Monitoring Forest Ecosystems of the Bruce Peninsula

Jason Myles
Bruce Peninsula Biosphere Association
2005

Acknowledgements

I would like to thank a number of individuals for their knowledge, expertise, and assistance, which made this year's monitoring activities possible. Thanks to the support of these people, this report will provide additional data and allow for a better understanding of forest ecosystems in the Municipality of Northern Bruce Peninsula, an integral part of the Niagara Escarpment Biosphere Reserve.

- The Bruce Peninsula Biosphere Association was awarded a grant by Environment Canada and the Ecological Monitoring and Assessment Network under the Science Horizons Youth Internship program this year. I would like to thank Brian Craig for his ongoing support and guidance throughout this monitoring program.
- I would like to thank HRDC Canada for providing a wage subsidy for this project.
- I would like to thank Ashley Hellyer for her assistance in both the field and office this summer. Ashley was a very capable and enthusiastic assistant throughout her work term.
- I would like to thank John Haselmayer and Scott Currie for providing various field assistance and technical advice.
- Sean Liipere and Frank Burrows acted as my supervisors this summer. Sean and Frank provided guidance and ongoing technical and moral support throughout this year's monitoring activities. They allowed me to be independent in my work but were always able to provide useful suggestions and guidance whenever I needed it.
- I would like to thank Sean Liipere, Teresa Boyle, and Nancy McAfee for their previous monitoring reports, which proved useful in the development of this year's report.
- I would like to thank the directors of the Bruce Peninsula Biosphere Association for providing me with this great experience.

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Section One

Terrestrial Vegetation Biodiversity

Introduction

Long term forest monitoring plots can be a useful tool in examining the health of various forest ecosystems within an area over a long period of time. Through long term ecological monitoring, changes in ecosystem health can be documented and trends can be observed and analysed over time. The examination of these trends may be useful in analyzing the effects of various natural and anthropogenic stressors on ecosystem health. The use of long term monitoring plots allows specific areas to be re-studied from year to year and the use of these sites may provide early warning signs of potential ecological stress.

In 2002, the Bruce Peninsula Biosphere Association established a forest monitoring program in the Municipality of Northern Bruce Peninsula for the purpose of monitoring forest health in the local area. Fifteen forest plots were established in 2002 and one plot was established in 2003, for a total of sixteen forest plots. In order to assess forest health, a number of protocols developed by the Ecological Monitoring and Assessment Network (EMAN) have been initiated and continued throughout the monitoring program. Within this program, three protocols have been used to document terrestrial vegetation condition. The first protocol, which is a measure of tree condition, is used to document crown condition and stem defects of each tree as an indicator of overall tree health. The second protocol is used to measure the regeneration rates of seedlings and saplings as an indicator of forest succession trends and recruitment rates of various tree species. The third protocol, which is used to measure the amount of downed woody debris on the forest floor, can provide information regarding nutrient cycling, soil erosion, and water retention.

This year represents the fourth monitoring year of the forest plots on the Northern Bruce Peninsula. This year's monitoring activities involved re-assessing tree condition, seedling and sapling regeneration, and downed woody debris for the sixteen forest monitoring plots.

Methods

Location and Design

A total of 16 forest monitoring plots, each measuring twenty metres by twenty metres in size, have been established on the Northern Bruce Peninsula with the purpose of monitoring forest health in the area. Fifteen of these plots were established in 2002 and one was established in 2003. The location of each of these plots is shown below in Figure 1. For a complete history and descriptions of the sixteen forest monitoring plots, as well as general diagrams of plot design, refer to Liipere, 2002 and Boyle, 2003.

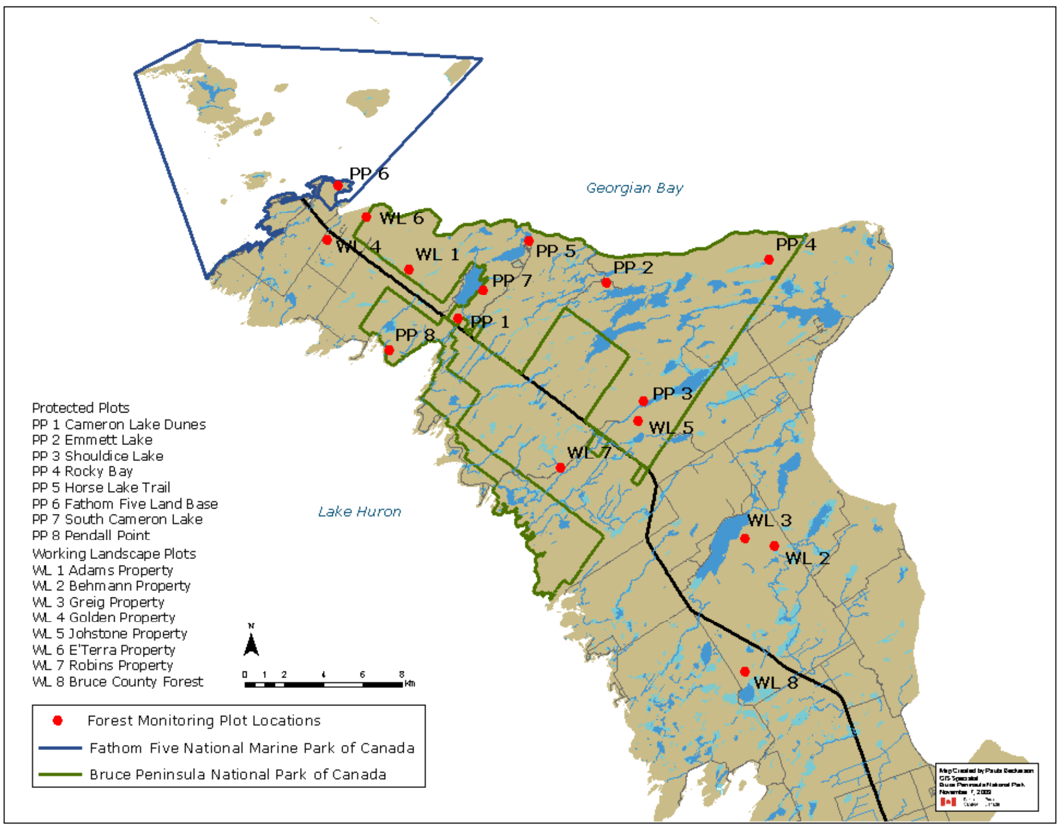

Figure 1: Location of the sixteen forest monitoring plots on the Northern Bruce Peninsula in Ontario, Canada. PP represents protected property (property within Bruce Peninsula National Park), and WL represents working landscape (private property).

Data Collection

Forest health data was collected for each of the sixteen monitoring plots using EMAN protocols to measure tree condition, seedling and sapling regeneration rates, and presence of downed woody debris. Tree condition was determined for each tree by assigning the tree a categorical number based on the incidence of branch mortality present on the tree. Any stem defects that were present were also recorded for each tree using a categorical numbering system. In addition, each tree was categorized based on crown class, which essentially involves classifying each tree according to the amount of sunlight that the canopy of the tree receives.

Seedling and sapling regeneration surveys were also conducted for each plot. Five quadrats, each measuring two metres by two metres in size, were set up at each monitoring plot. Four are located outside the perimeter of the plot and one is located in the centre of the plot. Each seedling and sapling within these quadrats was identified and tallied according to different height classes.

Downed woody debris was measured differently this year than in past years as a result of changes to EMAN protocols. In previous years, three transects were established around the perimeter of the forest plot. Two transects were established along the west and north edges of the plot, each measuring 20 metres in length. The third transect was measured from the northeast corner of the plot for a distance of 5.14 metres in a southerly direction. In total, the three transects covered a distance of 45.14 metres. This methodology has been revised in recent years by EMAN and in accordance with this revision, the methodology for measuring downed woody debris was altered at the 16 forest monitoring plots this year. Downed woody debris is now measured along three transects, each measuring 45.14 metres. These transects are located along the north, east, and west sides of the plot perimeter. Figure 2 shows the configuration of these transects.

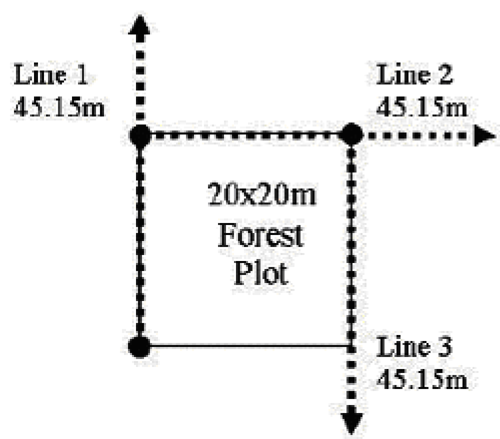

Figure 2: Configuration of the three transects used to measure downed woody debris at each of the forest plots (EMAN, 2003).

For each transect, a distance of 20 metres was measured between the appropriate plot corners. For the remainder of the transect, a compass azimuth was taken in the same direction in which the plot corners were lined up and the tape was extended for a distance of 25.14 metres in that direction. Once these transects were established, the presence of any downed log or stump with a diameter equal to or greater than 7.5 centimetres at the point of transect intersection was recorded. Each piece of woody debris was assigned a decomposition classification number from one to five, one indicating the least amount of decomposition and five indicating the most extensive amount of decomposition. Diameter at the point of intersection was recorded for each piece of downed woody debris, as well as the transect number where it was located, and tree species, if identifiable.

Refer to the most recent versions of these EMAN protocols for further information regarding data collection. These protocols are available online at http://www.eman-rese.ca/eman/ecotools/protocols/terrestrial/.

Data Analysis

In order to evaluate crown rating for each plot, dominant and co-dominant trees were isolated from trees of the remaining crown classes. The percentage of dominant and co-dominant trees with a severe decline crown rating (trees having branch mortality greater than 50 percent) at each plot is displayed in bar charts (Figures 4 and 5), on a year-to-year basis. Similarly, a bar chart is used to display the mean percentage of dominant and co-dominant trees in the severe decline category over the course of the four sampling years (Figure 3). The threshold for crown rating has been set at greater than ten percent of dominant and co-dominant trees exhibiting severe decline over two consecutive years, for each plot (Boyle, 2003).

In evaluating stem defects, the presence or absence of decay fungus is evaluated. Decay fungus is a symptom of disease and is therefore the defect of interest in this monitoring program. Other defects, such as cracks and cankers, can be caused due to adverse weather conditions (McAfee, 2004). The percentage of dominant and co-dominant trees having decay fungus is shown for each plot in Figures 7 and 8, with the results displayed on a year-to-year basis. A bar chart is also used to display the mean percentage of dominant and co-dominant trees having decay fungus over the four sampling years (Figure 6). The threshold for decay fungus has been set at greater than ten percent of dominant and co-dominant trees exhibiting decay fungus over two consecutive years, within each plot (Boyle, 2003).

In evaluating regeneration rates of seedlings and saplings, the mean number of dominant seedlings and saplings, which are species representing 25 % or more of the total number of seedlings and saplings within the regeneration quadrats, is displayed in a bar chart, displaying results for each plot (Figure 9). Additional bar charts are provided indicating the number of dominant seedlings and saplings at each plot on a year-to-year basis (Figures 10 and 11).

