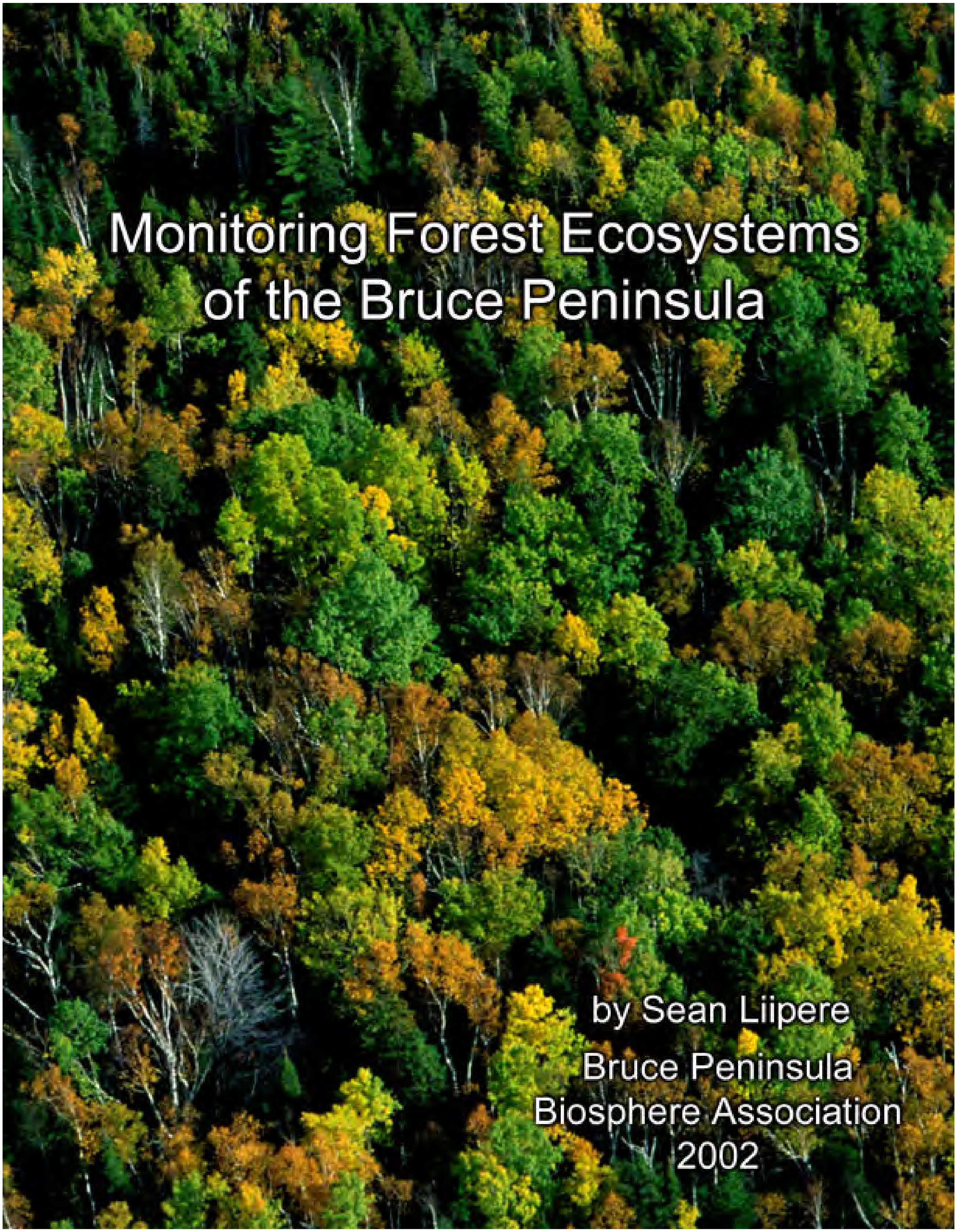

Monitoring Forest Ecosystems of the Bruce Peninsula

by Sean Liipere

Bruce Peninsula Biosphere Association
2002

MONITORING FOREST ECOSYSTEMS OF THE BRUCE PENINSULA

SEAN LIIPERE
SCIENCE HORIZON INTERN
BRUCE PENINSULA BIOSPHERE ASSOCATION

DECEMBER 2002

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I. INTRODUCTION

i. Biosphere Reserves

In 1974, the United Nations Educational, Scientific and Cultural Organization (UNESCO) introduced the concept of a Biosphere Reserve in attempt to reconcile the conservation of biodiversity, economic and social development, and the maintenance of cultural values. Each Biosphere Reserve provides opportunities for cooperative and participatory community-led projects and serves as a potential model to demonstrate innovative approaches to conservation and sustainable development. Each designated Biosphere Reserve includes one or more protected core areas, a buffer area of controlled land use, and a large zone of cooperation or working landscape in which people live and work.

The Niagara Escarpment was designated as a Biosphere Reserve in 1990, giving international recognition to the Escarpment's ecological uniqueness and significance. The diverse landscape possesses incredible ecosystems within the heart of Canada's most densely populated region, serving as a home to an outstanding assortment of flora and fauna, including 36 species of reptiles and amphibians, 53 species of mammals, 90 species of fish and more than 350 species of birds. Because of the highly populated working landscape adjacent to the protected areas within the Biosphere Reserve, it is necessary to understand the effects of human activity, on natural ecosystems in order to conserve the biodiversity of this area. It is only through this understanding that informed natural resource management decision-making is possible, eventually leading towards a sustainable community with a balance between development and conservation.

ii. The Bruce Peninsula: A Biosphere Community

The Bruce Peninsula, located at the northern end of the Niagara Escarpment, serves as a significant model for Biosphere Reserves. The area includes two protected core areas (Bruce Peninsula National Park and Fathom Five National Marine Park), buffer areas of controlled land use, (NEC, county and municipal land use zoning) and large zones of cooperation (Municipality of Northern Bruce Peninsula). The Bruce Peninsula Biosphere Association, a non-profit, community-based organization, was established in 2000 in accordance with the Biosphere Reserve concept. The Bruce Peninsula Biosphere Association addresses local environmental concerns by taking an approach that allows for informed decision-making in support of a sustainable community with a balance between local development and ecological conservation. A major aspect of the Association's objectives is capacity building, providing support for research, monitoring, education and information exchange related to local issues of conservation and development. Part of this includes the involvement of local communities in research and monitoring activities within the Biosphere Reserve, from which the participants will learn information on conservation and sustainable use.

iii. Traditional Logging on the Bruce Peninsula

The original forests of the Bruce Peninsula were composed of red, white and jack pine, black and white spruce, hemlock, white cedar, tamarack, red maple, beech, American elm, red oak, white and black ash, and basswood (Fox 1962). After a treaty with the Saugeen Nation in 1854 was signed, surrendering 90% of the Bruce Peninsula (Suffling et al. 1995), the high demand for these vast forest resources instigated settlement in the area, including the development of roads and the clearing of land.

With the arrival of the Cook and Brothers logging company of Toronto in the early 1870's (Suffling et al. 1995), the logging industry on the Bruce Peninsula boomed until the 20th century. The logging of pine began to slow down in the area by the late 1870's and by 1881, the Cook and Brothers Company was taken over by the British Canadian Lumbering and Timber Company. With a shift in product profitability, the demand for cedar replaced that of pine, being used for railway ties, telegraph poles and fence posts (Suffling et al. 1995). With the depletion of the large white pine and cedar stands by 1884, the success of the British Canadian Lumbering and Timber Company had come to an end, and an influx of small lumber companies and saw milling operations were established (Suffling et al 1995). During this time, the forests on the Bruce Peninsula were cut faster than ever. As a result of the infertility of the area, the logging practices of that time, and the huge demand for timber, the forest resources were exhausted in about 40 years, causing the industry to collapse between 1900 and 1920 (Suffling et al. 1995).

The result of historical logging practices has been dramatic changes in the landscape of Bruce Peninsula. Between 1855 and 1981 there was an overall reduction in total area dominated by tamarack, hemlock, beech, black ash, oak, balsam fir and red, white and jack pine, and an overall increase in areas dominated by trembling aspen, poplar, white birch, maple, white cedar and non-forested communities (Suffling et al. 1995).

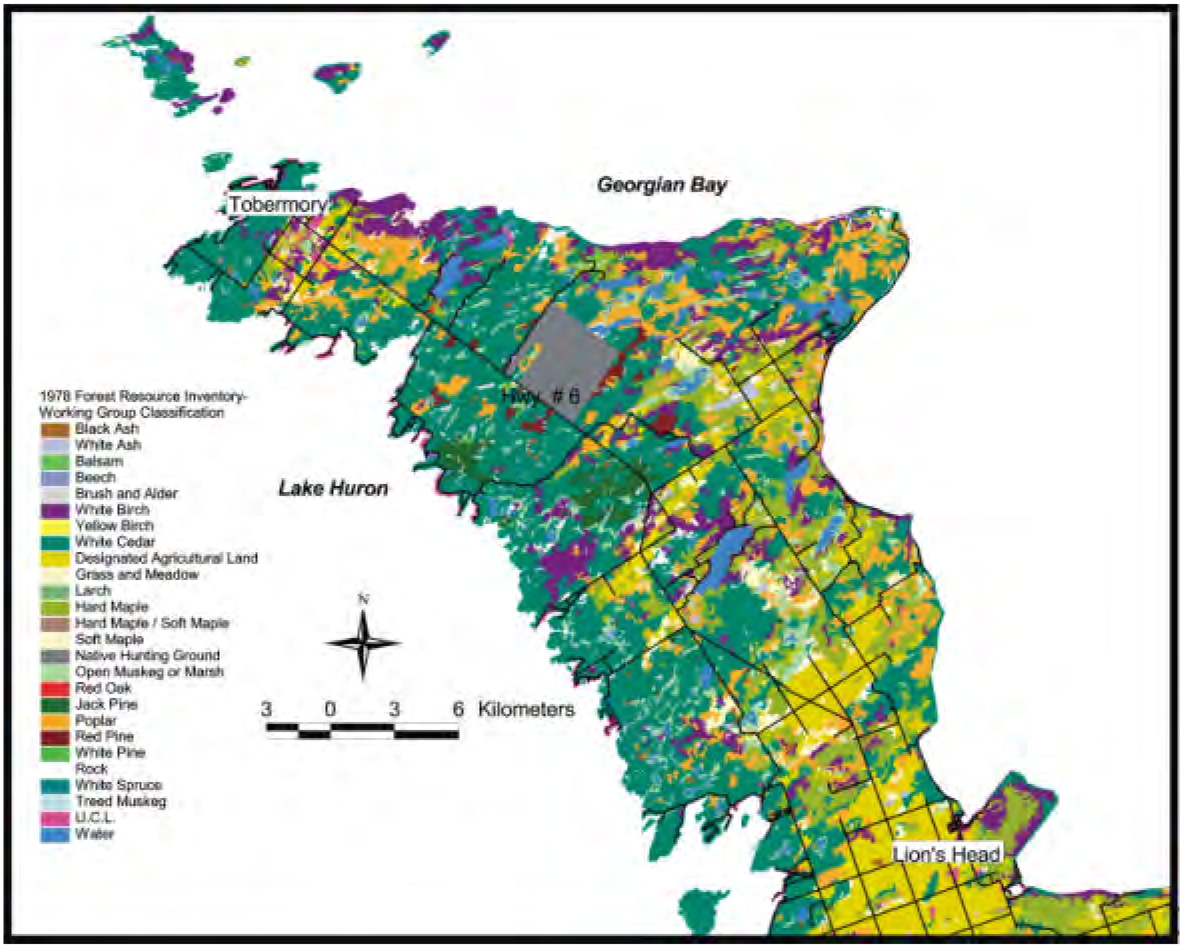


Figure 1: Forest Resource Inventory (working group) of the Upper Bruce Peninsula 1978 (OMNR).

iv. Long-term Ecological Monitoring

Long term ecological monitoring is a way to document changes in an ecosystem over an extended period of time, usually for 50 years or longer. These changes can be indicative of natural stresses, such as seasonal population cycles or disease outbreaks, as well as human stresses, such as land conversion for agriculture or logging. Monitoring of these changes would allow for early warning of potential ecological problems and provide information on which to base management decisions and to adopt practices that will lead to sustainability.

II. OBJECTIVES

- To provide an assessment of examples of the dominant forest types of the Northern Bruce Peninsula, offering information on the structure and composition of these unique forest ecosystems

- To provide information on the effects of forest management and logging practices on forest ecosystems by providing data on which to base informed forest management decisions

- To establish a warning system for potential conservation and sustainability issues on the Bruce Peninsula, allowing early preventative action to be implemented

- To initiate a participatory community-based project to help develop a sense of pride and increased understanding in the ecological significance of the Northern Bruce Peninsula

- To contribute to a national monitoring network initiated by the Ecological Monitoring and Assessment Network (EMAN) to establish a national database on the state of Canadian forests

III. RATIONALE

i. Stratification

Fifteen forest monitoring plots have been established in both protected areas of the Bruce Peninsula National Park and the working landscape within the Municipality of the Northern Bruce Peninsula. This working landscape represents private land that forests have been harvested from within the past 30 years using selective logging practices. The Forest Monitoring Program was stratified into tolerant hardwood forests and cedar/poplar forests, representing the two dominant vegetation types of the Bruce Peninsula.

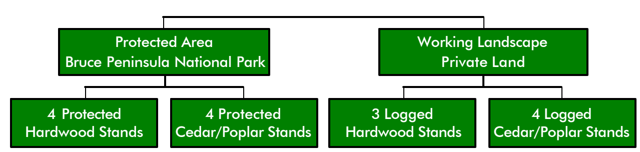


Figure 2. Stratification of forest biodiversity monitoring sites.

ii. Experimental Design

Protocols compiled by the Ecological Monitoring and Assessment Network (EMAN) – Terrestrial Monitoring Protocols were selected for the Forest Monitoring Program as they monitor a wide range of features within a forest ecosystem working collectively to identify significant changes over time. The chosen EMAN protocols are a standardized set of protocols, allowing for a direct comparison to be made between different monitoring groups, and, furthermore, allowing data gathered for local purposes to be useful in a broader context. Furthermore they are becoming a national standard.

The twenty by twenty metre stand-alone quadrat was chosen as the plot size for the monitoring program as it is relatively inexpensive and allows multiple plots to be established in a single large stand. Within each of these monitoring quadrats, mature canopy trees, seedling and sapling regeneration, and ground vegetation will all be monitored, allowing for an assessment of the structure, composition and condition of the forests.

The implementation of EMAN protocols should offer an effective assessment of the overall condition of forest ecosystems on the Northern Bruce Peninsula and provide useful information for natural resource management. Furthermore, these protocols should allow a comparison to be made between the protected core area within the Bruce Peninsula National Park and the surrounding working landscapes of the Municipality of the Northern Bruce Peninsula. This is a key principal of the biosphere reserve model. This comparison will offer valuable information concerning the effects of forest management on the state of forest ecosystems. From this, informed forestry management decision-making can be based. Good decisions based on good information is ultimately what the concept of “building capacity” is in the Biosphere Reserve concept.

The following demonstrates the utility of monitoring each of these forest strata. The monitoring indicators are based on these aspects.

Canopy-tree stratum

- Provide information on the structure and composition of a forest
- Identify changes in species diversity and abundance over time
- Assess the impacts of environmental disruptions on mature trees
- Assess levels of damage on various age and size classes and track their recovery and mortality rates

Seedling/sapling regeneration

- Provide information on the rates of growth and mortality of saplings and replacement rates of canopy species
- Determine the influence of the canopy stratum on seedling regeneration

Ground Vegetation Stratum

- Large number of species and individuals will yield an extensive sample size for analysis of their response to environmental changes
- Differentiate between short-term natural population variation and longer term vegetation shifts driven by environmental change

Downed Woody Debris

- Determine changes in the nutrient cycle, soil erosion and formation and water retention
- Provides a seedbed for forest vegetation and acts as a habitat for terrestrial organisms

PLOT DESCRIPTIONS

Selection of Plot Locations

This monitoring program expands on eight plots established as part of the earlier versions of EMAN protocols in 1998 within the Bruce Peninsula National Park by Parks Canada. Four permanent monitoring plots were established in each of the interior of both hardwood stands and cedar/poplar stands, representing the two dominant vegetation types on the Bruce Peninsula (for a total of eight plots). A Geographic Information System (GIS) model was used to randomly locate areas that are: (i) at least 50 m from a change in dominant vegetation, (ii) at least 50 m from any road, (iii) at least 200 m from any primary road, and (iv) at least 50 m within land owned by Parks Canada.

This project in 2002 established seven new monitoring sites, representing the zone of cooperation or the working landscape of the Biosphere Reserve within the Municipality of Northern Bruce Peninsula. By monitoring areas exposed to logging, changes in forest condition as a result of human activity can be identified and assessed. The location of these plots was limited by landowner permission and by areas on the Peninsula which have been logged, and as a result, were not selected randomly. These plots were stratified the same as the 1998 monitoring plots with three located in dominant hardwood stands (insufficient time to establish the 4th) and four located in dominant cedar/poplar stands, therefore representing the dominant species on the Bruce Peninsula.

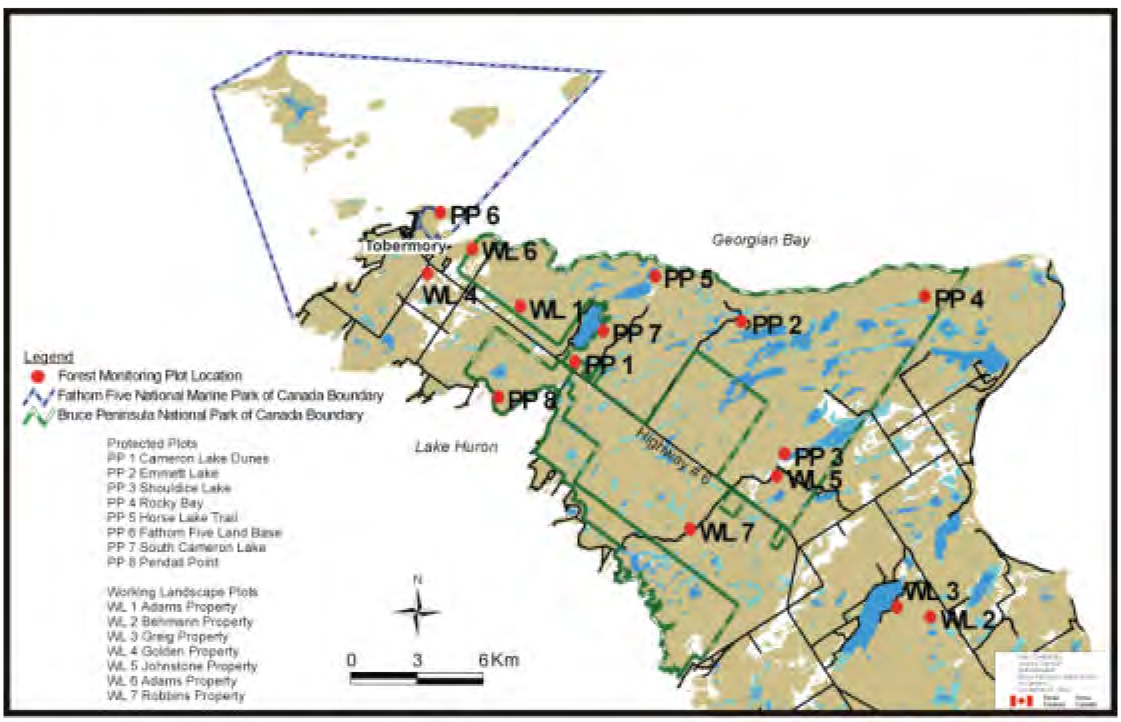
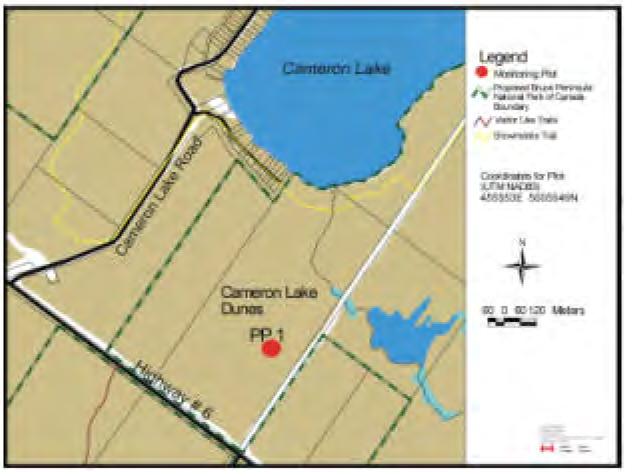


Figure 3: Location of monitoring plots in the Upper Bruce Peninsula (PP=protected area, WL= working landscape).

