1-1-2012

Survey of the Native and Nonnative Vascular Plant Species of Three Islands in Lake Winnipesaukee, New Hampshire

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SURVEY OF THE NATIVE AND NONNATIVE VASCULAR PLANT SPECIES OF THREE ISLANDS IN LAKE WINNIPESAUKEE, NEW HAMPSHIRE

A Thesis
presented in partial fulfillment of requirements
for the degree of Master of Sciences
in the department of Biology
The University of Mississippi

by

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May 2012

ABSTRACT

This study examined the long-term patterns in vascular plant composition on three islands in Lake Winnipesaukee, NH. It also tested the role of island biogeography in ecology as it analyzed the effectiveness of a land use plan implemented on the islands. Samplings were made on the islands in the summer of 2011 and were compared to earlier samplings in 1978, 1991, and 2001. The flora was observed and measured in 25 permanent plots that were established on the three islands in 1978. The understory flora was measured by presence and percent cover and the overstory was measured by frequency and density of individual trees and shrubs, dominance ratings, and basal areas. This study also focused on plants of interest including certain rare (*Rhododendron maximum*), introduced (*Halesia carolina*) and potentially invasive species (*Poa compressa*).

Data from the study shows that the species richness on all the islands increased significantly from 1978 to 1991 on all three islands but remained relatively constant in the 1991, 2001, and 2011 samplings. Species evenness on all the islands remained relatively constant in all four years of sampling. The statistical analyses showed that all samplings were statistically significant across all the islands and years of sampling.

The plants of interest mostly remained in the same areas that they were found in earlier samplings. In particular, the rare plants remained in the least disturbed areas of the islands while the introduced and potentially invasive species were found in the most disturbed areas of the islands.

ACKNOWLEDGEMENTS

I wish to thank my advisor, Dr. Marjorie Holland, for the opportunity to assist with the ongoing floristic research on the Lake Winnipesaukee islands. She has been very supportive of my project and my path to a future career. I would also like to thank my graduate committee members Dr. Stephen Brewer and Dr. Lucile McCook for their helpful advice on my project. I would also like to thank Dr. Jason Hoeksema for his help with some of my statistical analyses.

I would like to thank all the following volunteers who helped Dr. Holland and I sample the plots on TMI, HNI, and BNI in 2011: Betsy Johnson, Marjorie Freeman, Jeanne Albert, Heather Pembrook, Anne Latchis, Carolyn Kasper, Lesley Harrington, Joan Gulovsen, Tersh Palmer, Nancy Grant, Carolynn Ernst, Joan Liehe, Philip Fitz, Holly Tanguay, and Besty Atkins. These ladies and gentlemen braved the elements in the name of science and counting plants. I also would like to thank the Three Mile Island Camp Staff and Appalachian Mountain Club for providing us food and shelter during the samplings.

This journey through my Master's program certainly would have been harder without the help of fellow peers and students. Dr. Holland's former graduate students Ying Chen and Dr. Rani Menon were especially helpful in providing tips from their own experiences. The undergraduate students who worked in the lab were helpful for assembling data and providing advice for my presentations. These students are Tanaya Johnson, Shannon Moore, Dustin Culver, and Cherrelle Williams. Lastly I want to thank my parents for all their support and guidance. Without their help, I would have not made it this far in my education.

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I. LITERATURE REVIEW

Islands are important in the studies of ecosystems because of their relatively "closed" habitats separated from the much larger mainland ecosystems. According to Robert MacArthur and E.O. Wilson (1967), islands serve as individual units of ecosystems because their resident populations can be identified discretely from other habitats. By studying clusters of islands, biologists can study a simpler microcosm of the seemingly vast complexity of continental and oceanic biogeography. In other words, islands can serve as simpler means of studying the functions and structures of ecosystems due to their smaller size. Despite their size, islands are typically subject to similar functions of mainland ecosystems among their organisms and environmental factors (MacArthur and Wilson 1967; Adserson 1995). One model proposed by MacArthur and Wilson (1967) states that the immigration rate and the distance to the mainland are inversely proportional; that is, the immigration rate decreases as the distance from mainland increases and vice versa.

Lake islands are not typically considered "ecological islands" as compared to oceanic islands (Bradley and Crow 2010). Lake islands such as the islands of Lake Winnipesaukee are generally closer to the mainland than oceanic islands. As such, they are not as closed as oceanic islands, and their floras may be comparable to the surrounding mainland due to their close proximity and lack of definitive physical barriers that may separate their flora from the mainland flora. Despite this, they may still be subject to similar principles that apply to oceanic islands (Powledge 2003).

Island ecosystems are also of particular interest due to their susceptibility to invasion compared to the mainland. According to D'Antonio and Dudley (1995), the susceptibility of an island to invasion is directly proportional to the distance from the mainland. Some of their studies show that introduced species may have more of an effect on islands than on mainland continents. Examples of these effects include the alteration of soil properties or the fire regime (D'Antonio and Dudley 1995). These properties and models may also apply to lake islands such as the islands of Lake Winnipesaukee and their respective floras.

Individual plant species have often been of great importance to many organisms and ecosystems. However, humans have often endangered certain plant species through different activities from habitat destruction to simply the movement from one area to another. In particular, these activities often lead to the introduction of nonnative plant species to a habitat and sometimes may threaten to wipe out any native vegetation within the habitat. The introductions of such exotic species have led to the concern of the impact that these nonnative species may have on the native flora and even fauna of ecosystems.

Species of plants or other organisms that are introduced to a habitat are referred to as introduced, exotic, or nonnative species. Species that can negatively impact the native species within an ecosystem or the ecosystem itself are known as "invasive species." Not all introduced species are necessarily invasive, for some may become beneficial to ecosystems (NISC 2010). Despite this, these introduced species need to be studied in case they become invasive and potentially impact the native species negatively (NISC 2010).

As defined by the National Invasive Species Council (abbreviated NISC) (2010), an invasive species can cause widespread damage to an ecosystem. For example, invasive aquatic and terrestrial species can alter nutrient availability and water quality as well as interfere with the

flow of water throughout the ecosystem. Terrestrial invasive plants can penetrate deep into the soil and lower the nutrient availability to other species as well as interfere with the reproduction, growth and development of native plants (NISC 2010). However, it should be noted that the definition of an invasive species is not consistent throughout all of invasion ecology. Some ecologists may define an invasive species by its ability to overcome biological barriers or by the impact it has on native species including direct competition (Valéry et al 2007). Because of this, for the sake of simplicity the invasive species listed in this thesis are those that are considered invasive by databases such as the USDA Plants Database (2011) or the Invasive Plant Atlases (Invasive Plant Atlas 2010; IPANE 2011).

There are several factors that determine the susceptibility of a habitat to invasion. One factor is the disturbance regime of the habitat. Typically habitats that are prone to disturbance are more susceptible to invasion. Disturbances can be either natural or human-induced such as the clearing of native vegetation. Other factors include the state of native vegetation in that habitat and the ability of the invasive species to spread quickly in an area (Burke and Grime 1996; Inderjit 2005). Phenology, or the seasonal patterns of growth or reproduction, may also play a role in the relationships between native and nonnative compositions (Brewer 2010).

The effects of invasive species have led to a growing concern by ecologists and governments across the world. Efforts against the spread of invasive plants started around the 1970s when the United States government enacted the Federal Noxious Weed Act of 1974 (U.S. Fish and Wildlife Service 2010). This law gave the authority to list certain plants as "noxious weeds" to federal agencies, and this law began the prohibition of the movement of certain exotic plants into the United States. Further laws were enacted, including the Farm Bill of 1990 and the

presidential document signed by President William Clinton (1999) concerning the control and management of invasive species.

Throughout the country, several atlases of invasive plants have been established both at the regional and national levels. The atlas for the New England region, including the state of New Hampshire, is the Invasive Plant Atlas of New England (IPANE). IPANE is an ongoing project at the University of Connecticut that lists all invasive plants in the New England area (IPANE 2009). Another atlas of invasive species is known as the Invasive Plant Atlas of the United States, which is a collaboration of several agencies to document invasive plants on the national scale (Invasive Plant Atlas 2010).

One difficulty of studying invasive species is determining whether the invasive species has a direct impact on native species. In some cases, the "invasive" species may be the "passenger" of change in disturbed habitats (MacDougall and Turkington 2005). In other words, the potentially invasive species may not necessarily have a direct impact on the native species of the ecosystem but rather may take advantage of the disturbed region. For example, when a disturbance wipes out the native vegetation of a particular community, an opportunistic species may quickly take over the area even though it may not have been able to establish itself in the presence of native species. There are several studies that document cases of impacts by invasive species (Brewer 2011). However, there still remain uncertainties that lead to the question of whether or not a species can truly be considered "invasive" in a community.

Habitat destruction and the introduction of exotic species have also led to the endangerment of other species. Endangered species in general have been under government protection under the Endangered Species Preservation Act of 1966. The United States government passed another act, the Endangered Species Act of 1973, which protected rare plants

as well. The Endangered Species Act listed several levels of endangerment of species, including endangered and threatened, and provided authority to government agencies to preserve natural wildlife. The act defined an endangered species as a species that is "in danger of extinction throughout all or a significant portion of its range." The act also defined a threatened species as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (U.S. Congress 1973).

