


SPOOKY HOLLOW NATURE SANCTUARY
2003 Inventory Report

Long Point World Biosphere Reserve Monitoring Program

Brent H. Parker


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Executive Summary

After the 1992 Earth Summit in Rio de Janeiro, many international agencies recognized the need to document changes in biodiversity and began to establish biological monitoring programs. In 1995 in response to this need, and with the assistance of Environment Canada's Ecological Monitoring and Assessment Program, the Long Point World Biosphere Reserve Foundation (LPWBRF) initiated a Forest Biodiversity Monitoring Program within the reserve. More recently, the Hamilton Naturalists' Club (HNC) joined the LPWBR monitoring initiative by establishing a set of monitoring plots within Spooky Hollow Nature Sanctuary, a club-owned property.

Over the summer of 2003 a permanent biodiversity monitoring plot consisting of 21 dispersed quadrats was established across Spooky Hollow. Monitoring is focused on the establishment and inventory of trees in the plots, assessment of arboreal lichen diversity, and surveys of benthic invertebrate communities in surrounding watercourses.

This report provides background information on the development of the biodiversity monitoring initiative in the Long Point World Biosphere Reserve, and details the results of the initial inventory of Spooky Hollow. A brief natural history of the Spooky Hollow Natural Area is also included. Preliminary analysis of this monitoring data provides a foundation for comparison with future reinventories.

The inventory at Spooky Hollow is the first to quantitatively document the tree biodiversity in the area. Although the total area sampled was less than that of typical one hectare plots 24 tree species were recorded. The high tree diversity is in part due to the dispersed sampling method employed, which encompasses a large variety of forest types and topographical features. *Castanea dentata*, a nationally and provincially rare species, occurs in Spooky Hollow, however none were recorded in the quadrats.

The canopy layer is intermittent to partially closed and ranges in average height from 20 m to 44 m across the quadrats. A maximum dbh of 76.25 cm was measured from a *Quercus velutina*. The canopy is composed of a wide diversity of species associated with early (e.g. *Prunus serotina*) and late (various *Acer* sp.) successional stages.

Acer rubrum is a strongly dominant species accounting for 40.6% of the stems in the plot. *P. serotina, Q. velutina, Pinus strobus, Tsuga canadensis,* and *Quercus rubra* each account for at least 5% of the rest of the stems. Many species in the plot are represented by only a few individuals.

The majority of trees are in the smallest size class, 4.01-9.0 cm. Likewise a large percentage of the total stems is in the next largest size class (9.01-14.0 cm). This suggests that many new saplings are being successfully recruited into the plot population. The majority of these new recruits are *A. rubrum* (42.9%) and *P. serotina* (17.5%).

A. rubrum was clearly the most important species in the plot; it had the highest relative density, dominance and frequency by far. Although the inventory data represents only a point in time the high relative density and frequency, and large numbers of young *A. rubrum* suggests that its dominance will likely continue to increase.

The arboreal lichen monitoring in Spooky Hollow revealed a diverse community comprised of a variety of common and widespread lichens that are typical of the mixed hardwood forests of southern Ontario. The lichen diversity value (LDV) was 19.8, the highest of any of the LPWBR monitoring plots. The lichen species found include those that are tolerant of slight-moderate levels of air pollution. Lichen species that are intolerant of pollution, namely

Usnea sp. and *Lobaria sp*., were not found, nor have they been documented in the surrounding regional forests of Norfolk County since 1940. Their absence may speak to historic loss of habitat and the air quality of the region as a whole.

Fishers Creek is one of five benthic invertebrate community reference sites established to represent a range of physiographic environments, which will enable comparison with test sites across the region. Taxa that are sensitive to water quality (mayflies, stoneflies, and caddisflies) were present at all sites, indicating relatively high water quality. Ultimately, diversity measures linked to the physiographic attributes of each reference site will enable characterization of baseline conditions for comparisons with test sites.

Over the long-term the monitoring indicators will act as an integrated monitoring suite that will track changes within Spooky Hollow and across the LPWBR's terrestrial, atmospheric, and aquatic environments. Through our efforts to track and understand change in these ecosystems we will be able to provide feedback and direction for regional development to ensure that these natural areas continue to function as environmental sanctuaries.

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Key to the Abbreviations Used in the Text

Abbreviation	Full Name
EMAN	Ecological Monitoring and Assessment Network
HNC	Hamilton Naturalists' Club
IVI	Importance Value Index
LDV	Lichen Diversity Value
LPRCA	Long Point Region Conservation Authority
LPWBR	Long Point World Biosphere Reserve
LPWBRF	Long Point World Biosphere Reserve Foundation
MOE	Ministry of the Environment
OBBN	Ontario Benthos Biomonitoring Network
OMNR	Ontario Ministry of Natural Resources
RCA	Reference Condition Approach
SI/MAB	Smithsonian Institution's Monitoring and Assessment of Biodiversity Program

Introduction

The loss of biological diversity due to human activities is now widely recognized as being one of today's most serious environmental problems. According to Bridgewater (1993) habitat loss and degradation are the leading causes of biodiversity reduction. The implications of declining biodiversity are enormous in terms of maintaining the integrity and structure of the world's ecosystems, and efforts are often hampered by the absence of basic information on the biological resources in need of protection. The establishment of a monitoring program in the Long Point World Biosphere Reserve is one means of obtaining such information.

The purpose of this report is to provide a detailed analysis of the baseline data collected in 2003 in the Spooky Hollow Nature Sanctuary. Inventory data on trees, lichens, and benthic invertebrates is presented. In time analysis of this monitoring data will be used not only to document environmental changes and trends but also to provide insight as to the causes and impacts of change. Already the monitoring at other sites in the Biosphere Reserve is proving useful (see *Long Point World Biosphere Reserve Monitoring Program – Status Report 2003* (Parker 2003).

First, a brief overview of the LPWBR Monitoring Program is given. The results from each monitoring protocol are then described in turn. A concise discussion and summary is provided for each.