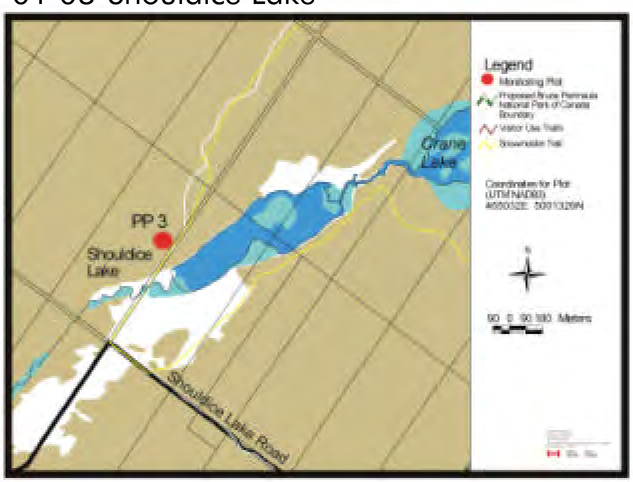
01.a. PROTECTED LANDSCAPE (01) HARDWOOD PLOTS

01 01 Cameron Lake Dunes

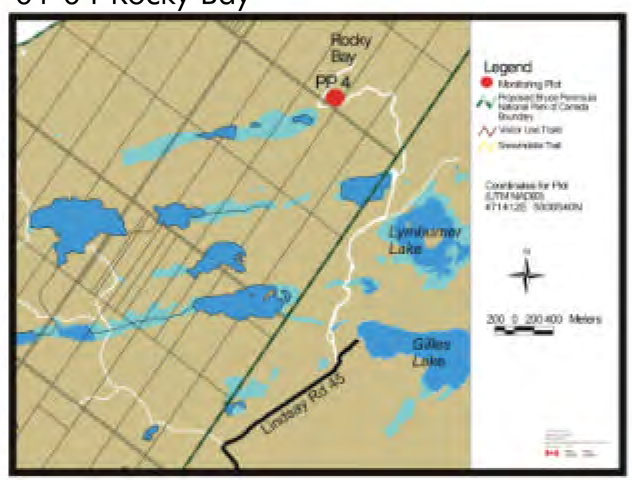


01 02 Emmett Lake

01 03 Shouldice Lake

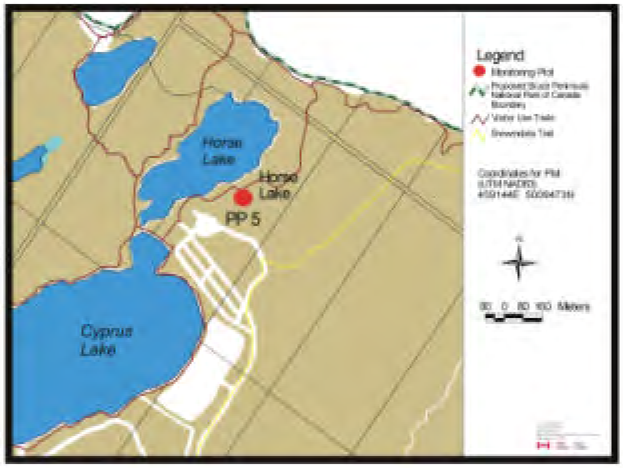


01 04 Rocky Bay

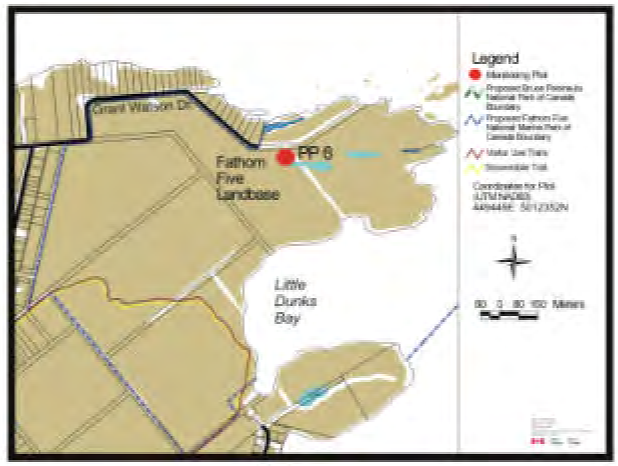


01.b. PROTECTED LANDSCAPE (01) CEDAR/POPLAR PLOTS

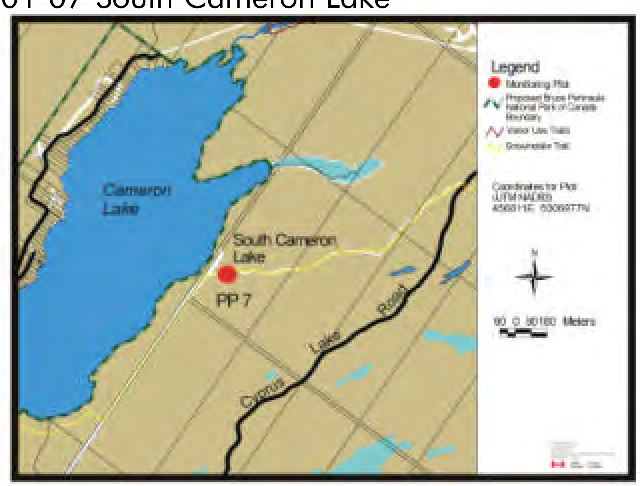
01 05 Horse Lake Trail



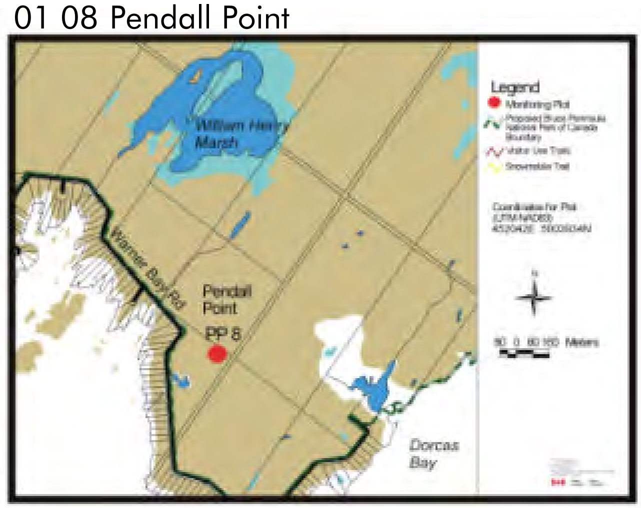
01 06 Fathom Five Landbase



01 07 South Cameron Lake

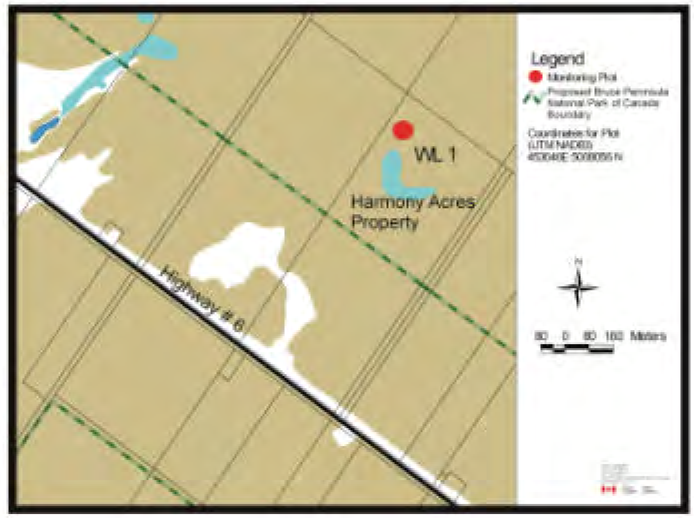


01 08 Pendall Point



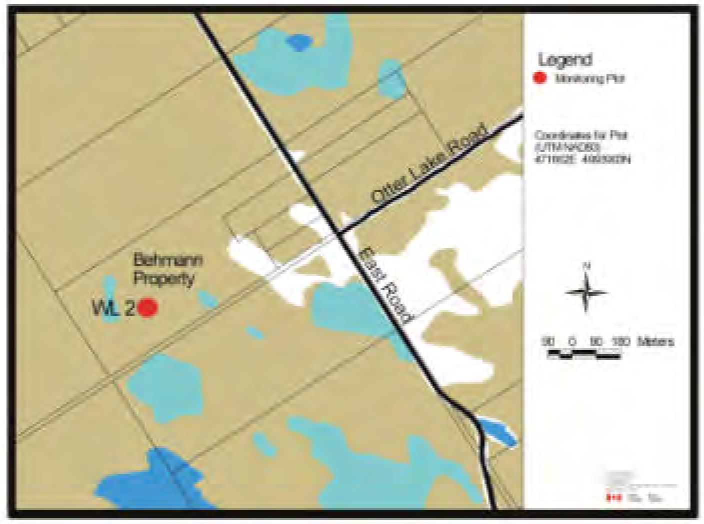
02.a. WORKING LANDSCAPE (02) HARDWOOD PLOTS

02 01 Harmony Acres Property



Originally purchased on July 30, 1879 by Thomas Earl, son of Charles Earl, regarding the Davis Earl feud. He kept the property for timbering until 1888 when after his father died he moved to northern Ontario. He sold it to T.S. Bridge and Myers who also timbered the remaining hardwoods on and off before it was sold back to the crown. It missed the fires of the early 1900's and then was bought for $5.00 by Jim Hopkins (great-grandparents of the Wyonch families). In 1916, Hopkins sold the property to Earl Lampkin and Mathersons. A little bit of firewood was cut from this forest over the years until it was bought by Earl Craig for a Riding Stable in 1974. It was once again sold in 1979 to Laurie Adams, where the business grew, on the closest 25 acres to the highway. Small amounts of hardwood were cut over the next three years and sold as firewood. It was then virtually left in a natural state and the last logging was done in 1991 where 50 spectacular trees, mostly ash with some maple and beech were cut and sold for flooring. The diameters were a minimum of 22 inches and went for 60 feet at that diameter and continued straight for a total length of 80 to 110 feet with 12 inch diameter tops. In 1997, a tornado came through and toppled a few trees and once again, due to heavy leaf, six giant oaks came down with trunk diameters of 30 inches minimum. These were sawn into heavy planks.

02 02 Behmann Property



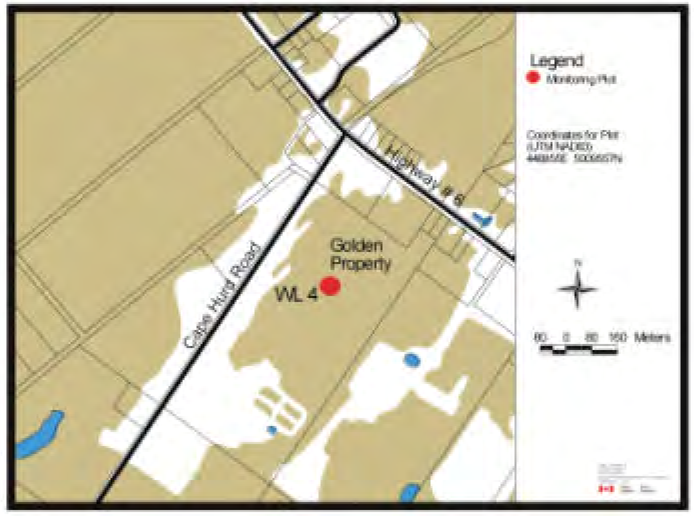
The Behmann Property was originally sold as a 100 acre lot by the Crown to William George Bray in August 1894. It was then sold to the Goderich Lumber Company in June 1899 and was timbered for the next eight years. Charles Pedwell and Charles Lemeke purchased it for "timber only" in December 1907. A road that still exists today in a rough form, winds through the property. It orginally provided southern and eastern access to Miller Lake until Tammy's Cove road was built. In 1924, Archie Rouse and family took over ownership which lasted until 1969. There were many changes in ownership after that over the next 30 years for which the property's use is not specified. Within the last ten years, it was selectively logged for timber and firewood using heavy machinery. In 1997, three lots were severed from the front of the 100 acres leaving 81 acres that was purchased by Birch Behmann in October 1999. The forest is now selectively logged by hand for firewood for an individual household and is also used for part-time outdoor education centre. The approximate 75 acres of bush and 6 acres of clearing are mostly enjoyed for personal recreation including skiing, snowshoeing, swamp skating, hiking, and gardening.

02 03 Greig Property

The original 100 acres of the Greig property was bought by Tessie Greig in the 1950's. Birch was timbered on the property during the 1960's for the production of toothpicks. In 1976, John Greig bought the property, along with two more 100 acre farm lots. In 1982 the lot was timbered again for maple and some birch, which was taken to local mills. Since 1982, John has selectively cut primarily maple trees, taking many of the unhealthy and wind fallen trees for firewood and leaving the healthy trees to stand.

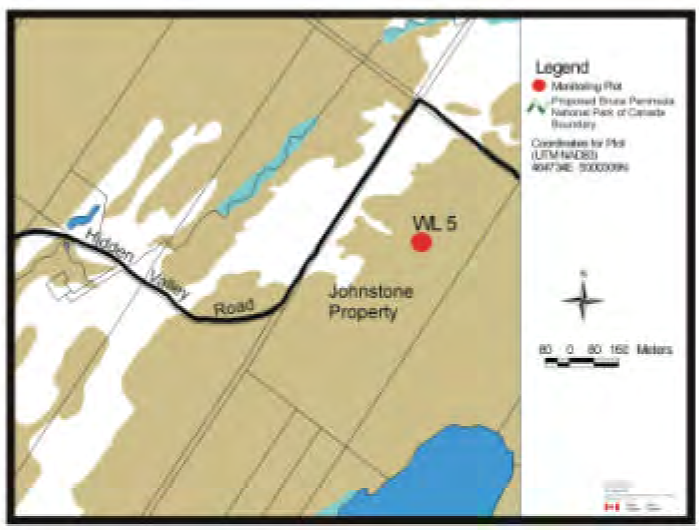
02.b. WORKING LANDSCAPE (02) CEDAR/POPLAR PLOTS

02 04 Golden Property



The house located on the Golden property was built in 1892 and originally used as a post office. Starr Munn bought the 100 acres of land surrounding the house and established a sheep and chicken farm on the property. In 1964, the property changed ownership and firewood was cut. In 1971, Bert Munn harvested all the cedar on the lot and subsequently grazing occurred on the property for the next seven years. Lance and Smokey Golden took over the property in the late 1970's and have selectively cut hardwoods for firewood and pruned balsam fir for retail.

02 05 Johnstone Property



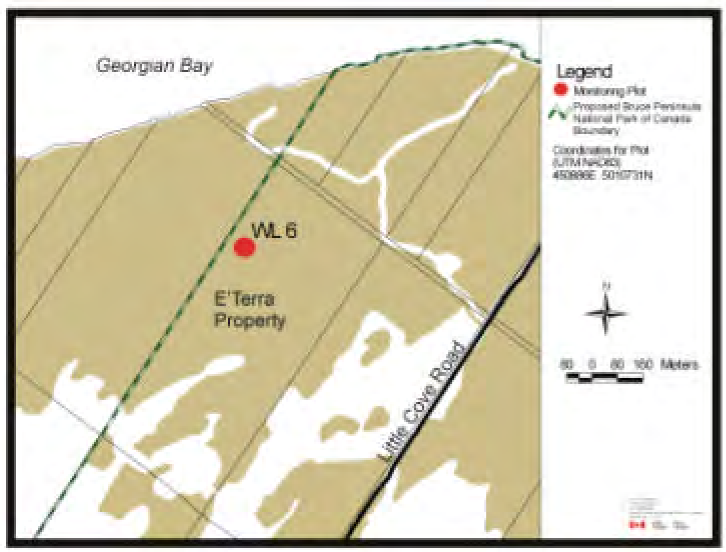
Between 1872 and 1874 James Cockwell purchased four lots near the Crane River. Along with two other lots purchased by Cockwell's son-in-law William Grant, one of the most prosperous lumber operations of St. Edmund's Township was established. By 1875 Cockwell had obtained a timber permit and reported 200,000 feet of pine logs at the mill. The mill was powered by a 20 foot water wheel, drawing power from a dammed portion of the Crane River. The timber from the mill was taken by sleigh ten miles to Pine Tree Harbour where a wharf was built to accommodate loading onto ships. The settlement created around the mill provided over 80 jobs in the winter months including blacksmiths, teamsters, loggers, farmers, cooks, helpers, and other service jobs. In 1881, Cockwell and Grant sold their holding to Robert P. Bearman who operated the mill at a smaller scale until 1889 when it was taken over by William and

Peter McVicar. Unlike the previous owners who only wanted white pine, the McVicars harvested a complete range of logs from their holdings. In 1895, they established a second sawmill at Johnson's Harbour, which between the two processed over two million feet of pine and cedar annually along with birch, ash, basswood, and hemlock.

Charles Pedwell bought the property in 1912, four years after a huge forest fire had swept through the Northern Bruce Peninsula, and established a post office and a new lodge on the property. Its bunkhouse and outbuildings still housed a significant work force to operate the logging operations and enlarging farming operations.

By 1952, the Pedwell operation was sold to J.P. Johnstone of Walkerton, who re-established the logging operation on the property. During this time, pine was primarily harvested.

02 06 E'Terra Property



Originally purchased in 1879 by George Bartman for the purpose of logging – mostly big pines and cedars. Fires went through around the east of the property in the early 1920's and the slash and remaining trees were burned off. It was bought by an older sister of Percy Adams and then sold back into the Adams family in the 1930's. The first major timbering since the late 1890's, was harvesting for pines in 1947 and 1948 which were hauled into Tobermory for the new docks for the Norisle. All timbering was done by horse. Then again Percy and son Cleveland logged cedar using horses on both Lots 47 and 48 in 1956. Over the next few years sections were logged never taking anything smaller than a 12 inch base and posts were cut form the tops. Lot 48 was cut in 1976 for 95% cedar, now using farm tractors, and again in 1987, east of the 'clover' field towards Dunks Bay. Again a few big pines were harvested but mostly cedar logs that would be milled into V-match paneling by Cleve Adams. The last section to be logged was in 1995 by Tony and Brent Adams along with Cleve, and is visible form the laneway. The property was sold in 1999 to daughter Laurie Adams for the purpose of building an environmentally based inn, with no future plans for cedar harvesting.

02 07 Robins Property

A small mill operation was established on the first 100 acres of the Robins property in the 1950's. This mill, owned at the time by Walter Wardrop, sold pine and cedar primarily to local customers. Percy Robins, who ran the mill for a few years for Wardrop, bought the 100 acre lot in the 1960's, later purchasing a few hundred acres more. This became a family operation, with the lot being selectively cut yearly, taking only mature trees. Logs were moved using horses instead of skidders during this time and timbered areas were rotated to prevent clear-cutting. In 1998 Lynn Robins took over the operation and has logged pine and cedar for personal use and retail to local customers.

IV. METHODS

i. Protocols for Forest Biodiversity Monitoring

This Forest Monitoring Program incorporates a suite of monitoring protocols known as the Terrestrial Monitoring Protocols prepared by the Ecological Monitoring and Assessment Network (EMAN). Their purpose is to assess and document long-term changes in forest condition and health. Presently there are 12 indicators. In 2002 we only used the first 4.

1. Canopy Trees
2. Seedling and Sapling Regeneration
3. Ground Vegetation
4. Downed Woody Debris
5. Worm Diversity
6. Lichen Diversity
7. Decay Rate
8. Frog and Toad Diversity
9. Salamander Diversity
10. Invasive Species Abundance
11. Plant Phenology
12. Ice Phenology

The forest monitoring sites are based on the establishment of permanent 20m x 20m forest biodiversity monitoring plots which represent the surrounding forest stand (Figure 4). Within the 20m x 20m monitoring plot the structure, composition and condition of the mature canopy trees are assessed. Each tree within the plot is tagged and identified allowing a map of the plot to be generated and, furthermore, specific trees to be inventories and monitored. Measurements of height and diameter at breast height (dbh) are taken and each tree is assessed for stem defects and crown decline.

To monitor the vegetation regeneration, five 2m x 2m quadrats are established at the site with four located on each side of the 20m x 20m plot and one located at the centre. The outer regeneration quadrats are situated two metres from the 20m x 20m plot boundary to allow for a corridor, thus minimizing impacts from the surveyors. In each of these quadrats the seedlings and saplings are categorized by species into height classes of 20 cm increments.

Ground vegetation is identified using four 1m x 1m quadrats within each of the regeneration quadrats allowing for a total sample size of 20 m^2. Each species found in these quadrats is counted and identified, and 5 of the 20 quadrats are mapped to determine the area that each species occupies.

Using a 45.14m transect around the perimeter of the 20m x 20m plot, the amount of downed woody debris found within the plot is estimated. All debris with a dbh >7cm that intersects the 20m x 20m plot boundary is identified and placed into a decomposition class.

Refer to Appendix 1 and EMAN's Terrestrial Monitoring Protocols Manual for more details.

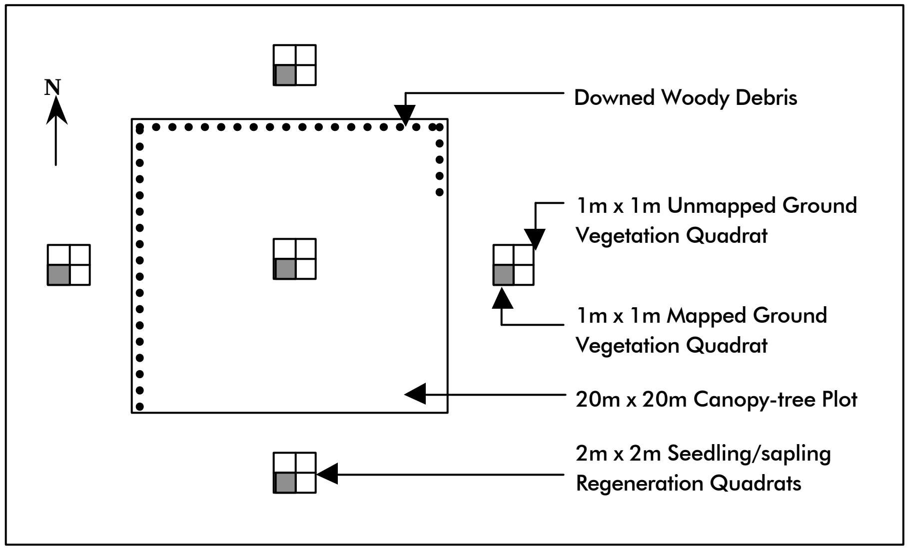


Figure 4. Design of forest monitoring plot.

ii. Data Compilation and Processing

Data for each plot was entered into a Microsoft Excel Spreadsheet for data storage. See Appendix 3 for examples. Using these spreadsheets, initial analyses of each stratum was performed providing the following variables:

Canopy-tree Stratum

Abundance, Basal Area, Density, Relative Density, Dominance, Relative Dominance, Frequency, Relative Frequency, and Importance Value

Seedling and Sapling Regeneration

Abundance, Density, Relative Density, Frequency, and Relative Frequency

Ground Vegetation Stratum

Abundance, Basal Area, Density, Relative Density, Dominance, Relative Dominance, Frequency, Relative Frequency, and Importance Value

iii. Subsequent Plot Inventory

As this monitoring program is based on acquiring a plot data over an extended period of time, a schedule of subsequent monitoring years is necessary. If they are subject to severe weather, fire, or other extreme events, the plots should be re-measured as soon after the event as it is safe.

- **Canopy-tree Stratum**
  Plot inventory and tree condition assessment should be taken every five years. If they are subject to severe weather, fire, or other extreme events, the plots should be re-measured as soon after the event as it is safe.

  1. Check that all corner stakes are in place and replace if necessary
  2. Re-measure dbh of all tagged trees (replace missing tags)
  3. Number, identify, measure dbh and determine location of all small trees that have reached 10 cm dbh
  4. Note the changes in condition of all tagged trees (note tag number and species of the trees that have fallen or died)
  5. Prepare and check a new map for each 20m x 20m plot

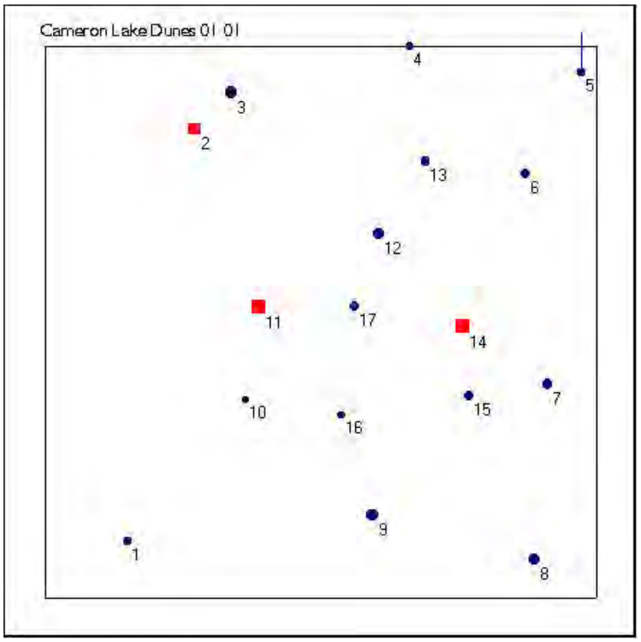
- **Seedling and Sapling Regeneration**
  The regeneration quadrats are measured on the five year schedule at the same time as the canopy-tree stratum measurements. Follow protocols in *EMAN's Terrestrial Monitoring Protocols Manual.*

- **Ground Vegetation Stratum**
  In each of the first two years following quadrat establishment, remap and remeasure those quadrats previously mapped. Every five years or less as necessary the mapped quadrats should be remeasured, remapped, and the species in the unmapped quadrats identified and recounted. It is recommended that these measurements be taken at the beginning and end of the season to ensure that all species are counted and properly identified.