The importance of such rare species is summarized in the Endangered Species Act as "of esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people" (U.S. Congress 1973). These rare species may perform specific services to other organisms or to ecosystems, and the removal of such species may negatively alter the ecosystems in ways that may even impact humans, including the loss of rare species and furthermore the loss of certain medicines and materials produced from such rare species (U.S. Fish and Wildlife 2005).

While extinction may be natural, the rate of extinction has increased rapidly with the growth of human population and the activities associated with such growth. The main reason for such extinctions is habitat loss (U.S. Fish and Wildlife 2005), including the exploitation of wildlife and resources for human consumption. Other factors that may lead to extinction include the introduction of exotic species and pathogens (U.S. Fish and Wildlife 2005). To help prevent such extinctions, state-level heritage programs were created to emphasize the importance of the rare species. These programs list rare species, including threatened and endangered species, and classify their rarity based on their abundance and occurrences in the regions (NH Heritage 2010).

This study was part of a major effort to document the flora of the three islands which started in 1901 when the camp on Three Mile Island (TMI) was founded. The earliest floristic

study was made in 1901 by the landscaper Harlan P. Kelsey (1902). The most extensive early compilation of vascular plant species on the island was made by Arthur S. Pease and included many of the notations and collections made by Pease himself, J.H. Emerton (1906) and R.A. Ware (1906) (Holland and Sorrie 1989, Pease 1911). Other collections on the island included those of E. Hartmann (1941) and M. Holland and B. Sorrie (1989). Holland and Sorrie (1989) undertook an extensive study that compared the flora in their study with the collections made by Kelsey (1902), Pease (1911), and Hartmann (1941). Many of these collections are preserved in herbaria throughout New England including Harvard University and Smith College. Floral studies were also conducted on other islands in Lake Winnipesaukee, including Rattlesnake (Berry 1966), Bear (Jackson 1969) and Timber Islands (Bradley 2005; Bradley and Crow 2010). Table 1 summarizes the number of plant species and sizes of the studied islands.

This study looked at the relationships between the native and nonnative plant species on three islands in Lake Winnipesaukee. In this study, "nonnative" species are those that had been introduced to the islands since 1901, even those that are native to the New England area. In particular, this study looked at the composition and abundance of the native and nonnative plant species historically since 1978 when ecological studies began (Holland et al. 1983).

Table 1. Lake Winnipesaukee islands whose flora was surveyed. This table includes the most recent number of species and sizes of the islands in hectares. Bear, Timber, and Rattlesnake islands' data were summarized from Bradley and Crow (2010). Three Mile, Hawk's Nest and Blueberry Islands were summarized from the 2011 sampling.

Island	Size (ha)	No. of plant species
Bear	303.5	317
Rattlesnake	161.9	255
Timber	54.6	187
TMI	17.4	80
HNI	0.41	35
BI	0.27	40

Since this collection was started, the protection of the natural character of the island has been a continuing concern to the camp management (Holland and Sorrie 1989). Despite all the development on the island for the camp, the camp oversight committee wished to preserve the natural flora on the island subsequent to Kelsey's initial survey in 1902 (Kelsey 1903). The report of the committee stated that no exotics should be planted and that native vegetation would not be removed from the island without prior permission from the committee. This included the rare orchid *Cypripedium arietinum*, the Ram's Head lady slipper, which is now considered an endangered species (USDA 2011) and is of great concern to the camp (Holland and Sorrie 1989).

The conservation of the islands continued when the camp's advisory board adopted a Land Use Plan in 1973, which has been successful in protecting various natural habitats (Holland, et al. 1983, Holland and Sorrie 1989). The land use plan was ecological in nature and was derived from a model of the basic kinds of environments required by humans (Odum 1969). Land areas throughout the island were divided into four major zones based on the amount of use of the environments by humans.

The first zone is the "Protective zone" and is generally untouched by the camp; it is the least developed of the four. The second category is the "Compromise zone" which consists of land areas maintained for the safety of the campers. The third category is the "Productive zone," which is primarily designed for forestry and wildlife habitat. The only development in this area is the cutting and harvesting of firewood for management projects. The fourth and final zone is the "Urban zone" and is the most disturbed zone of Three Mile Island including dining areas and the main boat dock (Holland and Sorrie 1989).

This study surveyed the native and nonnative plant compositions and compared the species compositions of each of the four zones with one another. Plant names are current as of

September 2011 as listed in the USDA Plants Database (2011). Information from previous collections (Holland and Clapham 2012) along with quantitative data from understory samplings (Maciejowski et al. 1981; Briggs et al. 2008) were available for use in the current study and provided a baseline for the historical compositions of the native and nonnative species.

Nonnative species of plants have been present on the island since the initial collections of 1901. Back in Three Mile Island Camp's early years, a donation was required from all members of the camp committee, including landscaper Harlan P. Kelsey. Kelsey donated 481 plants of 60 different species, only 9 of which were native to the island. However, most of these introductions did not survive over the years as shown in Tables 2 and 3. When E. G. Hartmann visited the island in 1941, only about 28% of Kelsey's introductions were observed (Hartmann 1941; Holland and Sorrie 1989). When Holland and Sorrie (1989) completed their floristic study, only about 20% of Kelsey's introductions had survived. One example of a Kelsey introduction that did not survive for long is the Japanese honeysuckle, *Lonicera japonica*. Despite being an invasive species, the honeysuckle did not fare well on the island, probably due to the plant's low tolerance for cold temperatures.

Table 2. Total species reported, new taxa, and persistence from previous collections of plant species at Three Mile Island, New Hampshire, USA. From Holland and Sorrie (1989)

Collector	Number of Species			
	Total Species Reported	New to TMI	Persistence of Non-Indigenous Species Introduced by Kelsey in 1901	Persistence of Indigenous Species Reported by Pease (1911)
Kelsey (1902)*	60	–	–	–
Pease (1911)	265	–	51	–
Hartmann (1941)**	193	31	9	153
MMH/BAS (1989)	243	66	10	157
* Nine species planted by Kelsey were indigenous to the islands ** Ten species first observed on the islands by Hartmann persist today				

Table 3. Comparison of native versus introduced species on Three Mile Island, NH, USA from 1901 to 1985. Native refers to indigenous species found on TMI. Adventive species are ones found outside of the island. From Holland and Sorrie (1989)

Habitat	Number of Species		
	Persistent [Common to Pease (1911) and to Holland and Sorrie (1989)]	Lost [reported only by Pease (1911)]	Influx [Reported only in Holland and Sorrie]
Native Woodland	91	34	30
Native Open Area	68	22	21
Native aquatic	11	8	6
Adventive	14	1	24
Kelsey introductions	10	41	0

The following are the species of concern on Three Mile, Hawk's Nest and Blueberry Islands. The species listed as invasive in various databases are *Berberis thunbergii* (IPANE 2011), *Poa compressa* (IPANE 2011), and *Robinia hispida* (Invasive Plant Atlas 2010). The species that are not native to the islands but were introduced by Harlan Kelsey in 1901 (Holland and Sorrie 1989) are *Halesia carolina* and *Rhododendron calendulaceum* (USDA 2011). The rare, threatened and endangered species are *Cypripedium arietinum* (NH Heritage 2011), *Rhododendron maximum* (NH Heritage 2011), and *Rhododendron viscosum* (USDA 2011). The species that are of concern by the campers on the islands but do not fall under the above categories are *Apios americana* and *Desmodium perplexum* (IPANE 2011; USDA 2011).

Apios americana is commonly known as the groundnut and belongs in the family Fabaceae. This perennial herb is native to the eastern United States and Canada including New England and is found throughout the region. The groundnut can grow via rhizomes and has thickenings ranging from 1.0 – 4.0 cm thick on these rhizomes, hence the name "groundnut" (USDA 2011). It is typically found in moist to wet areas of woodlands, meadows and low thickets and can survive temperatures as low as -30.5^{o}C (USDA 2011). It blooms from July to October and forms indehiscent legumes for fruit (USDA 2011). This species is of concern on Three Mile Island due to its spread on the western shoreline; however it is not considered an invasive species by any source. The groundnut has been documented on TMI in 1903 by Kelsey but has not been reported since 1909 (Holland and Sorrie 1989). It has been documented on Timber, Rattlesnake, and Bear Islands (Berry 1966; Jackson 1969; Bradley 2005; Bradley and Crow 2010,).

Berberis thunbergii is commonly known as the Japanese barberry and belongs in the family Berberidaceae. A native of Japan, the Japanese barberry is an exotic species found

throughout northeastern United States and eastern Canada including all the New England states. This perennial shrub can grow to 0.5 – 2.4 m tall with spatulate leaves. The barberry also has pale yellow umbellate inflorescences that bloom from mid-April to May. These flowers form into bright red berries from July to October. The Japanese barberry can be found in a variety of habitats throughout New England including disturbed forested areas and relatively undisturbed closed-canopy forests (IPANE 2011). The Japanese barberry has been documented on TMI, Timber, Rattlesnake, and Bear Islands (Berry 1966; Jackson 1969; Holland and Sorrie 1989; Bradley 2005; Bradley and Crow 2010), but it had not been found on TMI since 1909 (Holland and Sorrie 1989).