Downed woody debris is evaluated by comparing the presence and locations of woody debris found this year to the presence and locations of woody debris found in the previous year to account for any loss in class 1 downed woody debris. Class 1 woody debris is defined as debris that is structurally intact and has not softened due to decomposition (Boyle, 2003). Class 1 debris is commonly removed from forest ecosystems for campfire wood and the removal of this debris can have an impact on nutrient cycling, soil erosion patterns, and animal habitat (Boyle, 2003). A threshold of 0 is in place for the removal of class 1 downed woody debris from forest ecosystems. Although the methodologies for the measurement of downed woody debris were changed this year, the transects used this year were simply extensions of the transects sampled in previous years. Therefore, comparisons between this year's data and previous year's data was possible due to the fact that transects established this year overlapped the entire length of each transect used in past years.

Results

Crown Rating

Within the eight hardwood plots sampled, only the Emmett Lake plot (PP2) was found to contain trees within the severe decline category this year. Collectively, over the past four years of monitoring, only three of the hardwood plots have contained trees within the severe decline category. The Rocky Bay plot (PP4) was found to have trees in the severe decline category in 2002, but in subsequent years, there have been no incidences of trees within this category. The other two hardwood plots that have contained trees in the severe decline category are the Emmett Lake plot (PP2) and the Behmann Property plot (WL2). Both of these plots have remained below the ten percent threshold in past years and have continued to do so.

Throughout this monitoring program, every cedar/poplar plot has contained trees within the severe decline category at one time or another. Upon examination of the cedar/poplar plots located on protected property, two of the plots appear to have passed the ten percent threshold. The Horse Lake Trail plot (PP5) has consistently surpassed the ten percent threshold for four years in row. The Fathom Five Landbase plot (PP6), which had passed the ten percent threshold last year, remains above the threshold when observing the mean percentage of trees in the severe decline category over the last four years (Figure 3). The South Cameron Lake plot and the Pendall Point plot have remained below the ten percent threshold for the fourth year in a row. The Golden Property plot (WL4), which had clearly passed the ten percent threshold last year, appears only borderline this year, as does the E'Terra plot (WL6). The percentage of trees in the severe decline category appears to be increasing at the Johnstone Property and the Robins Property plot has remained below the threshold for the fourth year in a row.

Figure 3 displays the mean percentage of dominant and co-dominant trees in the severe decline category over the four monitoring years. Figures 4 and 5 indicate the percentage of dominant and co-dominant trees within the severe decline category at each plot, on a year-to-year basis.

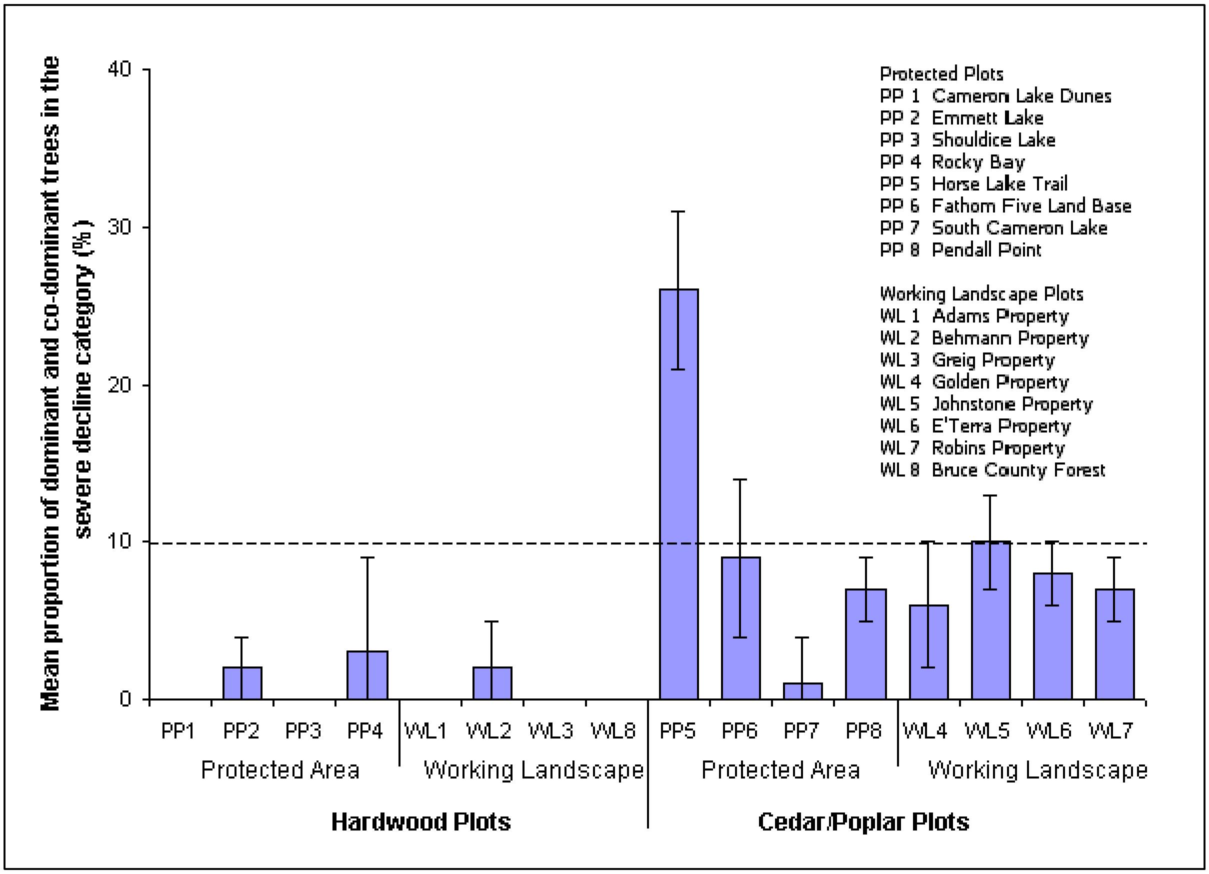

Figure 3: Mean proportion of dominant and co-dominant trees in the severe decline category at each of the forest plots on the Northern Bruce Peninsula. Bars represent the mean proportion of trees in severe decline for 2002, 2003, 2004, and 2005, ± the maximum and minimum values. The dotted line represents the ten percent threshold.

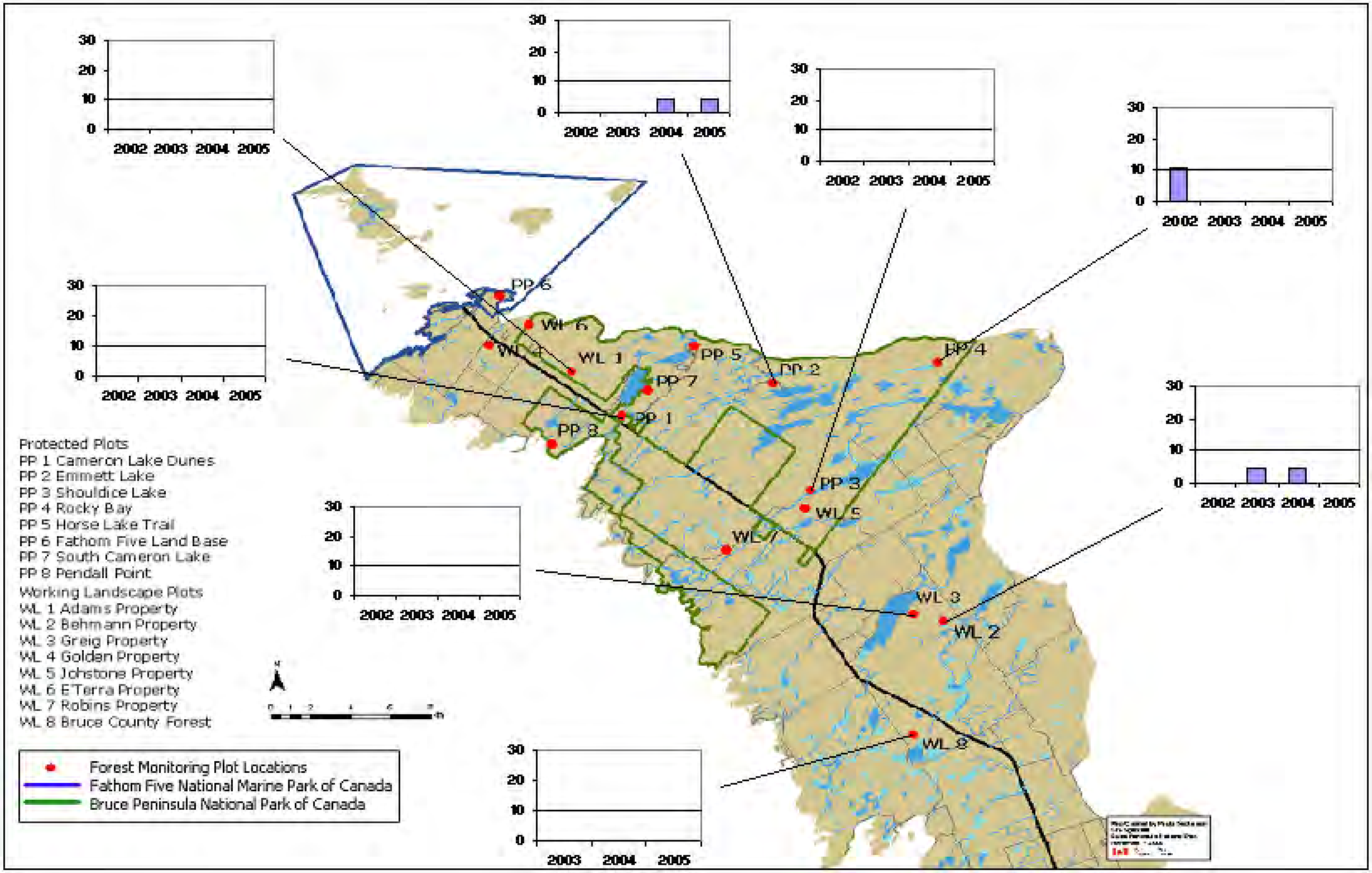

Figure 4: Percentage of dominant and co-dominant trees within the severe decline category at each of the hardwood plots located on the Northern Bruce Peninsula. Bars represent the percentage of trees in severe decline and the solid line represents the ten percent threshold.