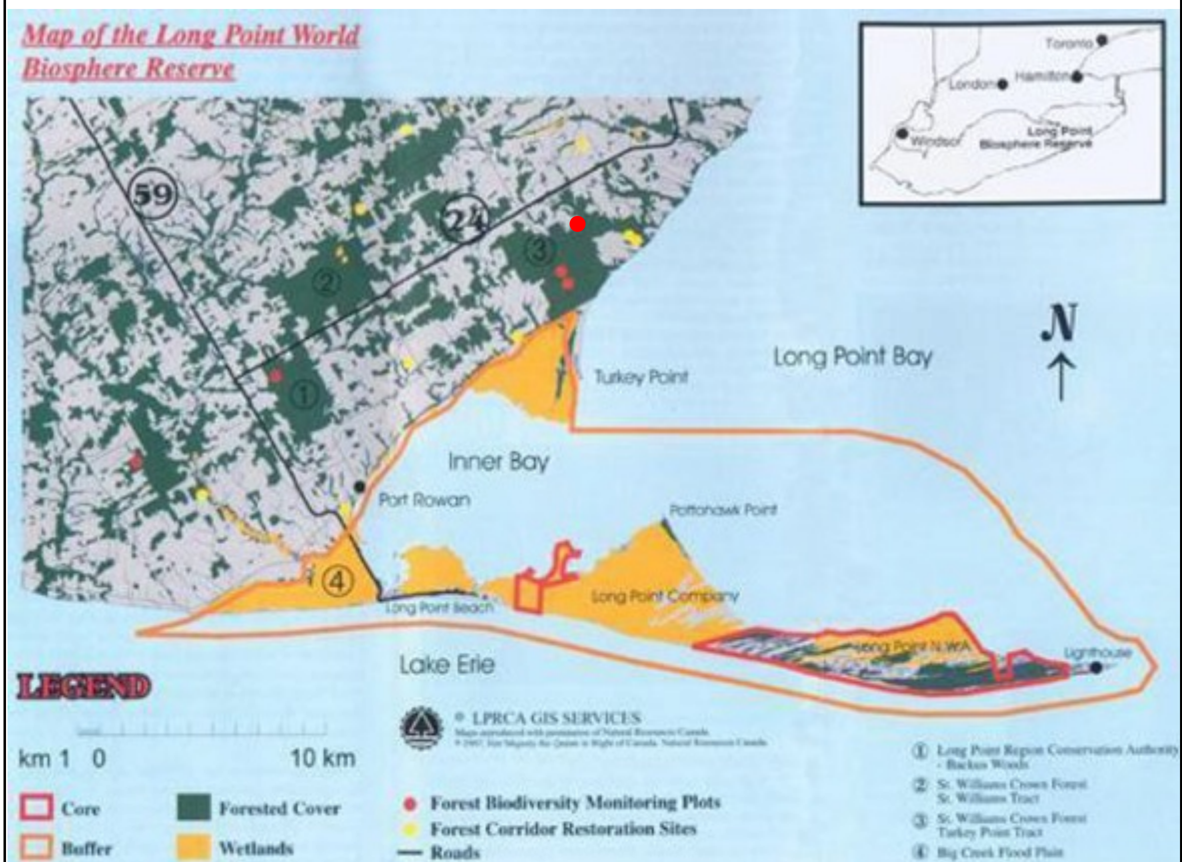
Overview of the LPWBR Monitoring Program

As of 2003 the Long Point World Biosphere Reserve Foundation (LPWBRF) has established five permanent Forest Biodiversity Monitoring plots within the Long Point Biosphere Reserve's zone of co-operation (Figure 1). The plots which follow the Smithsonian Institution Man and the Biosphere (SI/MAB) protocol are 1 hectare in size (Backus Woods, Wilson Tract, Turkey Point Plot #1, and Turkey Point Plot #2). More recently in 2003 another forest biodiversity monitoring plot, modelled after the EMAN Terrestrial Vegetation Monitoring Protocol, was established. The latest plot is in Spooky Hollow and is composed of 21 20x20 m quadrats, which are dispersed across the LPRCA's Anderson Tract property and the HNC Spooky Hollow Nature Sanctuary. These plot locations were chosen because each is representative of the principle forest types in the Long Point region.

To date, the LPWBR monitoring program has focused predominantly on the establishment and (re) inventory of permanent forest biodiversity monitoring plots. These plots function as nodes around which to establish other monitoring protocols i.e. trees, shrubs, ground vegetation, salamanders, lichens, and to a lesser degree benthic invertebrates.

Over the years the LPWBR's monitoring program has expanded not only in geographical coverage but in ecological coverage as well. The LPWBR has also initiated a salamander monitoring program at two of the forest monitoring plots (Backus Woods and Wilson Tract). The monitoring program was further expanded in 2003 to include lichen monitoring at four of the five sites (Backus Woods, Wilson Tract, Turkey Point 2, and Spooky Hollow). In co-operation with the LPRCA, the LPWBR also began a benthic invertebrate monitoring program under the auspices of the newly formed Ontario Benthos Biomonitoring Network. For a full description of the protocols used in the LPWBR Monitoring Program see the *Long Point World Biosphere Reserve Monitoring Program - User Guide* (Parker *et al.* 2003a).

Figure 1: Monitoring Sites in the Long Point World Biosphere Reserve



Natural History of Spooky Hollow

The Spooky Hollow Natural Area is approximately 333 ha in size and is made up of the Fisher-Cornell Conservation Area, the Anderson Tract and Spooky Hollow Nature Sanctuary, which includes a recent addition. Properties in the area are owned by the Long Point Region Conservation Authority, the Hamilton Naturalists' Club as well as privately. Spooky Hollow contains very little mature forest other than the Eastern Hemlock forest along Fishers Creek. This creek is considered to be one of the most pristine in the region. Old fields, a product of historic agriculture in the Anderson Tract and surrounding private lands have been replanted in pine. Figure 2 shows the location of quadrats in Spooky Hollow Nature Sanctuary.

Located on the edge of the Norfolk Sand Plain, Fishers Creek drains the dry upland sandy areas while mesic to wet areas are found on the clay floodplain. The flooplains of Spooky

Hollow consist of variably-drained, alluvium deposits while the valley slopes are made up of well-drained, loamy fine sand and fine sandy loam of the Wattford series as well as moderately well-drained, lacustrine silty clay of the Brantford series (Gartshore *et al.*, 1987).

Over 604 species of vascular plants have been recorded in and around the Spooky Hollow Natural Area. Of these 28 are considered nationally, provincially, or regionally rare. A diversity of species characteristic of the Great Lakes-St.Lawrence Forest, Carolinian Forest and those with southern affinities are found here. Typical in the area are American Yew (*Taxus canadensis*), Bunchberry (*Cornus canadensis*), Wedgegrass (*Sphenopholis nitida*), American Chestnut, and Bird-foot Violet (*Viola pedata*). Whorled Milkweed (*Asclepia verticillata*) and Hooker's Orchid (*Platanthera hookeri*) have been reported in the area circa 1937 and 1952, however these have not been seen more recently.

