the non-polewood size classes.

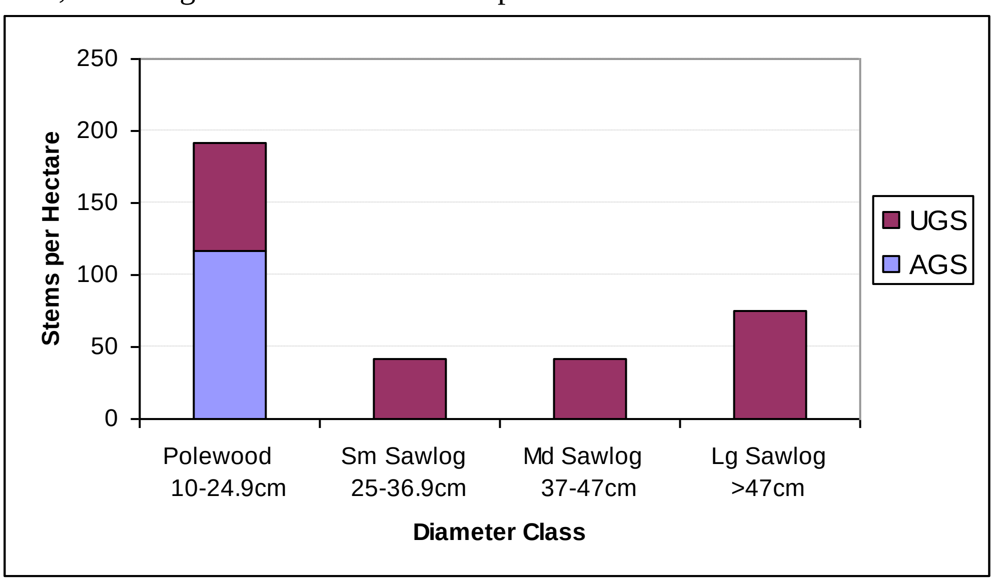

Figure 158: Tree abundance by size class and quality for PSP TL2 (2005 data).

Table 23: Summary of PSP TL2 results

PSP TL2	
Forest type	Hard maple and Yellow birch dominated, mid-slope, northern exposure
Dominant Tree Species	Mh5By3Be1He1
Regeneration Species	Be6Mh3OH1
Disturbance type	Currently, gap disturbance; no cut stems in growth plots
FEC classification	ES 28.1 (Mh-He-By; dry to moderately fresh)
Basal area	35.9 m^2/ha
Canopy height	28.4 m
Mean DBH	28.2 cm
Location	NNE of The Loop, northeast corner of property

Discussion

How are forests growing and how much merchantable wood is accumulating annually?
The overall average growth rate for all PSPs was 0.21 m^2/ha/year (Table 24). This estimate is based on including the basal area of trees harvested from PSP growth plots in the last 5 years. Net growth (with removal of trees) was 0.13 m^2/ha/year. Of the 22 PSPs, 3 had 4-6 trees harvested from growth plots within the last 5 years. Two PSPs had one tree removed, one in 2003, 2 years prior to sampling, the other at least 5 years before the most recent sampling. Removal of the one tree in the latter scenario may have stimulated enough growth in remaining trees to compensate for basal area loss. At least 5 more PSPs are in stands that have been selection harvested, but no trees were removed from growth plots.

Table 24. Annual growth rates, by PSP, under 3 scenarios, actual basal areas, projected basal areas had 4 PSPs not been harvested, and basal areas without storm-damaged plots (*).

PSP	Forest Type	Basal Area m^2/ha Recent sampling year	Basal Area m^2/ha/yr Cut	Basal Area m^2/ha/yr No cut	Basal Area m^2/ha/yr No storm
T1	HW*	19.6	0.8	0.8	
T2	HW	26	0.45	0.45	0.45
T3	MWD*	13.7	0.75	0.75	
T4	HW*	14.4	0.76	0.76	
T5	HW	25	0.16	0.16	0.16
T6PSP1	HW	23.7	-0.35	0.14	-0.35
T6PSP2	HW + He (25%)	29.4	0.26	0.26	0.26
DL	CON	50	-0.12	-0.12	-0.12
DT	MWD*	18.4	0.92	0.92	
ER	MWD	49.7	-0.005	-0.005	-0.005
HT	HW	16.7	-0.4	0.05	-0.4
KL1	HW	21.1	0.4	0.4	0.4
KL2	HW	20.3	0.58	0.58	0.58
KLRT	HW	24.0			
L'Azure	HW (mid)	33.1	-0.12	0.04	-0.12
MDL	CON	42.4	-0.07	0.49	-0.07
NT	CON	47.8	-0.3	-0.3	-0.3
RL	MWD	32.6	-0.02	-0.02	-0.02
RSR	CON	41.9	-0.54	-0.54	-0.54
RT	HW (mid)	27.9	0.03	0.03	0.03
TL1	HW	25.4	0.4	0.4	0.4
TL2	HW	35.9	-0.8	-0.8	-0.8
Average growth rate			0.13	0.21	-0.02

The rapid growth rates of 4 storm-damaged plots (0.75-0.92 m^2/ha/year) is included in the above estimates. 12-83% (average 37%) of the basal area of these storm-damaged plots is in the large sapling size class (2.5-10 cm DBH). Excluding these 4 plots, the net growth rate for the remaining PSPs was -0.02 m^2/ha/year (Table 24).