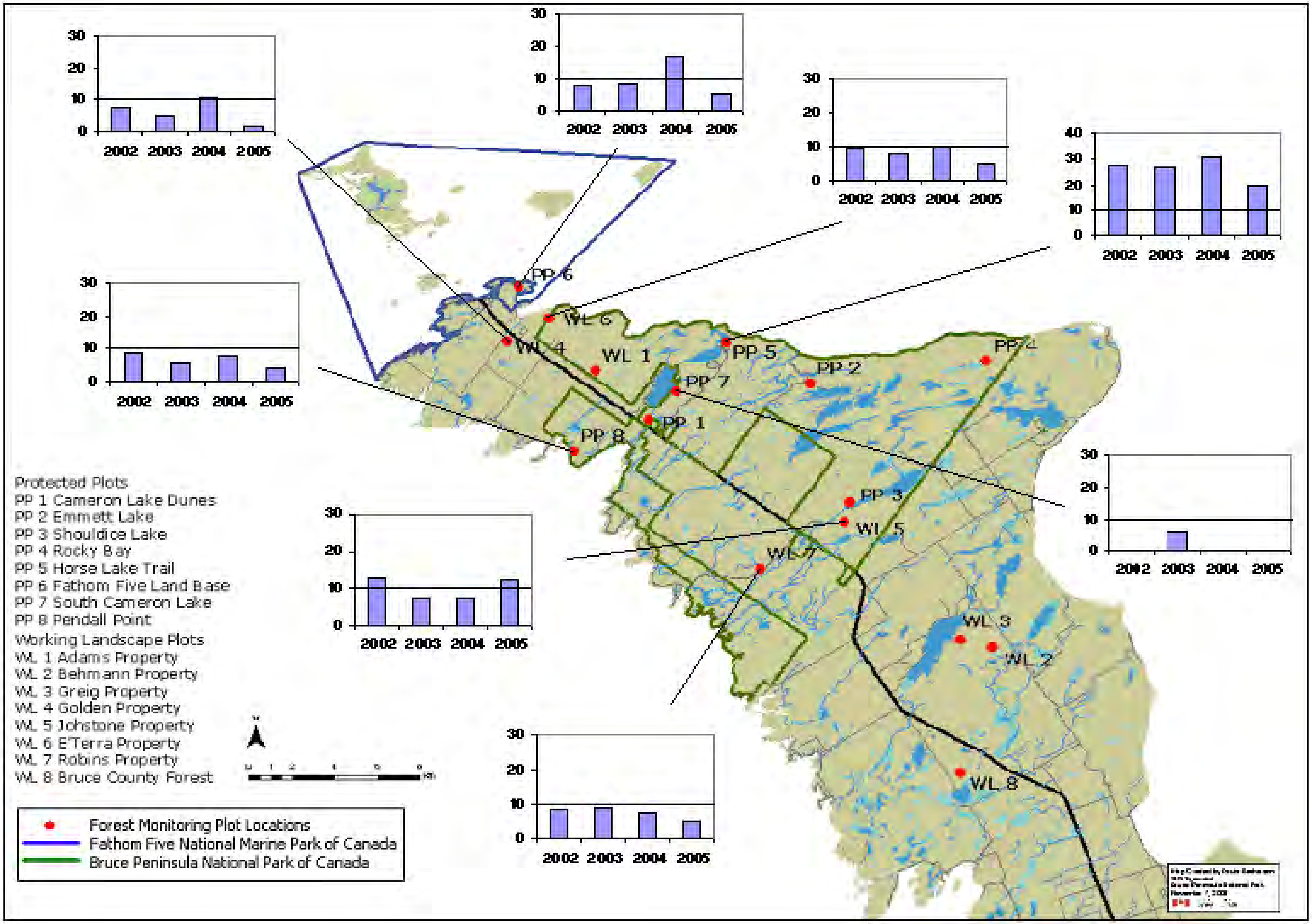

Figure 5: Percentage of dominant and co-dominant trees within the severe decline category at each of the cedar/poplar plots located on the Northern Bruce Peninsula. Bars represent the percentage of trees in severe decline and the solid line represents the ten percent threshold.

Stem Defects

Throughout this monitoring program, decay fungus has been found at a total of six of the monitoring plots. These plots are located at the Behmann Property (WL2), Horse Lake Trail (PP5), Johnstone Property (WL5), Robins Property (WL7), Emmett Lake Property (PP2), and Fathom Five Landbase (PP6). The presence of decay fungus at the Emmett Lake plot and the Fathom Five Landbase plot was only discovered this year. The mean percentage of dominant and co-dominant trees with decay fungus has been consistently below the ten percent threshold for all of the plots. Figure 6 shows the mean percentage of dominant and co-dominant trees with decay fungus for 2002, 2003, 2004, and 2005. Figure 7 and Figure 8 illustrate the percentage of dominant and co-dominant trees with decay fungus at each of the plots on a year-to-year basis.

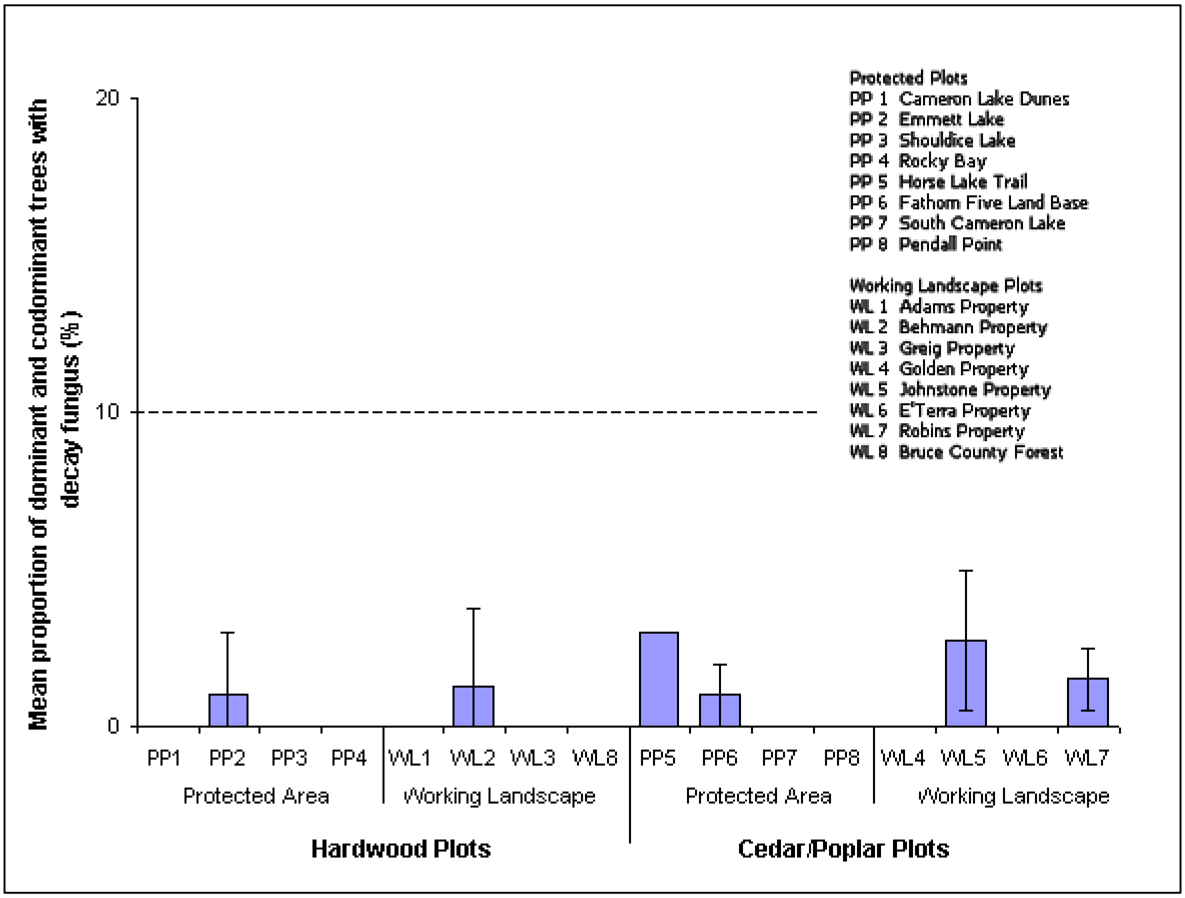

Figure 6: Mean proportion of dominant and co-dominant trees with decay fungus stem defects at each of the forest plots on the Northern Bruce Peninsula. Bars represent the mean proportion of trees with decay fungus for 2002, 2003, 2004, and 2005, ± the maximum and minimum values. The dotted line represents the ten percent threshold.

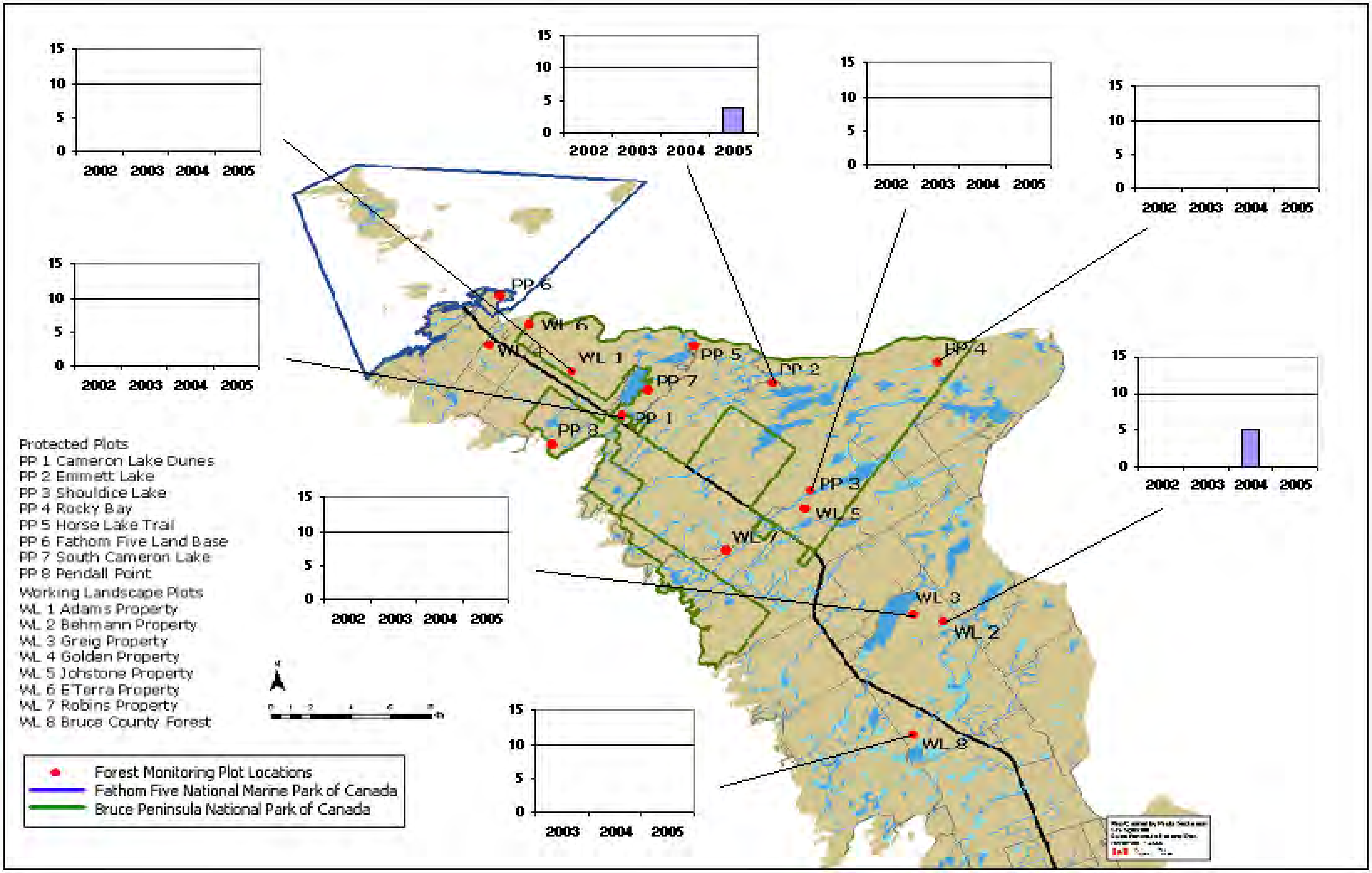

Figure 7: Percentage of dominant and co-dominant trees with decay fungus stem defects at each of the hardwood plots located on the Northern Bruce Peninsula. Bars represent the percentage of trees with decay fungus and the solid line represents the ten percent threshold.