V. RESULTS

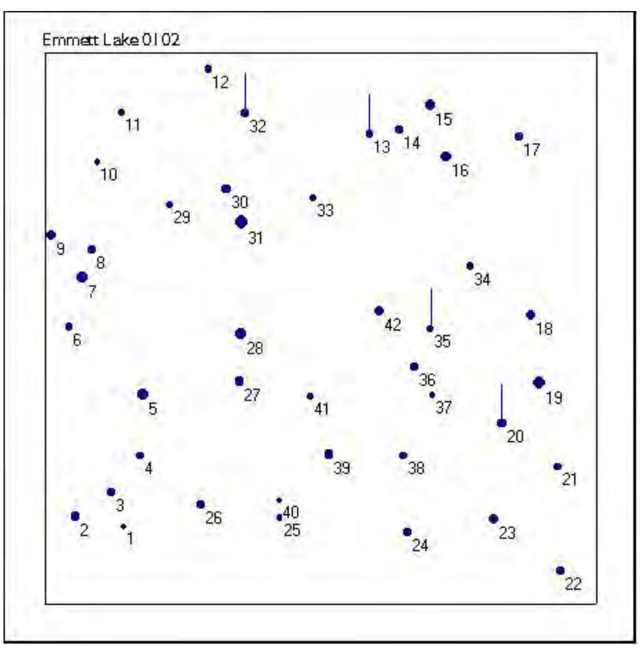
01.a: Protected Area Hardwood Plots

Cameron Lake Dunes 01-01



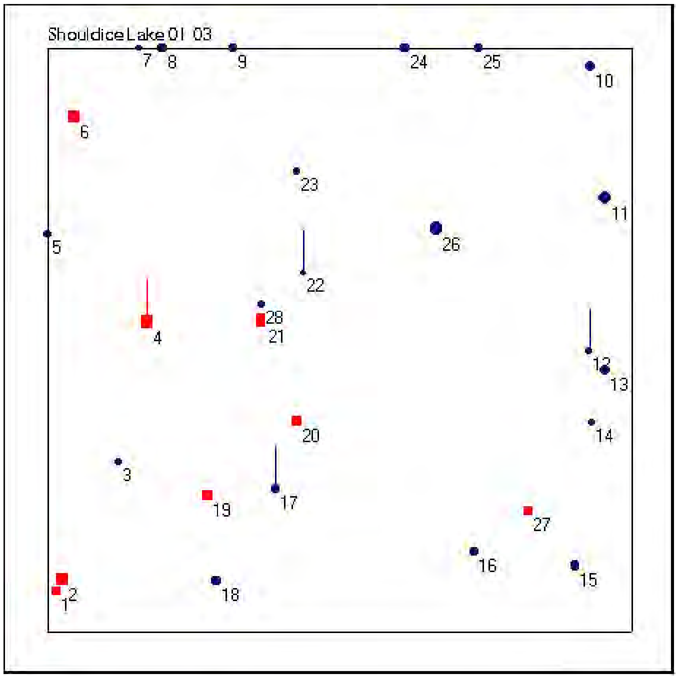
Mean Stand Age
60.0 years (min=43, max=76)
Total Stand Density
0.0425 per sq. m
Mean Stand Height
23.63 m (SD=5.73, max=31.8, min=12.9)
Mean DBH
28.69 cm (SD=10.25, max=42.1, min=13.4)
Dominant Canopy Species
Hard Maple
Dominant Regeneration Species
Hard Maple
Dominant Ground Vegetation
Hard Maple

Emmett Lake 01-02



Mean Stand Age
56.2 years (min=31, max=104)
Total Stand Density
0.0725 per sq. m
Mean Stand Height
13.45 m (SD=5.36, max=23.4, min=2.07)
Mean DBH
20.90 cm (SD=8.65, max=49.8, min=10.5)
Dominant Canopy Species
Hard Maple
Dominant Regeneration Species
Balsam Fir
Dominant Ground Vegetation
Wild Sarsaparilla

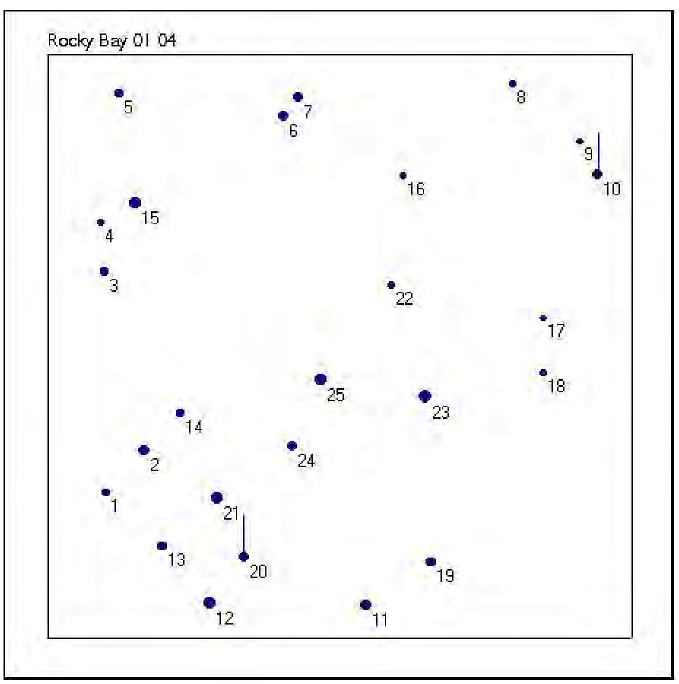
Shouldice Lake 01-03



Mean Stand Age
50.6 years (min=26, max=66)
Total Stand Density
0.0775 per sq. m
Mean Stand Height
16.25 m (SD=6.17, max=26.8, min=3.1)
Mean DBH
19.36 cm (SD=7.86, max=45.2, min=10.4)
Dominant Canopy Species
Hard Maple
Dominant Regeneration Species
Hard Maple
Dominant Ground Vegetation
White Birch

Rocky Bay 01-04

Mean Stand Age



52.0 years (min=25, max=86)
Total Stand Density
0.055 per sq. m
Mean Stand Height
19.84 m (SD=5.70, max=29.6, min=9.15)
Mean DBH
22.86 cm (SD=9.58, max.=40.2, min=10.1)
Dominant Canopy Species
Hard Maple
Dominant Regeneration Species
Hard Maple
Dominant Ground Vegetation
Hard Maple

01.a. Comparisons within protected area hardwood plots

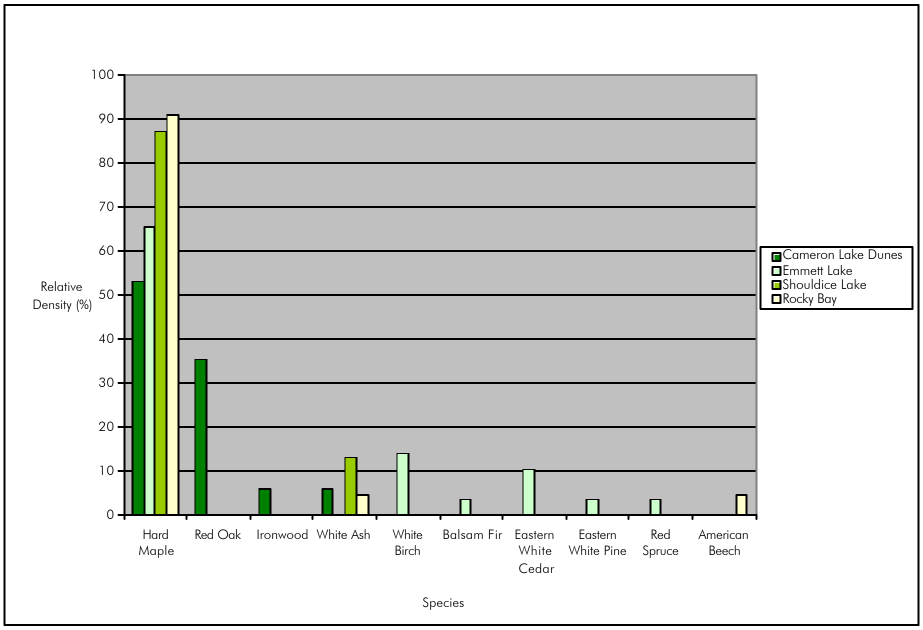


Figure 5: Over story species relative density (%) in protected area hardwood plots 2002 .

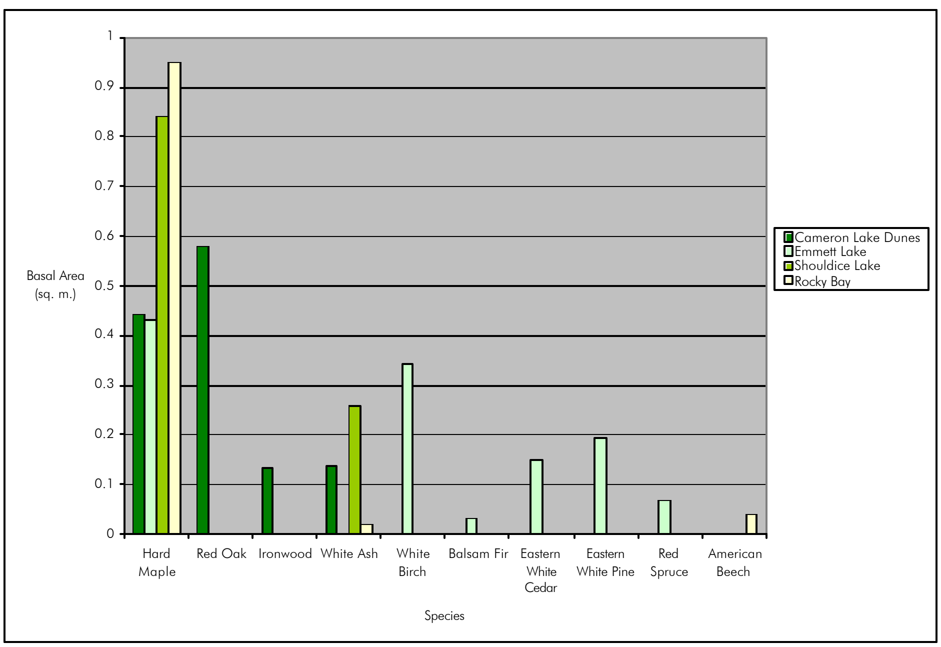


Figure 6: Basal Area (sq. m.) by overstory species in protected area hardwood plots 2002.

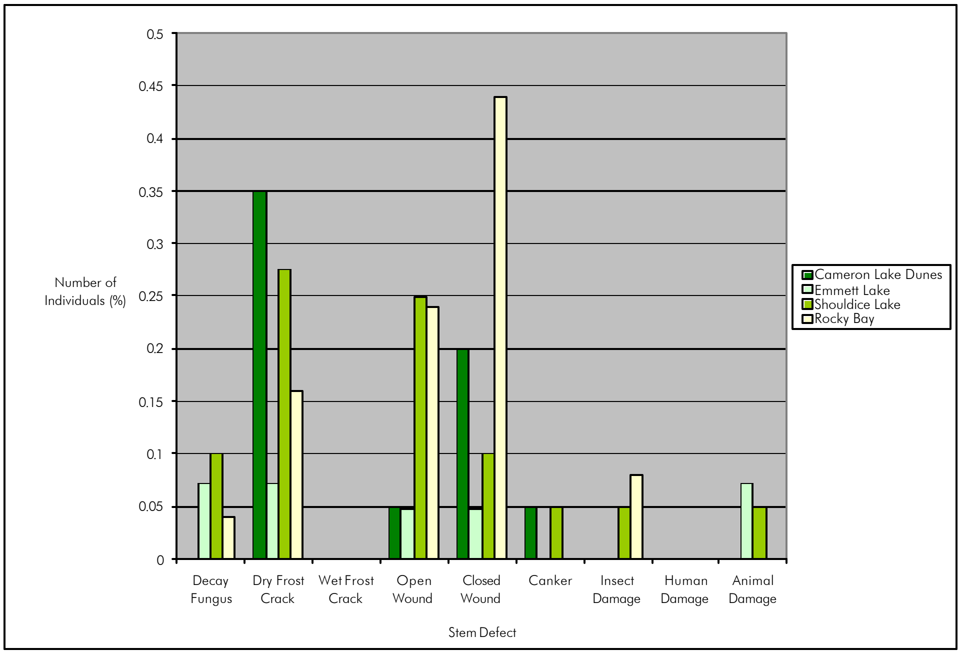


Figure 7: Type of stem defects (% of individuals) in protected area hardwood plots 2002.

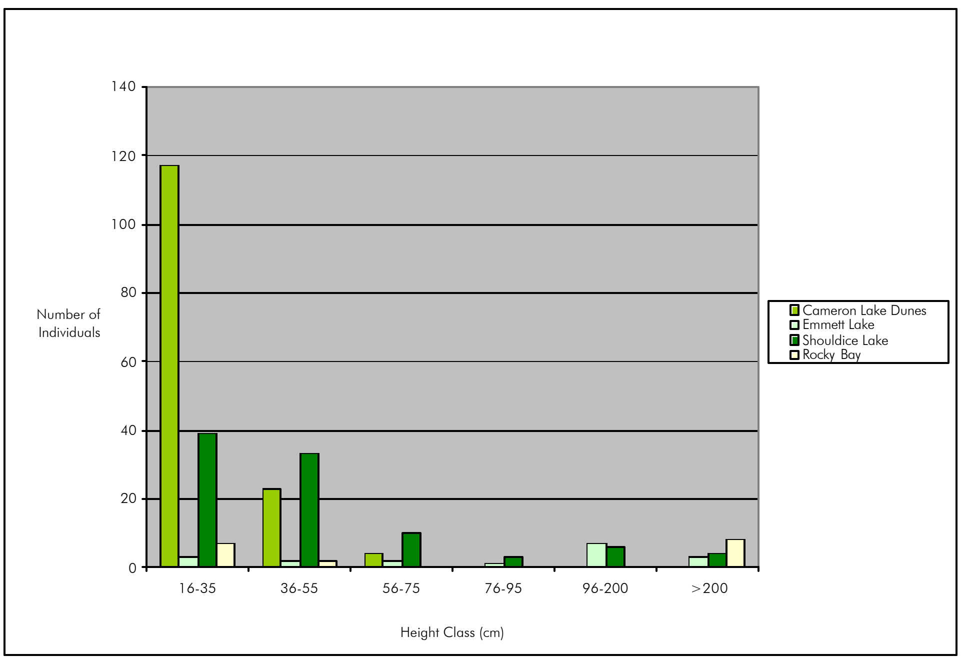


Figure 8: Number of individual tree stems by regeneration height class in protected area hardwood plots 2002 .

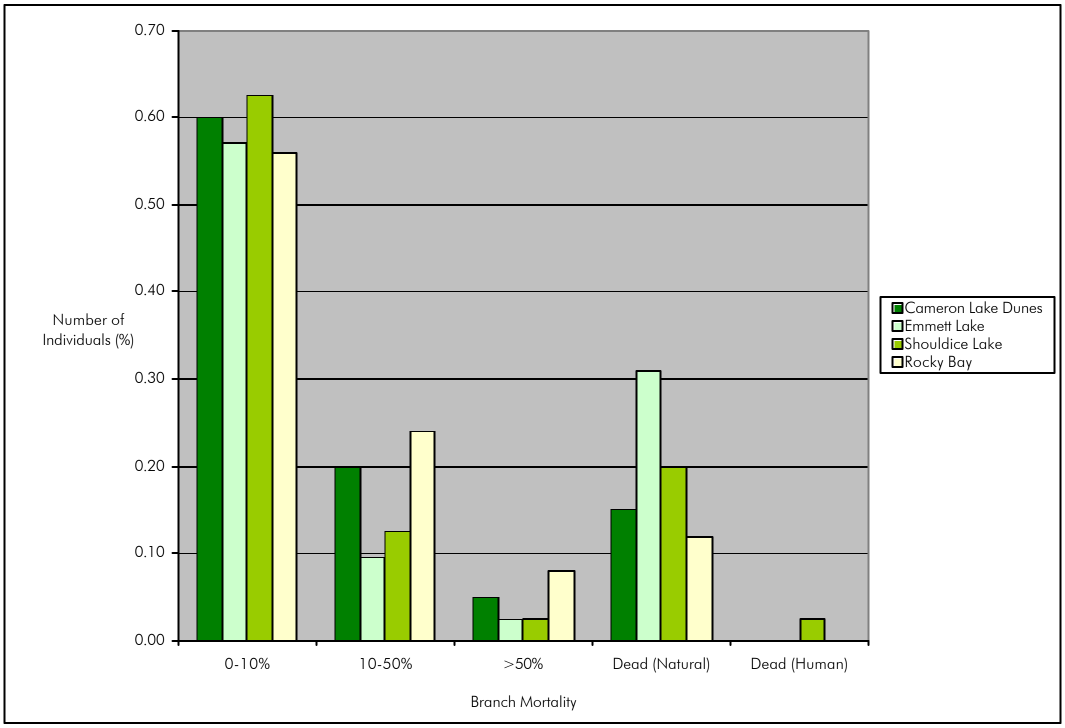


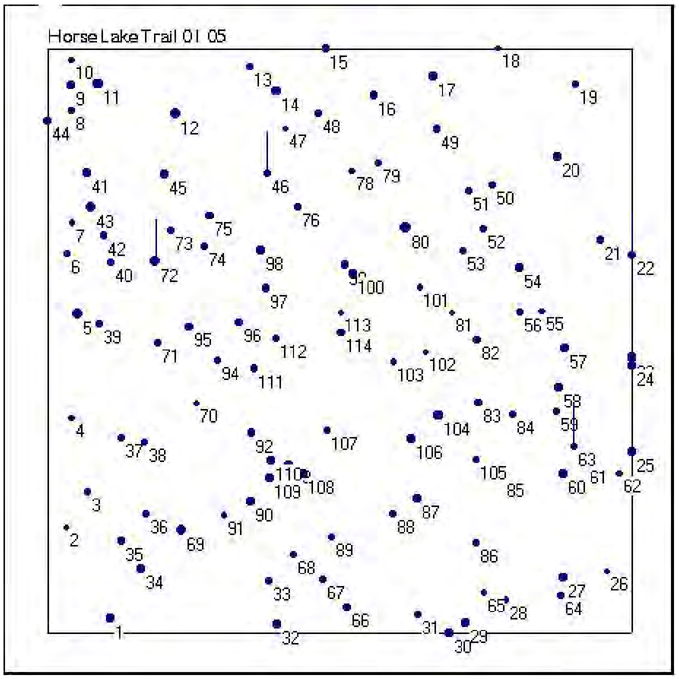
Figure 9: % Branch mortality by class in protected area hardwood plots 2002.

GROUND VEGETATION SPECIES	CAMERON LAKE DUNES	EMMETT LAKE	SHOULDICE LAKE	ROCKY BAY
Balsam Fir	1	8	1	-
Bearded Shorthusk Grass	1	-	-	-
Canada Mayflower	2	22	-	5
False Solomon's Seal	-	8	-	-
Hard Maple	311	7	90	20
Helleborine	-	11	3	2
Ironwood	3	-	-	-
Poison Ivy	-	1	-	-
Red Oak	4	1	-	-
Shining Club Moss	13	-	-	-
Starflower	-	12	-	1
White Ash	30	5	7	3
White Baneberry	-	1	-	-
White Birch	-	-	26	-
White Trillium	-	16	-	-
Wild Sarsaparilla	-	76	5	-

Table 1. Abundance of ground vegetation species within the 1m x 1m sample area at each of the protected area hardwood sites.