With the exception of TL2, and PSPs that have been harvested recently, all the tolerant hardwood stands dominated by sugar maple and beech had positive annual growth rates. TL2, with a negative annual growth rate of -0.8 m^2/ha/yr, had the highest basal area of any tolerant hardwood stand (39.9 m^2/ha in 2000, and 35.9 m^2/ha in 2005).

The 4 conifer dominated stands had negative annual growth rates. They also had basal areas of 41.9 m^2/ha and higher. Hemlock-dominated MDL would have had a growth rate of 0.49 m^2/ha/yr had it not been harvested in 2006 (assuming residual trees did not have a sudden growth spurt after harvesting).

Both mid-tolerant hardwood stands had relatively high basal areas, and minimal growth rates. One 35.1-cm-diameter sugar maple was harvested from PSP L'Azure, resulting in a slightly negative growth rate. RT is on a bedrock ridge. It was sampled for the third time in the fall of 2009, and harvested in the winter of 2010.

What is the optimal residual basal area? When is growth maximized?
Of the 22 PSPs, only 3 had 4-6 trees harvested from growth plots since establishment of the PSPs. Due to these harvests, all 3 PSPs showed negative growth rates in the post-harvest sampling year (Table 24). Less than 5 years have passed since these trees were harvested, so it is likely too soon to see growth rates increase from spacing of residual trees. L'Azure had 1 tree removed, and showed a negative growth rate as a result. It also had a basal area in the low 30s. T5 had one tree removed more than 5 years ago, as well as some sapling-sized trees for a skid trail. By 2009, it had a basal area of 25m^2/ha and a relatively slow annual growth rate of 0.16 m^2/ha.

Many other PSPs were harvested prior to establishment, but their harvesting history is vague.

The highest rates of annual growth are associated with 4 storm-damaged stands, which were reduced to basal areas of 6.2-11.6 m^2/ha in 1998/99. Today, much of the basal area in these stands is polewood and large sapling-sized.

Tolerant hardwood stands with basal areas in the 20.3-26 m^2/ha range had growth rates of 0.4-0.58 m^2/ha/yr. KLII had the highest growth rate, with a basal area of 20.3 m^2/ha, of which 3.9 m^2/ha was large saplings (< 10 cm DBH). T6 PSP2, with a basal area of 29.4 m^2/ha, was still growing relatively well, at 0.26 m^2/ha/yr. As noted earlier, TL2 had a strong negative growth rate and a basal area in the high 30s.

When do stands stop accumulating basal area?
All the PSPs with basal areas above 32 m^2/ha had negligible or negative growth rates. All but one of these PSPs were in conifer or mixedwood stands. TL2 was the only exception. MDL had a negative growth rate because it had been harvested 3 years before sampling, otherwise growth was still strong, at 0.49 m^2/ha/yr.

As noted earlier. both PSPs in mid-tolerant stands had very poor growth rates – likely due, in large part, to poor growing conditions – RT was on bedrock, and L'Azure was very wet.

What is an ideal stand structure?

For selection management in tolerant hardwoods in central Ontario, OMNR advocates a post-harvest basal of 20 m^2/ha and size class distribution of 6 polewood: 6 small sawlog: 5 medium sawlog: 3 large sawlog. This corresponds to over 300 polewood sized trees per hectare, 100 small-sawlog sized trees, 21 medium and 12 large (resembling the reverse-J-shaped curve recommended for selection management in the Algonquin Region (OMNR 1998)). This type of stand structure is supposed to ensure continuous recruitment into larger (more valuable) size classes, and a regular 20- to 25-year cutting rotation.

The owner and manager of Haliburton Forest believes in cutting down to 16-18 m^2/ha in tolerant hardwoods, and re-entering stands in about 15 years, before the canopy closes in and slows down growth. One of the primary goals of the PSPs set up in HF are to provide feedback on this approach to management.

The 4 fastest growing PSPs - measured by increments in basal area - were damaged in the 1995 storm. Three of these 4 are early successional stands dominated by large sapling and polewood-sized trees. The majority of stems are not of merchantable size. The forth, T1, is fast-growing like these other storm-damaged plots, and had a basal area below 12 m^2/ha in 1998. However it is dominated by sugar maple and beech, and has a size class distribution resembling a multi-aged stand (and is thus included in the comparison below).

The 4 tolerant hardwood PSPs with growth rates of 0.4-0.58 m^2/ha/yr and relatively good size class diversity had basal areas in the 20.3-26 m^2/ha range (T2, KL1, KL2, TL1). As noted earlier, KL2, with the lowest basal area and highest growth rate of these 4, had a high proportion of large saplings, comprising 3.9 m^2/ha in basal area. Without large saplings, the basal area of KL2 was 16.4 m^2/ha. The stand structures of each of these PSPs varied significantly (Table 25).

PSP TL1 grew vigorously between 2000 and 2005, and is due for resampling in 2010. It will be interesting to analyse growth rates for this PSP over the past 5 years. All the large-sized trees were UGS, and may have died or slowed down in growth.