The Japanese barberry was introduced to the United States in 1875 as an ornamental plant from Russia, and it was used to replace the similar species *Berberis vulgaris* since the latter was under attack by black stem grain rust (IPANE 2011). It may not have naturalized until 1910 when it became popular among homeowners in New England, and some time later it became classified as invasive by IPANE (2011). The barberry can spread via ground birds and small mammals that feed on its berries and the ability to root in the soil from branches. It also has the ability to form monocultures in certain habitats. However, despite its invasive status, its impact on native flora is currently unknown (IPANE 2011).

Cypripedium arietinum is commonly known as the Ram's Head Lady Slipper or Ram's Head Orchid and belongs in the family Orchidaceae. The lady slipper is a native endangered plant that is found in the northern United States from Minnesota to Maine (Brackley 1985; USDA 2011). The lady slipper flowers in May to early June. The plant is about 20 cm tall and grows from a short rhizome with fibrous, musky-smelling roots. The flower is unusually shaped with a lip and is a mixture of white and magenta. The lady slipper occurs mostly in wet Northern

White Cedar woods and is also found in well-drained slopes. The plant needs cool soils and partial shade. The lady slipper was found by A. S. Pease in August of 1903, J. H. Emerton in May of 1906, E. G. Hartmann in 1941 and by Holland and Sorrie in August of 1985 (Pease 1911; Hartmann 1941; Holland and Sorrie 1989). The lady slipper was reported to have been found in wooded, sloped areas on Three Mile Island (Holland and Sorrie 1989). Since this lady slipper is a member of the family Orchidaceae and genus *Cypripedium*, this plant may likely experience a "dormant season" where growth and photosynthesis are suppressed during the growing season (Primack and Stacy 1998; Shefferson 2006). The lady slipper has only been documented on Three Mile Island (Holland and Sorrie 1989).

Desmodium perplexum is also known as the perplexed ticktrefoil and belongs in the family Fabaceae. This perennial herb is native to the majority of the eastern United States including New England. The ticktrefoil is typically found on the edge of habitats in more sunny areas and can survive in temperatures as low as -33 ^{o}C (USDA 2011). It mostly grows, blooms, and fruits throughout the summer and can grow up to 1.21 meters with white flowers and brown fruits (USDA 2011). It is of concern on Three Mile Island due to its apparent rapid spread as described by the campers. However, it is not listed as rare, introduced or invasive in any database (IPANE 2009; NH Heritage 2011; USDA 2012). The ticktrefoil has only been documented on Three Mile Island (Holland and Sorrie 1989).

Halesia carolina is also known as the Carolina silverbell and belongs to the family Styracaceae. This perennial shrub is native to the United States in the southeastern states of Mississippi, Alabama, Georgia, Florida and South Carolina; however it is not native to the Lake Winnipesaukee region. The *H. carolina* of Three Mile Island was brought to the island in 1901 by Harlan Kelsey. *H. carolina* is mostly found in low forested areas and the minimum

temperature that it can survive is -23^{o}C (Sluder 1990). The Carolina silverbell grows throughout spring and summer and can grow up to 9 m (30 ft). It is found in a swampy area on the island known as "Rhododendron swamp" and has not been found on any other part of the islands. It sprouts white flowers from March to May and sprouts red fruits from June to August (USDA 2011). The silver bell has only been documented on Three Mile Island (Holland and Sorrie 1989).

Poa compressa is commonly known as the Canada bluegrass and belongs in the grass family Poaceae. Despite its name, the Canada bluegrass is an exotic plant from Eurasia found in the continental US and Canada, Alaska and Hawaii. The bluegrass can grow up to 0.6 m (2 ft) in height and mostly grows from March to May. This plant can use rhizomes to grow across an area. The bluegrass blooms yellow flowers from April to May and produces a medium abundance of brown fruits later from May to June (USDA 2011). This species was most likely introduced as a forage plant, but the exact timing of its introduction is unclear. Currently this species poses no threat to undisturbed natural habitats of New England. However, it does have the potential to spread quickly in areas that are recovering from a disturbance due to its ability to spread via rhizomes and high seed dispersal (IPANE 2003). The Canada bluegrass has been documented on TMI, Timber, Rattlesnake, and Bear Islands (Berry 1966; Jackson 1969; Holland and Sorrie 1989; Bradley 2005; Bradley and Crow 2010).

Rhododendron calendulaceum is also known as the flame azalea and belongs in the family Ericaceae. This perennial shrub is native to the southeastern states from Alabama to Virginia and north to Connecticut, New York and Pennsylvania, however it is not native to the Lake Winnipesaukee region (USDA 2011). The *R. calendulaceum* on Three Mile Island was introduced in 1901 by Kelsey. The flame azalea is a deciduous shrub that can grow to about 1.8-

3.6 m in height with medium green summer foliage and red and yellow foliage in the fall. The azalea can typically be found in forested areas. The flowers range in color from pale yellow to apricot to scarlet red and bloom in May and June. The flowers become brown capsules in the fall months including September and October (Lady Bird Johnson 2010). Several specimens have survived in "Rhododendron swamp" on Three Mile Island along with other species of the genus *Rhododendron* (Holland field notes). The flame azalea has only been documented on Three Mile Island (Holland and Sorrie 1989).

Rhododendron maximum is also known as the great laurel and belongs in the Ericaceae family. This perennial shrub is native to the United States and is found in the eastern United States from Georgia to Maine. On Three Mile Island, it is a Kelsey introduction despite being native to the region (Holland and Sorrie 1989). It actively grows in the spring and summer and can grow up to 7.62 m (25 ft) in height. It is suited to grow in medium and coarse textured soils and in soils with a pH between 4.0 and 5.5. The great laurel has a high drought tolerance and a medium fire tolerance. It can be found in swampy habitats. It grows red blooms in June and fruits in the summer (Lady Bird Johnson 2010). The seeds are small (0.09 mg each) and disperse relatively slowly (USDA 2011). Several specimens have survived in "Rhododendron swamp" on Three Mile Island (Holland field notes). The great laurel has only been documented on Three Mile Island (Holland and Sorrie 1989).

Rhododendron viscosum is also known as the swamp azalea and belongs in the Ericaceae family. This perennial shrub is native to the United States and is found throughout the southeastern United States from Texas to Florida to North Carolina up to the New England area. The *R. viscosum* found on Three Mile Island was introduced in 1901 by Kelsey. It actively grows in the spring and can grow up to 4.9 m (16 ft) in height. It is adapted to grow in all

textures of soils, but it has no fire tolerance and a medium drought tolerance. It can grow in soils with a pH of 4.0 to 7.0. It can be found on the edges of wetlands including swamps. It sprouts red blooms from May to August and it sprouts fruits from summer to fall (Lady Bird Johnson 2010). It has a medium fruit and seed abundance and has a slow seed spread rate (USDA 2011). Several species have survived in "Rhododendron swamp" (Holland field notes). The swamp azalea has only been documented on Three Mile Island (Holland and Sorrie 1989).

Robinia hispida is also known as the bristly locust and belongs in the legume family Fabaceae. This perennial shrub is native to the United States and is found throughout the eastern half of the US as well as the Pacific coastal states (USDA 2011). The *R. hispida* found on Three Mile Island (TMI) was introduced in 1901 by Kelsey. The bristly locust can grow up to 2.4 m (8 ft) tall with compound, alternate, deciduous leaves. The bristly locust also grows dark pink to rose, two-lipped flowers. The flowering season is from April to July. The bristly locust is typically found in open woods, slopes and sand hills where there is much sunlight and sandy or thin soils (Lady Bird Johnson 2010). It has been found on the southern end of TMI in disturbed areas (Holland field notes). *R. hispida* is considered invasive by the Invasive Plant Atlas of the US (2010), however it is only listed as escaping cultivation and no known threats were listed for the locust. The bristly locust has only been documented on Three Mile Island (Holland and Sorrie 1989).

On the islands, the dominant woody understory species of all the islands have historically been tree seedlings, including *Acer rubrum* (red maple), *A. pensylvanicum* (striped maple), and *Fagus grandifolia* (American beech) (Briggs et al. 2008). Other dominant understory species include *Aralia nudicaulis* (wild sarsaparilla), *Pteridium aquilinum* (western brackenfern), *Vaccinium angustifolium* (lowbush blueberry), and *Gaylussacia baccata* (Black huckleberry)

(Maciejowski et al. 1981). It should be noted that historically none of the dominant understory species have been nonnative species (Briggs et al. 2008; Clapham et al. 2009).

Bradley and Crow (2010) used Sørensen's Index of Similarity to compare four island floras, one of which was Three Mile Island. This analysis measures the similarity between two samples. The index is calculated using the following formula: $S = 2C/(A+B)$, where A and B are the number of species in each sample and C is the number of species shared by the two samples.

The following table includes the species comparisons among Bear, Rattlesnake, Timber and Three Mile Islands. The analysis shows the number of species shared among each pair of islands and the percentage of the combined compositions of both islands that they share in common. For example, Rattlesnake and Bear islands share the most species (155 species). However, Three Mile and Bear islands share the most species out of their combined species compositions (55.4%).

Table 4. Sørensen's Index of Similarity for four island floras in Lake Winnipesaukee. Data from Bradley and Crow (2010). Numbers on the top right are species shared between the islands and the numbers on the bottom left are the percentage of shared species between the islands.