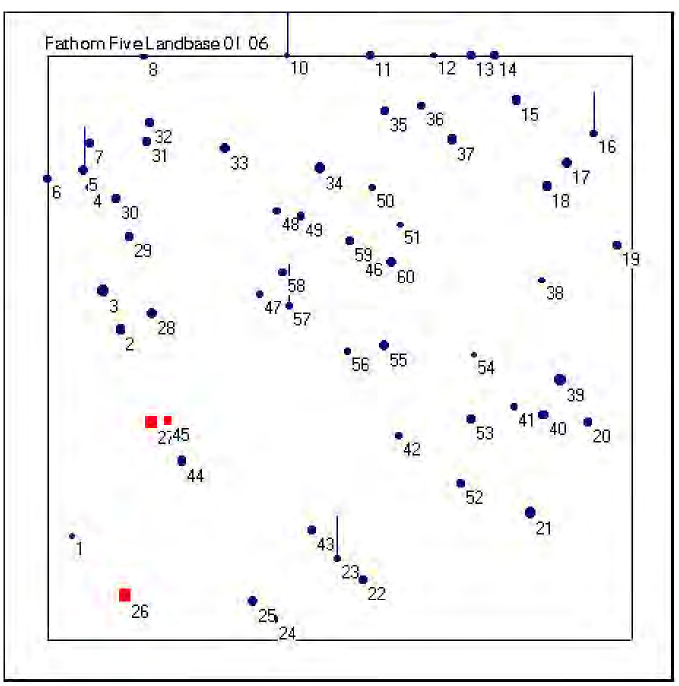
01.b. Protected Area Cedar/Poplar Plots

Horse Lake Trail 01-05



Mean Stand Age
75.6 years (min=64, max=86)
Total Stand Density
0.255 per sq. m
Mean Stand Height
11.80 m (SD=3.37, max=20.8, min=1.8)
Mean DBH
15.93 cm (SD=4.25, max=30.4, min=10.0)
Dominant Canopy Species
Eastern White Cedar
Dominant Regeneration Species
White Birch
Dominant Ground Vegetation
Large-leaved Aster

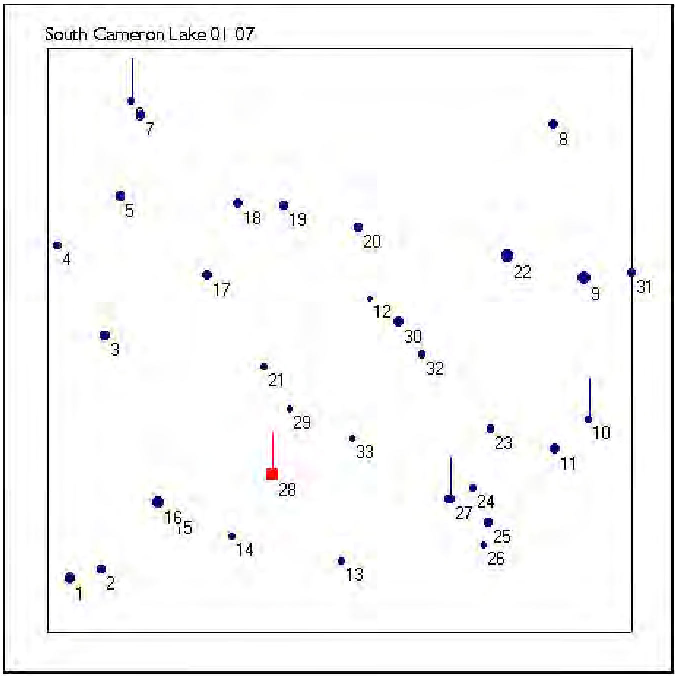
Fathom Five Landbase 01-06



Mean Stand Age
94.2 years (min=44, max=173)
Total Stand Density
0.14 per sq. m
Mean Stand Height
8.77 m (SD=2.41, max=16.1, min=2.3)
Mean DBH
18.86 cm (SD=5.87, max=30.6, min=10.1)
Dominant Canopy Species
Eastern White Cedar
Dominant Regeneration Species
Baslam Fir
Dominant Ground Vegetation
Balsam Fir

South Cameron Lake 01-07

Mean Stand Age



70 years (min=57, max=80)

Total Stand Density

0.0625 per sq. m

Mean Stand Height

12.40 m (SD=6.51, max=29.6, min=1.9)

Mean DBH

20.80 cm (SD=8.53, max=46.1, min=10.0)

Dominant Canopy Species

Eastern White Cedar

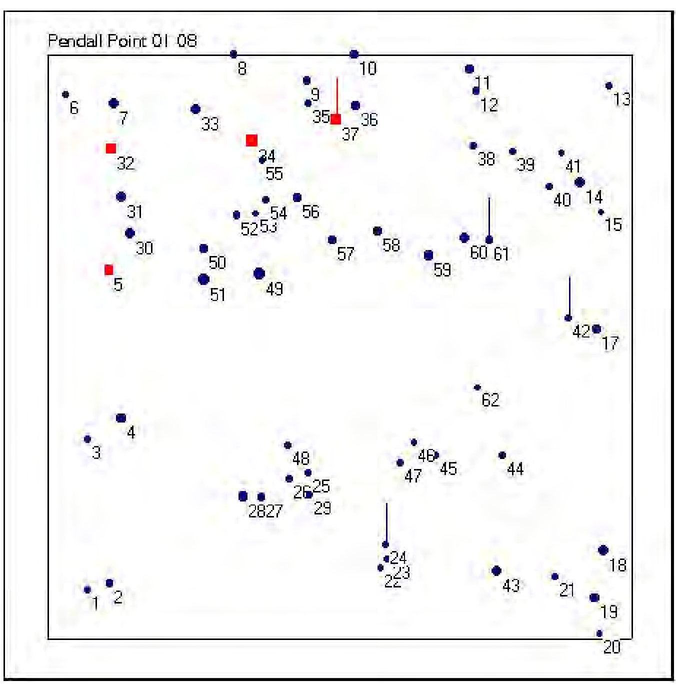
Dominant Regeneration Species

Balsam Poplar

Dominant Ground Vegetation

Baslam Fir

Pendall Point 01-08



Mean Stand Age

50.4 years (min=43, max=63)

Total Stand Density

0.15 per sq. m

Mean Stand Height

10.80 m (SD=3.02, max=15.4, min=3.23)

Mean DBH

17.13 cm (SD=5.86, max=36.0, min=10.1)

Dominant Canopy Species

Eastern White Cedar

Dominant Regeneration Species

Balsam Fir

Dominant Ground Vegetation

Large-leaved Aster

01.b. Comparisons within protected area cedar/poplar plots

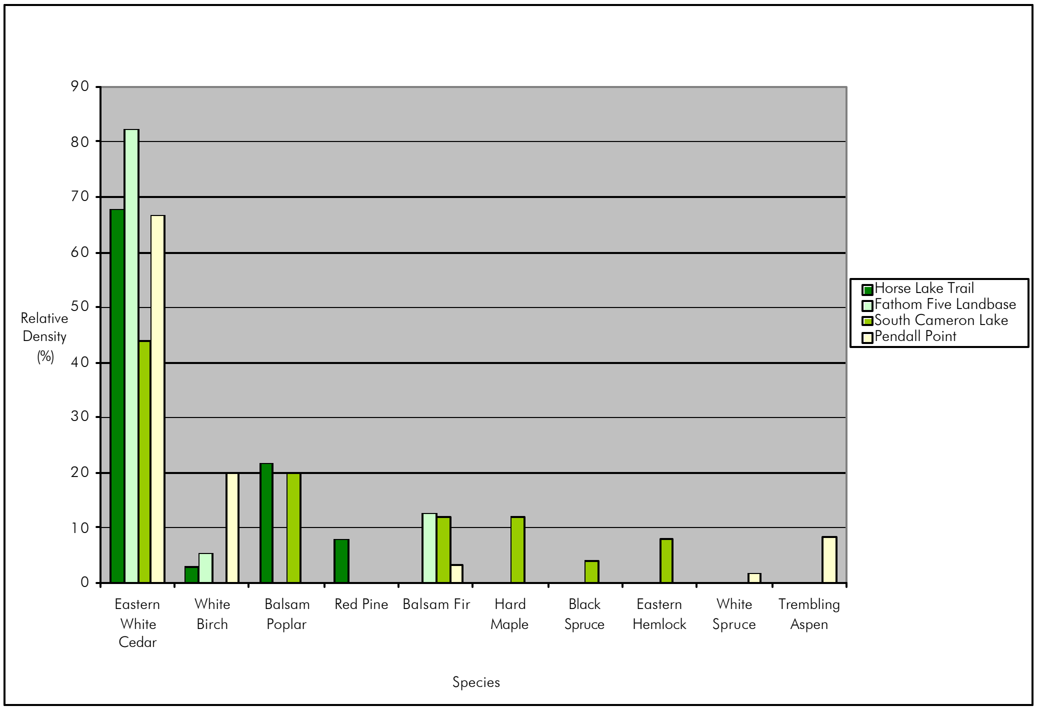


Figure 10: Relative density of overstory trees in protected area cedar/poplar plots 2002.

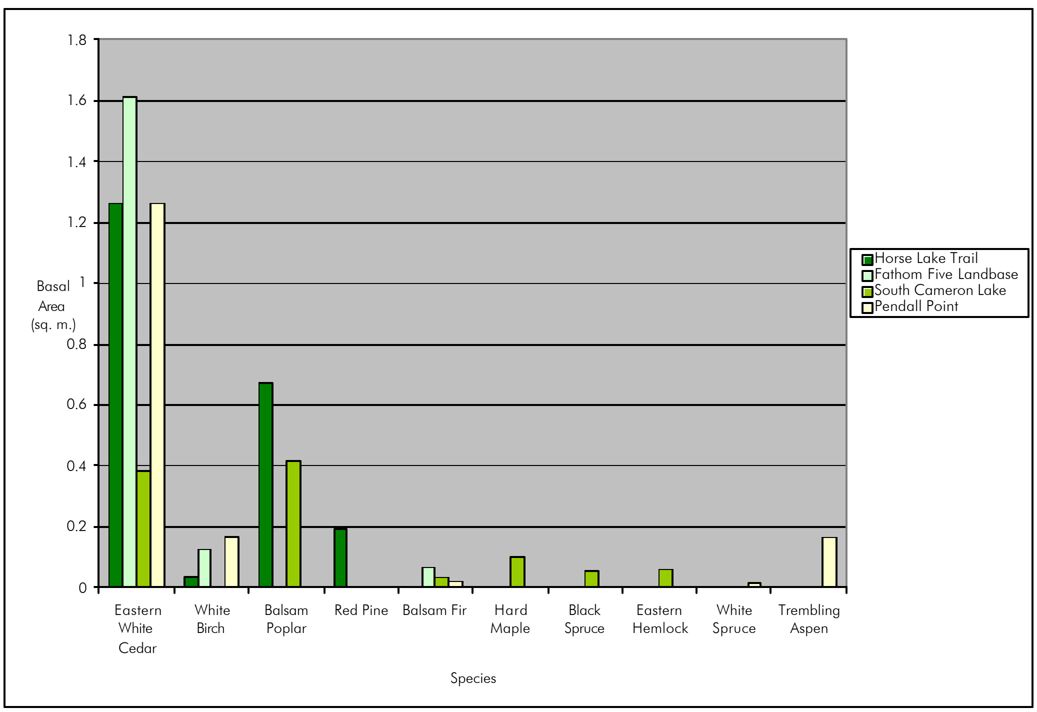


Figure 11: Basal Area in sq. m. by overstory species protected area cedar/poplar plots 2002.

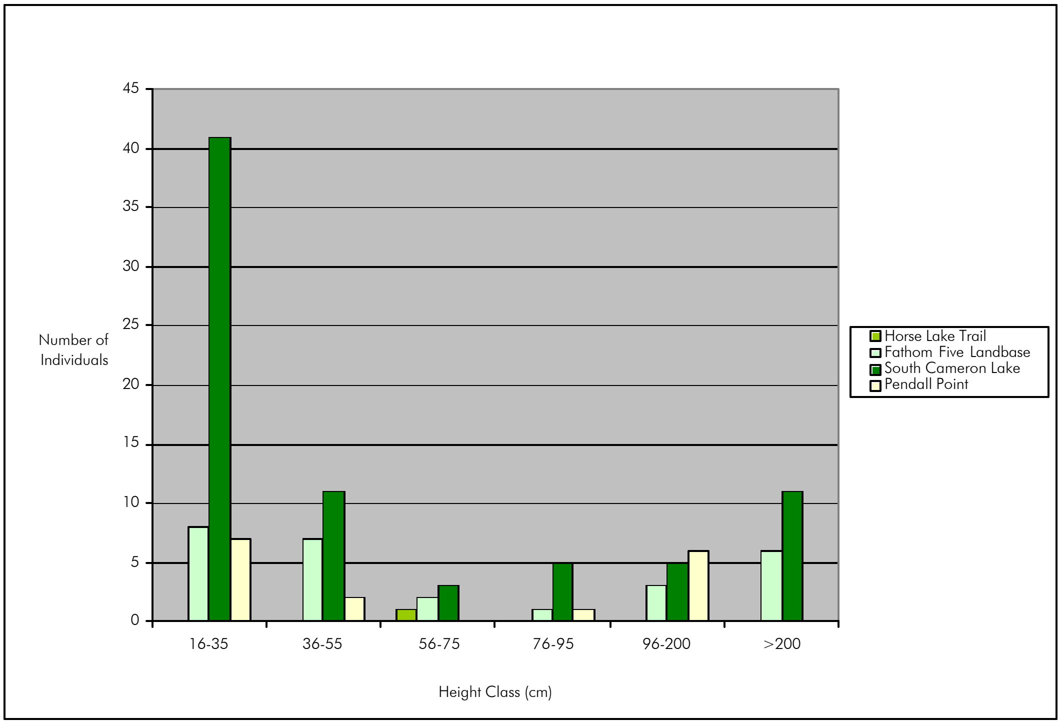


Figure 12: Number of individuals by regeneration height class in protected area cedar/poplar plots 2002.

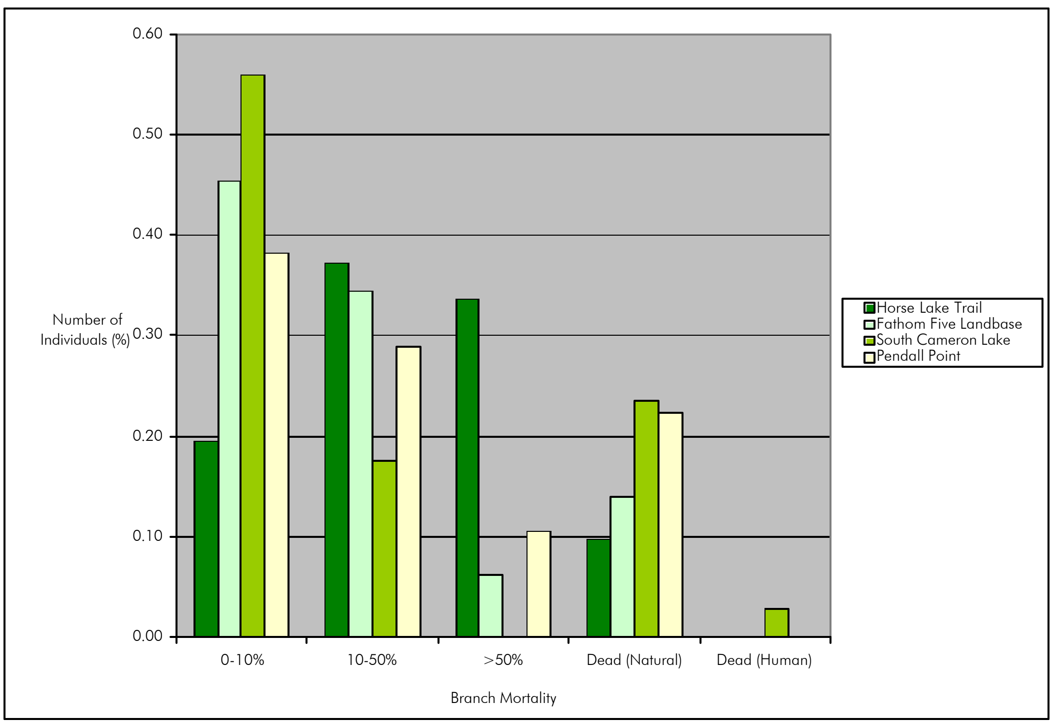


Figure 13: Percent stems with branch mortality (by class) in protected area cedar/poplar plots 2002.

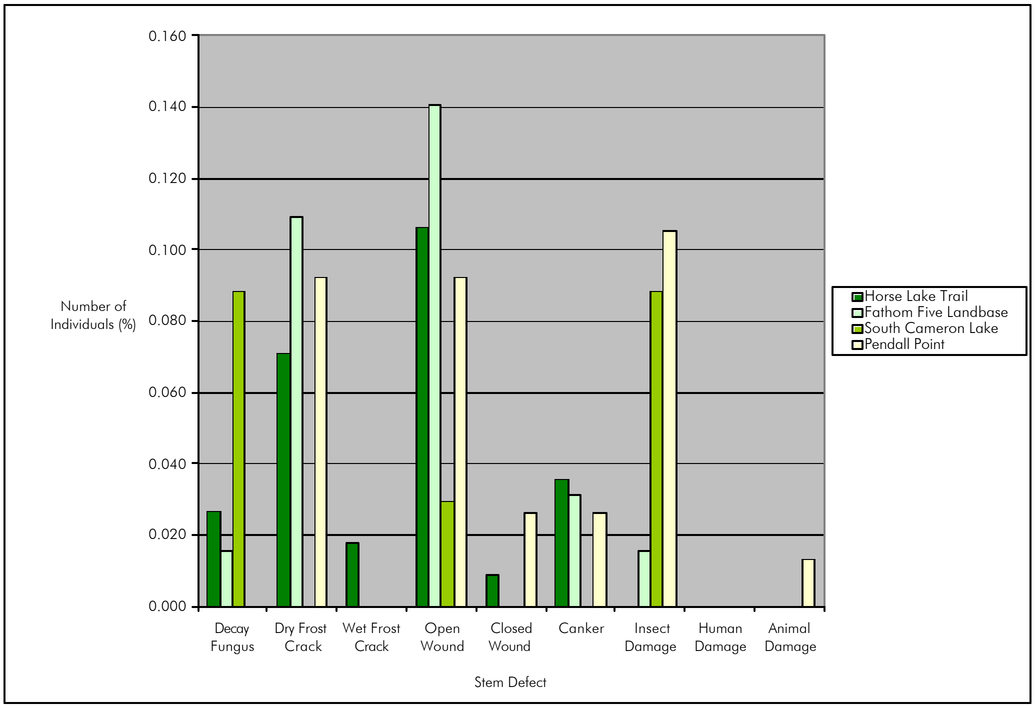


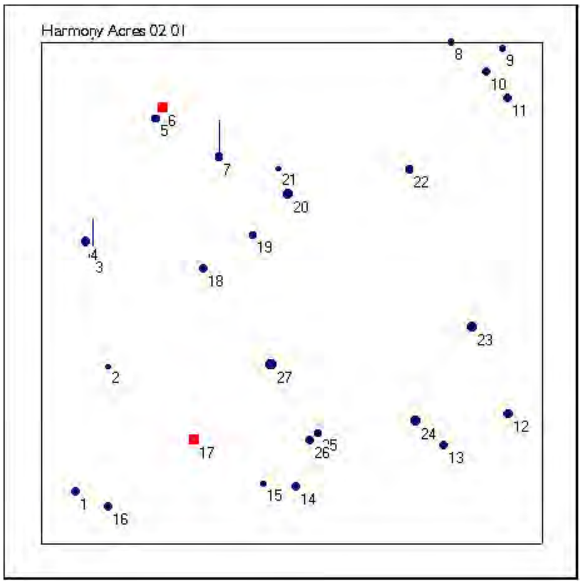
Figure 14: Number of individuals with stem defects (by type) in protected area cedar/poplar stands 2002.

GROUND VEGETATION SPECIES	HORSE LAKE TRAIL	FATHOM FIVE LANDBASE	SOUTH CAMERON LAKE	PENDALL POINT
Hard Maple			5	
Balsam Fir		61	28	9
Canada Mayflower	2	4		68
Eastern White Cedar		28	7	2
Fringed Polygala		3		208
Green-leaved Rattlesnake Plantain	3	1		
Helleborine	1			
Large-leaved Aster	14			114
Starflower		45	5	22
Balsam Poplar			30	
Striped Maple			1	
White Baneberry		2		
White Birch	1			
White Pine		1		
Bracken Fern			12	
Wild Sarsaparilla		4		
Bunchberry				12
White Ash			16	
Wood Strawberry				11
Yarrow		1		

Table 2. Abundance of ground vegetation species within the 1m x 1m sample area at each of the protected area cedar/poplar monitoring plots.

02.a. Working Landscape Hardwood Plots

Harmony Acres Property 02-01



Mean Stand Age
62 years (min=46, max=73)
Total Stand Density
0.07 per sq. m
Mean Stand Height
21.26 m (SD=5.26, max=27.6, min=7.12)
Mean DBH
23.57 cm (SD=7.17, max=39.1, min=11.7)
Dominant Canopy Species
Hard Maple
Dominant Regeneration Species
White Ash
Dominant Ground Vegetation
Hard Maple

I. Canopy-tree Stratum

The monitoring plot established on the Harmony Acres property was situated in a dominant hardwood stand with a mean stand age of 62 years. The mean height of the stand was 21.26m (SD=5.26, max=27.6, min=7.12) and the mean dbh of trees within the plot was 23.57 cm (SD=7.17, max=39.1, min=11.7). Hard maple (*Acer saccharum* Marsh) was the only species present within the canopy-tree stratum having 28 living trees within the plot. The total tree density within the Harmony Acres plot was 0.07 trees per square metre with hard maple having a dominance of 0.0034. Based on the cross-section area of each tree stem, hard maple had a total basal area of 1.38 m^2.

Crown rating assessments showed that the Harmony Acres stand was in good health with 63.3% of the trees having minimal decline (<10% branch mortality), 30% having light to moderate decline (10-50% branch mortality), and only 6.7% were dead as a result of natural events.

Stem defects were found on 66.7% of the mature hard maple trees within the Harmony Acres plot. Open wounds, dry frost cracks, and closed wounds were the predominant defects, found on 23.3%, 20.0%, and 16.7% of the trees, respectively. Both cankers and insect damage were also present in the plot, however, each were only found on 3.3% of the trees.

ii. Seedling and Sapling Regeneration

Four species were found within the 2m x 2m regeneration quadrats at Harmony Acres, with white ash being the dominant seedling. Seedling abundance declined as the height class increased with the 16-35 cm height class having the highest abundance of seedlings.

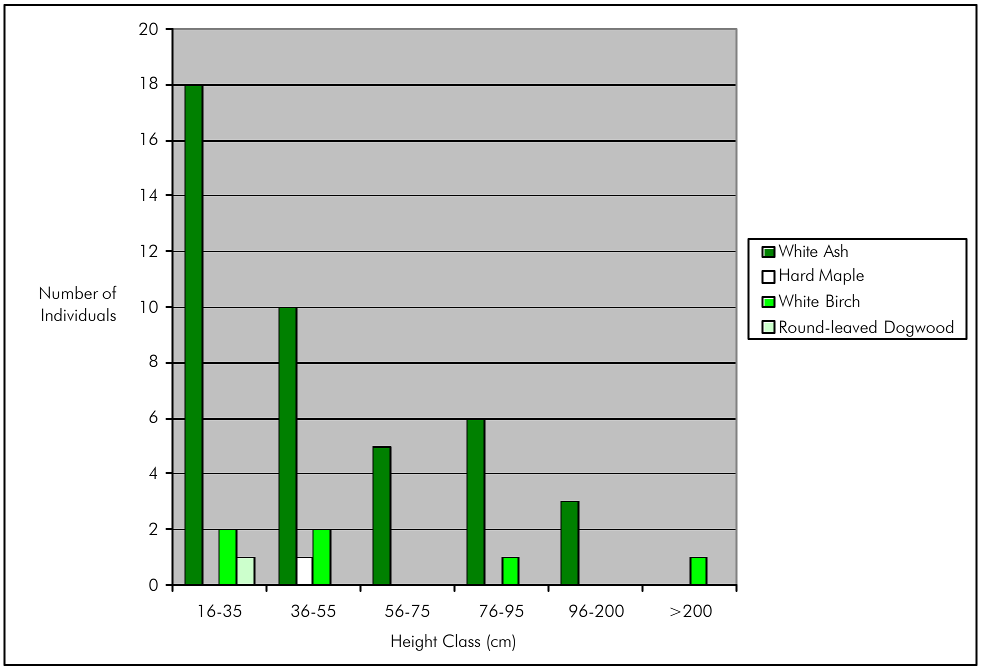


Figure 15. Mean number of individuals by species within each regeneration height class

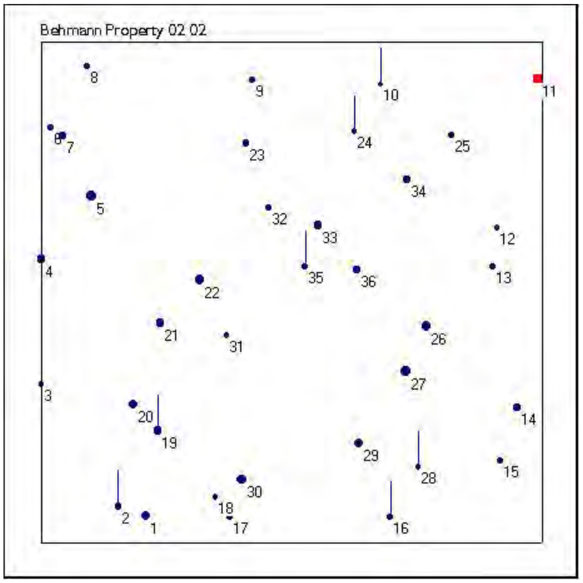
iii. Ground Vegetation

Ten species were located in the total ground vegetation sample area with white ash being the dominant species within the 20 unmapped one square metre quadrats. White ash, large-leaved aster and wild leeks had the highest densities of 2.60 per square metre, 2.35 per square metre, and 1.30 per square metre, respectively.