KL1 had a high proportion of UGS and large-sized trees. 78% of the large-sized trees, and 84% of the medium-sized trees were UGS. High growth rates for KL2 may have been a consequence of the high proportion of large-sapling sized trees.

Table 25. Basal area by size class for 4 fast growing tolerant hardwood PSPs.

PSP	Basal area by size class					Total basal area m^2/ha Recent sampling year
	Lg Sapling 2.5 - 10cm	Polewood 10-24.9cm	Sm Sawlog 25-36.9cm	Md Sawlog 37-47cm	Lg Sawlog >47cm	
T1	2.4	5.3	7.6	7.4	1.9	19.5
T2	1.3	3.6	6	12	3.2	26.1
KL1	0.8	2.1	3.3	5.5	9.3	21
KL2	3.9	5.4	6.5	0.9	3.6	20.3
TL1	1	6.1	7.3	5.3	5.8	25.5

Of these 5 PSPs, T1 and T2, with annual growth rates of 0.8 and 0.45 m^2/ha/yr, respectively, were sampled over a 10-year period, thus providing a longer time frame to analyse changes over time. Table 26 shows the size class distribution for T1 in 1998 and 2008, and T2 in 1999 and 2009.

Table 26. Basal area by size class for T1PSP1 and T2PSP1 (1999 & 2009).

PSP & Yr sampled	Basal area by size class					Total basal area (m^2/ha)
	Lg Sapling 2.5 - 10cm	Polewood 10-24.9cm	Sm Sawlog 25-36.9cm	Md Sawlog 37-47cm	Lg Sawlog >47cm	
T1/1998	1.0	4.6	3.1	3.1	0.0	11.8
T1/2008	2.4	5.3	7.5	2.4	1.9	19.5
T2/1999	1.2	4.2	5.3	10.9	0.0	21.6
T2/2009	1.3	3.6	6.0	12.0	3.2	26

T2 had an usually high proportion of medium-sized sawlogs compared to other size classes and compared to the other 3 PSPs. Growth of medium-sized trees likely drove the rapid growth rates for this PSP. T2 also had a higher proportion of AGS trees than the other 3 PSPs (15.4 m^2/ha compared to 4.3 m^2/ha for KL1, 7.6 m^2/ha for KL2, and 10 m^2/ha for TL1).

T1 started as a poorly stocked tolerant hardwood stand (due to storm damage and salvage harvesting), resulting in tremendous growth rates between 1998 and 2008. It will be interesting to analyse growth rates for T1 over the next 20 years. Currently, it resembles OMNR's recommended residual stocking by size class, though basal area, without large saplings, is still low at 17.1 m^2/ha.

Based on the information presented, it would appear that T2 is one of the fastest growing tolerant hardwood PSPs with a high proportion of good quality, large-diameter trees.

All the conifer dominated stands had high basal areas (>41 m^2/ha), as well as negative growth rates (MDL being the possible exception), as did PSP ER, a mixedwood pine and oak stand with a high basal area. They all had variable stand structures, though in comparison to other PSPs, they had high proportions of medium and large sawlog-sized trees, most of which were AGS.

Do some trees grow faster than others?

On average, beech, yellow birch and hemlock were the fastest growing trees for all PSPs. Logging in PSP MDL removed the equivalent of 16.65 m^2/ha in 2006. Hemlock grew so rapidly in this PSP that growth plot #3 increased in basal area between 2004 and 2009 even after removal of a medium sized tree (equivalent to 4.3 m^2/ha). Basal area in growth plot #2, dominated by hardwoods, dropped by 5.6 m^2/ha between 2004 and 2009 after the harvesting of 1-2 trees.

Balsam fir and pin cherry were the fastest growing trees in PSPs with severe storm damage.

Is there a shift in species dominance (based on basal area)?

Among the 3 PSPs that have had 3 or more trees harvested, beech and yellow birch have increased in dominance, while sugar maple has declined. However of the trees harvested, 10 of 14 were sugar maple, with 2 hemlocks from MDL and 2 red maple from HT.

Among the storm damaged stands, the most common species to increase in dominance were balsam fir and beech, and the most common species to decline in dominance were red and sugar maple.

Among all other stands, there were no consistent patterns. Balsam fir and sugar maple each decreased in dominance in several stands, and increased in dominance in one stand. Red spruce has decreased in basal area and abundance in RSR, the red spruce reserve, but it comprises more than 80% of basal area, and is still very much the dominant species.

Is there a shift in species dominance (based on abundance)?
Among the 3 PSPs with more than 3 trees harvested, the abundance of beech more than doubled for T6 PSP1, and increased slightly for MDL. Yellow birch and balsam fir abundance dropped significantly for MDL and HT. Sugar maple abundance declined slightly in all 3 PSPs.

Among the storm damaged plots, almost every species present increased in abundance though some, like pin cherry, did very well in all 3 plots.

Among the remaining plots, the most common patterns were an increase in beech abundance, and a decrease in sugar maple and balsam fir.

Is management improving tree quality?
Of the 3 PSPs in which more than 3 trees were cut, the proportion of AGS trees increased post harvest (Table 27). It should be noted that there was a great deal of subjectivity involved with the determination of quality, as well as a good deal of inconsistency among researchers.