The Natural Areas Inventory (Gartshore *et al.*, 1987) describes eight distinct vegetation communities within the Spooky Hollow including:

- I Semi-open saturated bog areas dominated by Tamarack and White Pine with typical bog species such as Sundew
- II American Elm, Yellow Birch, Black Ash, White Cedar swamp
- III Wet-mesic Eastern Hemlock, Yellow Birch, Red Maple, White Pine woodland
- IV Upland, mesic Red Oak, American Beech, Sugar Maple woodland on the west-facing slopes and tablelands
- V Dry-mesic Red Oak, Black Oak, White Oak scrub-wooland on drier hilltops
- VI Red Cedar, Sassafras and Bur Oak open woodlands on dry, disturbed sites
- VII Dry, sandy graminoid meadows with scattered low shrubs which contain a number of rare sand prairie species
- VIII Conifer plantations

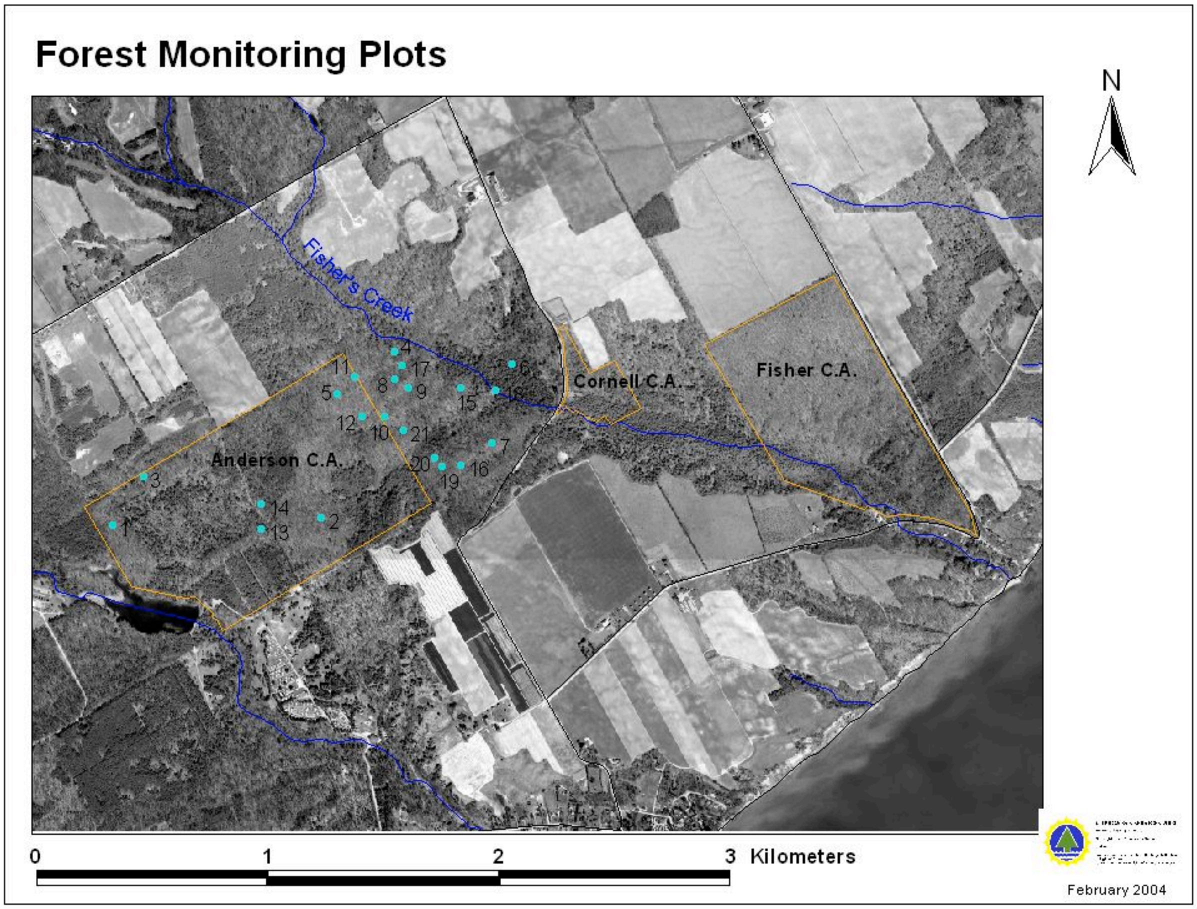
The Spooky Hollow permanent biodiversity monitoring plot is a dispersed plot consisting of 21 quadrats set up according to the EMAN Terrestrial Vegetation Monitoring Protocol (Roberts-Pichette and Gillespie 1999). The plots are located across the range of forest types listed above, excluding the saturated bog and conifer plantations. Access to the property and constituent quadrats is at approximately 42° 43' 39" N, 80° 19' 0.5" W. Surveying of the plots, tree identification and mapping took place over the summer of 2003. Shrub surveys and vegetation studies have not been undertaken in the area.

Preliminary data on the avifauna, mammal species, and herpetofauna in the Spooky Hollow Natural Area was compiled in the Natural Areas Inventory (Gartshore *et al.*, 1987). The following is a brief account of the inventory for the Spooky Hollow Natural Area.

Avifauna

At least 74 species of birds have been recorded at Spooky Hollow during the breeding season. Historical records include two additional species: Tufted Titmouse (*Baeolophus bicolor*) (Baillie, 1960) and Magnolia Warbler (*Dendroica magnolia*) (Snyder, 1931). Many species associated with the northern areas of the Great Lakes-St.Lawrence Forest have been documented in the area including: Broad-winged Hawk (*Buteo platypterus*), Solitary Vireo (*Vireo solitarius*), and a variety of warblers i.e. Blackburnian (*Dendroica fusca*), Black-throated Green (*Dendroica virens*), and Canada Warbler (*Wilsonia canadensis*). Typical southern species include Yellow-billed Cuckoo (*Coccyzus americanus*), Yellow-throated Vireo (*Vireo flavifrons*), Yellowbreasted Chat (*Icteria virens*), Blue-winged Warbler (*Vermivora pinus*) and Cerulean Warbler (*Dendroica cerulea*).

Figure 2: Locational Map of Spooky Hollow Plot



Mammals

A number of small mammals were trapped during the Natural Areas Inventory including the Woodland Jumping Mouse, Woodland Vole, Red Bat, Little Brown Bat, and Eastern Pipistrelle (*Pipistellus subflavus*), while Southern Flying Squirrels were observed in the vicinity. A dead Badger *(Taxidea taxus*) was found on a path in Spooky Hollow circa 1961-62. Suitable habitat still exists in the area and there have also been recent sitings at the nearby Normandale Hatchery.

Herpetofauna

According to the Natural Areas Inventory, there are at least 13 known species of amphibians and reptiles present in Spooky Hollow. Pickerel frogs are common, while only the Eastern Hognose Snake is significant.

Monitoring Results for Spooky Hollow

Other than the mature Eastern Hemlock forest along Fishers Creek Spooky Hollow is primarily comprised of semi-mature forest. The plots are located across the range of forest types listed above, excluding the saturated bog and conifer plantations.

Ground Vegetation

Ground vegetation studies have not been completed for Spooky Hollow. However, the Natural Areas Inventory (Gartshore *et al*., 1987) and studies by the Hamilton Naturalists' Club have recorded over 604 species of vascular plants in and around the Spooky Hollow Natural Area (see *Long Point World Biosphere Reserve Monitoring Program – Site Report* (Parker *et al.* 2003).

Shrubs

Shrub studies have not been completed at this time.

Trees

In the initial 2003 survey of the Spooky Hollow plot 24 tree species were recorded (Table 1). There are 3 stems that remain unidentified. The plot is composed of a wide diversity of species associated with early (e.g. *P. serotina*) and late (various *Acer* sp.) successional stages. Although the total area sampled was less than that of the one hectare plots (8400 m^2 versus 10000 m^2), the high tree diversity is in part due to the dispersed sampling method employed, which encompasses a large variety of forest types and topographical features.