	Bear Island	Rattlesnake Island	Timber Island	Three Mile Island
Bear Island (303.5 ha)	--	155	126	145
Rattlesnake Island (162 ha)	54.3%	--	113	124
Timber Island (54.6 ha)	50.0%	51.1%	--	105
Three Mile Island (17.4 ha)	55.4%	53.7%	52.7%	--

II. OBJECTIVES AND HYPOTHESES

This study is part of an ongoing floristic sampling at Three Mile, Hawk's Nest and Blueberry Islands. The sampling includes the overstory and understory flora of all 25 plots established on the islands previously. The understory is the herb stratum layer of the flora and the overstory includes both the shrub and canopy layers. The primary purpose of my study is to document the 2011 composition of the flora throughout the three islands with focus on the plants of concern including rare, introduced and potentially invasive species.

My first objective is to document the plant species of all the plots to allow for comparison with previous samplings in the permanent plots. The quantitative plot data collected by M.M. Holland from 1978 to present will be compared in order to document any changes in the compositions of the dominant plant species or any changes in the dominant plant species. This objective will also address any noticeable differences in composition among the four zones of the islands. The historical data gathered since 1901 will be used to note when the nonnative species were introduced to the islands. I predict that there will be some composition changes based on previous collections and samplings.

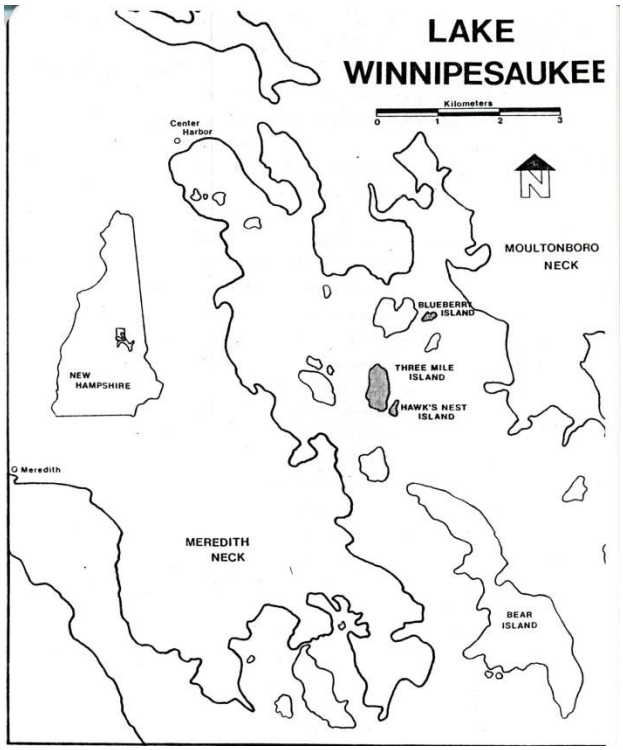
The second objective of this study is to document the presence of the plants of concern throughout the islands. This objective also addresses the disturbance around the plants of concern and determines if there is a relationship between the presence of plants of concern and the amount of disturbance. The presence of the plants is also compared among the four zones. The questions this objective addresses are "Is the relationship between the amount of disturbance

and the abundance of the plants of concern positive or negative?" and "Are certain plants such as invasive and rare species more abundant in particular zones as compared to the other zones?" Any presence of introduced or rare species is also documented from the plots data. My prediction is that most of the rare species will be found in the more protected parts of the island and that the Kelsey introductions and invasive species will mostly be found in the most disturbed areas on the island.

III. SITE DESCRIPTION

Lake Winnipesaukee is located in central New Hampshire and is roughly 18,043.3 hectares in size (Tiner 2007). The lake has approximately 253 islands within it, including Three Mile, Hawk's Nest, Blueberry, Timber, Rattlesnake and Bear Islands. The climate of Lake Winnipesaukee is characteristic of the continental New England area with regular precipitation at around 1.27" per month and no particular wet or dry seasons. Each winter, the lake freezes until late April, when the ice melts in an occurrence referred to as the "ice out" (Bradley 2005). The winters are generally cold with an average January temperature of -8.94^{o}C, and the summers are generally warm with an average July temperature of 19.33^{o}C (Bradley and Crow 2010). All three islands are comprised of outcrops of the Winnipesaukee Quartz Diorite, which is a medium-grained, gray quartz diorite (Holland and Sorrie 1989).

Figure 1. The northwestern portion of Lake Winnipesaukee with Bear, TMI, Blueberry and Hawk's Nest Islands (Holland and Sorrie 1989)



Three Mile Island is approximately 17.4 ha in size (Holland and Sorrie 1989) and is located in the northern part of Lake Winnipesaukee. The bedrock core of Three Mile Island is covered with a surface mantle of broken blocks of bedrock formed from the last glaciations in the local area. In some of the plots, there are large boulders that stick out of the ground (Holland and Sorrie 1989). Throughout the island, the soil grain types are either medium or coarse sand and the soils are typically acidic (O'Sullivan 1981). Development has occurred throughout Three Mile Island for its camp. As mentioned earlier, most of this development is located on the southern end of the island, or the "urban zone." Examples include the dining area, trails that were made through woods to make views of mainland mountains more visible, and forested island edges were cleared to make campsites (Atkins 1972).

Hawk's Nest Island (HNI) is 100 m east of TMI and currently has no man-made structures on it. The island is approximately 0.41 ha in size (Holland and Clapham 2012). Currently HNI is managed as part of the "protective zone," so permission for campfires is limited by the TMI Camp management. No botanical sampling had been conducted at HNI prior to 1979 (Holland and Clapham 2012).

Blueberry (BI) is 3.2 km northeast of TMI and is approximately 0.27 ha in size (Holland and Clapham 2012). The northeast and southeast ends of BI are managed by TMI staff as part of the Protective zone, while the central area near a cabin built in 1899 is managed as part of the Compromise zone. No botanical sampling had been conducted at BI prior to 1979 (Holland and Clapham 2012).

IV. METHODS

This study was a part of a regular sampling of the vascular flora that has occurred on Three Mile (TMI), Hawk's Nest (HNI) and Blueberry (BI) islands since 1978 (Holland et al. 1983). Samplings occurred on the islands at roughly ten year intervals in 1978, 1991, and 2001 (Briggs et al. 2008). The fourth sampling occurred in the summer of 2011 from June 11 to July 2 and followed the protocol of the other samplings. Twenty five circular plots were randomly distributed across the three islands, and their numbers were assigned from a grid of numbers. Each circular plot was 34 m (111.5 ft) in diameter and was approximately 908 m^2 (Maciejowski, Clapham and Holland 1981). Within each of these plots were ten square 1 m^2 quadrats that allowed sampling in a total of 250 square quadrats. The overstory plants were sampled in the big circular plots while the understory vascular plants were sampled in the meter square quadrats (Holland et al. 2000; Clapham et al. 2009). The original overall objectives of this sampling protocol were to measure the abundance of vegetation on the islands, to establish a recent history of the ecosystem and the role of disturbance in the maintenance and development on the islands, and to provide the tools necessary to establish a foundation for critical natural resource decisions (Maciejowski et al. 1981).

In the summer of 2011, a team of volunteers was gathered to assist with the sampling portions of the survey. They were campers at TMI and had prior knowledge of the islands' flora because of their experiences as New England gardeners or foresters. The team sampled the

understory first and then the overstory for each plot. Then the team surveyed the islands for the plant species of concern and completed disturbance rubrics for each species as described below.

Within the twenty five larger plots, woody plants (both trees and shrubs) that were over two meters in height were recorded as part of the "overstory" (Holland et al. 1983). In the samplings, the "overstory" included both the canopy and shrub layers. From this sampling the number of individuals (density), the number of plots (frequency), and the measure of size and/or area (dominance) of each species were recorded (Holland et al. 1983). For the 2011 sampling, two different methods for overstory dominance sampling were implemented to calculate the relative dominance using two different measurements. The first method was rating trees by size (Smith 1962; Smith 1986) and the second was measuring in diameters at breast height (dbhs) (Brewer and McCann 1982).

For the first method, the number rating for each tree was determined by a number from "1" to "4," referring to overtopped (formerly "suppressed" in Smith 1962), intermediate, codominant and dominant, respectively (Maciejowski et al. 1981; Smith 1986; Briggs et al. 2008). Dominant trees were those having crowns extending above the general level of crown cover receiving full light from above and partly from the sides. Co-dominant trees had medium-sized crowns and received little light from the sides. Intermediate trees were shorter than those in the two preceding classes; receiving a little direct light from above but none from the sides. Overtopped (e.g. short trees, saplings, and tall shrubs) had crowns entirely below the general level of the crown cover (Smith 1986; Holland and Clapham 2012). From these data, the mean rating was calculated for each species by dividing the summed ratings by the number of individuals of the species in each plot. Spreadsheets were made for each of the following data:

number of individuals, total ratings for each plot and island, and the mean rating of each species in the overstory.

For the 2011 sampling, diameter at breast height (dbh) was also recorded for the trees that were larger than 2.5 cm in diameter. This was done on TMI and HNI but not at BI due to the presence of bald eagles nesting on the island. The National Audubon Society determined the timing and duration of the 2011 vegetation sampling at BI. After each tree was identified and recorded, a piece of visible tape was placed on the tree to ensure that it was not recorded again.