Table 27. Quality improvement in 3 harvested PSPs.

PSP	Before harvest % AGS	Post harvest % AGS	Increase in AGS (%)
T6	14.8	20.2	5.4
HT	43.5	78.6	35.1
MDL	69.3	92	22.7

How does stem abundance vary among PSPs?
With the exception of T1 and KL2, all plots in tolerant hardwood stands had less than 1,000 stems per hectare (Table 28). This estimate includes large sapling-sized trees (2.5-10 cm DBH). T1 and KL2 both had unusually high proportions of large saplings relative to total basal area, and thus had high stem counts.

Storm damaged plots had stem counts ranging from 2900 – 5358/ha. Plots in mid-tolerant hardwood, conifer and pine dominated stands had stem counts between 1000-2000. RSR was an exception, with 3700 stems/ha in 1999, dropping to 1550/ha 10 years later. Most of the dead trees were small, sapling-sized red spruce and balsam fir. This stand appears to be in a state of transition, or perhaps recovering from a fairly severe wind disturbance that created large gaps. Alternately, fluctuations in water levels may have periodic effects on mortality, as this PSP borders a forest swamp.

RL is an anomaly. It is a transitional stand dominated by early and mid-successional species, and has an usually high stem abundance (3217 in 2000, dropping to 2758 in 2005).

Table 28. Stem abundance by PSP, forest type and sampling year.

PSP	**Forest Type**	**NUMBER OF STEMS**							
		Sampling Year:							
		1998	**1999**	**2000**	**2003**	**2005**	**2007**	**2008**	**2009**
T1	HW	817						1392	
T2	HW		900						983
T3	MWD		617						5358
T4	HW	217						3908	
T5	HW		875						817
T6PSP1	HW	667						775	
T6PSP2	HW + He (25%)	592						683	
DL	CON		2025						1467
DT	MWD		567						2900
ER	MWD		1417						1700
HT	HW		1617						1533
KL1	HW				341			625	
KL2	HW				1983			2175	
KLRT	HW						3192		
L'Azure	HW (mid)			1675		1825			
MDL	CON		1575						1367
NT	CON		1100						1158
RL	MWD			3217		2758			
RSR	CON		3700						1550
RT	HW (mid)		1325						1400
TL1	HW			842		883			
TL2	HW			558		575			

How tall are Haliburton forests, and what is the mean diameter of stands?
Average PSP canopy height is 22.4 m (Table 29). Excluding the storm-damaged PSPs, average canopy height is 24 m. The tallest stands were T6 PSP1 and T6 PSP2, ER, KL1 and TL2. ER was dominated by white pine, most of which were very tall and straight, though not yet large in diameter (in terms of their potential). The four other plots have unusually tall canopies for tolerant hardwoods, and were measured prior to 2009. In 2009, canopy height was measured by one person to ensure consistency of results, and several measurements of each tree were taken to improve accuracy.

Mean diameter at breast height is an indicator of the abundance of stems by size class. The mean DBH for the PSPs, including storm-damaged plots, was 16.4 cm, and, excluding these plots, 18.3 cm (Table 29). A plot with many sapling-sized trees will have a lower average DBH than a similar plot with fewer sapling-sized trees. Similarly, a plot with a large proportion of basal area in the medium and large diameters will have a much higher average DBH. It is interesting to note that the 4 conifer stands, all with large numbers of medium and large-sized trees, did not have higher mean DBHs. This is a reflection of the large number of stems of all sizes in these plots - especially sapling-sized trees – which pulled down the average DBH.

Table 29. Canopy height and mean DBH, by PSP.

PSP	Forest Type	Canopy Height (m)	Mean Diameter at Breast Height (cm)
T1	HW	24.0	12.8
T2	HW	23.0	18.2
T3	MWD	10.9	5.7
T4	HW	13.9	7.0
T5	HW	23.4	20.1
T6PSP1	HW	28.6	19.8
T6PSP2	HW + He (25%)	32.4	23.7
DL	CON	23.3	20.7
DT	MWD	10.8	8.8
ER	MWD	27.5	19.4
HT	HW	19.7	11.5
KL1	HW	29.6	20.7
KL2	HW	25.6	10.9
KLRT	HW	N/A	9.8
L'Azure	HW (mid)	19.3	15.4
MDL	CON	24.7	19.8
NT	CON	26.0	23.0
RL	MWD	18.9	12.3
RSR	CON	23.2	18.5
RT	HW (mid)	18.6	15.9
TL1	HW	18.3	19.1
TL2	HW	28.4	28.2

Other observations:
Data for PSP HT suggests a diameter limit cut in 2005. By 2009, no medium or large-sized trees remained in the growth plots. This raises several concerns. First, the profitability of a logging operation is closely related to both size and quality of trees. Cutting of medium and large-sized trees, especially if AGS, may result in heavier and heavier incursions into a stand in future rotations in order to meet volume and profit targets.

Secondly, the forests of this region used to have much greater numbers of large-sized trees. Massive old stumps are ubiquitous throughout Haliburton Forest. Many species of flora and fauna make use of the habitats created by these older trees, standing and down, including beetles, orchids, lichens, mosses, owls, goshawks, amphibians, flying squirrels, bats, marten, bears, porcupine, trout etc. Cutting of all but polewood and small sawlog-sized trees will result in a lack of recruitment of larger diameter trees, and the consequent impoverishment of forest habitats.