The common forest types encountered during sampling included:

- Wet-mesic Eastern Hemlock, Yellow Birch, Red Maple, White Pine woodland
- Upland, mesic Red Oak, American Beech, Sugar Maple woodland
- Dry-mesic Red Oak, Black Oak, White Oak scrub-woodland

A number of tree species recorded in this natural area were not recorded in the plots. Although the species accumulation curve used to determine the number of plots necessary to capture species diversity levelled off after establishing 21 quadrats, there are remaining forest types that were not captured: lowland swamps containing Black Ash (*Fraxinus nigra*) and American or White Elm (*Ulmus Americana*); and open scrub woodland areas of Bur Oak (*Quercus macrocarpa*). The overall diversity of Spooky Hollow is somewhat higher than what is captured in the quadrats because some of the local forest types were not captured.
C. dentata, a nationally and provincially rare species, occurs in Spooky Hollow, however none were recorded in the quadrats.

Table 1: Scientific and Common Names of Trees Recorded in Spooky Hollow Plot

Scientific Name	Family Name	Common Name
Acer rubrum	*Aceraceae*	Red Maple
Acer saccharum	*Aceraceae*	Sugar Maple
Amelanchier laevis	*Rosaceae*	Smooth Serviceberry
Betula alleghaniensis	*Betulaceae*	Yellow Birch
Carpinus caroliniana	*Betulaceae*	Blue Beech
Carya cordiformis	*Juglandaceae*	Bitternut Hickory
Carya ovata	*Juglandaceae*	Shagbark Hickory
Cornus alternifolia	*Cornaceae*	Alternate-leaved Dogwood
Cornus florida	*Cornaceae*	Flowering Dogwood
Fagus grandifolia	*Fagaceae*	American Beech
Fraxinus americana	*Oleaceae*	White Ash
Hamamelis virginiana	*Hamamelidaceae*	Witch-Hazel
Juniperus virginiana	*Cupressaceae*	Red Cedar
Ostrya virginiana	*Betulaceae*	Hop Hornbeam
Pinus strobus	*Pinaceae*	White Pine
Populus grandidentata	*Salicaceae*	Large-toothed Aspen
Prunus serotina	*Rosaceae*	Wild Black Cherry
Quercus alba	*Fagaceae*	White Oak
Quercus rubra	*Fagaceae*	Red Oak
Quercus velutina	*Fagaceae*	Black Oak
Sassafras albidum	*Lauraceae*	Sassafras
Tilia americana	*Tiliaceae*	Basswood
Tsuga Canadensis	*Pinaceae*	Hemlock
Ulmus rubra	*Ulmaceae*	Slippery Elm

Census Statistics

Table 2 summarizes the census statistics for the 2003 inventory. Dead fallen trees were not surveyed as dead fallen trees will be accounted for in subsequent measurements as tagged trees cede. Of the almost 800 stems onsite 620 were alive while 171 were dead. A calculation of tree mortality rate is not possible until a future reinventory is done. Average dbh is 26.52 cm^2, while the basal area is 34.04 m^2ha^{-1}.

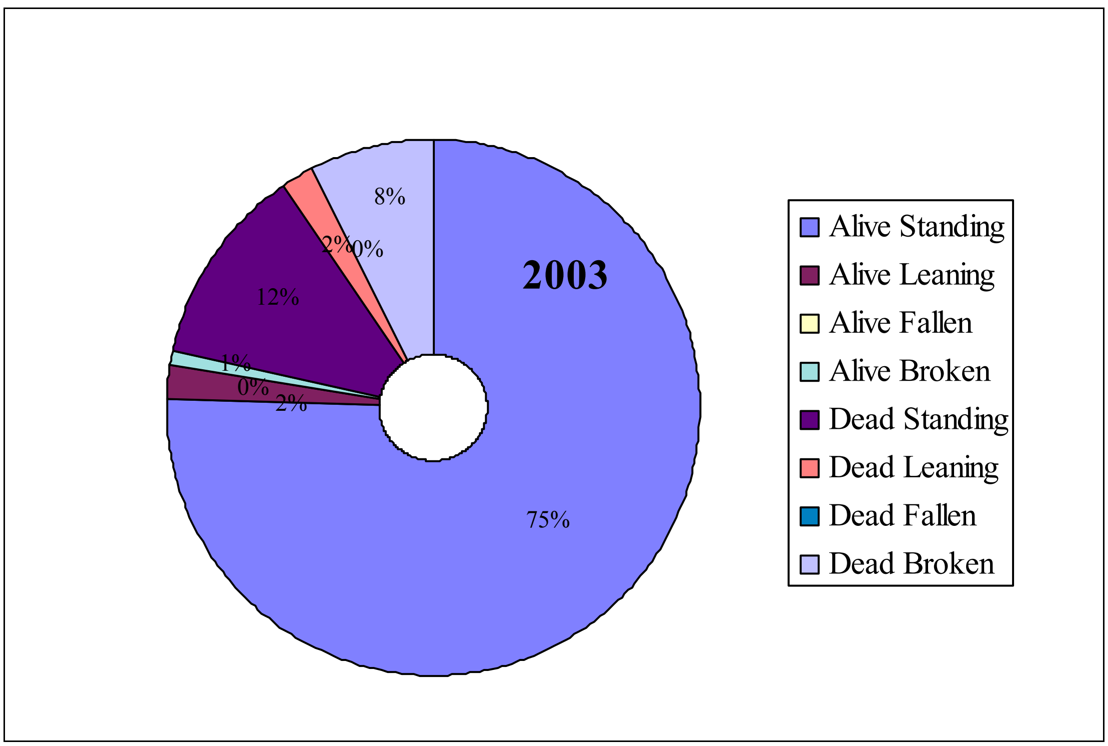
Table 2: Census Statistics from Spooky Hollow (2003)

Statistics	2003 Census
Area of plot (m^2)	8400
Families represented	14
Species represented	24
Unknown species	3
Live stems	620
standing	598
leaning	14

Statistics	2003 Census
fallen	N/A
broken	8
Dead stems	171
standing	97
leaning	14
fallen	N/A
broken	60
Total # of stems	792
Total # of trees	683
Average dbh	26.52
Total basal area of live standing trees (m^2ha^{-1})	34.04

Figure 3 graphically illustrates the percentage of trees in each status category. In Spooky Hollow 75% of the stems are alive standing. The next largest grouping is dead standing stems at12%. There is also a relatively high percentage of dead broken stems (8%). On nine occasions, the species of dead tree could not be determined.