Following the sampling, importance values were calculated for each species. The importance value of a species is a relative quantitative measurement of its presence in a sampling and is influenced by the density, dominance, and frequency of each species. These parameters' influence can range in different importance values, where one parameter such as frequency may be more important than density. Using Curtis's (1959) method, importance values are also influenced by the number of species, so if only one species is present, its importance value would be 300. In general an importance value represents the importance of a species in the ecosystem (Mueller-Dombois and Ellenberg 2002).

For the importance values of the understory, the following were calculated: relative percent cover and relative frequency. The relative percent cover was calculated using the formula: (total percent cover of species q/total percent cover of all species) *100. The total percent cover of each species was summed from all 25 plots. Relative frequency was calculated using the formula: (# of plots species q was found in/total # of plots of all species). The relative percent cover and relative frequency were then summed into the importance value for each species.

For the importance values of the overstory, the following were calculated: relative frequency, relative dominance and relative density (Briggs et al. 2008). Note that in the following formulas, "q" represents one species. Relative dominance was calculated using the following formula: (x rating species q/x ratings of all species) x 100 or (x basal area of species q/x basal area of all species). Relative density was calculated using the following formula: (number of individual species q)/(total number of individuals of all species) x 100. Relative frequency was calculated using the following formula: ((frequency of plots species q was found in/total frequency of all species) * 100). Lastly, the importance values were calculated from the sum of the relative density, relative dominance and relative frequency. The importance values used in this sampling protocol were derived from Curtis (1959). A spreadsheet was created for the relative parameters and importance values for each island with the two calculations of relative dominance noted (Tables 33-38). Lastly, the dominant species in the overstory of each island were determined from the importance values data.

The dbhs that were recorded on Three Mile and Hawk's Nest islands were converted into basal areas using the following formula: Basal area = $(DBH^2*0.7458)/10000$ (cm^2/m^2) (Brewer and McCann 1982). The basal areas were then summed up for each species in the plots and summarized on a spreadsheet. The dbhs from 2011 were summed up for HNI and TMI and these data were used to calculate relative dominance. Each calculation of relative dominance was used to calculate a second set of importance values. These importance values were compared with the first set of 2011 importance values to demonstrate any differences in the overstory sampling methods (Table 43).

Within the 250 smaller plots, herbaceous and woody plant species that were shorter than two meters were recorded. Nonvascular plants such as mosses were not included in this

sampling. From this sampling the species composition and visual estimates of percent cover for each species were recorded (Holland et al. 2000). The observers first identified the plants, then they stood above the plot to get a "bird's eye" aerial view of the plot and estimate the percent cover of each species. Percent covers were estimated by how much of the plot was covered by each species and were measured in percentages. Specimens were only included if the bases of their stems were found within the plot. Specimens outside the square plot were pushed aside so the observers would not include the cover of those specimens in the plot. Specimens that were overlapped by the same species were not included in the data, but specimens that were overlapped by other species were included. Because of this, the total percent cover by all species may have been more than 100% in some plots. Small seedlings of specimens and small specimens were accounted for by 0.5% in the data. After all the species were estimated, the "no vegetation" portion of the plot was estimated. This measured the portion of the plot that was not covered by any vascular plants.

Plant species that were not fully identified in the field were collected and identified later using resources such as the Gray's Manual of Botany (Fernald 1950), the Flora of the Northeast (Magee and Ahles 1999), and the USDA Plants Database (2011). In the data, plants not initially identified were referred to using names such as "Unknown grass #1" and the species' names were consistent across the plots as much as possible, so if a species was called "#1" on one plot, it would be referred to as such in the other plots. Once identified, the proper species name takes the place of the nickname. Not all species were identified initially due to the lack of certain structures such as fruits and flowers, so plants were collected weeks later with the necessary structures. All unknowns in the data were identified throughout all four years of data collection.

Plant names were updated using the latest nomenclature provided on the USDA Plants Database (2011).

After all the understory flora was measured, the percent covers from the ten smaller plots were summed into a total percent cover of each species. Next, the mean percent cover was calculated for each species by dividing the total percent cover by ten (ten plots per larger plot). A total percent cover and mean percent cover were calculated for each species in each of the 25 larger plots. The mean percent covers of each plot were summarized in a spreadsheet on Microsoft Excel and separated by island and year. In this spreadsheet, the total mean percent cover of each species was calculated for each island and the three islands summed together. From this data, the dominant species were determined from the highest importance values.

For the species of interest in this study, several methods were used to determine their presence on the islands. First, presence and absence of the plant species of interest in this study were noted and summarized. Surveys were taken on each island to search for any of the species of interest throughout the islands. The results were summarized for each species and included any notes on the species' presence since 1901.

Second, when a specimen of interest was discovered on the islands, a survey of the disturbance around the specimen was taken by 2-5 volunteers. Disturbance was measured using a rubric that describes the different kinds of natural and anthropogenic disturbances. Natural disturbances included natural fire, lightning, fallen trees and erosion. Anthropogenic disturbances included bulldozers, trail clearing, cut logs and people presence. The latter category included any presence of people in the area and the resulting disturbances such as foot traffic. Each category of disturbance was ranked by the recorder on a scale from 1 to 5. A "1" indicates no disturbance in the area around the species. A "2" indicates very little disturbance in the

immediate area surrounding the species, i.e. footsteps. A "3" indicates average disturbance surrounding the species, i.e. small fallen tree or trail. A "4" indicates much disturbance around the species with respect to area size, i.e. large clearing with many fallen trees or large burned area. A "5" indicates much disturbance with very little to no area that is not disturbed, i.e. a building next to the species.

An overall disturbance rank was also recorded to account for all disturbances in the area. The disturbance data from the surveys was summarized in a spreadsheet and compared among rare, introduced and invasive plant species. The field notes for the species of interest are documented in the Results section. These notes included observations of density and general presence in the area the species were found in.

Several statistical analyses were performed on the collected data from the samplings. Sørensen's Index of Similarity (Tables 11-20) (Bradley and Crow 2010) measures the similarity between two samples and is calculated using the following formula: $S = 2C/(A+B)$, where A and B are the number of species in each sampling and C is the number of species shared by the two samplings. It is mostly used to compare presence/absence data in samples, though it has been extended to apply to abundance data as well. This analysis was used to compare the four samplings (1978, 1991, 2001, and 2011) on the three islands. This analysis was also used to compare the samplings in the four zones throughout the four years of sampling. The similarity table pulled from Bradley and Crow's study (2010) was used to compare the other islands in Lake Winnipesaukee with Three Mile Island.

Another analysis that was performed on the understory and overstory floral data is the calculation of evenness and diversity of the floras of the three islands. For this analysis, I summarized the percent cover data of the understory into spreadsheets with the mean percent

cover for all the species in each of the 25 plots. Each spreadsheet consisted of data from one sampling year. The percent covers of the understory had to be rounded up to the nearest integer because the software package could not interpret data with decimal places. The rounding also accounted for covers that were less than one so that a sampling with 0.5% cover would be counted as 1% instead of 0%. The total individual data for the overstory was composed in a similar method on separate spreadsheets. The spreadsheets were analyzed using the EstimateS software package available online at http://purl.oclc.org/estimates (Colwell 2009).

Shannon's Diversity index was calculated to determine the diversity of the plots and the islands. The Shannon's Diversity index took into account both the species richness and evenness in the sampling year. The index was calculated using the following formula:
$H' = -\Sigma^{S}_{i=}1(p_i*\ln(p_i))$ where p_i is the proportion of individuals of a species (no. of individuals/total # of individuals in the sampling) and S is the total number of species in the sampling. The closer the index is to ln(S), the more even the sampling. Species evenness was calculated using the formula $E = H'/\ln(S)$ where H' is the Shannon's Diversity Index and S is the number of species from that sample. From these values, the diversity and evenness were compared across the four years of sampling for both the understory and overstory of the islands.

Using the same software, the sampling depth was also determined from the software and graphed into a rarefaction curve. In ecology, rarefaction is a technique used to compare the species richness computed from samples of different sizes. Rarefaction is used to calculate the species richness of a sampling based on the number of individuals from that sampling. A rarefaction curve is a plot that depicts the species richness as a function of the number of individuals sampled. If the curve flattens to the right of the graph, then the number of species would not increase much if more individuals were sampled. However, if the curve does not

flatten, then there is a possibility for a much higher number of species that have yet to be sampled. The former case typically indicates a thorough sampling while the latter indicates the opposite. In this study, I composed four rarefaction curves each representing one year of sampling into two figures (21-22) that separately represent the overstory and understory samplings.

Lastly, I analyzed the abundance data of the understory and overstory using a statistical analysis known as the repeated measures permutations analysis. The analysis is a type of a multivariate analysis of variance (MANOVA) that shuffles the sample data up to 1000 times and analyzes any interactions between specified factors. The factors that I chose for this analysis are islands, years, and plots. The first two are fixed effects while the latter is a random nested factor in the islands because the plots are a portion of the islands. For the understory data, I analyzed the total percent cover for all three islands and four samplings. For the overstory data, I analyzed the density data for all three islands and four samplings. I used the PERMANOVA+ for PRIMER v6 software to analyze these data.

V. RESULTS

Overstory composition

The following figures show three parameters measured during the overstory and understory samplings. These parameters are species richness, evenness, and diversity. Throughout all four years of sampling, 124 plant species were sampled in the understory and 46 species were sampled in the overstory.