What new plots need to be established? Or what do we need to do in existing ones?
There is no long-term data to show whether the current management approach at Haliburton Forest is successful. Forests develop and change over decades and centuries, and a small network of 22 PSPs, measured at most 2 to 3 times over 5-10 years, cannot be expected to yield results that become the basis for sound management decisions.

Time, and an expanded network of PSPs, will increase sample size, and capture a greater range of conditions and treatments. One of the most valuable forest products from Haliburton Forest is hemlock. There is also a significant component of hemlock in HF. There are currently 2 hemlock-dominated PSPs - both old growth stands on slopes down to MacDonald Lake. Several trees were harvested from one of these in 2006. It may be a good idea to establish at least 1 if not 2 more PSPs in hemlock stands slated for harvest in the near future.

There are only 2 PSPs in stands dominated by mid-tolerant hardwoods. Both are unproductive sites due to site conditions. Perhaps this is the norm for mid-tolerant species in this area. If not, there should be at least one more PSP to capture a more productive site dominated by mid-tolerant hardwood species.

PSP ER is a very well stocked pine and oak stand. Management may want to experiment with opening up this stand, as there is currently negative net growth, and no pine or oak regeneration.

Sugar maple is the meat, potatoes and gravy at HF, and the backbone of the hardwood industry in central Ontario. As such it is critical that it be managed sustainably. Based on the PSP results (admittedly a very small sample size), it appears that sugar maple is being harvested preferentially, and that this – and possibly other factors – are leading to a general trend towards reduced volumes and abundance. While there are a number of PSPs in sugar maple-dominated, tolerant hardwood stands, only 2 have been harvested in recent years (in which >3 trees were cut).

There needs to be greater experimentation with management approaches in tolerant hardwoods: entering stands with higher and lower-than average basal areas, leaving differing proportions of medium and larger AGS trees. HF would also benefit from comparisons with OMNR's PSP data for this area.

Sources of error

Since the establishment of PSPs in 1998 at Haliburton Forest there have been many researchers and volunteers collecting data. Too many. Every new person had their own writing style, method of recording data, interpreting tree quality, measuring tree height and diameter, level of knowledge and experience with tree and plant identification, and with PSP procedures and protocols. What may be 40% cover to one researcher in a shrub plot may be 20% cover for another. One data recorder will distinguish between trees that have died naturally from those that have been cut; the next person will make no such distinction. A sugar maple is misidentified and called a red maple. Dead trees are included in calculations of basal area and growth. Full-sized trees are called saplings.

In short, there has been little consistency in data collection, and many mistakes with calculations, data entry and analysis. Several months were spent correcting errors and inconsistencies, re-entering data, and recalculating basal areas and stem counts.

To remedy this situation, HF needs to have the same researcher carrying out year-to-year measurements. There also needs to be fewer people involved in data collection. Whenever possible, new researchers should be trained by previous ones to ensure that the same thought processes and sampling methods are undertaken. Also, OMNR PSP specialists have offered

HF their assistance with setting up new PSPs and guiding new staff with protocols and procedures.

Inconsistent measurements of tree diameter resulted in some trees shrinking or others growing by unrealistic amounts. By the time data was inputted and the inconsistencies discovered, it was impractical to resample trees. If the researchers had noticed the discrepancies in the field, these could have been addressed and remedied on site. Thus, it is critical to bring records from the previous sampling year (photocopies, not originals) into the field. By referencing current measurements with previous data, one can keep sampling consistent and discrepancies can be addressed immediately. Also, a DBH line should be painted (with tube paint) on all trees to ensure accuracy and consistency of diameter measurements.

Taking accurate tree heights can be very difficult in the field. Trees have appeared to shrink in stature or grow enormously. Often the topography is inconsistent and the foliage is so thick that one cannot find the top of the tree. The optimal time for measuring tree heights is during the spring and fall when the leaves are less dense. The altimeter also needs to be handled correctly. One must wait until the wheel in the eyepiece stops swinging. If this is not done then it will give a false reading.

Assessment of quality class (for every tree in the growth plot tree data form) is highly subjective. Trees that were deemed UGS in one sampling year became AGS in the next sampling year. The system was simplified somewhat in 2009, whereby trees were only assessed as AGS or UGS, not A1, A, B1, B, C or D. Though this determination will always have some element of subjectivity, all future researchers should use the defect table in the OMNR treemarking guide to decide if a tree is AGS or UGS.

Another common error in the past was to underestimate the number of tree stems (and basal area) in a plot. If a tree has multiple vertical stems starting below DBH, then each stem over 2.5 cm DBH is considered a tree, numbered, measured, etc. If one or more stems, well above 2.5 cm in DBH, is added to the data set in sampling year 3, though it was clearly large enough to have been included in the 2 previous sampling years, then basal area will increase disproportionately. An attempt was made to reduce this sudden leap by estimating basal area for the 2 previous sampling years (and adding a note in the file to explain what was being done).

Similarly, the radius of the original growth plot #1 for PSP DT was too short in all directions, resulting in a number of good-sized trees excluded from the original plot added in 2009.