Figure 3: A Comparison of the Ratio of Trees in each Status Category from Spooky Hollow (2003)

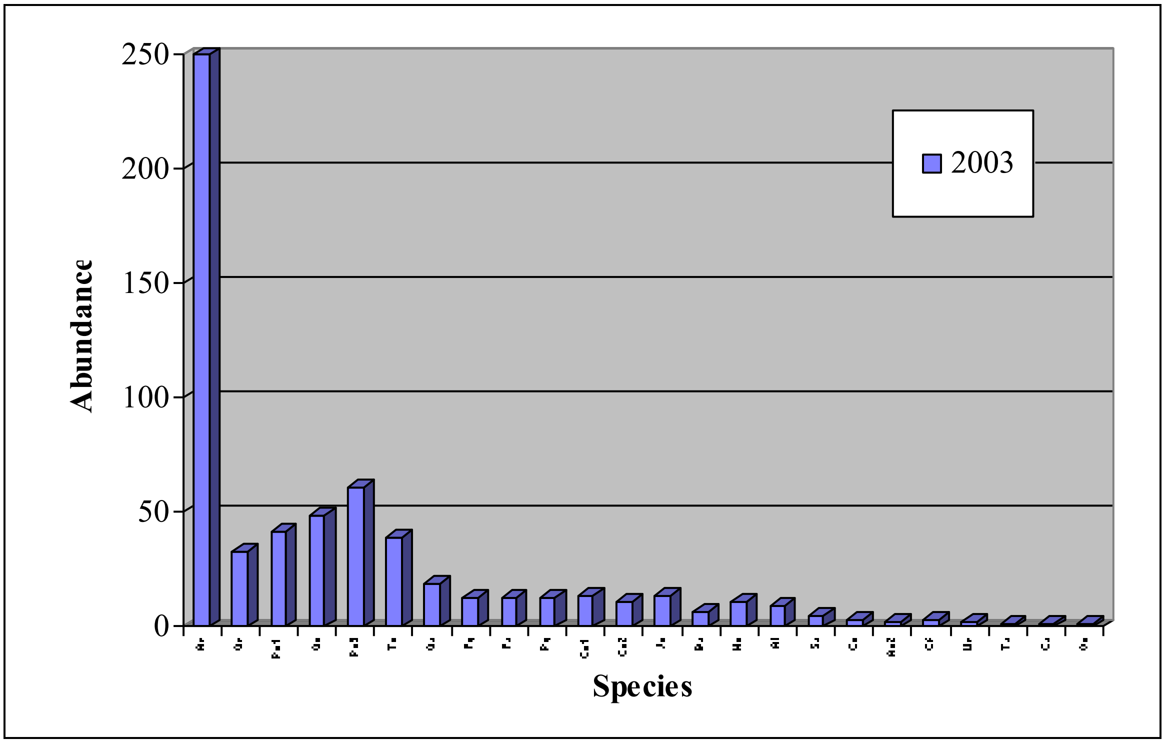


Abundance

Figure 4 compares the abundance of different species in 2003. *A. rubrum* is a strongly dominant species accounting for 40.6% of the stems in the plot. *P. serotina, Q. velutina, P.*

strobus, T. canadensis, and *Q. rubra* each account for at least 5% of the rest of the stems. Many species in the plot are represented by only a few individuals.

Figure 4: Abundance of each Species in Spooky Hollow (2003)

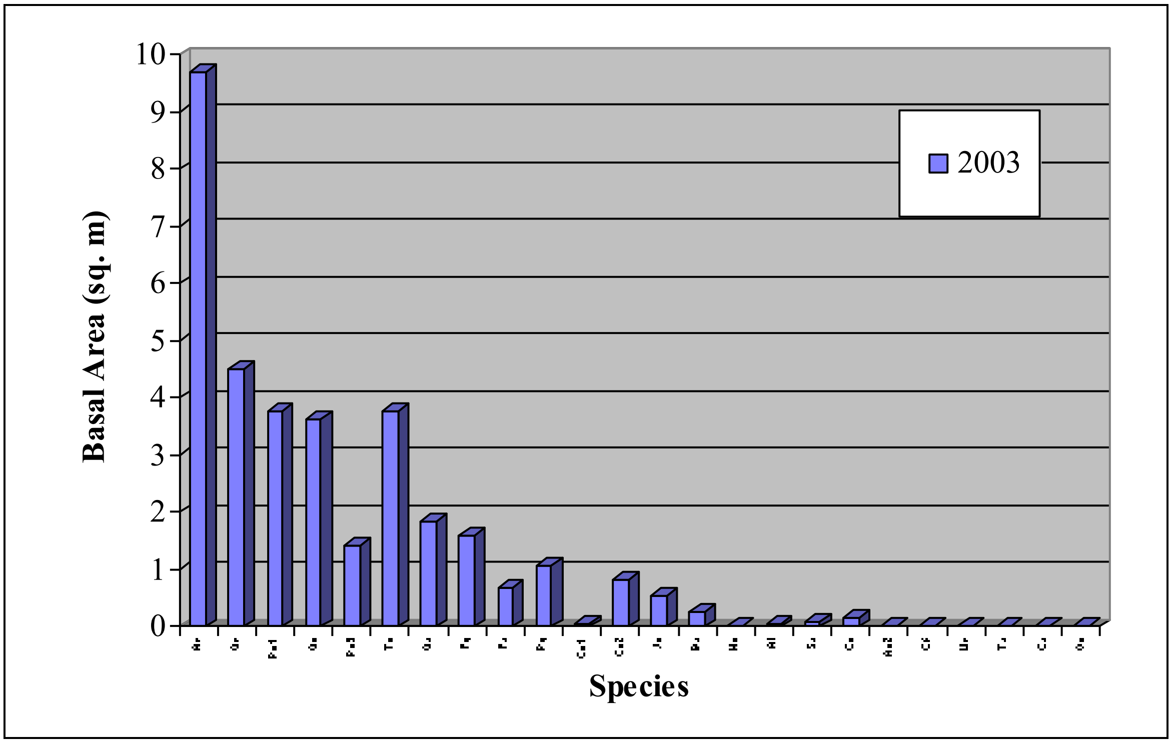


KEY: (Ar=Red Maple, Qr=Red Oak, Ps1=White Pine, Qv=Black Oak, Ps3=Wild Black Cherry, Tc=Hemlock, Qa=White Oak, Fg=American Beech, Fa=White Ash, Pg=Large-toothed Aspen, Cc1=Blue Beech, Cc2=Bitternut Hickory, Jv=Juniperus virginiana, Ba=Yellow Birch, Hv=Witch Hazel, Al=Smooth serviceberry, Sa=Sassafras, Co=Shagbark Hickory, As2=Sugar Maple, Cf=Flowering Dogwood, Ur=Slippery Elm, Ta=Basswood, Ca=Alternate-leaved Dogwood, Ov=Hop Hornbeam)

Basal Area

The large basal area of the plot (34.04 m^2ha^{-1}) is broken down by species in Figure 5. *A. rubrum* has more than twice the basal area (9.702 m^2ha^{-1}) of the next most dominant species. Although *P. serotina* is second most dominant in terms of abundance its basal area ranks only eighth at (1.426 m^2ha^{-1}). Other dominant species, in order of importance, include *Q. rubra, P. strobus, T. canadensis, Q. velutina, Q. alba,* and *F. grandifolia*.