In the overstory sampling, the parameters remained relatively constant among the sampling years (Table 5). On Three Mile Island, species richness increased significantly from 1978 to 1991 and remained constant in the later samplings (Figure 2). Species evenness decreased from 1978 to 1991 and remained constant in the later samplings (Figure 3). However, the diversity index remained constant throughout the four samplings (Figure 4).

On Hawk's Nest Island, the species richness increased from 12 species to 18 from 1978 to 2011 (Figure 2). The species evenness and diversity index increased through the sampling years (Figures 3 and 4). On Blueberry Island, the species richness increased through the years (Figure 2). However, the species evenness decreased through the sampling years (Figure 3). Similarly to TMI, the diversity index remained constant through the years, but it was highest during the 2001 sampling (Figure 4).

Overall, the three islands saw a significant increase in species richness from 1978 to 1991 though remained constant in 2001 and 2011 (Figure 2). Species evenness did not change much

among the four samplings (Figure 3). Lastly, the diversity on all three islands increased from 1978 to 1991 but decreased from 2001 to 2011 (Figure 4).

Throughout the years of sampling, the overstory increased in the number of individuals and in total ratings on all three islands (See Tables 5-7). In particular, the overstory on Blueberry Island increased significantly from 1978 to 1991 in both the number of individuals and total ratings (Tables 6 and 7). Also, the BI increases in overstory individuals from 1991 to 2001 were relatively the same as from 2001 to 2011 (Table 6).

The dominant species in terms of importance values remained consistent on the three islands (Table 45). On Three Mile Island, *Acer pensylvanicum* remained a dominant species for all four sampling years. Other TMI dominant species in multiple samplings include *Acer rubrum, Fagus grandifolia, Hamamelis virginiana,* and *Quercus rubra* (Table 45). On Hawk's Nest Island, *Pinus resinosa, Pinus strobus, Quercus rubra,* and *Tsuga canadensis* were dominant species in all four samplings (Table 45). Blueberry island's dominant species shifted from 1978 to 1991, but the consistently dominant species since 1991 were *Ilex mucronata* and *Vaccinium corymbosum* (Table 45). Overall the dominant species for all the islands were *Acer rubrum, Hamamelis virginiana, Pinus resinosa, P. strobus, Quercus rubra, Tsuga canadensis,* and *Vaccinium corymbosum* (Table 45).

Table 5. Overstory data compilation including species richness (Species), species evenness, and Shannon's Diversity Index. Data were compiled for all plots found on TMI, HNI and BI. Shannon's Diversity Index was calculated using the EstimateS software package.

Island	Year	Species	Evenness	Shannon
All	1978	22	0.782907397	2.42
All	1991	39	0.775201914	2.84
All	2001	36	0.789726537	2.83
All	2011	38	0.747748611	2.72
Three Mile	1978	17	0.836506014	2.37
Three Mile	1991	35	0.705978699	2.51
Three Mile	2001	31	0.728016691	2.5
Three Mile	2011	28	0.717242892	2.39
Hawk's Nest	1978	12	0.75254336	1.87
Hawk's Nest	1991	16	0.807909223	2.24
Hawk's Nest	2001	15	0.867783027	2.35
Hawk's Nest	2011	18	0.878779691	2.54
Blueberry	1978	14	0.70858635	1.87
Blueberry	1991	18	0.646975599	1.87
Blueberry	2001	23	0.641047268	2.01
Blueberry	2011	25	0.543668068	1.75

On TMI, the following species were absent from the plots in 2011 but not 2001: *Ilex mucronata, Lyonia ligustrina, Populus tremuloides, Quercus alba,* and *Viburnum nudum var. cassinoides*. The following species were present in the plots in 2011 but not 2001: *Rhododendron maximum, Vaccinium fuscatum,* and *Viburnum lentago*. On HNI, *Gaylussacia baccata* was absent in 2011 but not 2001. The following species were present in 2011 but not 2001: *Nyssa sylvatica, Rhododendron canadense, Rosa palustris,* and *Vaccinium corymbosum*. On BI, the following species were absent in 2011 but not 2001: *Myrica gale, Populus grandidentata, Prunus pensylvanica,* and *P. serotina.* The following species were present in 2011 but not 2001: *Fraxinus nigra, Populus tremuloides, Quercus rubra, Rosa palustris, Vaccinium fuscatum,* and *Viburnum lentago.*

Figure 2. Overstory species richness of TMI, HNI and BI in the four years of sampling. A total of 46 species was found in the plots in the four sampling years.

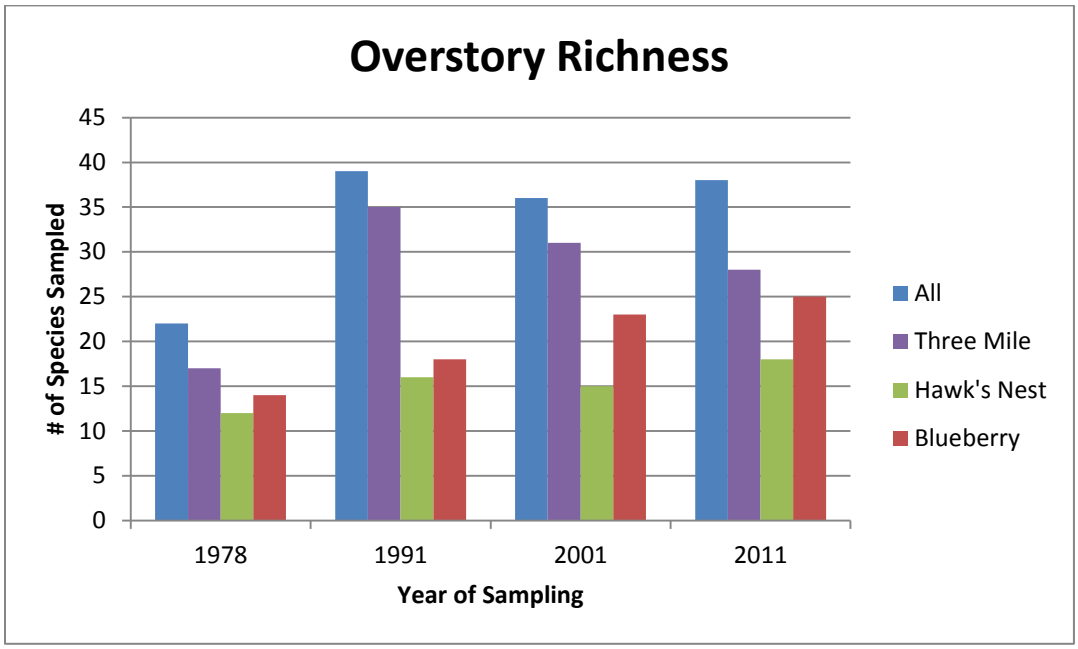


Figure 3. Overstory species evenness of TMI, HNI and BI in the four years of plot sampling.

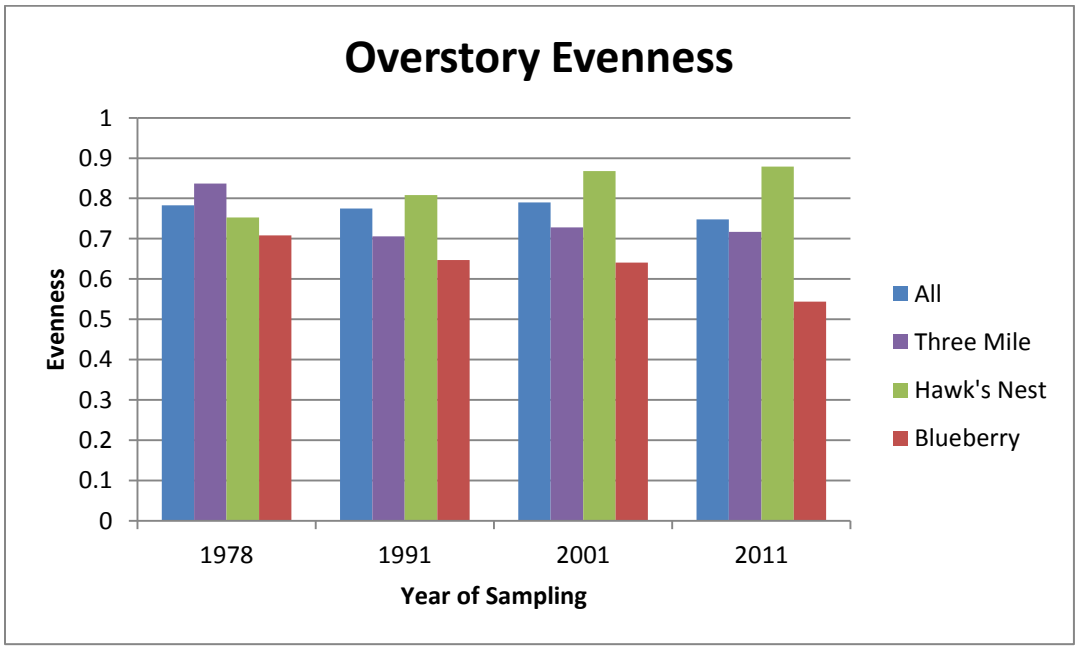


Figure 4. Overstory Shannon's Diversity Index of TMI, HNI and BI in the four years of plot sampling.