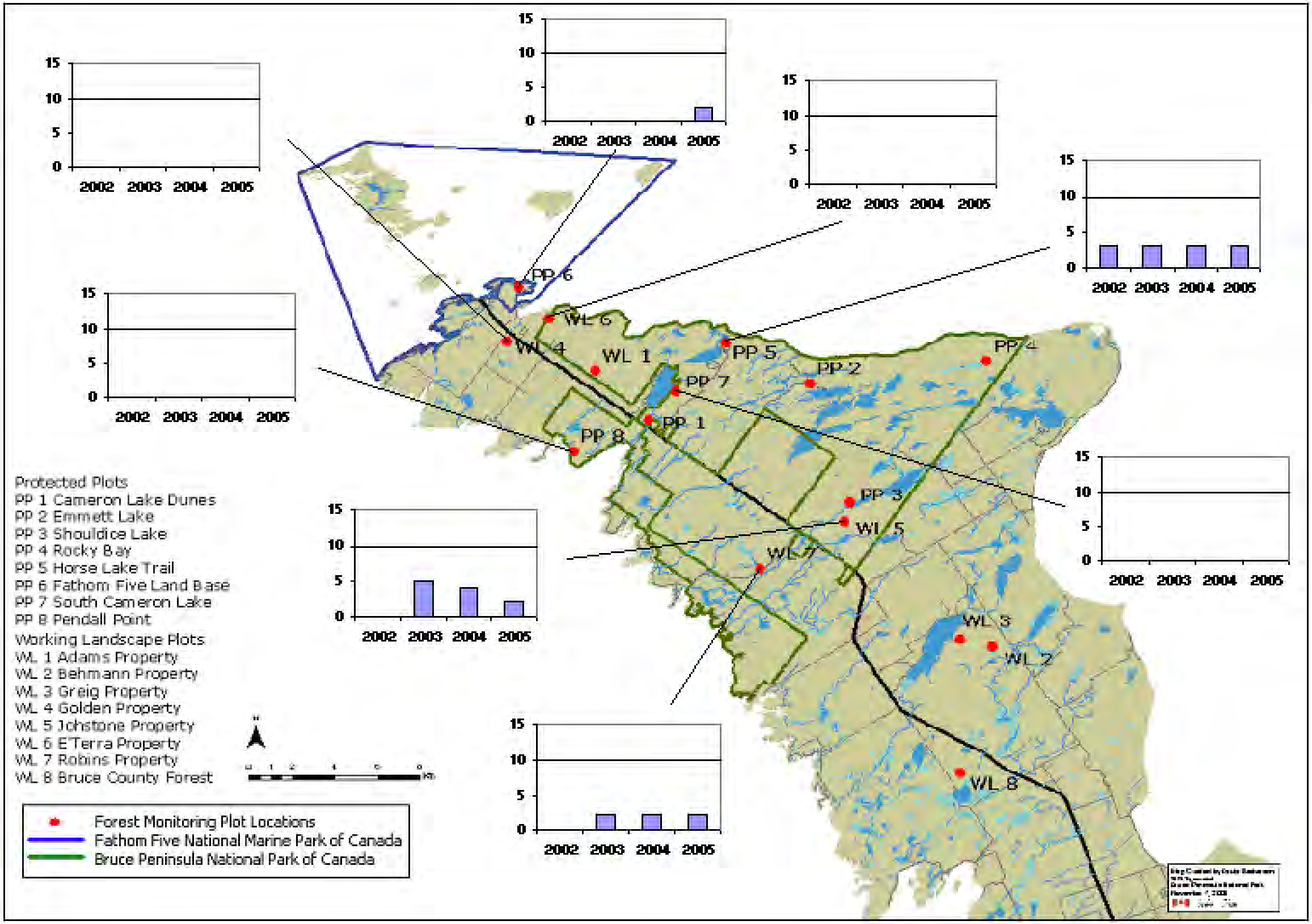

Figure 8: Percentage of dominant and co-dominant trees with decay fungus stem defects at each of the cedar/poplar plots located on the Northern Bruce Peninsula. Bars represent the percentage of trees with decay fungus and the solid line represents the ten percent threshold.

Seedling and Sapling Regeneration

Four species of dominant seedlings and saplings have been observed throughout this monitoring program. Sugar maple has been present as a dominant species at six of the hardwood plots. White ash has been a dominant species at three hardwood plots and balsam fir has been dominant at one hardwood plot. Within the cedar/poplar plots, balsam fir has been a dominant species at seven plots. White ash and eastern white cedar have each been dominant species at one site apiece. Figure 9 displays the mean number of each dominant species at each of the forest plots in 2002, 2003, 2004, and 2005. Figures 10 and 11 display the number of each dominant species, at each plot, on a year-to-year basis.

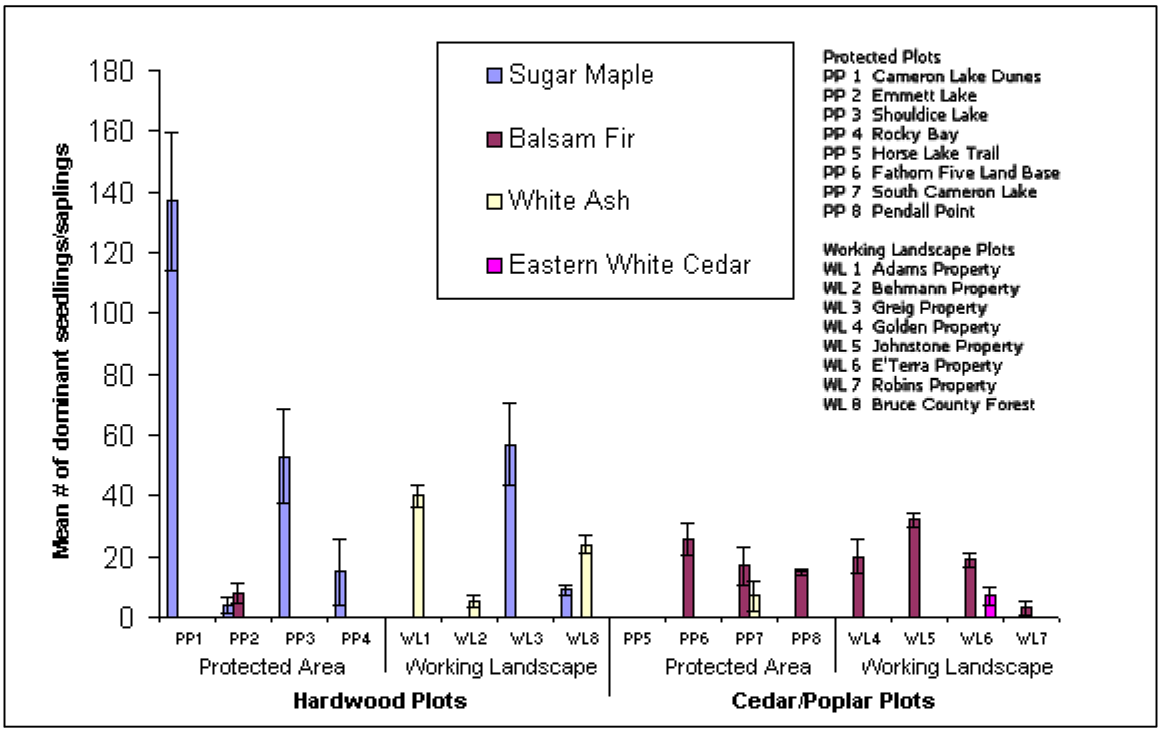

Figure 9: Mean number of dominant seedlings and saplings at each of the forest plots on the Northern Bruce Peninsula. Bars represent the mean number of dominant seedlings and saplings for 2002, 2003, 2004, and 2005, ± the maximum and minimum values.

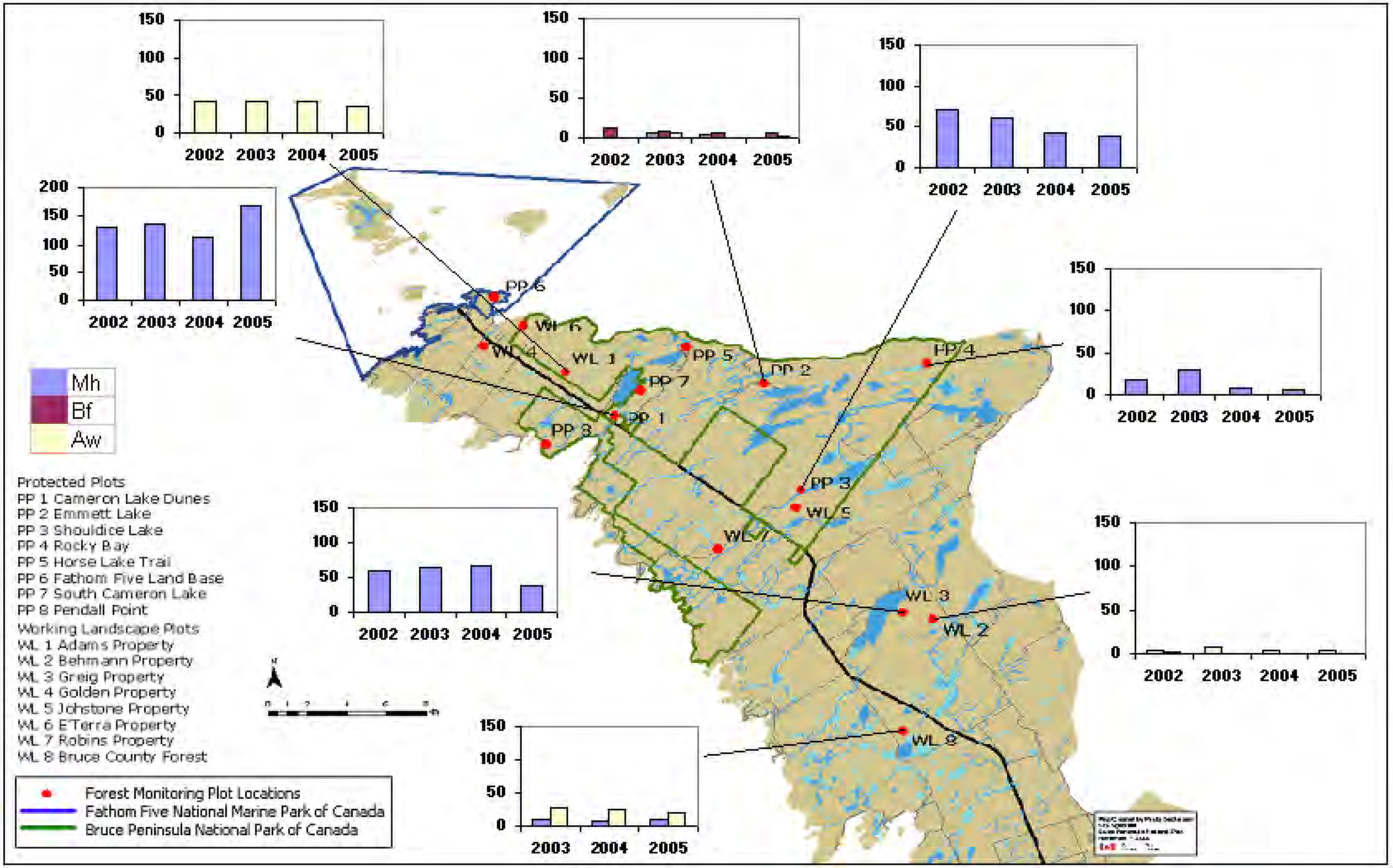

Figure 10: Total number of dominant seedlings and saplings, by species, found at each of the hardwood forest plots located on the Northern Bruce Peninsula.