Figure 5: Basal Area occupied by each Species in Spooky Hollow (2003)



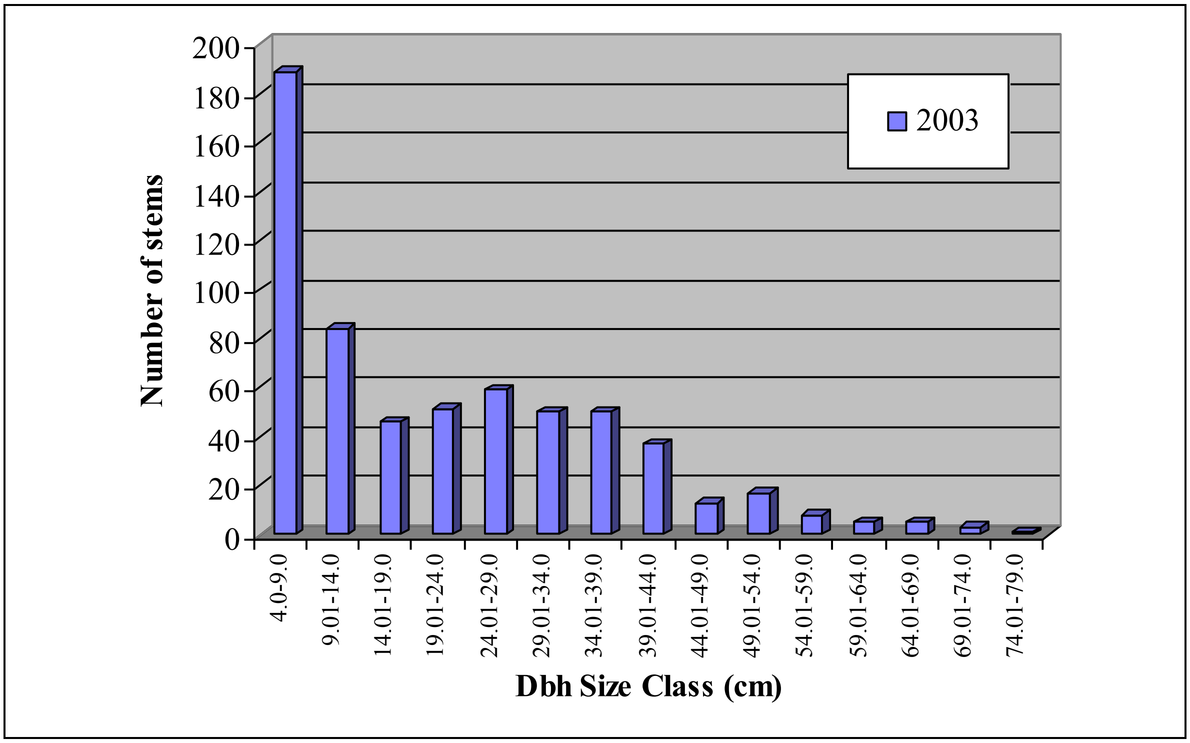
KEY: (Ar=Red Maple, Qr=Red Oak, Ps1=White Pine, Qv=Black Oak, Ps3=Wild Black Cherry, Tc=Hemlock, Qa=White Oak, Fg=American Beech, Fa=White Ash, Pg=Large-toothed Aspen, Cc1=Blue Beech, Cc2=Bitternut Hickory, Jv=Juniperus virginiana, Ba=Yellow Birch, Hv=Witch Hazel, Al=Smooth serviceberry, Sa=Sassafras, Co=Shagbark Hickory, As2=Sugar Maple, Cf=Flowering Dogwood, Ur=Slippery Elm, Ta=Basswood, Ca=Alternate-leaved Dogwood, Ov=Hop Hornbeam)

Distribution of DBH Size Classes

The majority of trees are in the smallest size class, 4.01-9.0 cm (Figure 6). Likewise a large percentage of the total stems is in the next largest size class (9.01-14.0 cm). This suggests that many new saplings are being successfully recruited into the plot population. The majority of these new recruits are *A. rubrum* (42.9%) and *P. serotina* (17.5%).

The canopy is intermittent to partially closed and ranges in average height from 20 m to 44 m across the quadrats. Because *Quercus* sp. are shade-intolerant, only four new saplings were recorded, suggesting that the forest will undergo compositional changes to be dominated by *A. rubrum* in the future. A maximum dbh of 76.25 cm was measured from a *Q. velutina*.

Figure 6: Size Class Distribution of Stems in Spooky Hollow (2003)



Relative Frequency/Density/Dominance and Importance Value Index (IVI)

A. rubrum was clearly the most important species in the plot (Table 3); it had the highest relative density, dominance and frequency by far. A high number of saplings accounts for the high relative frequencies of *A. rubrum* and *P. serotina.* Few saplings (0-8 individuals) are being recruited for other presently dominant species (i.e. *Q. rubra, P. strobus, Q. velutina,* and *T. canadensis*). Although the inventory data represents only a point in time the high relative density and frequency, and large numbers of young *A. rubrum* in comparison to the other dominants in the quadrats, suggests that *A. rubrum* dominance will likely continue to increase.

Table 3: Relative Density, Relative Dominance, Relative Frequency, and Importance Value Index for Trees in Spooky Hollow (2003)

Species	Relative Density	Relative Dominance	Relative Frequency	Importance Value Index
Acer rubrum	37.75	28.50	15.63	81.88
Quercus rubra	5.63	13.21	8.59	27.43
Pinus strobus	7.44	11.10	8.59	27.14
Quercus velutina	7.08	10.67	7.81	25.56
Prunus serotina	10.16	4.19	8.59	22.95
Tsuga canadensis	6.90	11.04	4.69	22.63

Species	Relative Density	Relative Dominance	Relative Frequency	Importance Value Index
Quercus alba	3.27	5.42	7.03	15.72
Fagus grandifolia	2.18	4.70	3.91	10.79
Fraxinus americana	2.36	1.99	4.69	9.04
Populus grandidentata	2.36	3.12	2.34	7.82
Carpinus caroliniana	2.36	0.12	3.91	6.38
Carya cordifomis	1.63	2.39	2.34	6.36
Juniperus virginiana	2.36	1.65	1.56	5.57
Betula alleghaniensis	1.27	0.75	3.13	5.15
Hamamelis virginiana	1.81	0.05	2.34	4.21
Amelanchier laevis	1.45	0.12	2.34	3.91
Sassafras albidum	0.91	0.29	2.34	3.54
Carya ovata	0.54	0.48	2.34	3.37
Acer saccharum	0.54	0.04	1.56	2.14
Cornus florida	0.54	0.02	1.56	2.13
Ulmus rubra	0.36	0.06	0.78	1.20
Tilia americana	0.18	0.02	0.78	0.99
Cornus alternifolia	0.18	0.00	0.78	0.97
Ostrya virginiana	0.18	0.00	0.78	0.97

Lichen Diversity

Arboreal lichens (tree trunk dwelling lichens) are particularly good biomonitors, due to their sensitivity to environmental stress, especially air pollution, eutrophication, and climate change (Asta *et al*. 2002; Richardson, 1992). By tracking the composition of lichen communities over time (i.e. the distribution and abundance of lichen species) one can assess past and ambient air quality. It was with the goal of tracking air quality that this initial lichen community survey was done.