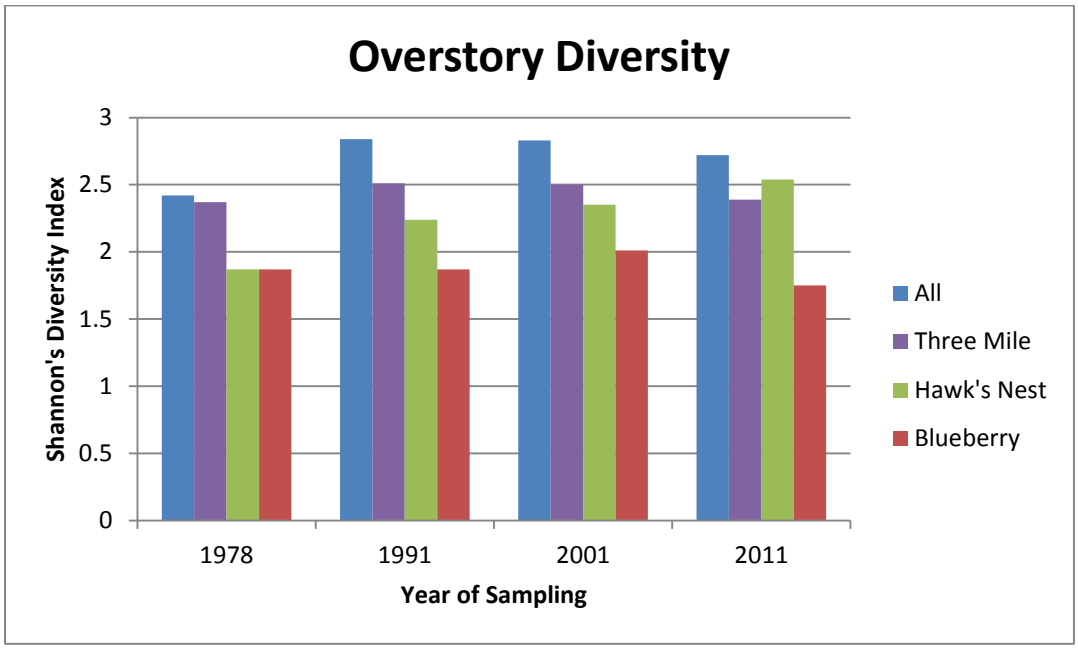


Table 6. Total number of woody individuals sampled in the overstory plots on TMI, HNI and BI by sampling year.

	TMI	Hawk	Blue	Overall
1978	2207	176	121	2504
1991	3759	483	2175	6417
2001	4588	656	2764	8008
2011	5459	806	3458	9723

Table 7. Total ratings of individuals sampled in the overstory plots on TMI, HNI and BI in all four sampling years.

	TMI	Hawk	Blue	Overall
1978	4253	379	229	4861
1991	5683	887	2417	8987
2001	7395	1197	3081	11673
2011	7892	1212	3972	13076

The repeated measures analysis on the overstory shows that all of the factors (islands, years and plots) and the interactions between island and year were significant across all samplings ($p<0.001$) (Table 8). This indicates that the overstory species composition varied significantly across all three islands and among all four years. The Island x Year interaction indicates that the magnitude and/or direction of change in overstory species composition among years varied among islands. In summary, the species composition of the three islands changed significantly in composition across all four sampling years.

The principal coordinates analysis (PCO) of the overstory (Figure 19) shows that many species contributed to the dissimilarities in species compositions described above: *Acer pensylvanicum, Acer rubrum, Alnus incana ssp. rugosa, Amelanchier laevis, Betula populifolia, Fagus grandifolia, Hamamelis virginiana*, and *Tsuga canadensis*. This can be attributed to the fact that many of the species were only dominant on TMI (*H. virginiana, A. pensylvanicum, F. grandifolia*). Another contributing factor is that *Acer rubrum* was only a dominant species on TMI in 1978, 1991, and 2001, and it became dominant on HNI and BI only in 2011.

Table 8. The repeated measures permutations MANOVA of the overstory abundance data. Included are the degrees of freedom (df), the means of squares (MS), the pseudo-F statistic, the p-value, and the number of permutations (Unique perms). Factors used in the analysis include Islands (Is), Years, (Ye), Plots nested in Islands [Pl(Is)], and the interaction between Island and Year (IsxYe).

					Unique
Source	df	MS	Pseudo-F	P(perm)	perms
Is	2	24457	4.6374	0.001	998
Ye	3	4803.1	5.9943	0.001	998
Pl(Is)	22	5273.9	6.5817	0.001	997
IsxYe	6	2269.7	2.8326	0.001	995
Res	66	801.29			
Total	99				

Understory composition

The understory of all three islands experienced an increase in species richness and diversity from 1978 to 1991 (Figures 5-7). On Three Mile Island, the understory species richness increased from 1978 to 1991 but decreased in 2001 and increased again in 2011 (Figure 5). The species evenness, however, remained constant in all four samplings (Figure 6). Lastly, the diversity increased significantly from 1978 to 1991 but remained constant in later samplings (Figure 7).

On Hawk's Nest Island, the species richness increased until 2011, where it decreased slightly (Figure 5). Similarly to TMI, the species evenness remained constant in all four samplings (Figure 6). Hawk's Nest's understory diversity increased from 1978 to 1991 but remained constant in later samplings (Figure 7). Blueberry Island experienced a significant species richness increase from 1978 to 1991 (Figure 5). Similarly to TMI and Hawk's Nest, BI's species evenness remained constant and the diversity increased from 1978 to 1991. However, the diversity decreased from 1991 to 2001 and increased again in 2011.

The dominant understory species on TMI in terms of importance values were *Aralia nudicaulis* and *Gaylussacia baccata* in all four sampling years (Table 44). Hawk's Nest Island's dominant species included only *G. baccata*. Blueberry Island seemed to experience the most variety of dominant species in each sampling. The only consistently dominant species on Blueberry was *G. baccata* in every sampling except 1978. Overall, the only consistently dominant species across all three islands were *Aralia nudicaulis* and *Gaylussacia baccata* along with species of *Vaccinium* dominant in 2011 and 1978.

Table 9. Understory data compilation including species richness (Species), species evenness, and Shannon's Diversity Index (Shannon). Data were compiled for all plots found on all islands, TMI, HNI, and BI respectively. Shannon's Diversity Index was calculated using the EstimateS software package.

Island	Year	Species	Evenness	Shannon
All	1978	41	0.743219722	2.76
All	1991	81	0.744120568	3.27
All	2001	75	0.762017153	3.29
All	2011	83	0.762643485	3.37
Three Mile	1978	35	0.72004202	2.56
Three Mile	1991	69	0.743958612	3.15
Three Mile	2001	64	0.77665083	3.23
Three Mile	2011	73	0.762156138	3.27
Hawk's Nest	1978	15	0.657299484	1.78
Hawk's Nest	1991	20	0.667616401	2
Hawk's Nest	2001	28	0.723244925	2.41
Hawk's Nest	2011	23	0.698454486	2.19
Blueberry	1978	8	0.788673289	1.64
Blueberry	1991	27	0.801010519	2.64
Blueberry	2001	23	0.698454486	2.19
Blueberry	2011	25	0.782882018	2.52

Figure 5. Understory species richness in permanent plots on TMI, HNI, and BI in the four years of sampling. A total of 124 species was found in the four sampling years.

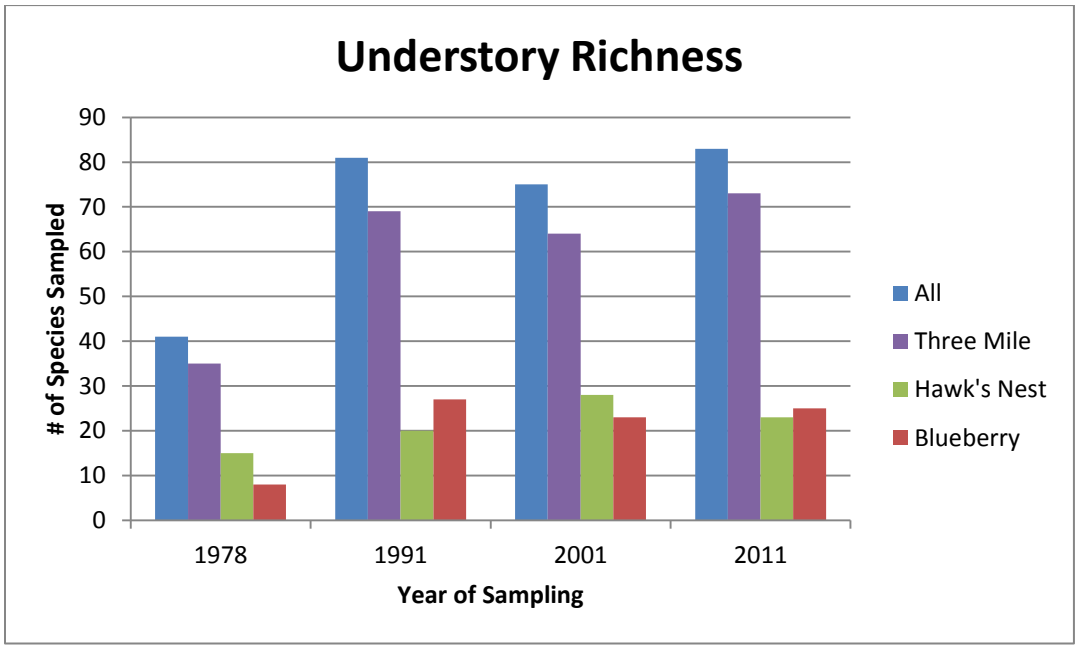


Figure 6. Understory species evenness of TMI, HNI and BI in the four years of sampling.