White ash was the species of highest frequency throughout the Harmony Acres stand, located in 70% of the ground vegetation quadrats, wild leeks were found in 35% and large-leaved aster was found in 20%.

Only five of the total species were located in the mapped ground vegetation quadrats, and as a result, cover area and dominance could only be determined for these species. Based on the ground cover area that each species occupied, white ash was the dominant ground vegetation species occupying 1.53 m^2, giving it a relative dominance of 62.62.

Behmann Property 02-02



Mean Stand Age
57.4 years (min=36, max=80)
Total Stand Density
0.07 per sq. m
Mean Stand Height
16.14 m (SD=5.68, max=25.2, min=3.29)
Mean DBH
18.06 cm (SD=7.53, max=37.2, min=10.4)
Dominant Canopy Species
Hard Maple
Dominant Regeneration Species
White Ash
Dominant Ground Vegetation
Canada Mayflower

I. Canopy-tree Stratum

The Behmann property monitoring plot was located in a dominant hardwood stand with a mean stand age of 57.4 years. The mean height of the stand was 16.14 m (SD=5.68, max=25.2, min=3.29) and the mean dbh of trees within the plot was 18.06 cm (SD=7.53, max=37.2, min=10.4). Four species were present within the sample area with hard maple (*Acer saccharum* Marsh) being the dominant species. The stand was composed of 23 living hard maple, one ironwood, and two of both american beech and white ash.

The total Behmann stand density was 0.07 trees per square metre with hard maple having a relative dominance of 67.65 within the sample area, compared to 22.36 for white ash, 8.75 for american beech, and 1.25 for ironwood. Based on the cross-section area of each tree stem, hard maple had a total basal area of 0.613 m^2 in comparison to 0.203 m^2, 0.079 m^2, and 0.011 m^2 for white ash, american beech, and ironwood, respectively.

Crown rating assessments showed that the Behmann stand had low branch mortality as 57.9% of the trees had minimal decline (<10% branch mortality), 10.5% had light to moderate decline (10-50% branch mortality), and only 5.3% had severe decline. A high number of dead trees were found within the plot having 23.7% of the total trees dead as a result of natural events and 2.6% dead from human activity.

Stem defects were found on only 36.8% of the mature trees within the Behmann plot. Open and closed wounds were the predominant defects, which were both present on only 10.5% of the mature trees, while decay fungus and dry frost cracks were found on 5.3%.

ii. Seedling and Sapling Regeneration

Only ten seedlings were found in the 2m x 2m regeneration quadrats at the Behmann monitoring plot. Of the four species found, white ash composed 40.0% of the total seedlings in the quadrat and leatherwood composed 30.0%.

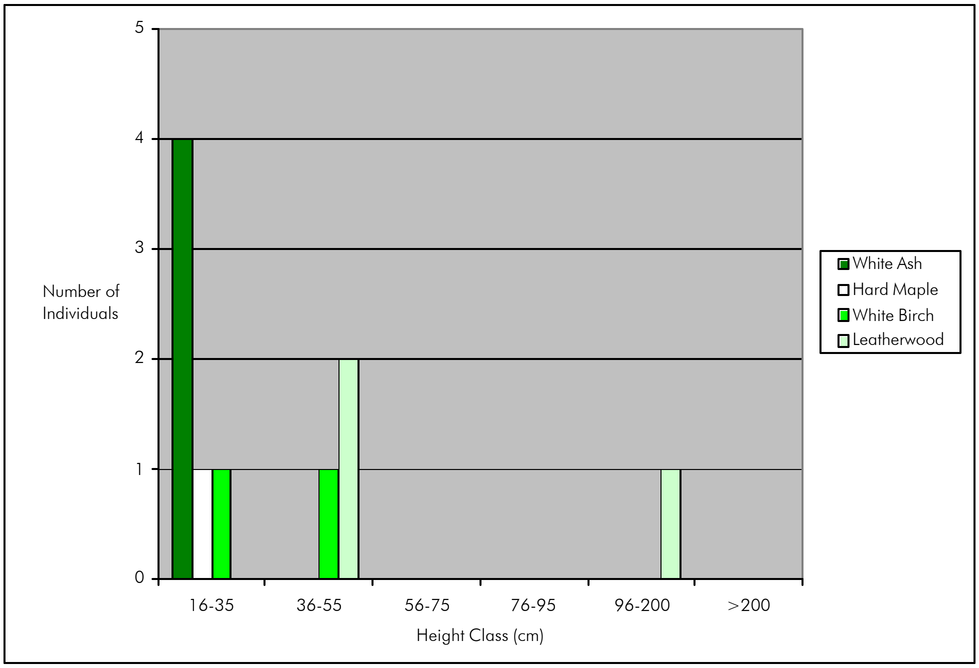


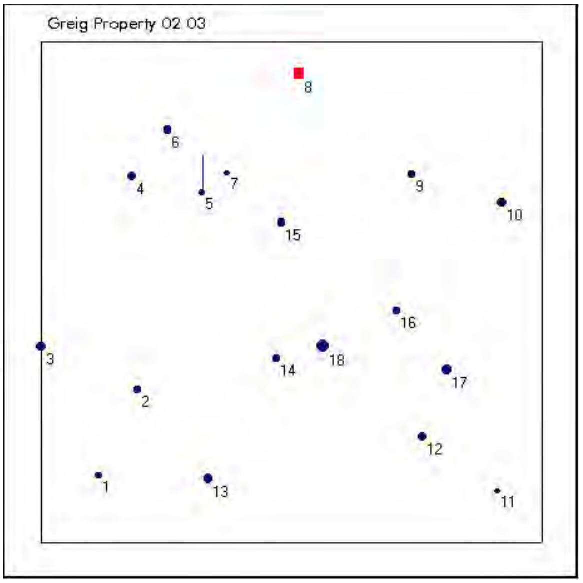
Figure 16. Mean number of individuals by species within each regeneration height class.

iii. Ground Vegetation

Eleven species were located in the total ground vegetation sample area at the Behmann plot with Canada mayflower having the highest density of 3.05 per square metre and the highest frequency, located in 70% of the ground vegetation quadrats.

Cover area and dominance could only be determined for the four species located in the mapped ground vegetation quadrats. Based on the ground cover area that each species occupied, Canada mayflower was the dominant ground vegetation species occupying 0.0061 m^2, giving it a relative dominance of 57.01.

Greig Property 02-03



Mean Stand Age
57.6 years (min=45, max=84)
Total Stand Density
0.0425 per sq. m
Mean Stand Height
22.09 m (SD=7.79, max=30.6, min.=4.2)
Mean DBH
23.96 cm (SD=9.58, max=49.3, min=11.0)
Dominant Canopy Species
Hard Maple
Dominant Regeneration Species
Hard Maple
Dominant Ground Vegetation
Hard Maple

I. Canopy-tree Stratum

The Greig property monitoring plot was established in a dominant hardwood stand that had a mean stand age of 57.6 years. The mean height of the stand was 22.09 m (SD=7.79, max=30.6, min.=4.2) and the mean dbh of trees within the plot was 23.96 cm (SD=9.58, max.=49.3, min=11.0). Hard Maple (*Acer saccharum* Marsh) was the dominant species within the canopy-tree stratum having 16 living trees while only one ironwood was present.

The total Greig property stand density was 0.0425 trees per square metre with hard maple having a dominance of 0.0022 within the sample area compared to 0.0002 for ironwood. Based on the cross-section area of each tree stem, hard maple had a total basal area of 0.87 m^2 in comparison to 0.06 m^2 for ironwood.

Crown rating assessments showed that the Greig stand was in good health with 78.9% of the mature trees having minimal decline (<10% branch mortality), 10.5% having light to moderate decline (10-50% branch mortality), and no trees showing severe decline (>50% branch mortality). Only 10.5% of the mature trees were dead as a result of natural events and none were dead by human activity.

Stem defects were found on 63.2% of the mature trees within the Greig plot. Open wounds were the predominant defects, which were found on 47.4% of the mature trees. Closed wounds, decay fungus, and dry frost cracks were found in minimal numbers, each present on 5.3% of the mature trees.

ii. Seedling and Sapling Regeneration

Hard maple and white ash were the only species found in the 2m x 2m regeneration quadrats with hard maple representing the dominant seedling/sapling. The predominant height class was 36-55 cm with 24 seedlings present, while 12 were within the 16-35 cm height and 14 were within the 56-75 cm height class. Seedlings were also found to be in the 76-95 cm and 96-200 cm height classes, only with fewer individuals. Eleven saplings (>200 cm) were also located within the regeneration quadrats.

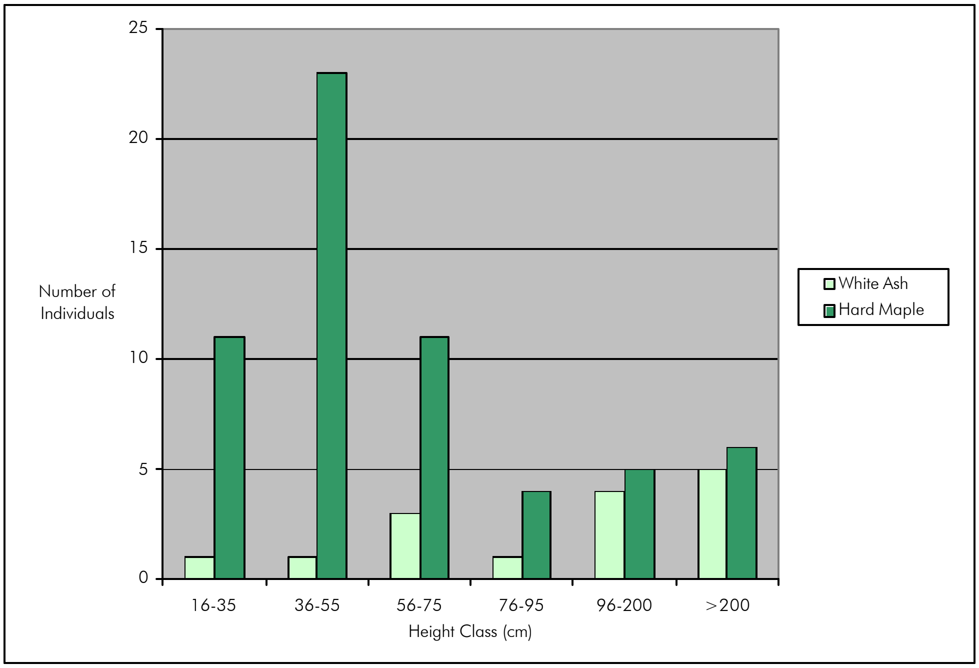


Figure 17. Mean number of individuals by species within each regeneration height class.

iii. Ground Vegetation

Four species were located in the total ground vegetation sample area with hard maple being the dominant species within the 20 unmapped one square metre quadrats. Hard maple had the highest density of 3.60 per square metre, while white ash, wild leek, and bulblet fern had densities of 0.95, and 0.75, and 0.25 respectively.

Hard maple was the species of highest frequency throughout the Harmony Acres stand, located in 80% of the ground vegetation quadrats, while white ash, wild leeks and bulblet ferns had a frequency of 55%, 40%, and 20%, respectively.

Based on the ground cover area that each species occupied, white ash was the dominant ground vegetation species occupying 1.86 m^2, giving it a relative dominance of 62.62. Hard maple, bulblet fern, and wild leek occupied 1.04 m^2, 0.27 m^2, and 0.03 m^2, respectively.

02.a. Comparison within Working Landscape Hardwood Plots

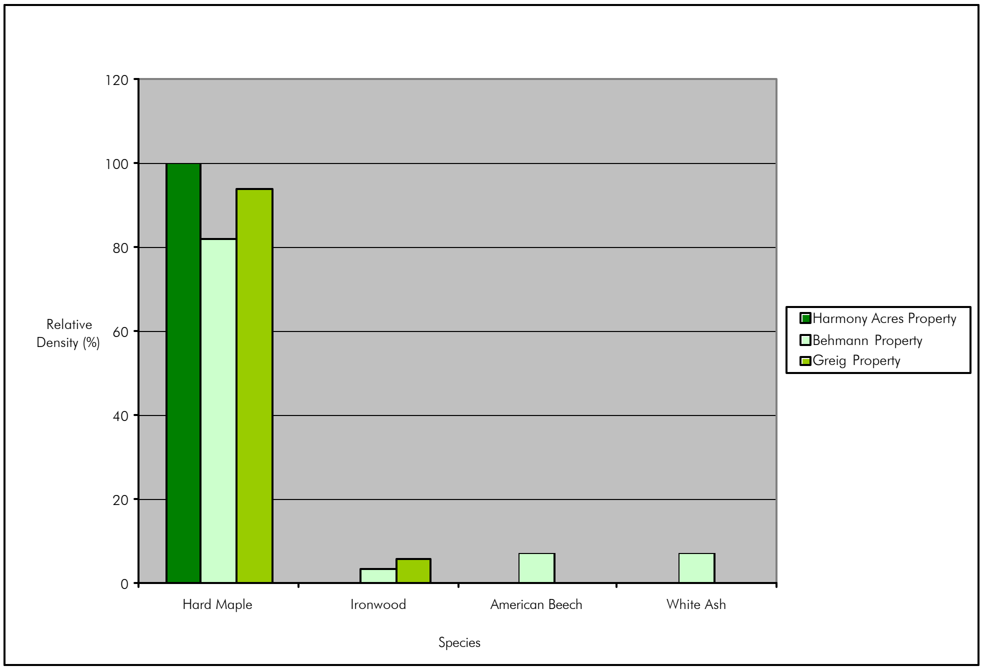


Figure 18: Relative Density of overstory species in working landscape hardwood plots 2002.

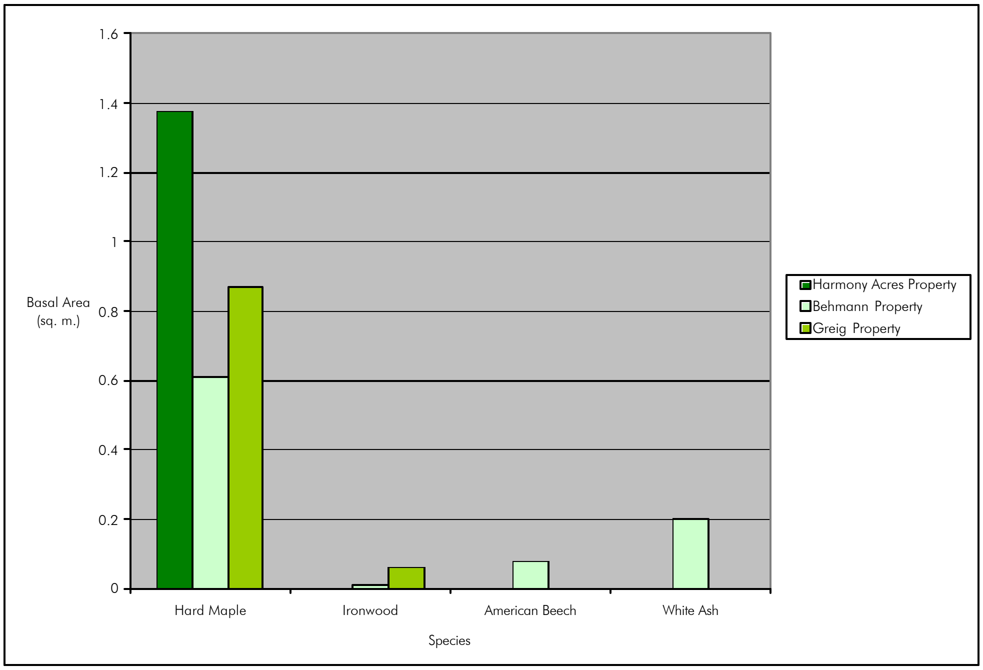


Figure 19: Basal area (sq m) of overstory species in working landscape hardwood plots 2002.

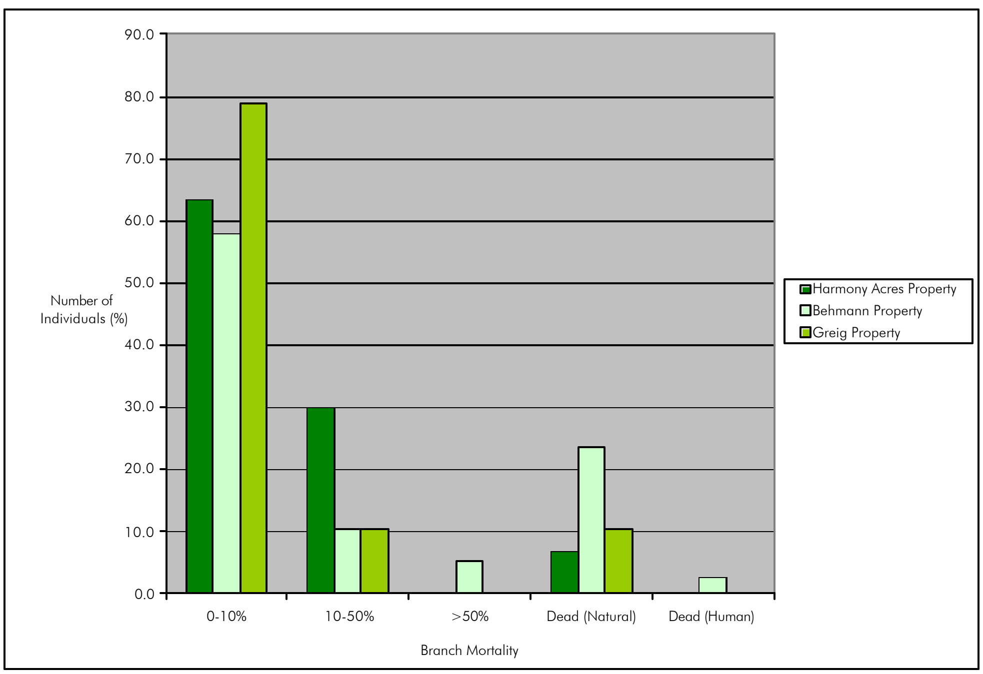


Figure 20: Branch Mortality by class in working landscape hardwood plots 2002.

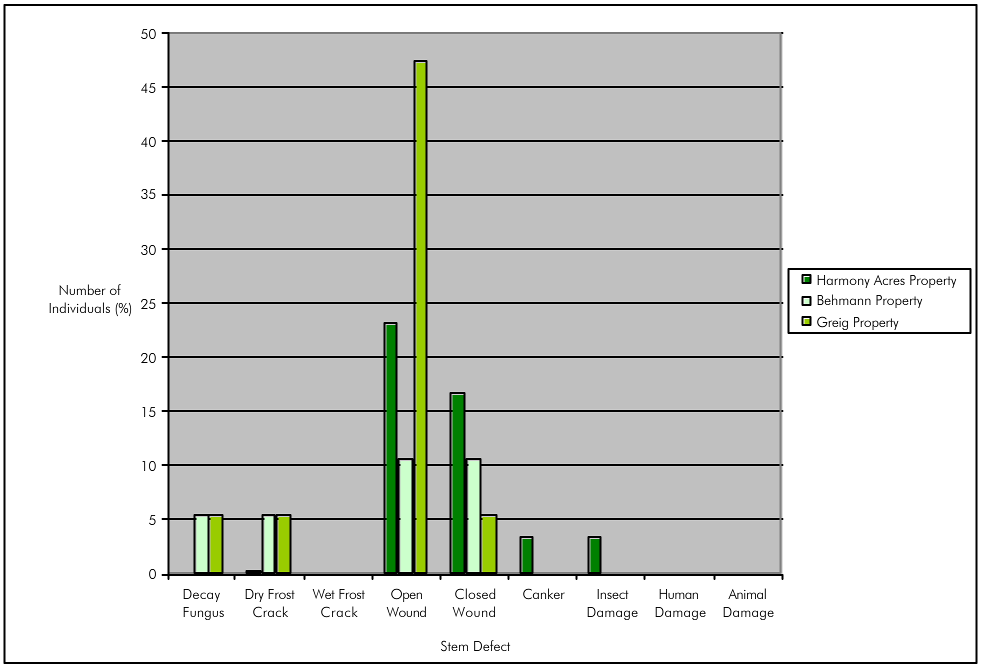


Figure 21: Stem defects and type in working landscape hardwood plots 2002.