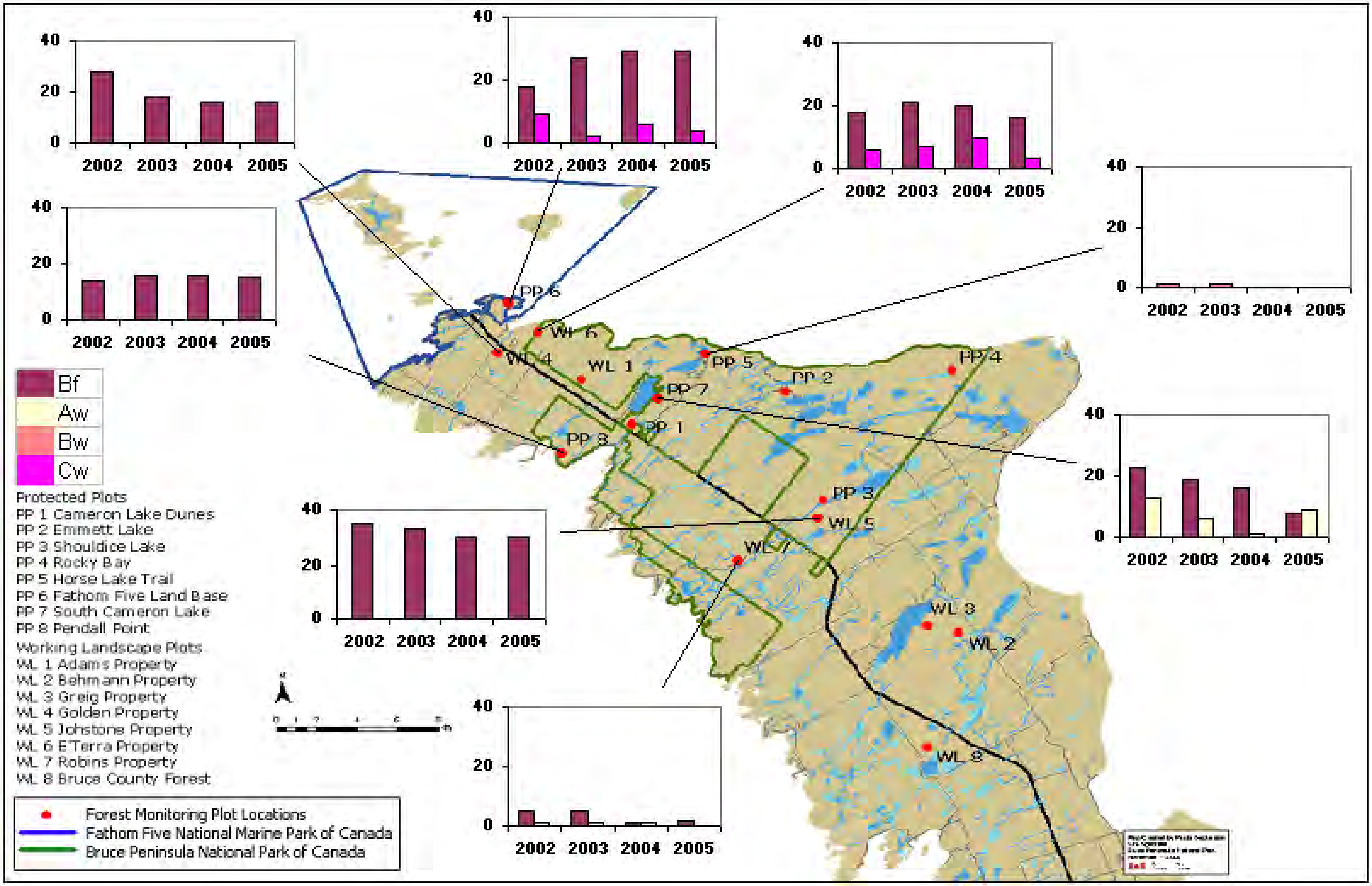

Figure 11: Total number of dominant seedlings and saplings, by species, found at each of the cedar/poplar forest plots located on the Northern Bruce Peninsula.

Downed Woody Debris

All downed woody debris that had been classified as class 1 debris last year has been accounted for this year. Class 1 debris refers to logs or stumps that are structurally intact and have not softened due to decomposition. Class 2 debris refers to logs or stumps that are generally intact but have some softening due to decomposition. All class 1 debris that was found last year either remained as class 1 debris this year, or was classified as class 2 debris due to decomposition.

Discussion

The data collected this year represents the fourth year of the long term monitoring program established at the 16 forest monitoring plots on the Northern Bruce Peninsula. The ongoing collection of annual forest health data will allow for changes in forest ecosystem health to be observed over time. After several years of additional data collection, trends in forest health may be observed and forest management strategies can be considered.

Throughout this monitoring program, three terrestrial vegetation monitoring protocols have been used as indicators of forest health. These protocols measure tree condition, regeneration rates of seedlings and saplings, and the abundance of downed woody debris present. The measurement of tree condition uses the incidence of branch mortality as an indicator of tree health and, in this particular monitoring program, a threshold of ten percent has been set in regards to the acceptable proportion of trees having severe dieback levels. The Horse Lake Trail plot (PP5) is the only plot which has exceeded the severe decline threshold for two consecutive years, when examining results on a year-to-year basis, as indicated in Figures 4 and 5. This is the fourth consecutive year that the Horse Lake Trail plot has exceeded the ten percent threshold. However, when comparing this year's results to those of previous years, it appears as though the percentage of trees in the severe decline category has decreased. This could potentially indicate that forest health is improving at the Horse Lake Trail plot. Subsequent monitoring data will determine any potential improvement at this plot. The Johnstone Property plot (WL5) has exceeded the threshold this year as well. Future monitoring will determine if this trend continues over a longer period of time.

Stem defects are monitored at the forest plots because they can indicate the presence of disease or the potential for disease. Decay fungus is the defect of interest in this monitoring program because it can directly indicate the presence of disease. A threshold of ten percent has been set as an acceptable limit in regards to the percentage of trees within each plot possessing decay fungus. At this point, the presence of decay fungus is not a cause of concern, as all of the plots are below the ten percent threshold.

Regeneration rates of seedlings and saplings within forest ecosystems are an important measure of forest health as they can indicate patterns in forest succession and recruitment rates of dominant tree species. Upon examination of Figures 10 and 11, it appears as though the diversity and abundance of seedlings and saplings has remained relatively consistent over the four years of monitoring. As further data is collected, trend analysis can be performed in the future to determine any potential trends in regeneration diversity and abundance at each of the plots.

Downed woody debris is an important component of forest ecosystems, as it can affect patterns in nutrient cycling, soil erosion, and water retention. Class 1 woody debris is defined as debris that is structurally intact and has not softened due to decomposition (Boyle, 2003). There is the potential for this type of debris to be removed from forest ecosystems as it is commonly desirable for burning purposes. It is important to monitor the presence of this type of debris to ensure that it is not being removed. All class 1 woody debris has consistently been accounted for at the 16 monitoring plots over the four years of monitoring. Future monitoring is important to ensure that the presence of woody debris remains consistent, as the presence of woody debris is important in the health of any forest ecosystem.

There are some minor improvements that could be made to methodologies used in this monitoring program. In monitoring the presence of downed woody debris at each site, the methodology was altered this year. Instead of transects simply running along the perimeter of the forest plot, transects now run along the plot perimeter and are then extended in the same direction for a distance of 25.14 m. Three transects are created in this manner, each measuring 45.14 metres in length. It would be beneficial to permanently mark the end of each transect with a stake, so that the areas sampled remain consistent from year to year. Also, if available, a caliper would be a more accurate way to measure the diameter of downed woody debris.

Section Two

Terrestrial Salamander Abundance

Introduction

Plethodontid salamanders are lungless organisms which represent the largest group of salamanders in the world. This particular type of salamander respires through its moist skin and the roof of its mouth, making it particularly sensitive to changes in air and water quality. In addition to their sensitivity to environmental stress, salamanders are considered good indicators of ecosystem health because of their strong site fidelity, long life spans, and high annual survival rates (Zorn, Blazeski, & Craig, 2004).

Artificial cover objects (ACOs) are a practical and effective way to monitor salamander populations because they are easy to monitor, they have minimal effects on natural habitat, they provide a standardized sampling unit, and they are inexpensive to install (Boyle, 2003). In 2003, salamander monitoring boards were set up at eight of the forest monitoring plots in the Municipality of Northern Bruce Peninsula. The cover boards were left to settle for one year and abundance counts began in 2004. This year represents the second monitoring year for plethodontid salamander abundance on the Northern Bruce Peninsula. The purpose of this study is to re-inventory salamander abundance at the selected monitoring sites to further contribute to data regarding salamander populations in the area, so that as this monitoring program continues, changes in salamander abundance can be documented and analysed as an indicator of ecosystem health.

Methods

Location and Design

In 2003, artificial cover boards were set up at eight of the forest monitoring plots on the Northern Bruce Peninsula. Four of these plots are located on protected property and four are set up on working landscape plots. Listed in Table 1 are the existing salamander plot locations.

Table 1: Plot locations where salamanders cover boards have been installed.

Plot Name	Plot #	Landscape Type	Vegetation Strata
Cameron Lake Dunes	01 01	Protected Property	Hardwood
Emmett Lake	01 02	Protected Property	Hardwood
South Cameron Lake	01 07	Protected Property	Cedar/Poplar
Pendall Point	01 08	Protected Property	Cedar/Poplar
Harmony Acres	02 01	Working Landscape	Hardwood
Behmann Property	02 02	Working Landscape	Hardwood
Johnstone Property	02 05	Working Landscape	Cedar/Poplar
Robins Property	02 07	Working Landscape	Cedar/Poplar

There are forty cover boards set up around the outside of the forest monitoring plot perimeter. For a detailed diagram showing the configuration of the artificial cover boards at each site, refer to Zorn, Blazeski, & Craig, 2004.