In Spooky Hollow sixteen trees in four separate quadrats were sampled for lichen abundance and diversity. The lichen monitoring undertaken follows the Protocols for Monitoring with Lichens in development by EMAN (EMAN, 2003) see the CD accompanying the *Long Point World Biosphere Reserve Monitoring Program- User Guide* (Parker *et al.* 2003a).

Table 4 lists the species of arboreal lichens found in the monitoring quadrats. The arboreal lichen community found in the LPWBR is comprised of a variety of common and widespread lichens that are typical of the mixed hardwood forests of southern Ontario. The most common type of lichens found were the foliose lichens. The higher diversity of lichens sampled at Spooky Hollow is likely due to the dispersed plot sampling method that encompasses a larger variety of forest types and conditions.

The lichen species found include those that have been classified as being tolerant of slight-moderate levels of air pollution (Brodo and Craig, 2003). Lichen species that are intolerant of pollution, namely *Usnea sp.* and *Lobaria sp*., were not found in the monitoring sites, nor have they been documented in the surrounding regional forests of Norfolk County since 1940 (Brodo, 2003).

Table 4: Arboreal Foliose Lichens found in the Spooky Hollow Monitoring Quadrats

Scientific Name	Family Name	Common Name
Candelaria concolor	*Lecanoraceae*	Candleflame lichen
Candelariella efflorescens	*Lecanoraceae*	Powdery goldspeck lichen
Flavoparmelia caperata	*Parmeliaceae*	Common greenshield lichen
Graphis scripta	*Graphidaceae*	Common script lichen
Phaeophysica rubropulchra	*Physciaceae*	Orange-cored shadow lichen
Physcia millegrana	*Physciaceae*	Mealy rosette lichen
Physciella chloantha	*Physciaceae*	Cryptic rosette lichen
Punctelia rudecta	*Parmeliaceae*	Rough speckled shield lichen

Lichen diversity value (LDV) is a measure of the lichen diversity in a sample unit, in this case a monitoring site such as Spooky Hollow. LDVs were determined for each site monitored in the LPWBR. Spooky Hollow LDV is compared to these other sites in Table 5. Spooky Hollow has the highest measured LDV in the LPWBR, which is in part most likely due to the dispersed sampling method that encompasses greater forest diversity.

At this point it is not possible to determine if there are changes occurring in the lichen community as only an initial inventory has been completed. However, the analysis of subsequent reinventories will benefit from the establishment of a LDV Class Width for each site. The Class Width (equal to three standard errors of the LDV) is the threshold that will be used to indicate when a change over time is significant. If the LDV changes by a magnitude greater than the Class Width this means that the lichen community in that sampling unit has undergone a significant change and follow-up research is necessary.

Table 5: Lichen Diversity Values and Class Widths (2003)

Monitoring Site	**2003 LDV** (number of lichens)	**2003 LDV Class Width** (number of lichens)
Backus Woods	17.3	2.2
Wilson Tract	13.9	2.0
Turkey Point #2	19.1	2.5
Spooky Hollow	19.8	2.5

It is not appropriate to make comparisons between plots if sites differ greatly in topography or forest type. In future analyses, LDVs may be plotted on geographic base maps and assigned to lichen diversity classes. Overlaying maps of meteorology and regional pollutant concentrations may provide insight into changes in LDVs.

Benthic Invertebrate Community Diversity

Benthic invertebrates (large, bottom dwelling insects, crustaceans, worms, molluscs, and related aquatic animals) are good indicators of aquatic conditions because they respond relatively quickly to stressors (OBBN, 2003). The LPWBR benthic invertebrate monitoring is designed according to the protocols set out by the newly founded Ontario Benthos Biomonitoring Network (OBBN) see the CD accompanying the *Long Point World Biosphere Reserve Monitoring Program - User Guide* (Parker *et al.* 2003a).

The Reference Condition Approach (RCA) relies on sampling the benthic invertebrate community of least impacted streams in order to establish a normal range of variability for comparison with the more impacted test sites. Five reference sites, including Fishers Creek which bisects Spooky Hollow, have been selected for sampling to represent a range of physiographic environments. These reference sites will enable comparison with test sites across the region. The benefit of being part of the OBBN is that it will allow us to draw upon a large database of physiographically similar reference sites across the province in order to establish a normal range for reference benthic invertebrate communities, against which test sites will be evaluated. Comparison of test and reference sites will commence once the initial OBBN database is completed in 2004 (MOE, 2003). Future analysis will follow that laid out in the OBBN Protocol Manual. A suite of critical index values based on the reference condition will be calculated along with a range of variation (based on two standard errors), which will allow us to comparatively measure the health of test sites. The two-step process will include a multivariate t-test to determine if a test site falls outside of the normal range. Subsequently discriminant analysis will be used to determine which indices best distinguish the test site from the reference condition.