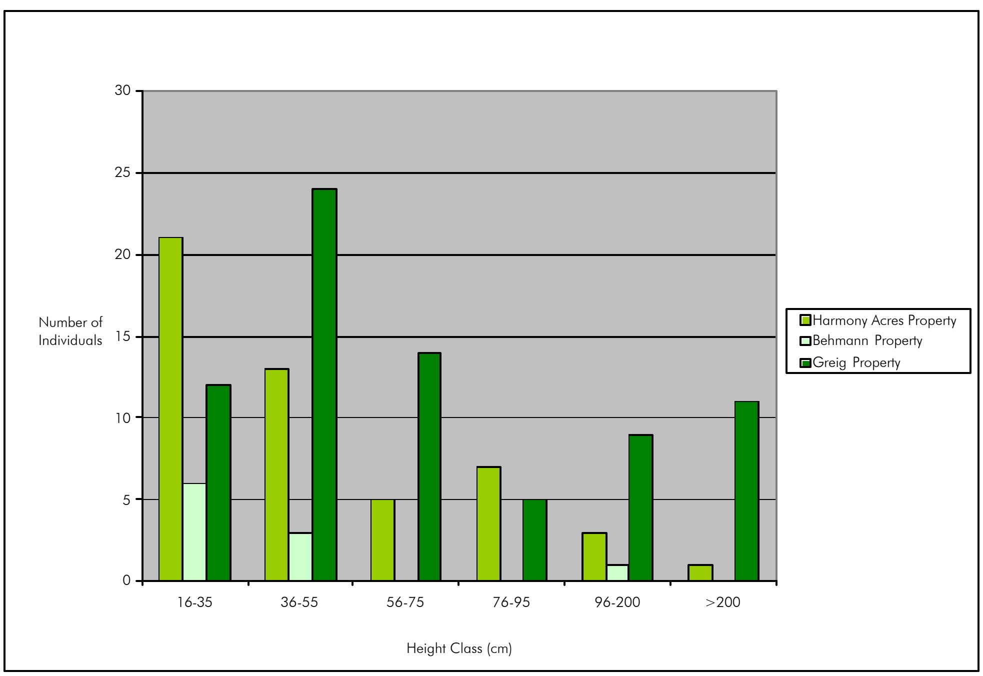


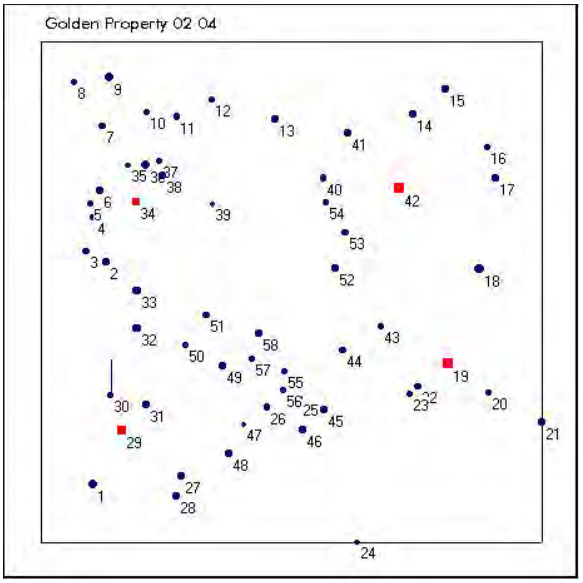
Figure 22: Number of individuals by regeneration height class in working landscape hardwood plots 2002.

GROUND VEGETATION SPECIES	HARMONY ACRES PROPERTY	BEHMANN PROPERTY	GREIG PROPERTY
Bulblet Fern	-	-	5
Canada Mayflower	-	61	-
Common Elder	-	2	-
Cynthia	-	3	-
False Solomon's Seal	1	-	-
Hairy Solomon's Seal	-	10	-
Hard Maple	2	7	72
Helleborine	8	-	-
Large-leaved Aster	47	-	-
Leatherwood	-	8	-
Northern White Violet	-	2	-
Round-leaved Dogwood	1	-	-
Spikenard	5	-	-
Starflower	2	1	-
Three-leaved Solomon's Seal	-	6	-
White Ash	52	4	19
White Birch	6	2	-
Wild Leek	26	-	15

Table 3. Abundance of ground vegetation species within the 1m x 1m sample area at each of the working landscape hardwood plots.

02.b. Working Landscape Cedar/Poplar Plots

Golden Property 02-04



Mean Stand Age
45.6 years (min=28, max=87)
Total Stand Density
0.128 per sq. m
Mean Stand Height
10.59 m (SD=2.99, max=17.2, min=3.2)
Mean DBH
17.12 cm (SD=4.42, max=27.8, min=10.1)
Dominant Canopy Species
Eastern White Cedar
Dominant Regeneration Species
Balsam Fir
Dominant Ground Vegetation
Balsam Fir

I. Canopy-tree Stratum

The monitoring plot established on the Golden property was situated in a dominant cedar stand with a mean age of 45.6 years. The mean height of the stand was 10.59 m (SD=2.99, max=17.2, min=3.2) and the mean dbh of trees within the plot was 17.12 cm (SD=4.42, max=27.8, min=10.1). Four species were present within the sample area including 29 living eastern white cedar, 11 hard maple, nine balsam fir, and two white birch.

The total Golden property stand density was 0.128 trees per square metre with eastern white cedar having a relative dominance of 61.01 within the sample area, compared to 23.38 for hard maple, 12.60 for balsam fir, and 3.02 for white birch. Based on the cross-section area of each tree stem, eastern white cedar had a total basal area of 0.730 m^2 in comparison to 0.280 m^2, 0.151 m^2, and 0.036 m^2 for hard maple, balsam fir, and white birch, respectively.

Crown rating assessments showed that the Golden stand had 32.3% of the trees with minimal decline (<10% branch mortality), 45.2% having light to moderate decline (10-50% branch mortality), and 4.8% having severe decline (>50% branch mortality). 17.7% of the total trees were dead from natural events.

Stem defects were found on 32.3% of the mature trees within the Golden plot. Open wounds and decay fungus were the predominant defects, found on 17.7% and 8.1% of the total trees, while dry frost cracks, closed wounds, and cankers were found on 3.2%, insect damage was found on 4.8%, and animal damage was found on 1.6%.

ii. Seedling and Sapling Regeneration

Three species were found within the 2m x 2m regeneration quadrats within the Golden stand, with balsam fir being the dominant seedling.

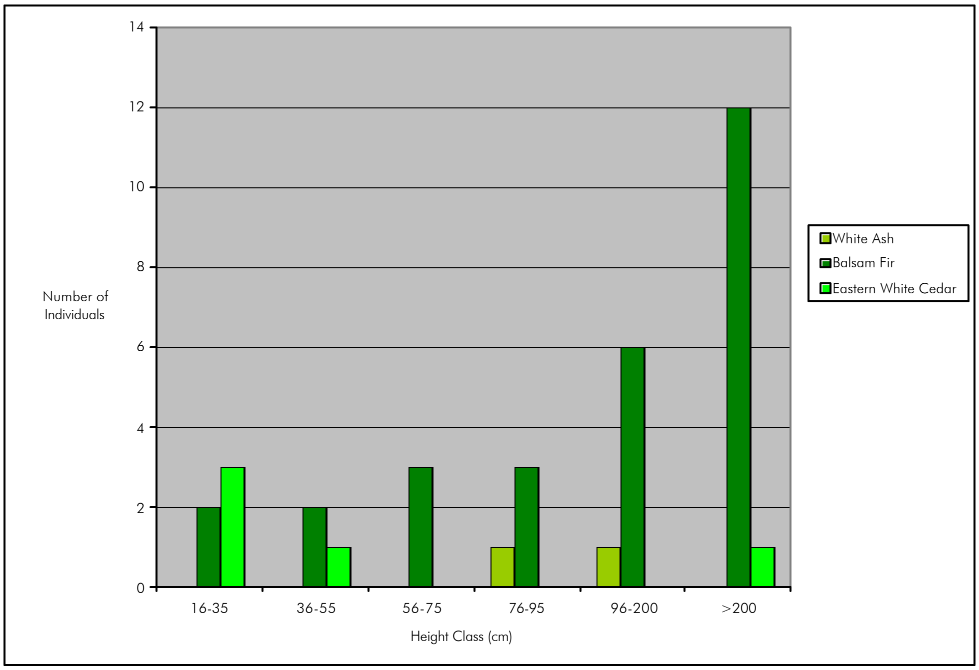


Figure 23: Mean number of individuals by species within each regeneration height class.

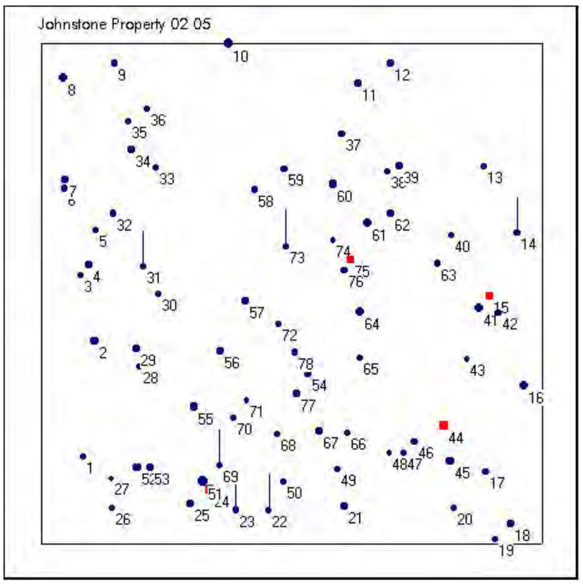
iii. Ground Vegetation

Six species were located in the total ground vegetation sample area (Table ***) with balsam fir being the dominant species within the 20 unmapped one square metre quadrats. Balsam fir had the highest density of 1.30 per square metre, while wild basil, green-leaved rattlesnake plantain, eastern white cedar, white ash and white baneberry had densities of 0.35, 0.25, 0.20, 0.10,and 0.05, respectively.

Balsam fir was the species of highest frequency throughout the Golden stand, located in 50% of the ground vegetation quadrats. Wild basil had a frequency of 20%, green-leaved rattlesnake plantain and white ash had a frequency of 10%, eastern white cedar had a frequency of 15%, and white baneberry had a frequency of 5%.

Only three of the total species were located in the mapped ground vegetation quadrats, and as a result, cover area and dominance could only be determined for these species. Based on the ground cover area that each species occupies, baslam fir was the dominant ground vegetation species occupying 0.41 m^2, giving it a relative dominance of 98.95.

Johnstone Property 02-05



Mean Stand Age
73.2 years (min=64, max=80)
Total Stand Density
0.165 per sq. m
Mean Stand Height
10.54 m (SD=3.45, max=17.3, min=1.4)
Mean DBH
16.59 cm (SD=4.56, max=32.6, min=10.2)
Dominant Canopy Species
Eastern White Cedar
Dominant Regeneration Species
Balsam Fir
Dominant Ground Vegetation
Large-leaved Aster

I. Canopy-tree Stratum

The Johnstone property monitoring plot was located in a dominant cedar/poplar stand with a mean stand age of 73.2 years (min=64, max=80). The mean height of the stand was 10.54 m (SD=3.45, max=17.3, min=1.4) and the mean dbh of trees within the plot was 16.59 cm (SD=4.56, max=32.6, min=10.2). Five species were present within the sample area with Eastern White Cedar being the dominant species. The stand was composed of 29 living eastern white cedar, 13 white birch, 11 balsam fir, nine black spruce, and four trembling aspen.

The total Johnstone stand density was 0.165 trees per square metre with eastern white cedar having a relative dominance of 46.08 within the sample area, compared to 20.28 for black spruce, 12.44 for white birch, 11.15 for balsam fir, and 10.04 for trembling aspen. Based on the cross-section area of each tree stem, eastern white cedar had a total basal area of 0.769 m^2 in comparison to 0.338, 0.208 m^2, 0.186 m^2, and 0.168 m^2 for black spruce, white birch, balsam fir, and trembling aspen, respectively.

Crown rating assessments showed that the Johnstone stand had 37.3% of the trees with minimal decline (<10% branch mortality), 30.1% with light to moderate decline (10-50% branch mortality), and only 13.3% with severe decline. A high number of dead trees were found within the plot having 19.3% of the total trees dead as a result of natural events.

Stem defects were found on 36.1% of the mature trees within the Johnstone monitoring plot. Decay fungus was found on 8.4% of the trees, dry frost cracks, closed wounds and cankers were found on 7.2%, wet frost cracks, open wounds, and animal damage were found on 2.4%, and insect damage was found on 3.6 % of the trees.

ii. Seedling and Sapling Regeneration

Five species were present in the seedling and sapling regeneration quadrats, with balsam fir constituting 71.4% of the total seedlings in the quadrat.

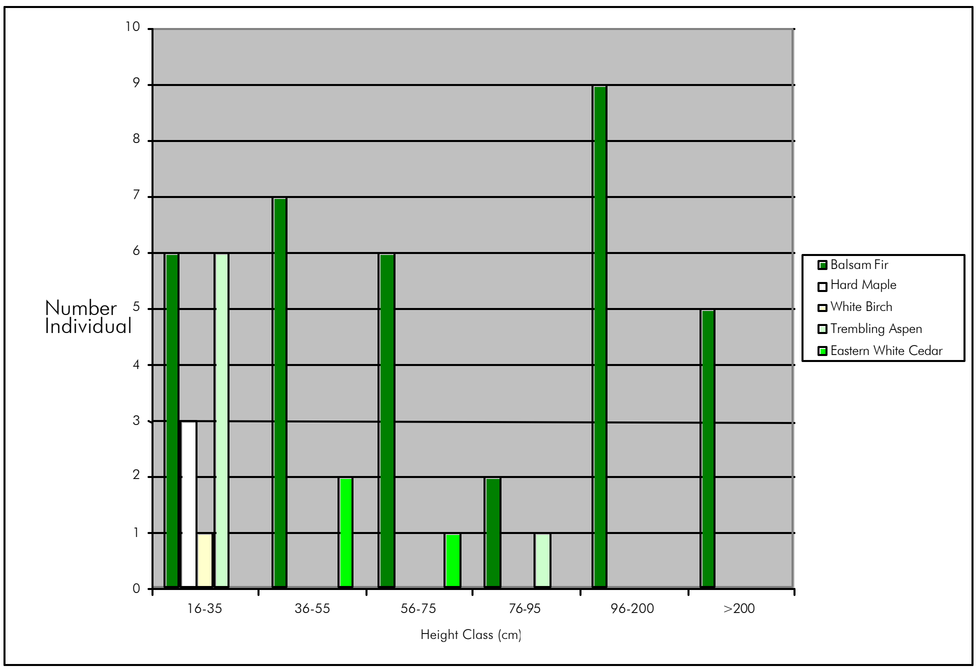


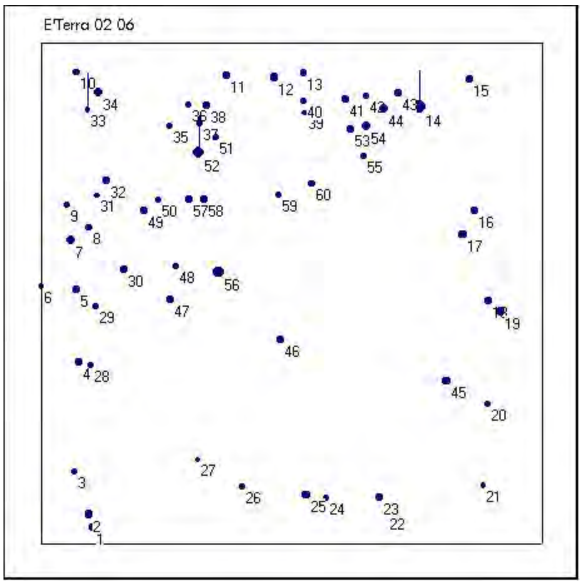
Figure 24: Mean number of individuals by species within each regeneration height class.

iii. Ground Vegetation

Seventeen species were located in the total ground vegetation sample area at the Johnstone monitoring plot with large-leaved aster having the highest density of 5.95 per square metre.

Cover area and dominance could only be determined for the four species located in the mapped ground vegetation quadrats. Based on the ground cover area that each species occupied, balsam fir was the dominant ground vegetation species occupying 2.13 m^2, giving it a relative dominance of 72.04.

E'Terra Property 02-06



Mean Stand Age
84.4 years (min=73, max=91)
Total Stand Density
0.123 per sq. m
Mean Stand Height
11.07 m (SD=3.95, max=21.6, min=2.9)
Mean DBH
18.58 cm (SD=7.21, max=49.0, min=9.9)
Dominant Canopy Species
Eastern White Cedar
Dominant Regeneration Species
Balsam Fir
Dominant Ground Vegetation
Large-leaved Aster

I. Canopy-tree Stratum

The E'Terra property monitoring plot was established in a dominant hardwood stand that had a mean stand age of 84.4 years. The mean height of the stand was 11.07 m (SD=3.95, max=21.6, min=2.9) and the mean dbh of trees within the plot was 18.58 cm (SD=7.21, max=49.0, min=9.9). Eastern white cedar was the dominant species within the canopy-tree stratum having 29 living trees while balsam poplar, balsam fir, and jack pine had 15, four, and one, respectively.

The total E'Terra property stand density was 0.123 trees per square metre with eastern white cedar having a dominance of 0.0017 within the sample area compared to 0.0012 for balsam poplar, 0.0004 for balsam fir, and 0.0002 for jack pine.

Crown rating assessments showed that the E'Terra stand was in good health with 41.7% of the mature trees having minimal decline (<10% branch mortality), 30.0% having light to moderate decline (10-50% branch mortality), and 8.3% having severe decline (>50% branch mortality). Only 2.0% of the mature trees were dead as a result of natural events and none were dead by human activity.

Stem defects were found on 31.7% of the mature trees within the E'Terra plot. Insect damage was the predominant defects, which was found on 13.3% of the mature trees. Open wounds were found on 6.7%, dry frost cracks and cankers were found on 3.3%, and wet frost cracks were found on 1.7%.

ii. Seedling and Sapling Regeneration

Baslam fir and eastern white cedar were the only species found in the 2m x 2m regeneration quadrats with balsam fir representing the dominant seedling/sapling.

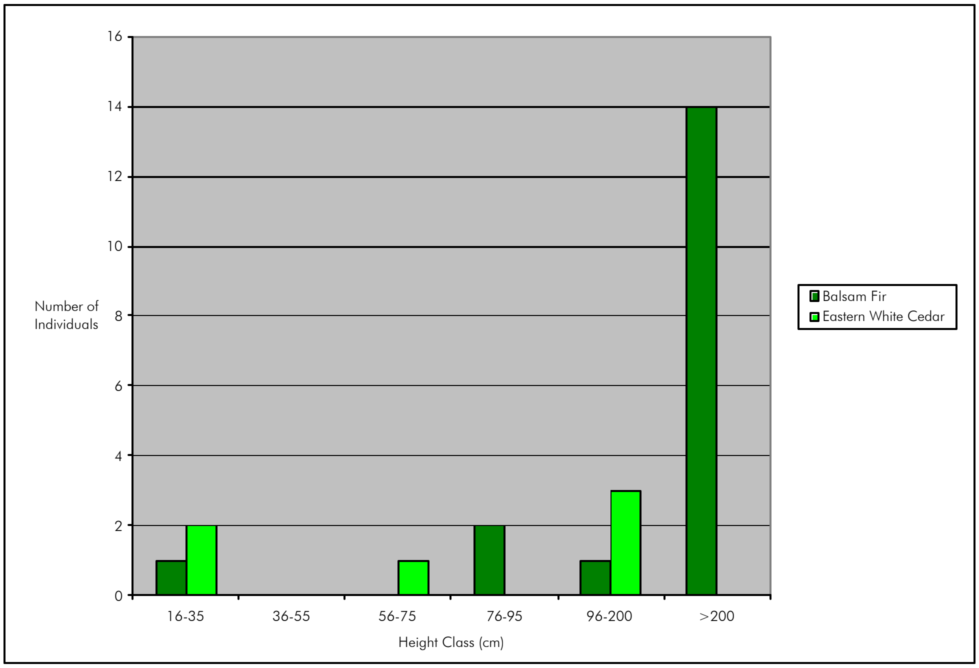


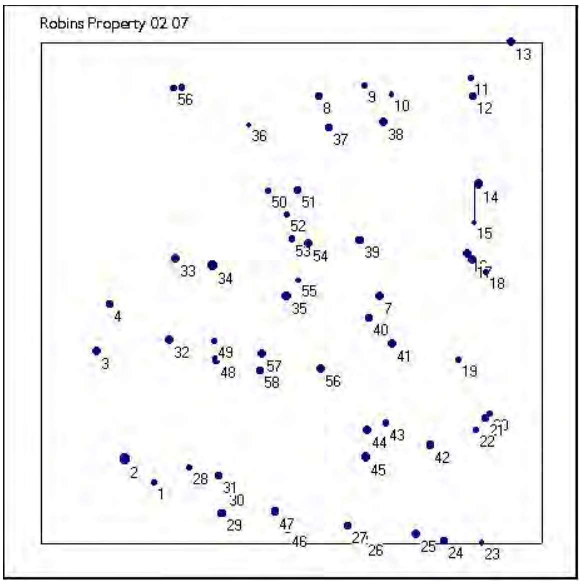
Figure 25: Mean number of individuals by species within each regeneration height class.

iii. Ground Vegetation

Seven species were located in the total ground vegetation sample area at the E'Terra stand with large-leaved aster being the dominant species within the 20 unmapped one square metre quadrats. Large-leaved aster and balsam fir had the highest densities of 2.70 per square metre and 1.05 per square metre, respectively.

Only three of the total species were located in the mapped ground vegetation quadrats, and as a result, cover area and dominance could only be determined for these species. Based on the ground cover area that each species occupies, white ash was the dominant ground vegetation species occupying 0.935 m^2, giving it a relative dominance of 56.09.

Robins Property 02-07



Mean Stand Age
67.6 years (min=52, max=79)
Total Stand Density
0.13 per sq. m
Mean Stand Height
13.61 m (SD=3.93, max=23.55, min=2.7)
Mean DBH
20.98 cm (SD=6.84, max.=41.5, min=10.0)
Dominant Canopy Species
Eastern White Cedar
Dominant Regeneration Species
Balsam Fir
Dominant Ground Vegetation

I. Canopy-tree Stratum

The Robins property monitoring plot was established in a dominant hardwood stand that had a mean stand age of 67.6 years. The mean height of the stand was 13.61 m (SD=3.93, max=23.55, min=2.7) and the mean dbh of trees within the plot was 20.98 cm (SD=6.84, max.=41.5, min=10.0). Eastern white cedar was the dominant species within the canopy-tree stratum having 27 living trees while 12 red pine, five balsam fir, four white pine, two trembling aspen, and one white birch and white spruce were present.

The total Robins property stand density was 0.13 trees per square metre with eastern white cedar having a dominance of 0.0026. Based on the cross-section area of each tree stem, eastern white cedar had a total basal area of 1.053 m^2 .

Crown rating assessments showed that the Robins stand had 36.2% of the mature trees having minimal decline (<10% branch mortality), 41.4% having light to moderate decline (10-50% branch mortality), and 12.1% showed severe decline (>50% branch mortality). Only 10.3% of the mature trees were dead as a result of natural events and none were dead by human activity.

Stem defects were found on 12.1% of the mature trees within the Robins plot. Wet frost cracks were the predominant defects, which were found on 3.4% of the mature trees, while decay fungus, dry frost cracks, open wounds, cankers, and insect damage were all found on 1.7%.

ii. Seedling and Sapling Regeneration

White ash, balsam fir, white spruce, and red osier dogwood were the species present in the 2m x 2m regeneration quadrats with balsam fir representing the dominant seedling/sapling.