Data Collection

This year, salamander abundance counts took place from May 30 to June 30. Cover boards at every site were checked once a week, for five weeks, for a total of five counts at each site. Counts for each site were performed at the same time every week in order to ensure consistency in data collection. Sampling was conducted in the mornings when the ground was potentially cooler and wetter than in the afternoon. Mandatory variables, such as plot location, salamander species and abundance, ground and air temperature, precipitation in the last 24 hours, and Beaufort sky and wind codes were recorded. The additional preferred variables, such as salamander weight, age, sex, and lengths were not recorded this year, as it was decided that documenting these variables was very time-consuming and was not necessary for the purpose of this monitoring program.

For additional information regarding the use of plethodontid salamanders as indicator species, as well as monitoring methodologies and data collection procedures, refer to the document entitled Joint EMAN / Parks Canada National Monitoring Protocol for Plethodontid Salamanders (Zorn, Blazeski, & Craig, 2004).

Data Analysis

In last year's report (McAfee, 2004), the total abundance data was calculated incorrectly. The total abundance for each site was calculated using a pivot table in Microsoft Excel. Instead of calculating the sum of the counts for each site, the total abundance results were calculated by adding together the number of entries for each site. The revised numbers for total abundance of Eastern Redback salamanders found last year are displayed below in Table 2 and Figure 12.

From the raw data collected this year, a bar chart was created showing the total number of eastern redback salamanders found at each of the monitoring locations this year (Figure 13). The other species of salamanders found were not displayed on the bar chart because they were found in very small abundance. In addition, the total number of eastern redback salamanders found at each site is displayed in chart form below, on a week-to-week basis (Figures 14 and 15). The weekly mean number of salamanders found at each plot was calculated on a year-to-year basis. These results are displayed in Figure 16.

Results

The revised abundance results for 2004 are displayed below in Table 2 and Figure 12.

Table 2: Revised total abundance of each species of salamander found at each of the monitoring locations in 2004.

Plot Name	# Redback	# Yellow Spotted	# Blue Spotted	# Red-Spotted Newt
Cameron Lake Dunes (PP1)	99	0	0	0
Emmett Lake (PP2)	153	1	0	0
Harmony Acres (WL1)	42	0	0	0
Behmann Property (WL2)	43	0	0	0
South Cameron Lake (PP7)	84	0	1	0
Pendall Point (PP8)	96	0	0	0
Johnstone Property (WL5)	6	0	0	0
Robins Property (WL7)	5	0	0	1

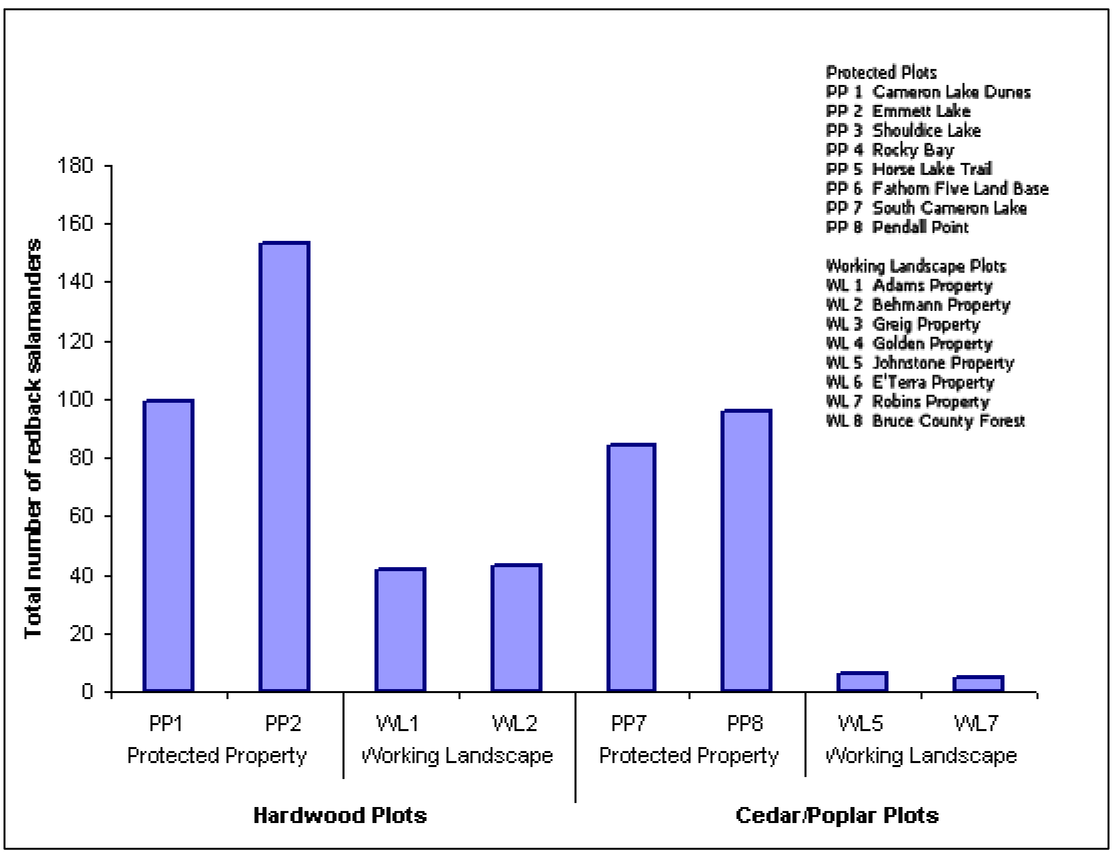

Figure 12: Revised total abundance of eastern redback salamanders found at each of the monitoring locations in 2004.

A total of three different species of salamanders were found in 2005. A total of 478 salamanders were found, with 473 of those being eastern redback salamanders, three being yellow spotted salamanders, and two being blue spotted salamanders. Table 3 and Figure 13 display the total abundance of each species found at each site this year. Figures 14 and 15 display the total abundance of eastern redback salamanders found at each of the forest plots on a week-by-week basis. Figure 16 displays the weekly mean number of eastern redback salamanders found at each plot, on a year-to-year basis.

Table 3: Total abundance of each species of salamander found at each of the monitoring locations in 2005.

Plot Name	# Redback	# Yellow Spotted	# Blue Spotted
Cameron Lake Dunes (PP1)	58	1	0
Emmett Lake (PP2)	143	0	0
Harmony Acres (WL1)	56	0	0
Behmann Property (WL2)	70	1	0
South Cameron Lake (PP7)	56	0	1
Pendall Point (PP8)	69	0	0
Johnstone Property (WL5)	12	0	1
Robins Property (WL7)	9	1	0

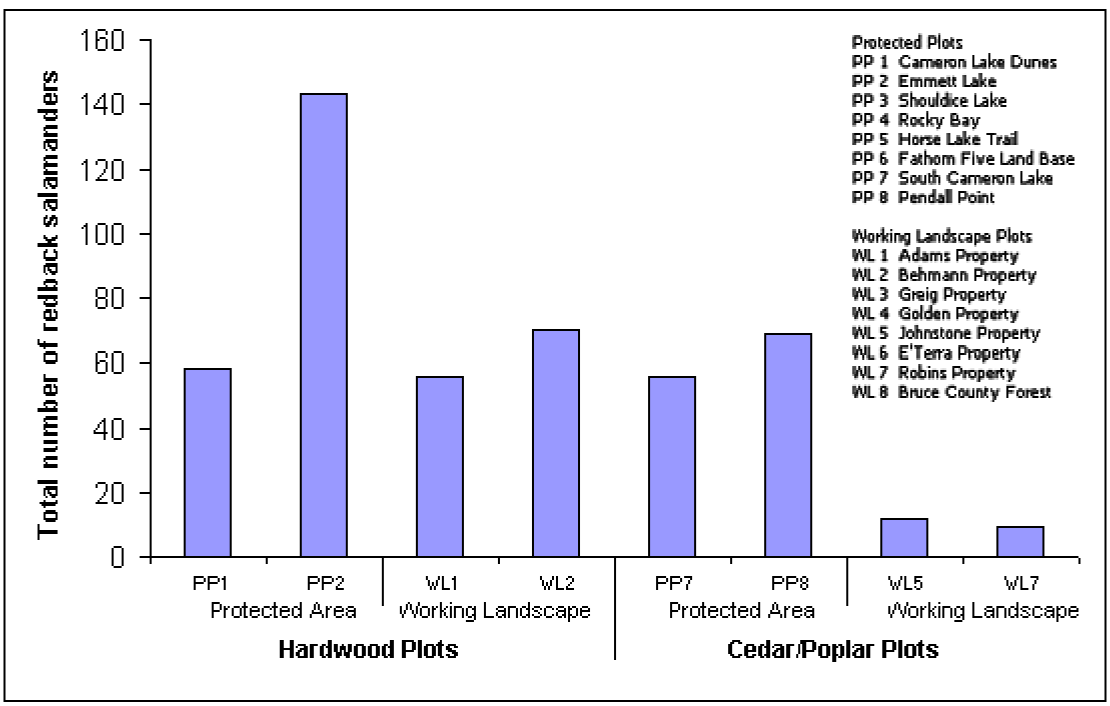

Figure 13: Total abundance of eastern redback salamanders found at each of the monitoring locations in 2005.

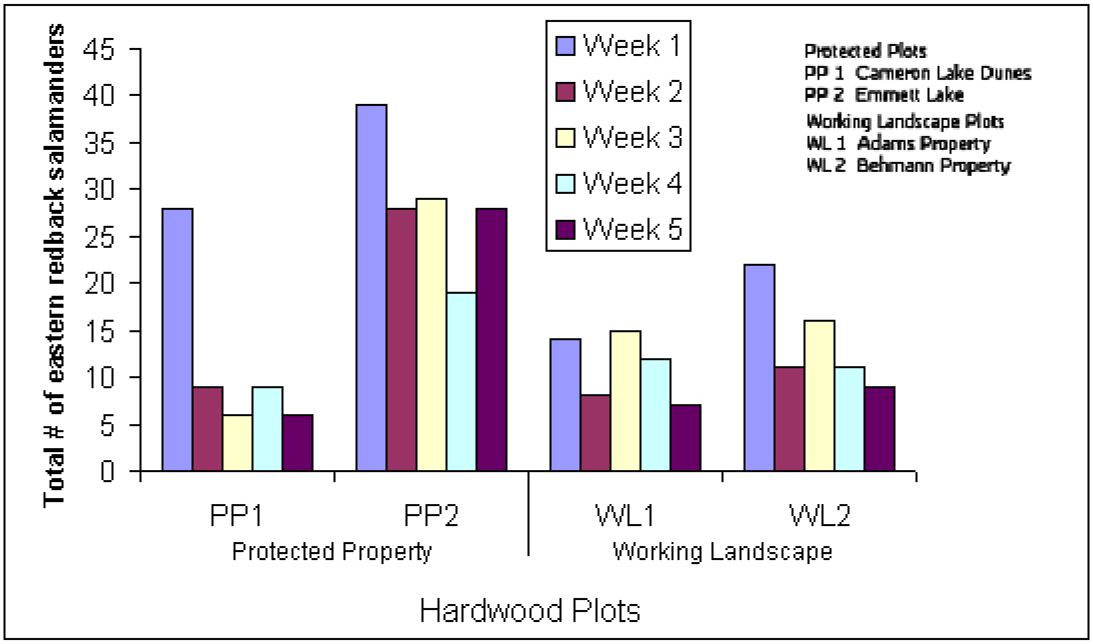

Figure 14: Total abundance of eastern redback salamanders found this year at each of the hardwood plots. Results are displayed on a week-to-week basis.