Inaccurate species identification was a common problem, especially with sapling-sized trees after leaf fall. Pin cherry abundance would appear to plummet from one sampling year to the next, while black cherry would suddenly increase. Other commonly confused species were red and sugar maple, white and yellow birch, white and red spruce, and trembling, large-tooth and balsam poplar.

Regeneration measurements required estimations of percent cover for ferns and allies, grasses, sedges, feather, sphagnum and other mosses, cladonia lichens and other bryophytes and fungi. The 1995 PSP manual provided little guidance on what species should be included under each of these groupings. Thus, until clarification was sought from OMNR part way through the sampling season, PSPs that had been measured up to that point likely had some erroneous groupings. Also, identification of grasses, sedges and mosses, especially early on in the sampling season, was inexact at best.

Another common problem was the loss of PSP centre and growth plot stakes. In a number of situations, they had rotted and fallen down, and were then buried by leaves and debris. Metal stakes were erected next to new, three-foot-long orange and blue-painted wooden stakes to ensure visibility and consistency of PSP and growth plot centres. Due to snowfall, metal stakes were not erected alongside wooden stakes in T4 and T6.

Lastly, the compass used during most of the 2009 field season had inaccurate declination, such that the location of shrub plots may have varied from previous years. Given that sapling abundance is extremely variable over space and time, this was not critical, however, for consistency, future researchers should set their compass declination at or near 12^{o}W. Declination changes over time, but slowly enough that 12^{o}W will be good for another 5-10 years.

Conclusions

Forest management at Haliburton Forest and Wildlife Reserve is oriented towards quality improvement, conserving natural forest ecosystems and tree species diversity. Peter Schleifenbaum, the owner and manager of HF, harvests his forests on a shorter rotation than that advocated by OMNR, with basal areas down to 16-18 m^2/ha. The intent of this approach is to maximize crown growth of residual trees, and to re-enter stands as crown expansion slows down.

Since 1998, a network of 22 permanent sample plots, based on protocols and procedures developed by OMNR's Forest Growth and Yield Program, was established in Haliburton Forest. The goal of this program was to test the success of HF's management approach, as well as to gain a better understanding of forest dynamics in different stand types.

This report summarises the data collected from the 22 PSPs, presenting results for each individual PSP, as well as comparisons among PSPs.

Since the fall of 2009, a great deal of effort was put into improving the consistency, accuracy, accessibility, visibility and utility of this PSP program. The vast number of data collectors, with greatly varying skill levels, as well as inadequate attention to the longevity of this project, had lead to numerous errors, inconsistencies and inefficiencies. The current state of this program is now much improved, and the data far more reliable.

Nevertheless, 10 years is a short time frame to study forest dynamics. Responses to natural or anthropogenic disturbances can be measured over many time scales. Longer time scales and larger sample sizes lend credibility and reliability to data. Drawing firm conclusions from such small sample sizes and short time frames would not be wise. Results could be compared with others to test the validity of findings. To that end, comparing OMNR's PSPs in this region with HF's PSPs would be highly beneficial.

If the PSP project is to persist, the author recommends *against* the use of interns and volunteers for PSP data collection. The same trained people should be assigned to PSP data collection from one sampling year to the next. Coordination with OMNR's PSP specialists is highly recommended – they have volunteered to help with establishing new PSPs, and with training new staff. Scott McPherson of the Southern Science & Information Section in North Bay has been our primary contact (705-475-5571).

References

Hayden et al. 1995. Ontario Forest Growth and Yield Program: Field Manual. Queens Printer for Ontario. Ontario, Canada.

OMNR. 1998. A silvicultural guide for the tolerant hardwood forest in Ontario. Ont. Min. Nat. Resour. Queen's Printer for Ontario. Toronto. 500p.

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Appendix I: Description and location of PSPs

Permanent Sample Plot Descriptions and Access Instructions

#	PSP	Forest Type	Location	Level of completion	Next Survey Schedule
1	T1-PSP1	Tolerant Hardwoods - salvage cut in 1995 by Barry Boice using a high-hoe and forwarder; previous harvest (possibly diameter cut) in 1987	**Access**: North Rd ➔ continue past East Rd ➔ left at sign for Kennisis Bridge trail ➔ drive in about 100-m to intersection with Wild Woods Walk ➔ park & go left on Wild Woods Walk to research sign on right. About 100-m to PSP. UTM Coordinates: 17T 0689436 mE 5012352 mN	Established & measured in 1998 Remeasured in 2003 & 2008	2013
2	T2-PSP1	Tolerant Hardwoods - selection cut by Larry Miscio in 2004; salvage harvest in 1995	**Access**: South off East Rd, about 50 m past beginning of Normac Trail UTM Coordinates: 17T 0689605 mE 5011733 mN	Established & measured in 1999 Remeasured in 2004 & 2009	2014
3	T3-PSP1	1995 Storm Damaged site; salvage harvest in 1995 by Tembec	**Access**: East off Redkenn Rd, about 20-m before driveway to Astronomy Centre. Walk about 50-m east to center stake. UTM Coordinates: 17T 0689351 mE 5010913 mN	Established & measured in 1998/9 Remeasured in 2004 & 2009	2014
4	T4-PSP2	Tolerant Hardwoods - Storm	**Access**: Most direct route is to start behind the outdoor education rooms in the main office at basecamp, and walk about 200m with an azimuth of 90^{o} (crossing Redkenn Rd). And/or, use GPS and UTM coordinates: 17T 0689477 mE 5010540 mN	Established & measured in 1998 Remeasured in 2003 & 2008	2013
5	T5-PSP1	Tolerant Hardwoods - selection cut with horses in 2007	**Access**: East off Redkenn Rd, about 50-m before intersection with Kennisis Lake Rd. PSP about 75-m in from Redkenn Rd. UTM Coordinates: 17T 0688988 mE 5009931 mN	Established & measured in 1998/9 Remeasured in 2004 & 2009	2014