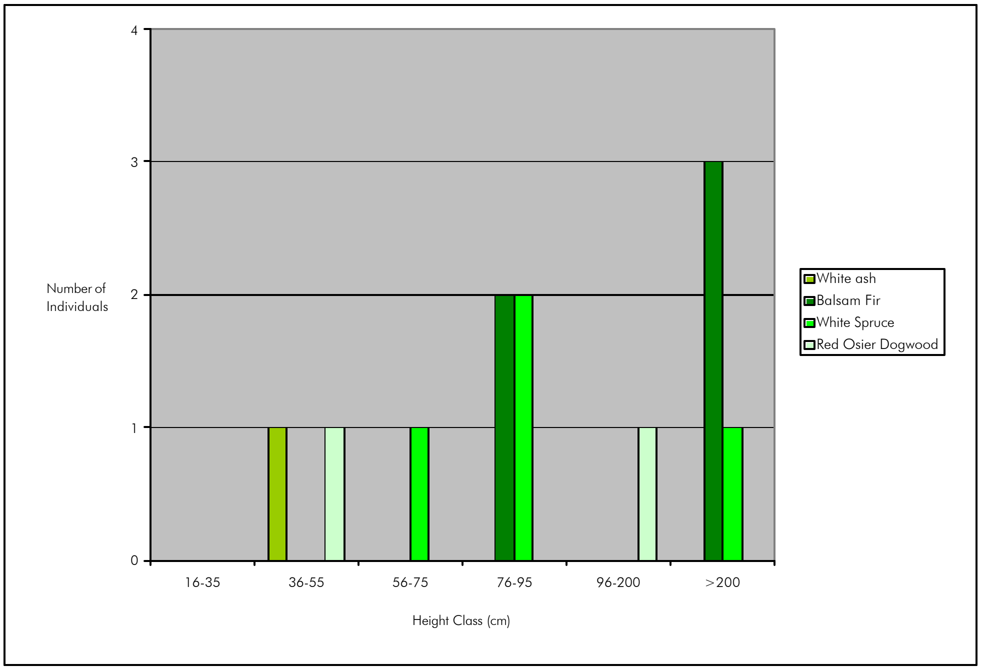


Figure 26: Mean number of individuals by species within each regeneration height class.

iii. Ground Vegetation

Sixteen species were located in the total ground vegetation sample area with fringed polygala being the most abundant species within the 20 unmapped one square metre quadrats. Fringed polygala and large-leaved aster had the highest densities of 9.80 per square metre and 4.15 per square metre, respectively.

Fringed polygala was the species of highest frequency throughout the E'Terra stand, located in 70% of the ground vegetation quadrats.

Only twelve of the total species were located in the mapped ground vegetation quadrats, and as a result, cover area and dominance could only be determined for these species. Based on the ground cover area that each species occupies, white ash was the dominant ground vegetation species occupying 0.381 m^2, giving it a relative dominance of 36.16.

02.b. Comparison within Working Landscape Cedar/Poplar Plots

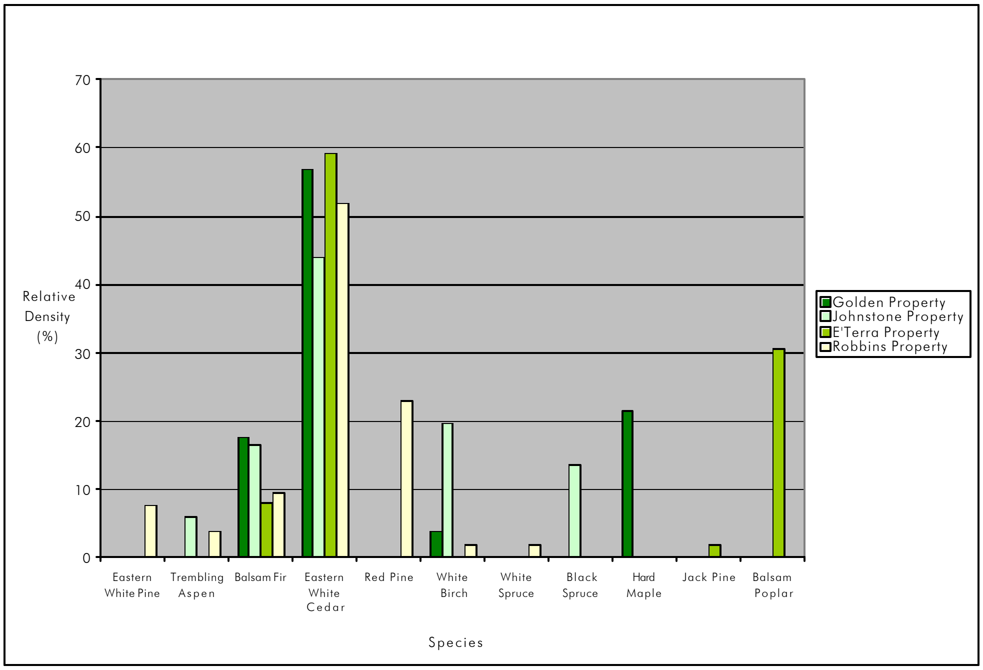


Figure 27: Relative Density of overstory species in working landscape cedar/poplar plots 2002.

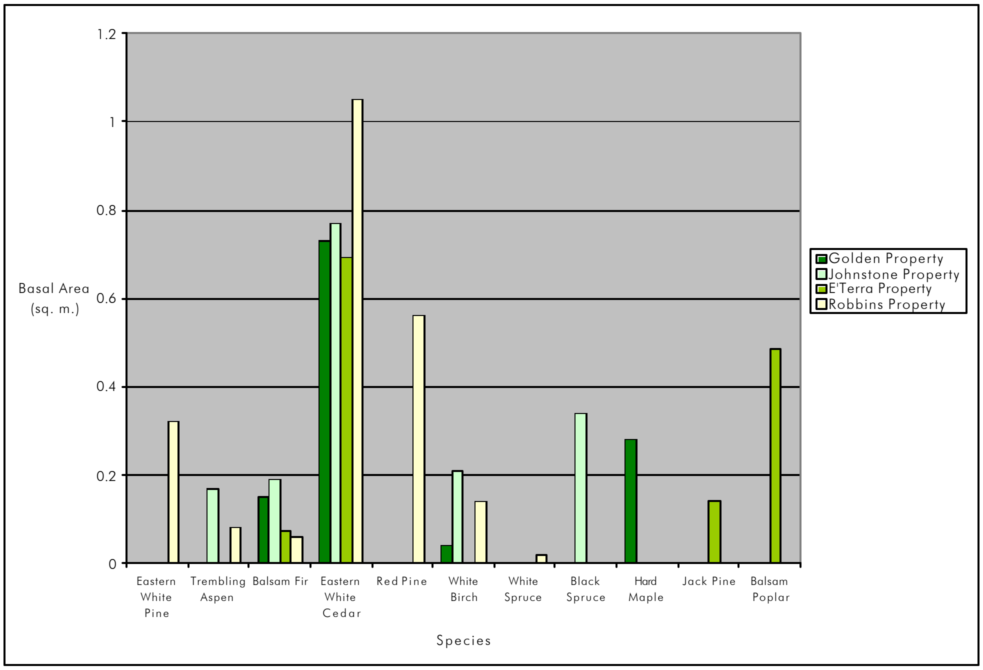


Figure 28: Basal area (sq m) of overstory species in working landscape cedar/poplar plots 2002.

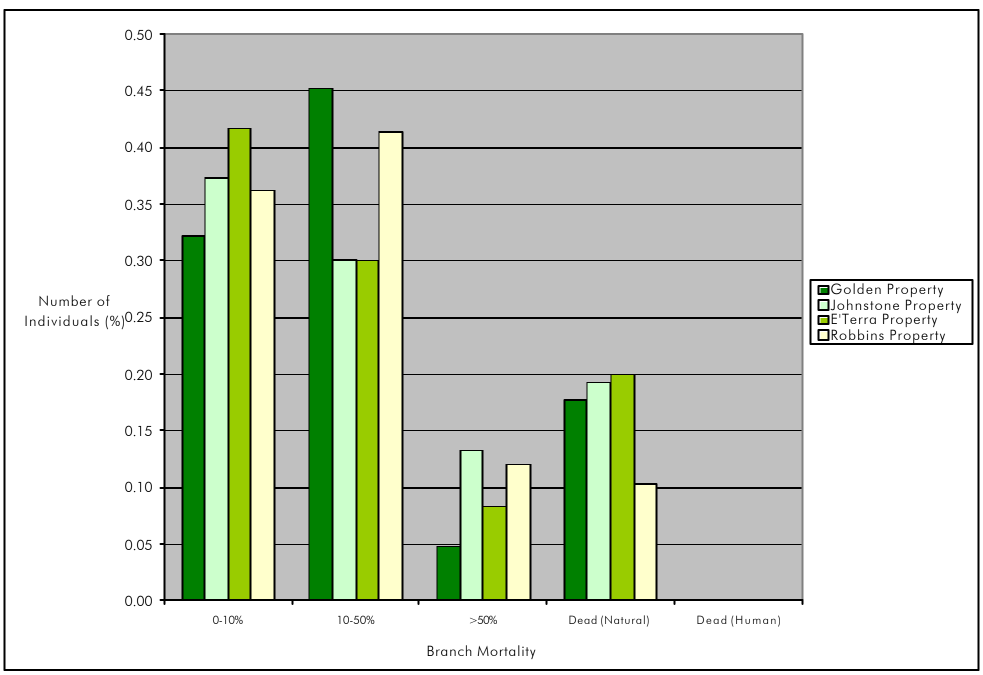


Figure 29: Branch mortality (by class) in overstory species in working landscape cedar/poplar plots 2002.

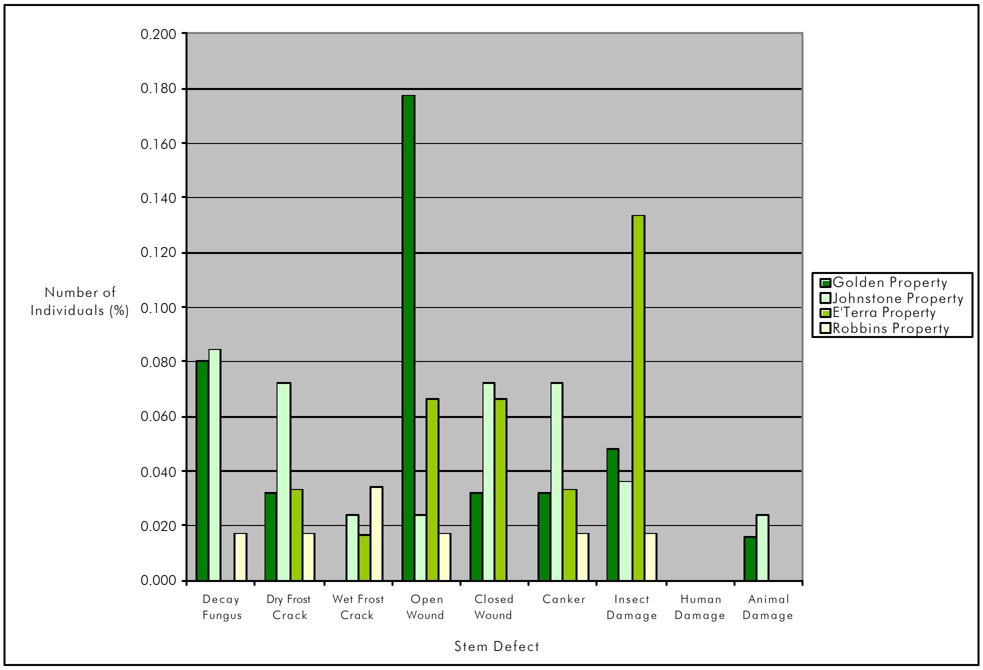


Figure 30: Stem defects and type in overstory species in working landscape cedar/poplar plots 2002.

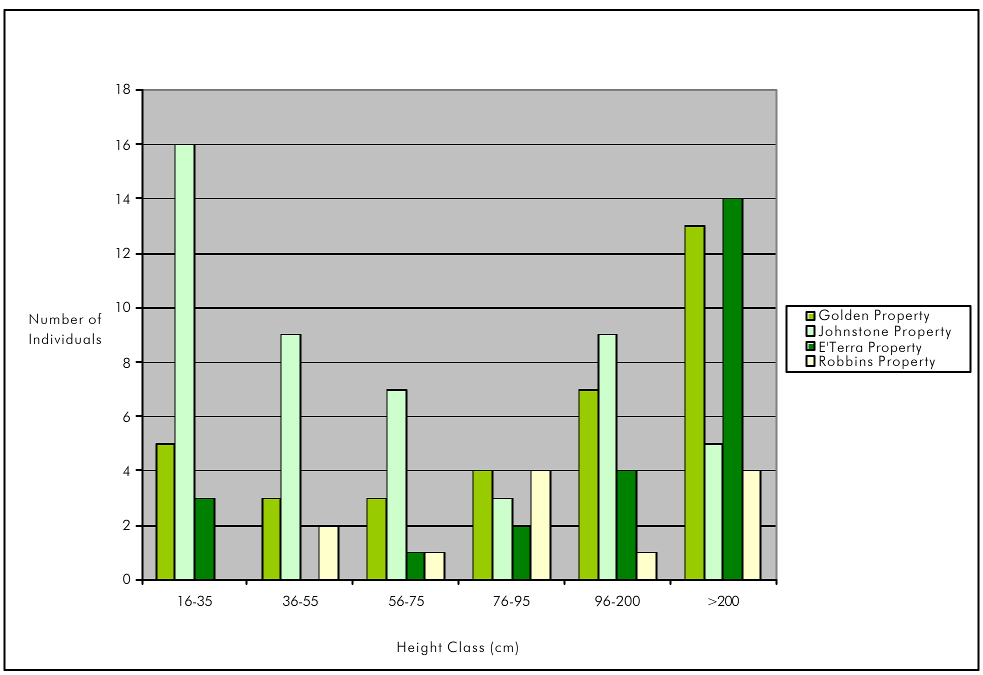


Figure 31: Number of individuals in each regeneration height class in working landscape cedar/poplar plots 2002.

GROUND VEGETATION SPECIES	GOLDEN PROPERTY	JOHNSTONE PROPERTY	E'TERRA PROPERTY	ROBBINS PROPERTY
Rattlesnake Weed	-	-	8	-
Balsam Fir	26	46	21	9
Bracken Fern	-	21-	-	18
Bunchberry	-	2	-	3
Bush Honeysuckle	-	-	-	7
Canada Mayflower	-	78	4	14
Ciliolate Aster	-	-	-	5
Eastern White Cedar	4	3	9	-
Fly Honeysuckle	-	-	-	7
Fringed Polygala	-	1	-	196
Green-leaved Rattlesnake Plantain	5	6	1	-
Hard Maple	-	9	-	-
Helleborine	-	3	-	-
Hooked Agrimonia	-	-	-	1
Large-leaved Aster	-	119	54	83
Lesser Pyrola	-	88	-	-
Red Maple	-	-	-	1
Red Osier Dogwood	-	-	-	3
Starflower	-	-	-	4
Trembling Aspen	-	22	-	-
Twinflower	-	12	-	-
White Ash	2	-	-	-
White Baneberry	1	5	-	-
White Birch	-	2	-	1
Wild Basil	7	-	-	-
Wild Lettuce	-	3		
Wild Saraparilla	-	45	1	10
Wild Strawberry	-	-		8

Table 4. Abundance of ground vegetation species within the 1m x 1m sample area at each of the working landscape cedar/poplar plots.

VI. DISCUSSION

The initiation of this Forest Monitoring Program in the Northern Bruce Peninsula by the Bruce Peninsula Biosphere Association has been successful in achieving the objectives initially proposed. Although it is difficult to extrapolate information on temporal changes of forest ecosystems in the first monitoring year, the data has provided an baseline of the dominant vegetation types and their condition on the Northern Bruce Peninsula. This information has illustrated the structure and composition of these forest ecosystems, allowing a qualitative assessment to be made. Preliminary analyses were performed to determine the abundance, basal area, density, dominance, frequency, and importance value of individuals within the canopy-tree and ground vegetation strata, as well as the abundance, density, and frequency of seedlings and saplings. This data attained from each of the fifteen monitoring plots should be representative of stands located throughout the Northern Bruce Peninsula.

As seven of the forest monitoring plots were established in working landscapes – primarily logging, the continual monitoring of these forest stands in comparison with protected sites will provide valuable information on the how forest ecosystem respond to these different types of management regimes. These working landscape sites were located on private land, allowing six community members to contribute to the monitoring program and, furthermore, understand the forest ecosystems on their properties.

Changes in monitoring protocols made comparability with the 1998 Parks Canada monitoring plots difficult and as a result of time limitations, these comparisons were not addressed. Regeneration and ground vegetation monitoring data cannot be compared as the protocols have been dramatically modified, however, it is possible to compare the canopy-tree strata between the two monitoring sessions. The protocols for tree tagging were different between the two sessions, so it will be necessary to use the cartesian coordinates of the trees entered into the *Biomon* software instead of the triangulation coordinates.

The EMAN monitoring protocols allow for the integration of other indicators into the established monitoring plots to provide a more extensive assessment of forest ecosystems. The implementation of the following indicators should be considered for subsequent monitoring years: i) worm diversity, ii) lichen diversity, iii) decay rate, iv) salamander diversity, v) invasive species abundance, and vi) plant phenology.

This Forest Monitoring Program has initiated a community-based project to provide information for the community in hopes of creating a sense of pride in Bruce Peninsula's forests, allowing the community work together to practice good land stewardship. Aside form the six participating landowners, interest among other community groups was shown, however as a result of time constraints, their participation in the first monitoring year was not possible. Below is the contact information of community members interested in participating either in providing locations for plot establishment or assistance in future years.

Clive Card
Institute for Outdoor Education
(519) 534-2767
clive_card@bwdsb.on.ca

John Appleton
Bruce Trail Association
(519)793-4838
japple@amtelecom.net

Anne-Marie Braid
Niagara Escarpment Commission
(905)877-5191 ext. 246
monitoring@escarpment.org

Kevin Reese
Ministry of Natural Resources
(705) 725-7553

VII. APPENDIX 1: DETAILED METHODS

I. PLOT ESTABLISHMENT

CANOPY-TREE STRATUM MONITORING PLOT

1. To survey a 20m x 20m plot, choose a starting point with a good northward line of sight. Mark the starting point with a flagged stake. Using a compass and a 30m measuring tape, stand directly over the pin, align the compass with true north and measure out the first baseline. Mark the 20m point with another flagged stake.

2. Once the corner has been staked, keep the measuring tape in place and mark the two points where the 2m x 2m seedling and sapling monitoring quadrat will be established, adjacent to the line – insert one metal pigtail pin at 9m and another at 11m.

3. Using the same procedure in 1, measure the other three 20m baselines along east, south and west bearings and insert one metal pigtail pin at 9m and 11m on each side.

4. The maximum error when measuring the plot should be no more than 4% of the baseline measurement (i.e. The plot should not be out more than 80cm).

5. Measure the diagonal of the plot to ensure accurate surveying. The diagonal should measure 28.28m. An error of less than 2% (56cm) is considered acceptable.

6. Tie a string to the stakes of the surveyed plot to facilitate orientation during tagging and mapping and to make quadrat boundaries clear. Remove the string when all measurements have been taken.

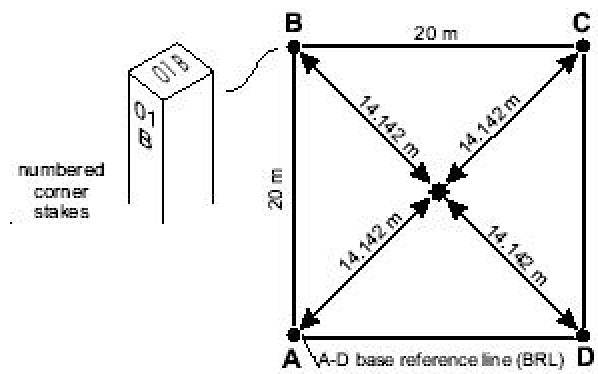


Figure 1. Plan of the 20m x 20m stand-alone tree biodiversity monitoring plot and method of labeling stakes.

NOTE: Stakes must be permanent and sufficiently large so that they can be labeled with the number of each quadrat of which they form a corner. The numbers could be written on the top of the stake or on each side of the stake.

SEEDLING AND SAPLING REGENERATION MONITORING QUADRATS

1. From the metal pigtails marked at 9m and 11m on each of side of the 20m x 20m canopy-tree stratum monitoring plot, measure 2m and 4m at right angles to the line outside of the plot. Measure the diagonal of the quadrat to ensure accurate surveying. The diagonal should measure 2.83m.

2. From the centre stake of the 20m x 20m canopy-tree stratum monitoring plot, measure 1.41m diagonally out from the centre pin towards the corners of the plot. Stake each corner with a metal pigtail pin. Again, ensure that the diagonal of the quadrat is 2.83m.

3. Tie a string to the metal pigtails of the 2m x 2m regeneration quadrat to facilitate orientation in order to minimize impacts of the surveyor on ground vegetation. Remove the string when all measurements have been taken.

GROUND VEGETATION STRATUM MONITORING QUADRATS

1. The 1m x 1m ground vegetation stratum monitoring quadrats are nested within the regeneration quadrats to minimize surveyor impacts on ground vegetation species. Place a metal pigtail at one metre on each side of the 2m x 2m regeneration quadrats.

2. Tie a string to the metal pigtails, dividing the 2m x 2m regeneration quadrat into four 1m x 1m quadrats. Remove the string when all measurements have been taken.

II. CANOPY-TREE STRATUM

i. PLOT INVENTORY

Tree Identification

Equipment
- Tree identification manual

Method

Trees must be correctly identified to species. Since errors in species identification can occur even among trained observers, an observer who has any doubt whatsoever should collect a specimen for expert identification. This specimen should be a small branch at least 40 cm long with the leaves attached and, if possible, with attached flowers or fruit/cones. A piece of the bark may be useful, but it should never be cut from a live tree. Each specimen should be labeled with the tree's identification number, placed in a plant press, or if the storage is temporary, in a plastic bag which is kept in the shade. Make sure that groups of plants given the same temporary identification are really the same species. Always have a manual in the field for making identifications.

Tree Tagging/Numbering

Equipment

- Tree tags to be secured by steel or galvanized nails
- Metric dbh tape
- Field data sheets and pencils

Method

1. Starting at the south-west corner, proceed in a clockwise spiral from the periphery to the centre of the quadrat, and number each live and dead tree ≥10 cm dbh.

2. Number the tree on an attached tag facing the south side of the plot.

3. Record each tree by number and species. The stand identifier refers to the landscape in which the stand is situated (protected landscape = 01 and working landscape = 02), and the quadrat number identifies the monitoring plot.

4. When a tree is multiple-stemmed and the branches separate below 1.3 m, number/tag and measure each stem that is ≥10 cm dbh. If the tree is on an outside line, only tag and measure it if at least half the stem is inside the quadrat, otherwise ignore it.

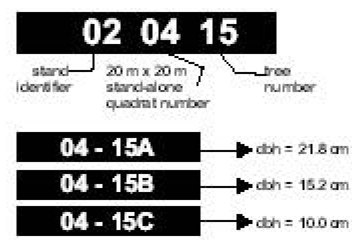


Figure 2. Tag numbering system for trees on 20m x 20m stand-alone plots. When numbering multiple-stemmed trees, the largest stem is the "A" stem.