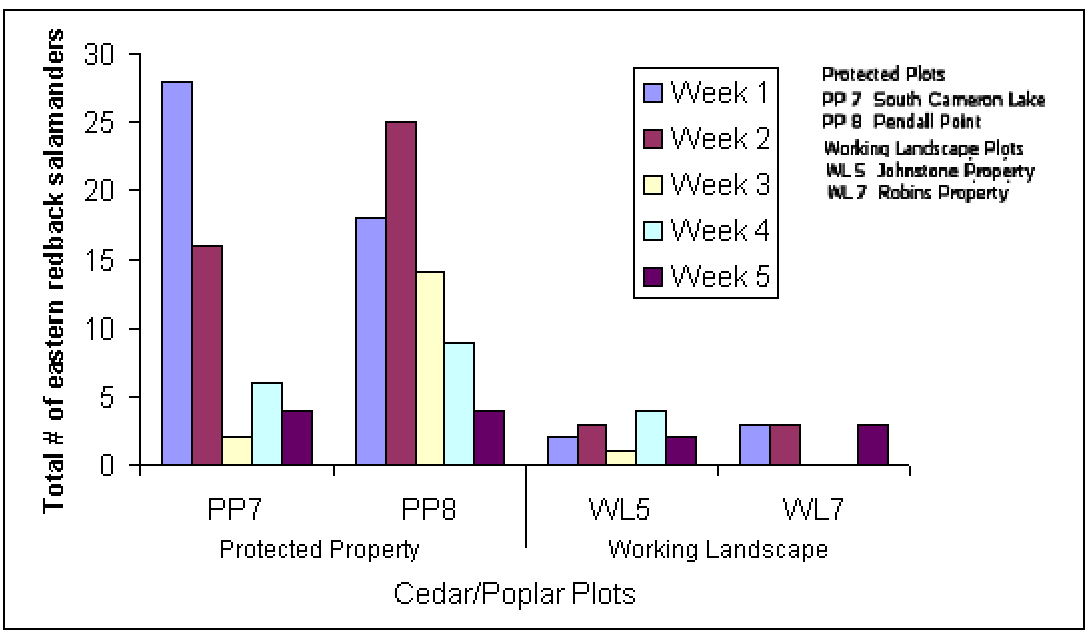

Figure 15: Total abundance of eastern redback salamanders found this year at each of the cedar/poplar plots. Results are displayed on a week-to-week basis.

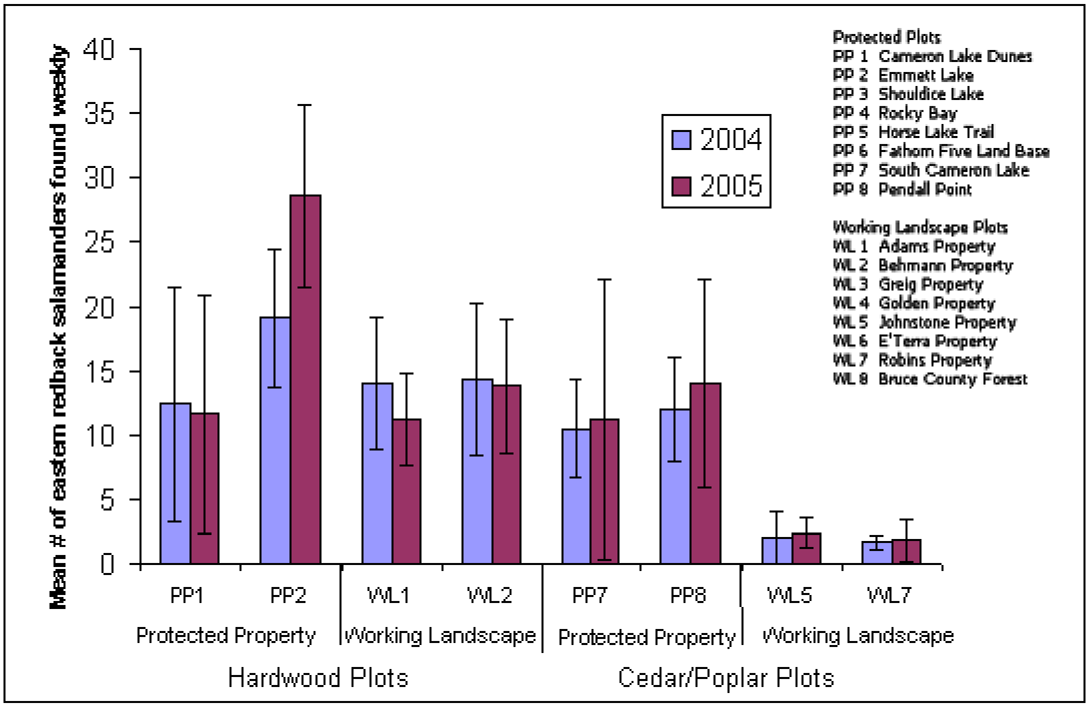

Figure 16: Mean number of eastern redback salamanders found at each plot on a weekly basis ± the maximum and minimum values.

Discussion

The data collected this year provides further information regarding salamander abundance on the Northern Bruce Peninsula. From this year's results, it appears as though the abundance of eastern redback salamanders in working landscape cedar/poplar plots is much lower than the abundance at any other plot. The remainder of the plots seem to have a similar abundance of eastern redback salamanders, with the exception of the Emmett Lake plot in which a significantly higher abundance was documented. As Figures 14 and 15 indicate, salamander abundance was higher at the beginning of the sampling period and lower at the conclusion of the sampling period. As salamanders prefer cool, moist conditions, the decreases in abundance could be attributed to ongoing temperature increases and soil moisture decreases resulting from the emerging summer season. In future monitoring, it may be beneficial to conduct abundance inventories in early spring when conditions are cooler and wetter, yielding more productive results.

Figure 16, which displays the weekly mean number of eastern redback salamanders found at each plot on a year-to-year basis, indicates that the mean number of salamanders found this year may be similar to results of last year. As monitoring continues, yearly comparisons of the mean number of salamanders found may be useful in determining any trends in salamander abundance at the monitoring plots.

It was difficult to make yearly comparisons of abundance data due to differences in this year's sampling periods and last year's sampling periods. Last year, the protected property sites were monitored for a period of eight consecutive weeks, whereas the working landscape plots were monitored for a period of three consecutive weeks. This year, every monitoring plot was monitored for a period of five consecutive weeks. In addition, sampling periods for certain plots took place at different times in the season, which may have an influence on results. In future monitoring years, if possible, it is recommended that sampling periods be clearly defined and carried out in the same manner every year to ensure consistency in data collection.

An additional recommendation for future monitoring is to document soil moisture and pH measurements. The protocol that was used this year outlines that two separate data sheets are to be used in data collection. One of these sheets is labelled Field Sheet A and is used to document mandatory variables, such as species and abundance information. The second field sheet, labelled Field Sheet B, is used for additional non-mandatory variables, such as specimen weight and length measurements, as well as soil moisture and pH measurements. Field Sheet B was not used this year, as its primary function is for the documentation of specimen measurements and, therefore, soil moisture and soil pH were inadvertently not included in the data collection. However, it is recommended that these variables be recorded in the future as fluctuations in these variables can largely impact salamander populations. As data collection continues over time, examining trends in these variables may be useful in analyzing any occurring trends in salamander populations.

As this was only the second year of monitoring, it is difficult to comment on changing trends in salamander abundance. Subsequent monitoring over the next few years will provide further data from which changing trends in populations can be examined and analysed more extensively.

Section Three

Lichen Abundance and Diversity Monitoring

Introduction

It is thought by many people that lichens are simple organisms, much like any other type of plant. In fact, lichens exist as a symbiotic relationship between a fungus and a photosynthetic partner. This photosynthetic partner, otherwise know as a photobiont, can be a type of green algae, a type of cyanobacteria (blue-green algae), or a combination of the two. (Purvis, 2000)

Arboreal lichens, which are defined as tree trunk dwelling lichens, are considered good bioindicators due to their sensitivity to environmental stress, especially air pollution and climate change. (Parker et al., 2003) Lichens are able to readily absorb chemicals from air and rainwater and the absorption of these materials can rapidly affect the delicate relationship between the fungal and algal components of the lichen, causing the lichen to die (Brodo, Duran Sharnoff, & Sharnoff, 2001). Through continuous monitoring of lichen diversity and abundance, trends in environmental change, particularly air quality, can be assessed over time.

The lichen monitoring program initiated on the Northern Bruce Peninsula this year utilised protocols prepared by the Ecological Monitoring and Assessment Network. This protocol involves measuring lichen diversity and abundance on selected trees in order to assess ecosystem health over time. In identifying lichens for this monitoring program, a reference notebook was used. The reference book, titled “Identifying Mixed Hardwood Forest Lichens” and written by Irwin M. Brodo and Brian Craig, provides descriptions and identification keys for a mix of hardwood lichen species. Species outlined in this manual were selected because of their varying sensitivities to various environmental stressors and their ease in identification. When initiating a lichen monitoring program, it should be kept in mind that identifying every lichen species present in an area may require advanced expertise and this may not be available for many monitoring programs. Therefore, a selected group of lichens, such as the group outlined in the reference notebook indicated above, may serve as an adequate sampling group for simple monitoring objectives. (EMAN, 2002)

Methods

Location and Design

A lichen monitoring protocol was introduced to eight of the forest monitoring plots on the Northern Bruce Peninsula this year. The plots selected for this protocol were the eight existing hardwood plots. Four plots are located on protected property within Bruce Peninsula National Park, while four are located on working landscape plots. A list of the eight selected plots with their plot names, plot numbers, and landscape type are listed in Table 4 shown below.