6	T6-PSP1	Tolerant Hardwoods - selection cut with horses in 2007; may have been additional salvage harvest in 1995	**Access**: start Forest Walk trail from west side of dog kennels (next to Redkenn Rd). Blue center stake is next to trail, roughly ½ km along. UTM Coordinates: 17T 0689039 mE 5009996 mN	Established & measured in 1998 Remeasured in 2003 & 2008	2013
7	T6-PSP2	Tolerant Hardwoods &Hemlock - selection cut in early 1990s; may have been additional salvage harvest in 1995	**Access**: start Forest Walk trail from west side of dog kennels (next to Redkenn Rd). Blue center stake is next to trail, roughly ¾ km along UTM Coordinates: 17T 0689221 mE 5010076 mN	Established & measured in 1998 Remeasured in 2003 & 2008	2013
8	PSP-DL "Depot Lake"	Bf – Sr – likely clearcut at least 80 years ago	**Access:** North Rd ➔ right at Nugget Rd ➔ after about ½ km, right at Red Trail ➔ cross bridge ➔ veer left after bridge, and park vehicle about 100 m past bridge. Old trail into PSP starts about 200-m southwest past bridge. PSP located about 400m along. Look for blue paint on dead trees in mortality plot. UTM Coordinates: 17T 0693455mE 5020046mN	Established & measured in 1998/9 Remeasured in 2004 & 2009	2014
9	PSP-DT "Dog Trail"	Storm Damaged Site; no salvage harvest	**Access:** From North Road ➔ follow shortcut to Normac Trail, then left onto Dog Trail. About 15 minute walk in. UTM Coordinates: 17T 0690173mE 5012297mN	Established & measured in 1998/9 Remeasured in 2004 & 2009	2014
10	PSP-ER "East Road"	Pw - Or	**Access**: From East Road, about 100-m before mile marker 4.3 UTM Coordinates: 17T 0692578mE 5012482mN	Established & measured in 1998/99 Remeasured in 2004 & 2009	2014
11	PSP-HT "Havelock Trail"	Tolerant Hardwoods - selection cut in 2005 by Doug Mastine	**Access:** First right off Stocking Lake Road after exit for Baby Loon Lake on left (less than ½ km) - on north-west side of logging road. Look for "Research Area" sign after about 100m, From this sign, go 81m at 280^{o} to PSP Centre, or use GPS. UTM Coordinates: 17T 0683855 mE 5015102 mN	Established & measured in 1999 Remeasured in 2004, 2005 (incomplete measurements) & 2009	2014

12	PSP – KLI "Kelly Lake 1"	Tolerant Hardwoods - selection cut in 2005 by Troy Barry but no trees cut from growth plots	**Access:** follow Wilkinson Rd to north side of Kennisis Lake ➔ turn right onto Kelly Lake Road. PSP on left side of Kelly Lake Rd, about 200-m past start of Kendra Trail. UTM Coordinates: 17T 0686483 mE 5013219 mN	Established and measured in 2003 Remeasured in 2008	2013
13	PSP – KLII "Kelly Lake 2"	Tolerant Hardwoods	**Access:** same as for KLI, except this PSP is up hill, about 200 m west of KI UTM Coordinates: 17T 0686377 mE 5013186 mN	Established and measured in 2003 Remeasured in 2008	2013
14	PSP – KLRT "Kelly Lake RT"	OMNR-prescribed clearcut with standards in 1983	**Access**: follow Wilkinson Rd to north side of Kennisis Lake ➔ pass turnoff to Kelly Lake Road ➔ about 300 m further, park at beginning of old road on right (cable across entrance). Walk along old road about ½ km, PSP on right. UTM Coordinates: 17T 0686345 mE 5012662 mN	Established & measured 2007	2012
15	PSP – L'Azure	Mixed hard and soft wood By – Mh - Ab – Bw; cut, very lightly, for Bw veneer in 2003 by Troy Barry	**Access:** Stocking Lake Rd ➔ left onto L'Azure Lake Rd. ➔ 100m before Kendra trail, enter forest at "research area" sign on south side of road. About 70m @ 175° to PSP plot ctr. UTM Coordinates: 17T 0683045 mE 5014165 mN	Established and measured in 2000 Remeasured in 2005	2010
16	PSP-MDL "MacDonald Lake"	He - By; horse logging in 2006	**Access:** Park at mile 2.4 on East Road. Walk down driveway towards campsite. About 50-m before campsite, head northwest about 200-m to PSP. UTM Coordinates: 17T 0691268mE 5011857 mN	Established & measured in 1998/9 Remeasured in 2004 & 2009	2014
17	~~PSP-ML~~ PSP destroyed by windburst in August, 2006. No longer accessible	~~Pw - Old Growth~~	~~Marsh Lk.~~ ~~**Access**:~~ ~~-By truck and boat to Canopy Tour~~	~~Established & measured completely 1999 Measured completely 2004 Sign needed~~	~~2009~~