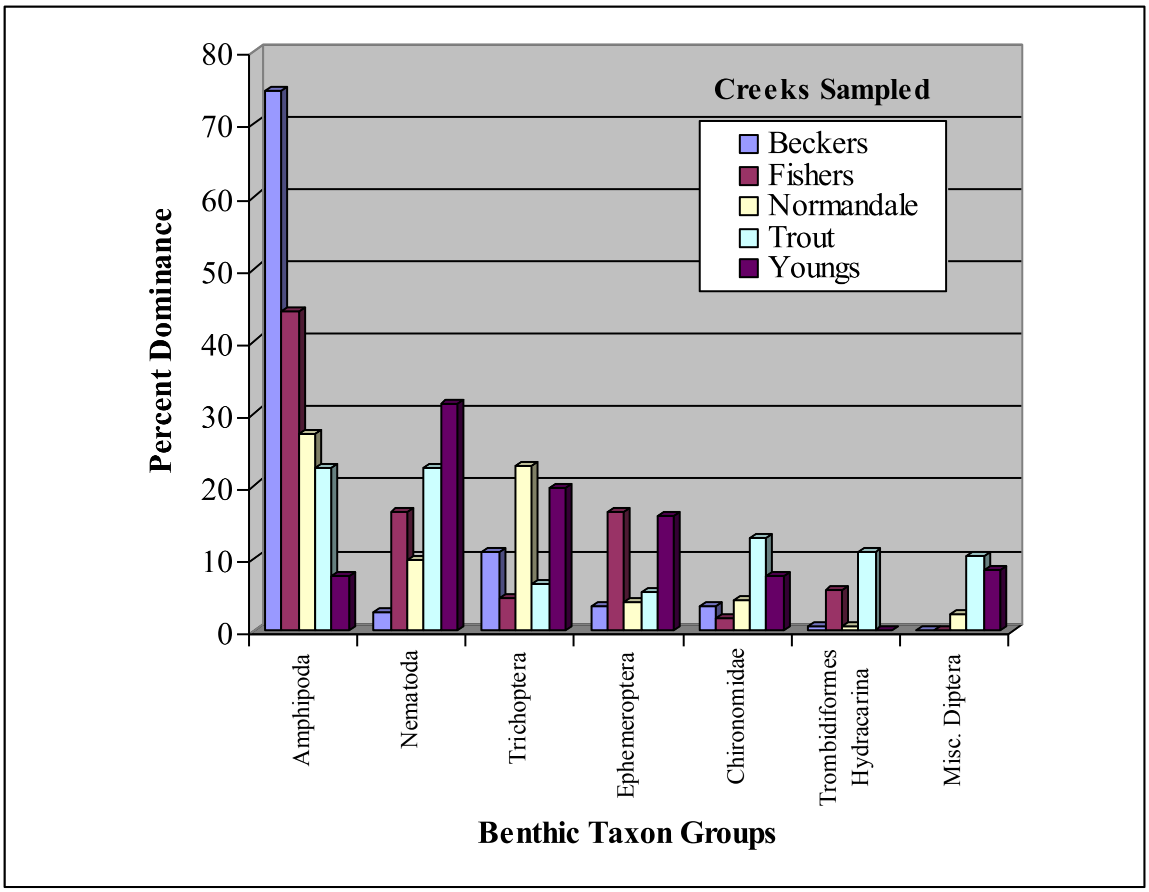
To date the benthic invertebrate data has been used to measure taxonomic richness, abundance and diversity of the five reference sites. Mayflies, stoneflies, and caddisflies, taxa that are sensitive to water quality, are present at all sites, however, their abundance ranges from about 14-36% of the total community (see Table 6). The number of taxonomic groups represented by each sample varies dramatically from 12 to 21, while amphipods are the dominant taxon at all sites expect Young's Creek where nematodes predominate.

Table 6: Benthic Invertebrate Abundance and Richness Measures of Reference Sites (2003)

Reference Site	Total # of Individuals	Total # of mayflies, stoneflies, and caddisflies	Total # of Taxonomic Groups	Ratio of Dominant Taxon
Beckers Creek	321	47 (15%)	12	75 % amphipoda
Fishers Creek	290	74 (26%)	12	44% amphipoda
Normandale Creek	348	94 (27%)	21	27% amphipoda
Trout Creek	311	44 (14%)	15	21% amphipoda
Youngs Creek	346	125 (36%)	16	32% nematoda

To further characterize the benthic invertebrate communities dominance-diversity curves were developed for each site (see Figure 7). The graph compares seven of the most dominant taxon across sample sites. Although amphipods and nematodes are dominant across sites, both caddisflies (Trichoptera) and mayflies (Ephemeroptera) are also quite abundant. Once sites are sampled multiple times at different periods in the year and combined with other physically similar sites from the OBBN database we will have a comprehensive understanding of the spatial and temporal variability associated with such benthic communities. Ultimately, such diversity measures linked to the physiographic attributes of each reference site will enable characterization of baseline conditions for comparisons with test sites.

Figure 7: Dominance-diversity curves for the Benthic Invertebrate Communities found at the LPWBR Reference Sites



Monitoring Summary

The inventory at Spooky Hollow is the first to quantitatively document the tree biodiversity in the area. Although the total area sampled was less than that of typical one hectare plots 24 tree species were recorded. The high tree diversity is in part due to the dispersed sampling method employed, which encompasses a large variety of forest types and topographical features. *Castanea dentata*, a nationally and provincially rare species, occurs in Spooky Hollow, however none were recorded in the quadrats.

The canopy layer is intermittent to partially closed and ranges in average height from 20 m to 44 m across the quadrats. A maximum dbh of 76.25 cm was measured from a *Quercus velutina*. The canopy is composed of a wide diversity of species associated with early (e.g. *Prunus serotina*) and late (various *Acer* sp.) successional stages.

Acer rubrum is a strongly dominant species accounting for 40.6% of the stems in the plot. *P. serotina, Q. velutina, Pinus strobus, Tsuga canadensis,* and *Quercus rubra* each account for at least 5% of the rest of the stems. Many species in the plot are represented by only a few individuals.

The majority of trees are in the smallest size class, 4.01-9.0 cm. Likewise a large percentage of the total stems is in the next largest size class (9.01-14.0 cm). This suggests that many new saplings are being successfully recruited into the plot population. The majority of these new recruits are *A. rubrum* (42.9%) and *P. serotina* (17.5%).

A. rubrum was clearly the most important species in the plot; it had the highest relative density, dominance and frequency by far. Although the inventory data represents only a point in time the high relative density and frequency, and large numbers of young *A. rubrum* suggests that its dominance will likely continue to increase.

The arboreal lichen monitoring in Spooky Hollow revealed a diverse community comprised of a variety of common and widespread lichens that are typical of the mixed hardwood forests of southern Ontario. The lichen diversity value (LDV) was 19.8, the highest of any of the LPWBR monitoring plots. The lichen species found include those that are tolerant of slight-moderate levels of air pollution. Lichen species that are intolerant of pollution, namely *Usnea sp.* and *Lobaria sp*., were not found, nor have they been documented in the surrounding regional forests of Norfolk County since 1940. Their absence may speak to historic loss of habitat and the air quality of the region as a whole.

Fishers Creek is one of five benthic invertebrate community reference sites established to represent a range of physiographic environments, which will enable comparison with test sites across the region. Taxa that are sensitive to water quality (mayflies, stoneflies, and caddisflies) were present at all sites, indicating relatively high water quality. Ultimately, diversity measures linked to the physiographic attributes of each reference site will enable characterization of baseline conditions for comparisons with test sites.

Future Direction

The monitoring program at LPWBR has developed and expanded greatly since 1995. This latest partnership with the HNC to implement new monitoring protocols within the Spooky Hollow Nature Sanctuary is testament to a shared vision and commitment to track and understand ecosystem change in the Long Point area. Partnerships such as these help to develop local monitoring capacity and to sustain regional monitoring programs. Linking this monitoring program to other regional initiatives and organizations is the key to developing a more comprehensive picture of the ecology of the Long Point area as a whole. Through monitoring the LPWBRF, its partners, and local citizens have detailed environmental changes occurring in the area and also gained a deeper understanding of the monitoring process itself.

We have accomplished much and built a solid framework for a permanent monitoring program. Over the long-term our monitoring indicators (trees, lichens, and benthos) will continue to expand and will act as an integrated monitoring suite that will track changes across Spooky Hollow and the LPWBR's terrestrial, atmospheric, and aquatic environments. Hopefully through our efforts to document change in these ecosystems we will be able to provide feedback and direction for regional development to ensure that these natural areas continue to function as an environmental sanctuary.

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