Measuring Diameter at Breast Height (dbh)

Equipment

- Metric dbh tape
- Lead-free tree paint
- Data sheets and pencils

Method

1. Mark each tagged tree with a small daub of environmentally friendly paint at 1.3 m above the ground. This is a permanent mark to ensure that all dbh measurements will be taken at the same place.

2. Make sure the tape is taut and correctly placed around the tree at right angles to the stem axis and not over an atypical part of the stem.

3. Many trees are irregular in form (e.g. leaning, branch at 1.3 m, windswept, buttressed etc.) and therefore require special handling when measuring the dbh. If the dbh is not taken at 1.3 m, record the height at which it is taken. Measure and record separately the dbh of branches which originate below 1.3 m.

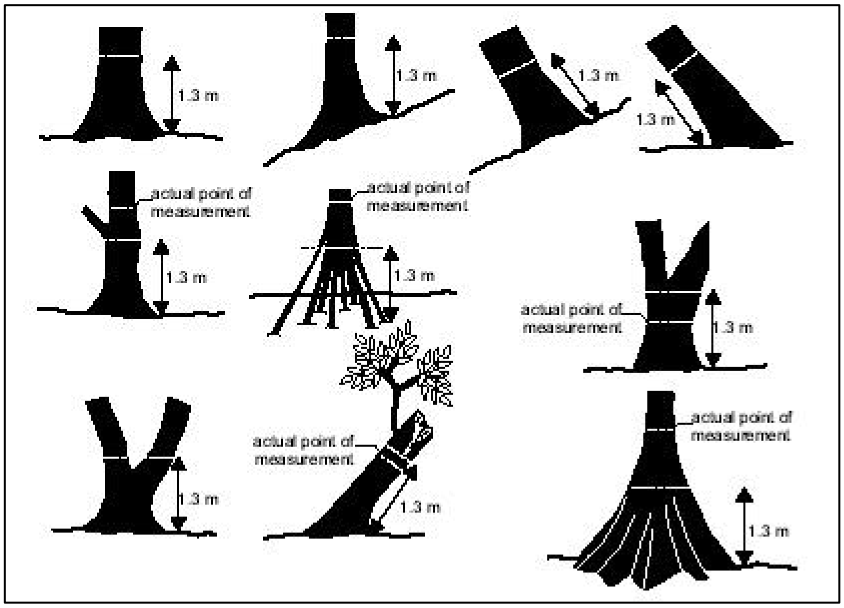


Figure 3. Measuring positions for diameter at breast height (dbh).

Tree Mapping

Equipment

- Steel survey tape (30 m)
- BIOMON software
- Data sheets and pencils

Method

1. Each numbered tree is mapped in relation to two adjacent, precisely located quadrat corner stakes. Each quadrat is bounded by four lines, the one parallel with and closest to the base reference line (A-D) is Line 1. For example, Line 1 goes from corner A to D, Line 2 from corner A to B, Line 3 from corner B to C and Line 4 from corner from C to D. Getting these lines correctly identified is essential for the BIOMON mapping software.

2. Measurements are made to the nearest centimetre. The sum of the A and B distances must be equal to or greater than 20 m.

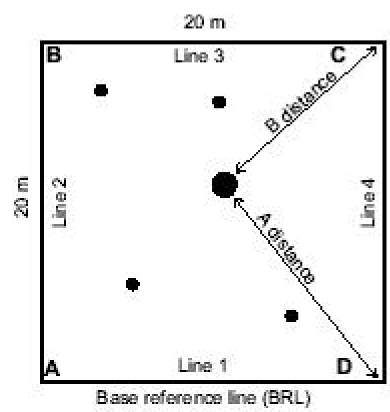


Figure 4. Set-up for mapping trees.

3. On the data sheet, record the tree number, the A distance, the B distance, and the line number (1, 2, 3, or 4). The two most common errors in mapping are switching A and B distances and incorrectly recording the line number.

4. Enter the data into the computer using the BIOMON software. This program calculates by triangulation the X and Y coordinates of the tree (taking into account the dbh) and generates a map of each quadrat showing the exact location of each tree. Verify the maps in the field. Correct any mistakes by remeasuring the trees, regenerating the maps and rechecking the results.

Tree Status

Equipment

- Illustrations of tree condition
- Field data sheets and pencils

Method

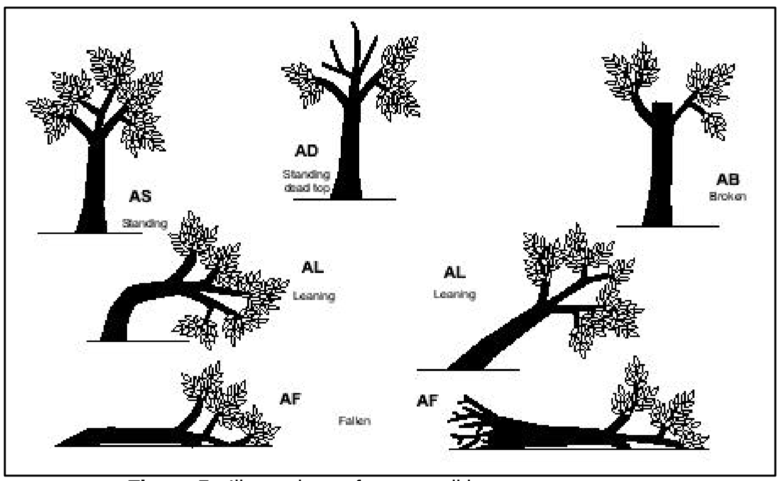


Figure 5. Illustrations of tree condition.

1. Note the condition or status of all tagged trees using the illustrations in Figure 5 for guidance. Record observations on the data sheet using the following symbols:

Standing alive (AS)	Standing dead (DS)
Broken alive (AB)	Broken dead (DB)
Leaning alive (AL)	Leaning dead (DL)
Fallen/prone alive (AF)	Fallen/prone dead (DF)
Standing alive dead top (AD)	

2. At each subsequent re-measurement period, record the condition of all tagged trees (alive or dead) that have fallen since the first data were collected. In addition, measure the length, diameter and orientation of all tagged fallen dead trees.

Tree Height

Equipment

- Clinometer (e.g. Haga level)
- 30-m steel survey tape
- Compass
- One 2-m surveying rod (with levelling bubble)
- Data sheets and pencils

Method

1. From a measured distance (such as 20 m) from the base of a tagged tree, record the readings (Figure 6a, b, c, d) for the top and base of the tree, and the horizontal line from the eye-level of the observer to the tree stem, or equivalent below the base of the tree.

2. Record the eye-level height of the observer and whether the base of the tree is above, the same, or below the eye-level of the observer. In addition, take the reading for the lowest live branch.

3. Calculate the height and canopy depth of each tree. To measure the average canopy height of a stand, from a convenient location and from a measured distance, take the readings for determining the average height and depth of the stand canopy.

4. Record the heights of emergent species, but exclude them when calculating the average height of the stand canopy.

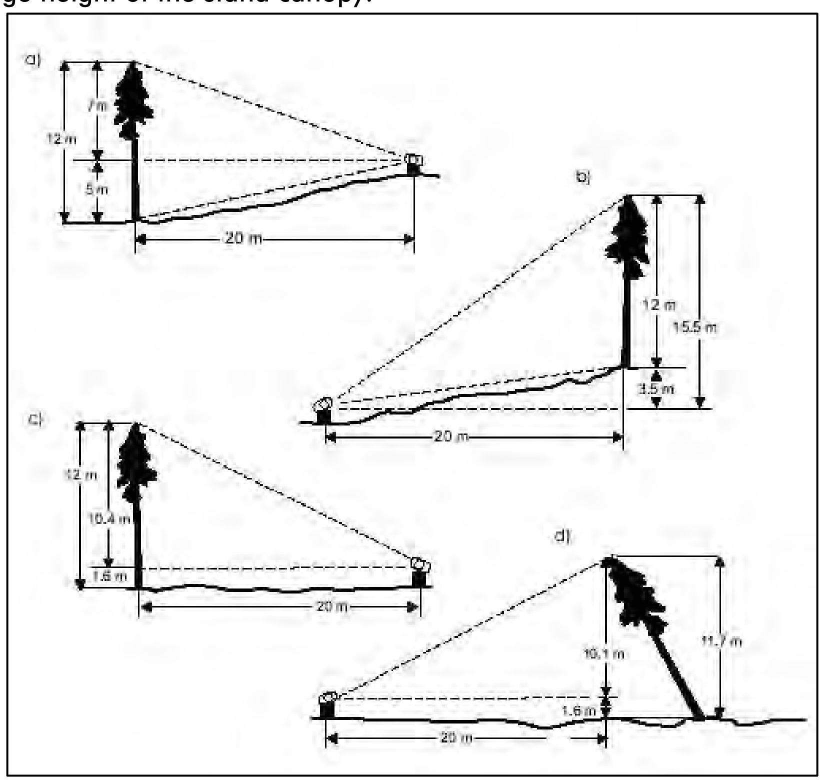


Figure 6. Measurement of the height of a tree.

Tree Age

Equipment

- Increment borer
- Milk shake drinking straws and masking tape
- Felt marker to label straws
- Metric dbh tape
- Field notebook and pencils

Method

1. Identify the species of trees that together represent the largest and most common canopy trees In the monitoring plot.

2. From the stand surrounding the plot, select five specimens of each species for age determination making sure that they mirror the range of sizes on the plot, and record their dbh. **Do not take cores of the trees on the plot**.

3. Tag the cored trees for future reference.

4. To give accurate ring widths, take the core on the north-facing side of the tree (if deformed, core the stem outside the deformed area) and at an angle to the stem axis to allow for an easy reading.

5. If the tree has a definite lean, core from the upper side. Take the core at 30 cm above the ground - just above the swelling (butt swell) where the roots originate.

6. Insert the bit of the increment borer in the handle and remove the extractor. Punch the bit through the bark and turn it gently until the end is beyond the centre of the tree. Insert the extractor, lifting it slightly to make sure it goes under the core, and then back off the borer about one turn to break contact between the core and the tree tissue. The notch on the extractor should be up so that if the core breaks, it will still rest in the extractor. Pull out the extractor with the core.

ii. TREE HEALTH ASSESSMENT

Equipment

- Tree Health data sheet
- Pens
- Tree identification key
- Dbh measuring tape
- Tree corer

Method

1. *Evaluate Crown Class.* Crown class ratings can be found in Appendix 1.

2. *Determine Crown Rating.*

(a) The tree crown is observed in silhouette, or single plane, outlined by the periphery of the branch tips.

(b) The base of the crown is the lowest foliated area, not including the large branch stems that support the crown. Large open areas within the crown are excluded. Old broken off branches (stubs) are not included in the overall rating of the crown.

(c) Two observers rate each tree, simultaneously, from opposite sides of the tree. Good communication between the observers will result in more accurate data being collected. The observers walk around under the crown of the tree until they find the location from which they have the best, unobstructed view.

(d) When evaluating mature hardwoods in a closed canopy situation, trees will often be encountered where only a portion of the crown is visible. In these instances rate only the portion that is visible and note in the remark section that the proportion of the crown that was visible was rated.

(e) One observer verbally delineates the area of the crown, deciding where the base of the crown is and if old dead branch stubs are to be included as part of the crown damage. Each observer in turn calls out the level of damage that is visible within the crown and where it is located. This gives the other observer an opportunity to re-examine the crown for areas of damage that may have been missed.

(f) Occasionally all of the damage will be visible from only one side of the tree. Once all of the damage has been located, the observers together determine the overall damage level to be recorded for the particular tree. Rating can be found in Appendix .

3. *Record Stem Damage*. The entire stem of all trees in the plot greater than 10 cm in diameter are examined for the presence of biotic or abiotic damage. For deciduous trees the stem is defined as the portion of the trunk that extends from just above the ground line to the base of the major branches. For conifers the stem extends from the ground line to the top of the tree or to the base of the major branches. The location and type of the defects are recorded on the Crown Condition data sheet.

4. Record all of the data collected on the Crown Condition data sheet. Rating locations and types can be found in Appendix 1.

III. SEEDLING AND SAPLING REGENERATION

Measuring Height Classes of Seedlings and Saplings

Equipment

- Tree identification manual
- Measuring stick (marking height classes)

Method

1. Count the number of each species within the 2mx 2m regeneration quadrats and categorize each individual into 16-35cm, 36-55cm, 56-75cm, 76-95cm, 96-200cm, and >200cm height classes. Use the measuring stick with these height classes marked on it to allow for fast inventory.

IV. GROUND VEGETATION STRATUM

Counting and Mapping Ground Vegetation Species

Equipment

- One sq. m. point grid frame
- Squared graph paper and pencils

Season: When counting and mapping ground vegetation, it is essential that the quadrats be visited several times a year to ensure that all species are identified. Record the dates when the measurements were taken or mapping done - they will determine the dates of all future counting or mapping.

To ensure that all species are mapped and identified, the following schedule is suggested for the first two - three years:

a. in late spring or early summer, when spring ephemerals are still visible and most of the other plants have started to grow (but might not be easily identified). At this time, mapping is easiest because growth in height is still slow and the positions of most plants are easily determined.
b. in mid-summer, when most of the plants can be identified (except for the fall bloomers, such as the aster family and many grasses and sedges).
c. in the fall, when the balance of the plants can be identified, and their maximum cover be determined.

Counting Ground Vegetation Species

Methods

1. Identify each species within the twenty 1mx1m ground vegetation quadrats, and count the number of individuals of each species that are present. When species cannot be identified, assign a temporary code to each unknown species. When identifications have been made replace the temporary codes with the proper name.

2. When it is not possible to separate individual low shrubs from one another (most likely in shrub-dominated communities), count the number of clumps and note that clumps, not individuals, have been recorded. Plants that form runners, or trail across the ground surface, create difficulties when counting. It is probably best to count such plants as one individual per quadrat and record how they were handled.

Mapping Ground Vegetation Species

Methods

1. Each of the 1mx1m quadrat located in the southwest corner of the regeneration quadrats is used for mapping the ground vegetation. Set a gridded frame over the quadrat to be mapped.

2. Transcribe to scale the outline of the plants in the quadrat on to graph paper so that the cover (area occupied) of each species can be calculated.

3. The decision as to what part of a plant to measure when trying to determine the area a plant occupies can be very difficult. For species such as bunch grasses, measure the base at the ground level. For taller species, record the stem position, and the approximate area the leaves cover when looked at from above. For dense stands of low shrubs, herbaceous species, mosses or lichens, where it is impossible to define an individual, treat that part of the stand that falls within the quadrat as a single clump and note that this has been done.

4. Tag or otherwise mark each plant that is mapped.

V. DOWNED WOODY DEBRIS

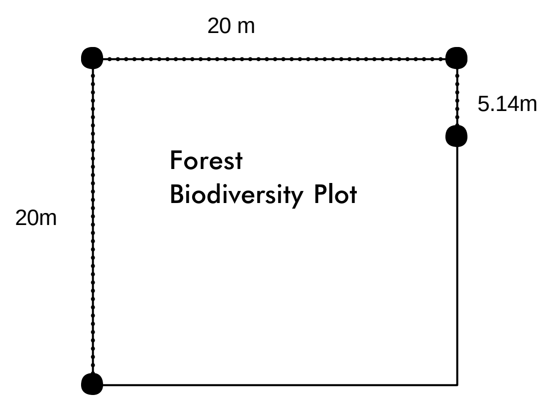
Equipment

- Site establishment data sheet
- Tape measure
- Pen
- Flagging tape
- Down woody debris data sheet

Method

1. Create a transect by going along two edges of the 20 x 20 metre forest plot and then an additional 5.14m in order to make a 45.14m transect.

2. Record species, type of debris (log/stump), diameter and log decomposition class for every piece of downed woody debris that intersects the transect and has a diameter of 7.5cm or more at the point of intersection. If you can not identify the species, record a *"0"*.



Example of 45.14 metre transect for down woody debris.

3. Record the location of the downed woody debris along the transect line.

APPENDIX 1: GLOSSARY

Basal area
the area of the stem of a tree calculated from the diameter measured at breast height. It is used as the measurement to describe the area occupied by a tree(s).

Breast height
as used in this document, the point on the stem of a tree 1.3 m above the soil level with debris removed. It is at this point that the diameter of a tree is measured.

Canopy
part of a forest or shrub community that is formed by the branches and leaves (or crowns) of its major woody species; also, any terrestrial plant community where a distinctive habitat is formed in the upper, denser regions of the taller plants.

Closed canopy
the continuous layer formed when the branches (crowns) of the species making up the canopy interlace or overlap. Little sunlight penetrates to the ground vegetation, except when the leaves are absent.

Open canopy
the discontinuous layer in forests or other plant communities when the branches (crowns) of the individual species do not overlap. Sunlight penetrates to the ground vegetation year round.

Clinometer
instrument for measuring slopes; in ecology, used as an aid for measuring tree heights.

Cover
the area occupied by individuals of a species. It is usually determined by measuring the area of the ground covered by a plant, either by vertical projection of the area covered by the leaves of a species or by measuring canopy width. It is used to determine dominance.

Density
describes the number of individuals of a species on a unit area basis.

$$D = \frac{\text{number of individuals of a species in the sample}}{\text{total area in the sample (m2)}}$$

Dominance
area occupied by a species on a unit area. Use basal area or cover as the measurement for area occupied.

$$Dom = \frac{\text{basal area or cover of a species in the sample (m2)}}{\text{total area of the sample (m2)}}$$

DBH

diameter at breast height; measurement taken on the stem of a tree 1.3 m above the ground.

Ecosystem

A dynamic complex of organisms (biota) including humans, and their physical environment interacting as a unit. They may vary in size and composition, the term being applied to the whole world and its atmosphere, to units dominated by particular plant types (prairies, boreal forest) to a local pond, or quarry. In its broadest sense it includes environmental, biological social and economic elements.

Field Layer

see stratum.

Forest ecosystem

ecosystem dominated by trees; the canopy may be closed or open.

Frequency

describes the distribution of a species through the stand. It is determined by calculating the percentage of plots in a sample on which a species occurs.

$$F = \frac{\text{number of plots in which a species occurs}}{\text{total number of plots in the sample}} \times 100$$

Ground layer

see stratum.

Ground vegetation

as used in this document, a combination of the field and ground layers (see stratum); includes all herbaceous species in a community and all woody species up to 1 m in height, and non-vascular species such as mosses, lichens and mushrooms; includes small shrubs and tree seedlings.

GPS

Global Positioning System. GPS is a satellite navigation system, which provides specially coded satellite signals that can be processed in a GPS receiver to compute the location of the instrument. Four GPS satellite signals are used to compute positions in three dimensions.

Herbaceous

not woody. The entire plant or the above-ground parts die back at the end of each growing season.

Importance value

an index made up of relative density, relative dominance, and relative frequency that profiles the structural role of a species in a stand. It is useful for making comparisons among stands in reference to species composition and stand.

$$IV = \text{Relative Density} + \text{Relative Dominance} + \text{Relative Frequency}$$

Leaning tree

any tree standing at an angle of greater than 30° from the vertical.

Nested plots

a sampling system in which plots of different sizes are so arranged that larger plots contain the smaller ones.

Plot

a general term referring to any area of land of any shape (e.g. circle, square, rectangle etc.) or size, which may be used for any purpose (e.g. sampling).

Quadrat

a specific ecological sampling term that refers usually to a square (original definition) or rectangular sampling plot of a predetermined area/size. As used in this document, the sample shape is square, and basic recommended sizes are: 100 m x 100 m (1 ha), 20 m x 20 m, 5 m x 5 m, and 1 m x 1 m. Other sizes are recommended for specific purposes.

Relative Density

describes the density of one species in relation to the density of all species.

$$RD = \frac{\text{number of individuals of a species in the sample}}{\text{total number of individuals of all species in the sample}} \times 100$$

Relative Dominance

describes the area occupied by one species relative to the area occupied by all species in the sample area. Basal area or cover are the variables commonly used for determining this value.

$$RDom = \frac{\text{basal area or cover of species in the sample (m2)}}{\text{total basal area or cover of all species in the sample (m2)}} \times 100$$

Relative Frequency

describes the distribution of one species relative to all species in the sample.

$$RF = \frac{\text{frequency of a species}}{\text{total frequency of all species in the sample}} \times 100$$

Sample

Example or portion showing qualities and characteristics of a whole. The number of quadrats used for sampling a particular stand; the area enclosed by a quadrat.

Sapling

young tree, normally single-stemmed, over 1 m in height, and smaller in height than a mature tree. Included with shrubs and small trees in this document.

Seedling

product of a germinated seed; may often be recognized by the presence of cotyledons (seed leaves). For convenience, young trees up to 1 m in height are considered as "seedlings".

Shrub

Multi-stemmed (i.e. without a clear trunk) woody plant; as used in this document a woody plant under 4 cm dbh and under 10 m in height that forms part of a plant community; may form the dominant woody vegetation in areas too wet or too dry to support trees (e.g. riparian areas subject to floods or ice damage; some tundra, and grassland communities).

Stand
standing growth of plants; a particular example of a plant community, e.g. forest or grassland in which monitoring plot(s) are established.

Stratification
the grouping into height classes of individual plants in a community or habitat.

Stratum
a horizontal layer of vegetation; most plant communities form well developed strata which are occupied by groups of species characteristic of that stratum. The strata are defined as follows:

Canopy
typically the uppermost, essentially continuous layer (stratum) of a plant community that is formed by the tallest individuals in a forest, shrub or herbaceous community; the area occupied by the leaves and branches of a single plant.

Shrub and small tree layer
beneath the canopy, consists of shade-tolerant woody species, consisting of small and immature canopy trees, small trees that do not reach into the canopy, and shrubs that are over 1 m in height. Shrubs may form the canopy in communities where conditions are not suitable for trees.

Field layer
made up of herbaceous species of any height, and woody species up to 1 m in height. In this document combined with the ground layer and called ground vegetation.

Ground layer
vegetation on the surface of the ground; usually mosses, lichens, and fungi together with low-growing herbaceous species, especially those with trailing or rosette growth forms. In this document combined with the field layer and called ground vegetation.

Transect
A line or belt of vegetation selected for sampling; as used in this document, a continuous string of contiguous quadrats set in a line across vegetation gradients.

Vegetation
Plants collectively; the plant life of a region. Differs from "flora" because the populations of the different species are taken into consideration; common species are given more weight than occasional species.

Vegetation gradient
obvious changes in the type of vegetation across a landscape as a result of some physical change e.g. change in moisture regime: as the distance from a water body increases, the vegetation may change from herbaceous species, through shrubs and trees to a grassland; or change in elevation: as altitude increases, the

vegetation may change from tall trees to small trees to alpine tundra (see also ecotone).

APPENDIX 3: SAMPLE DATA SHEETS