Table 4: Plot locations where lichen monitoring stations have been installed

Plot Name	Plot Number	Landscape Type
Cameron Lake Dunes	PP 1	Protected Property
Emmett Lake	PP 2	Protected Property
Shouldice Lake	PP 3	Protected Property
Rocky Bay	PP 4	Protected Property
Harmony Acres	WL 1	Working Landscape
Behmann Property	WL 2	Working Landscape
Greig Property	WL 3	Working Landscape
Bruce County Forest	WL 8	Working Landscape

Site and Tree Selection

Once the sampling plots were determined, the five largest sugar maple trees were selected for sampling within each plot. The number that was previously assigned to each of these plotted trees was recorded, along with the tree species and diameter at breast height for each tree. A second sampling site was then selected within reasonable proximity of the forest plot, along a forest edge. Edge species receive more sunlight than interior species and are more likely to have thriving populations of lichens for sampling (EMAN, 2002). In the event that a true forest edge could not be located within a reasonable distance of the forest plot, sample trees were selected within the forest interior in areas having relatively open canopies. Once this second sampling site was located, five of the largest diameter sugar maple trees in this area were selected for sampling. Each of these trees was tagged from 1 to 5 using a unique site number. These sites were numbered using the same site number as the corresponding forest plot, and placing an L in front of the plot number. For example, the Cameron Lake Dunes forest plot number is "01 01". The site number for the lichen monitoring site located along a forest edge at Cameron Lake Dunes is "L 01 01". Once the trees were tagged, diameter at breast height measurements were taken. GPS locations were taken for each of the trees for future reference.

Data Collection

Monitoring of lichens should take place annually at approximately the same time every year to ensure sampling consistency. Sampling should be avoided when it is raining or immediately after rainfall as this can affect size, colour, and identifiable characteristics of lichens. (EMAN, 2002)

Once the sites and sampling trees were selected, an inventory of diversity and abundance of lichen species was performed on each tree. For each tree, a piece of flagging tape was tied around the tree trunk at one metre and 1.3 metres from ground level. This 30 centimetre space acted as the lichen sampling area. The trees were then marked directly above the top piece of flagging tape and below the bottom piece of flagging tape with tree marking paint. This was done to ensure that the sampling area of each tree was permanently marked for future monitoring. The sampling of lichens was done separately on the north and south sides of the tree. Using a compass, due east and due west were found. Nails were placed on the east and west sides of the tree, directly above the bottom piece of flagging tape at one metre above ground level. These nails allow the tree to be vertically split into north and south quadrants, so that these areas can be monitored separately with visual ease. In the event that the flagging tape deteriorates and the marking paint is no longer visible in future years, the location of the nails can be used as a reference point for the placement of the bottom piece of flagging tape, as these nails are located at 1 metre above ground level which is the same height as the bottom piece of flagging tape. Starting on the north side of the tree, each lichen species present was identified using a 10X hand lens and the Lichen Reference Notebook (Brodo & Craig, 2003). The abundance of each of these species was determined by estimating the percentage of area that the lichen species was occupying on that side of the tree, within the sample area. If species were present that were unidentifiable, notes of their description and abundance were taken in case this information may be desired for future reference. This procedure was repeated for the south side of the tree.

Data Analysis

From the raw data, the mean percent coverage of each lichen species was calculated for each individual site. Figure 17 illustrates the mean percent coverage of each lichen species at each of the existing forest plot sites. Similarly, Figure 18 illustrates the mean percent coverage of each lichen species at each of the newly established forest edge locations.

Results

A total of five different lichen species were identified at the lichen sampling locations this year. The most dominant species of lichen found was Graphis scripta, which was found in varying abundance at every sample site. Phaeophysica rubropulchra was found in smaller abundance at five of the interior sites and five of the forest edge sites. Melanelia subaurifera was found in relatively small abundance at three of the forest interior sites and two of the forest edge sites. Candelariella efflorescens was found in very small abundance at two of the forest edge sites and one of the forest interior sites. Finally, Candelaria concolor was only found at the Shouldice Lake forest interior site in a very small abundance.

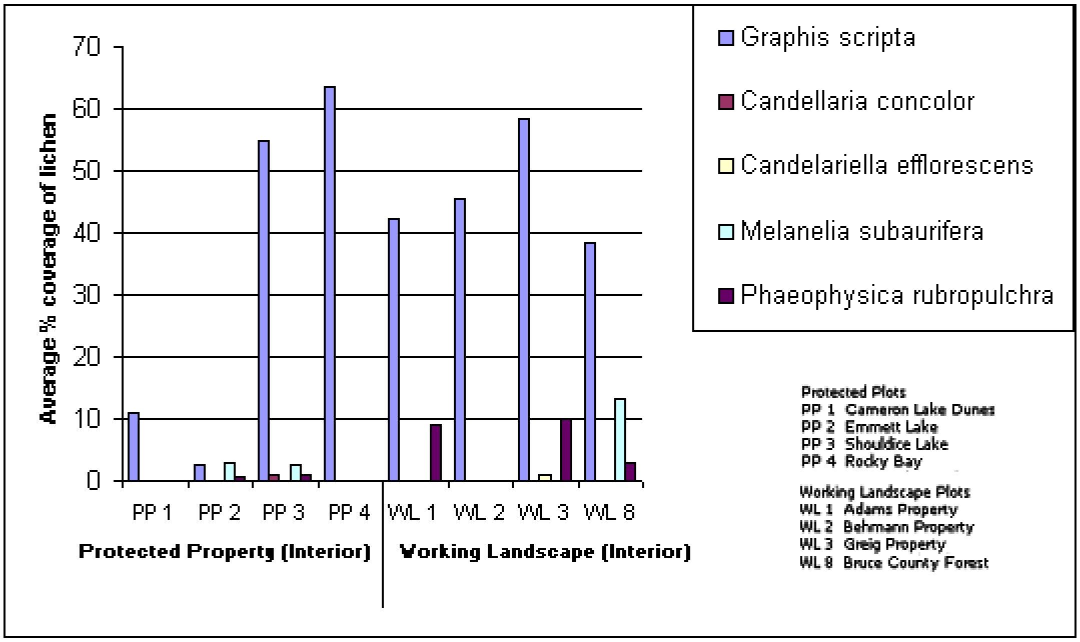

Figure 17: The average percent cover of each lichen species found at each of the forest interior monitoring plots

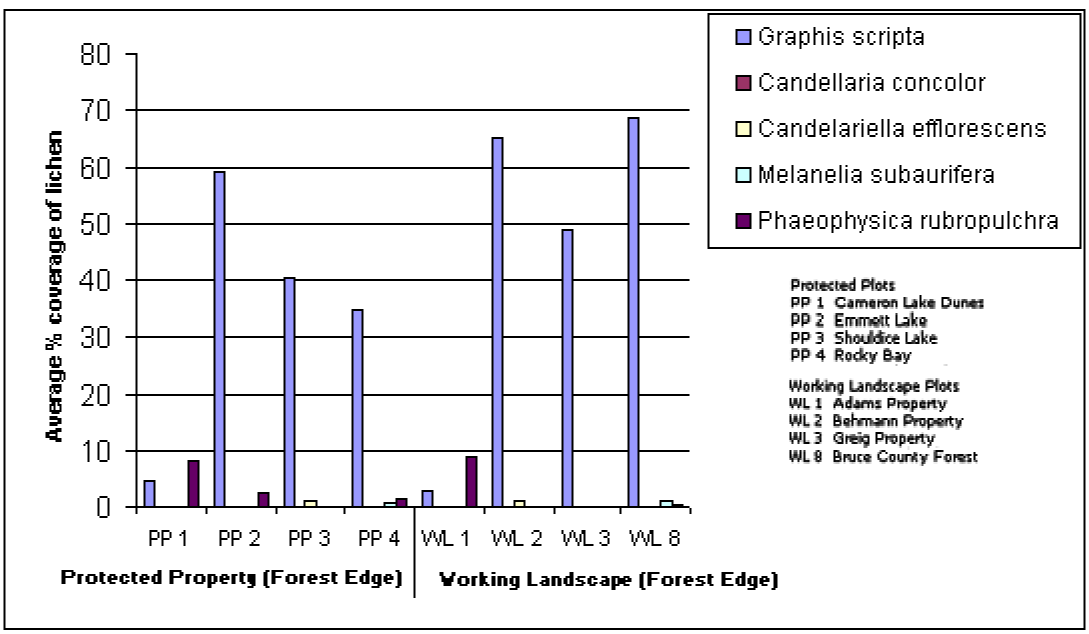

Figure 18: The average percent cover of each lichen species found at each of the forest edge monitoring sites.

Discussion

As this was the first monitoring year, the data collected provides a baseline summary of lichen diversity and abundance within the selected sites. Five species of lichens were found in varying abundance at the monitoring locations this year. The lichen species found include those that have been characterized as being tolerant of slight to moderate levels of air pollution (Brodo & Craig, 2003). As this is only an initial inventory, it is not possible to determine if changes are occurring in lichen populations at these sites. Subsequent monitoring will indicate any changes in diversity and abundance of lichen populations over time. Over longer periods of time, changes and trends in lichen populations can be examined as potential indicators of environmental change, including changes in air quality and climate change.

The establishment of the lichen monitoring sites is relatively time consuming in relation to the amount of time the actual data collection consumes. In future years, this monitoring protocol should be simple to carry out and should take relatively small amounts of time, since the sites have already been established.

In future years, the use of a visual estimation chart may be useful in estimating the percent area of lichens. The use of this item may decrease the year-to-year variation in results caused by visual subjectivity.

One thing to consider for future monitoring is the potential incorporation of the cedar/poplar plots as lichen monitoring stations. These plots are characterized as having very different tree species composition when compared to the hardwood forest plots. As a result of this, the cedar/polar plots will potentially have different species of lichen present and these additional lichens may contribute to sampling diversity and act as additional indicators of ecosystem health.

Section 4

Annual Decay Rates Monitoring

Overview

As vegetation within a forest ecosystem dies, decomposition of this organic matter occurs, along with the release of nutrients and gases such as carbon dioxide. Existing living plants take up the nutrients released. Decomposition rates of this vegetation can be influenced by many factors including climate, temperature, moisture, substrate type, nutrient availability, litter type and size, and types of soil organisms present. (EMAN, 2004)

Changes in decay rates can have a direct impact on climate change. It is thought that increases in atmospheric carbon dioxide may contribute to global warming. Since soils and vegetation in forests have the potential to store large amounts of carbon, it is possible that a temperature increase could result in increased decomposition rates, thereby resulting in an increase of carbon dioxide releases into the atmosphere. This increase of carbon dioxide into the atmosphere could then potentially affect global warming rates and climate change. These changes in global warming can have direct impacts on the health of ecosystems at a global level. By measuring decay rates in forest soils, in conjunction with examining trends in climate change, one can attempt to assess the correlation between these two variables and the effects that climate change can have on forest ecosystems. (EMAN, 2004)

The next monitoring protocol to be incorporated into the forest plots on the Northern Bruce Peninsula is an annual decay rates protocol. The protocol to be used is one that is in development by the Ecological Monitoring and Assessment Network. The protocol involves setting up twelve decay rate monitoring stations at each forest plot. Three decay rate stations are set up at each corner of the plot in a 1 metre X 1 metre quadrat. For each decay rate station, tongue depressors are weighed, tagged, and then installed at various levels in the soil horizon. One year later, the depressors are collected and weighed again to determine the resulting mass difference, which can be expressed as % mass loss. As this monitoring program continues, trends in the change of % mass loss can be observed over time as an indicator of change in decay rates. (EMAN, 2004)

Due to insufficient time, the annual decay rates monitoring protocol was not implemented this year. If possible, this protocol should be initiated in the following monitoring year, as annual decay rates monitoring could be a complementary indicator to the existing forest monitoring protocols established on the Northern Bruce Peninsula.

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