18	PSP-NT "Normac Trail"	He - By	**Access:** From North Road ➔ follow shortcut to Normac Trail. About 15 minute walk in. PSP between trail and MacDonald Lake. Look for blue paint on trees. UTM Coordinates: 17T 0690445mE 5012091 mN	Established & measured in 1998/99 Remeasured in 2004 & 2009	2014
19	PSP-RL "Rainbow Lake"	Po – Bw	**Access:** North Rd ➔ Nugget Rd ➔ right to Lost Lake along Rainbow Trail ➔ cross bridge over outlet from Rainbow Lk. ➔ through gravel pit ➔ ½ km past bridge, take first left, follow road for another ~ 1 km to a large landing. White "research" sign at landing. Follow skid trail south-west towards PSP, using GPS. UTM Coordinates: 17T 0698468 mE 5022027 mN	Established & measured in 1999 Remeasured in 2005	2010
20	PSP-RSR "Red Spruce Reserve"	Sr - Bf	**Access:** North Rd ➔ Nugget Rd ➔ about ¾ km after Owl Trail, road forks. Do not go right on "The Loop". Stay left, and after about ¼ km, park vehicle on narrow windy road and use GPS to hone in to shortest distance to PSP (less than 200m away). Need to go through boggy area to access PSP, so wear rubber boots. UTM Coordinates: 17T 0696909mE 5025955 mN	Established & measured in 1998/89 Remeasured in 2004 & 2009	2014
21	PSP-RT "Red Trail"	Or – Aw	**Access:** East Rd ➔ just before mile 4.3, go left, following signs for Red Trail (which requires taking a right after about 400-m). Just before last campsite on left, park vehicle at beginning of Red Trail. Walk about 150-m up steep hill, and turn right on Crank The Shield mountain bike trail. After about 200-m, trail goes through PSP. UTM Coordinates: 17T 0692308 mE 5012704mN	Established & measured in 1998/9 Remeasured in 2004 & 2009	2014

22	PSP-TL1 “The Loop 1”	Tolerant hardwood; disturbance history unclear; confirm in 2010; no recently cut stems in growth plots	**Access:** North Rd ➔ Nugget Rd ➔ about ¾ km past Owl Trail, go right at fork, heading north-east onto The Loop. About 2 km past fork, look for “Research Area” sign on right, next to start of old road. Follow old road ~ 450-m to a landing. Use GPS to reach PSP from here. UTM Coordinates: 17T 0697312 mE 5027928 mN	Established & measured in 1999/2000 Remeasured in 2005	2010
23	PSP-TL2 “The Loop2”	Tolerant hardwood; disturbance history unclear; confirm in 2010; no recently cut stems in growth plots	**Access:** North Rd ➔ Nugget Rd ➔ about ¾ past Owl Trail, go right at fork, heading north-east onto The Loop. About 2 km past fork, look for “Research Area” sign on right, next to start of old road. Follow old road ~ 450-m to a landing. From far end of landing, follow trail leading north-east. Veer right where trail forks (do not go north to bear hunting site). About 400-m along, should be an orange trail post on the right. PSP is about 200-m and 210^{o} from this post. UTM Coordinates: 17T 0697735 mE 5028088 mN	Established & measured in 2000 Remeasured in 2005	2010

Appendix II: Tree abbreviations

"Two letter" tree abbreviations with English and Latin names used in this report were taken from OMNR's FIM Forest Resources Inventory Technical Specifications, November, 2009.

Abbreviation	**English name**	**Latin name**
Aw	White ash	*Fraxinus americana*
Ab	Black ash	*Fraxinus nigra*
Bd	Basswood	*Tilia americana*
Be	American beech	*Fagus grandifolia*
Bf	Balsam fir	*Abies balsamea*
Bw	White birch	*Betula papyrifera*
By	Yellow birch	*Betula alleghaniensis*
Cb	Black cherry	*Prunus serotina*
Ce	Eastern white cedar	*Thuja occidentalis*
Cp	Pin cherry	*Prunus pensylvanica*
Ew	American elm	*Ulmus Americana*
He	Eastern hemlock	*Tsuga canadensis*
Iw or Id	Ironwood	*Ostrya virginiana*
Mh	Sugar maple	*Acer saccharum*
Mr	Red maple	*Acer rubrum*
Mr	Stripped maple	*Acer pensylvanicum*
Or	Red oak	*Quercus rubra*
Pb	Balsam poplar	*Populus balsamifera*
Pl	Large tooth aspen	*Populus grandidentata*
Pt	Trembling aspen	*Populus tremuloides*
Pw	White Pine	*Pinus strobus*
Sr	Red spruce	*Picea mariana*
Sw	White spruce	*Picea glauca*