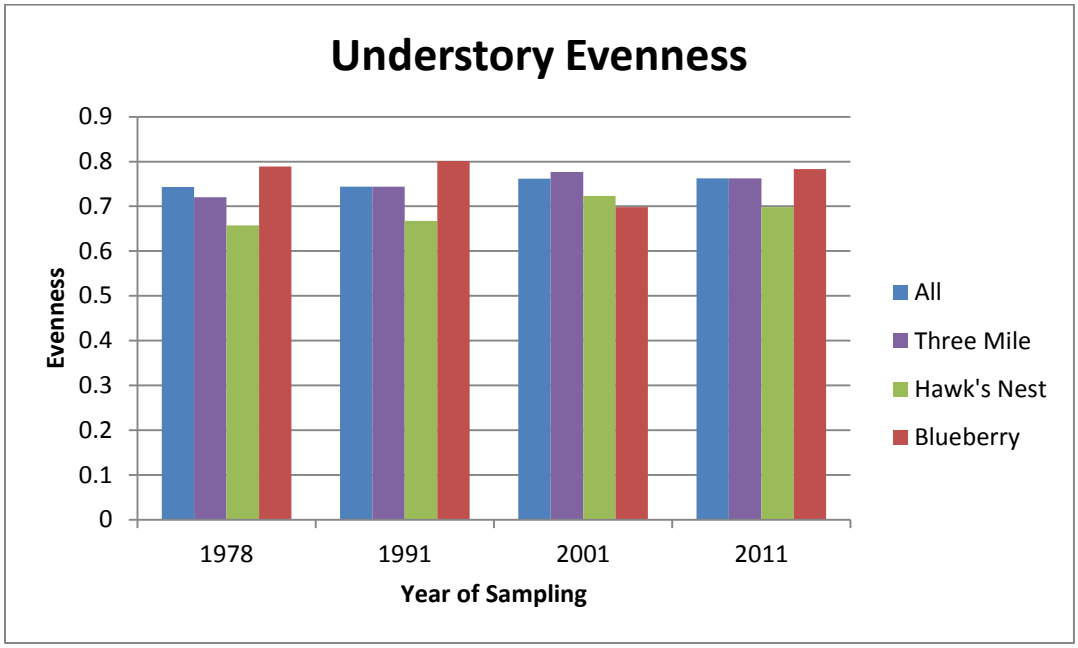
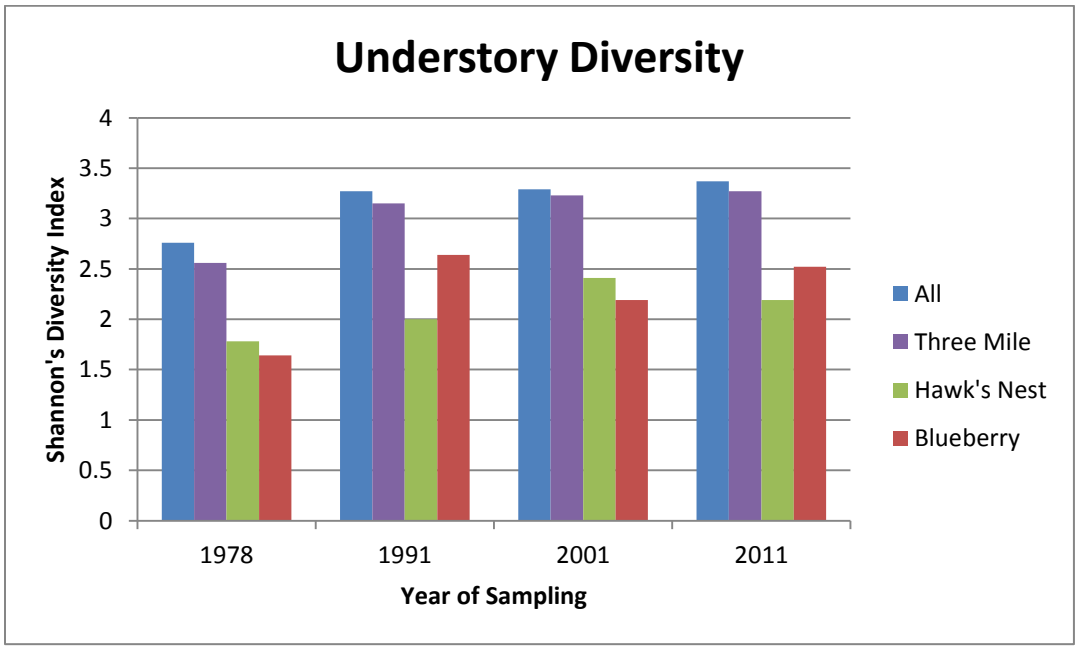


Figure 7. Understory Shannon's Diversity Index of TMI, HNI and BI islands in the four years of sampling.



The repeated measures analysis on the understory shows that all of the factors (islands, years and plots) and the interactions between island and year were significant across all samplings ($p<0.001$) (Table 9). This indicates that the understory compositions across all three islands and years were significantly different. The Island x Year interaction indicates that the samplings across all three islands and four samplings were significantly different in terms of composition changes. In summary, the species composition of the three islands changed significantly in composition across all four sampling years.

The species that contributed to the dissimilarity the most (Figure 20) are the following: *Aralia nudicaulis*, *Gaylussacia baccata*, and *Pteridium aquilinum*. *A. nudicaulis* and *P. aquilinum* were only dominant on TMI while *G. baccata* was dominant on all three islands.

Table 10. The repeated measures permutations MANOVA of the understory abundance data. Included are the degrees of freedom (df), the means of squares (MS), the pseudo-F statistic, the p-value, and the number of permutations (Unique perms). Factors used in the analysis include Islands (Is), Years, (Ye), Plots nested in Islands [Pl(Is)], and the interaction between Island and Year (IsxYe).

Source	df	MS	Pseudo-F	P(perm)	Unique perms
Is	2	23208	4.5053	0.001	997
Ye	3	6128.4	3.5147	0.001	997
Pl(Is)	22	5151.4	2.9544	0.001	997
IsxYe	6	3509.9	2.0129	0.001	998
Res	66	1743.6			
Total	99				

Sørensen's Index of Similarity of the samplings, zones, and Winnipesaukee Islands

According to Tables 11, 12, and 13, almost all samplings on Three Mile, Hawk's Nest and Blueberry Islands had at least 50% of the total species sampled in common. In the understory, the two most similar samplings in terms of species were the 1991 and 2001 samplings, which shared 56 species (72%). The two most dissimilar samplings were the 2011 and 1978 samplings, which only shared 30 species (48.39%) and the 1978 and 2001 samplings, which also only shared 30 species (51.72%).

In the overstory (Table 12), the two most similar samplings were the 1991 and 2001 samplings, which shared about 31 species (91%). The two most dissimilar samplings were both the 1978 and 2011 samplings as well as the 1978 and 2001 samplings, which all shared 19 species (69%).

In the combined understory and overstory samplings, the two most similar and dissimilar samplings were the same (Table 13). The most similar samplings were the 2001 and 1991 samplings, which shared 66 species (76%). The two most dissimilar samplings were the 2001 and 1978 samplings, which shared 38 species (58%).

Table 11. Sørensen's Index of Similarity of the understory flora of TMI, HNI and BI among all four sampling years. Species richness of each year is included in the second column. Values to the lower left of the diagonal represent percent similarity; values to the upper right of the diagonal represent the number of species in common between samplings.

	Species	2011	2001	1991	1978
2011	83	---	55	50	30
2001	75	69.62%	---	56	30
1991	81	60.98%	71.79%	---	31
1978	41	48.39%	51.72%	50.82%	---

Table 12. Sørensen's Index of Similarity of the overstory among the four sampling years on TMI, HNI and BI.

	Species	2011	2001	1991	1978
2011	34	---	29	28	19
2001	34	85.29%	---	31	19
1991	34	82.35%	91.18%	---	20
1978	21	69.09%	69.09%	72.73%	---

Table 13. Sørensen's Index of Similarity of the combined overstory and understory among the four sampling years on TMI, HNI and BI. Numbers to the top right are not simply the sums of the understory and overstory similarities because there are species found in both the overstory and understory.

	Species	2011	2001	1991	1978
2011	93	---	64	61	39
2001	82	73.14%	---	66	38
1991	90	66.67%	76.74%	---	40
1978	50	54.55%	57.58%	57.14%	---

In 2011, the two zones that shared the most species were the protective and the productive zones (Table 14, 41 species, 78.85%). The two zones that shared the least species were the urban and productive zones (24 species, 48.98%). In general, the urban zone shared fewer species with the other three zones individually than the three zones amongst each other.

In all four samplings combined, the results were similar among the zones (Table 15). The two zones that shared the most species were the protective and productive zones, which shared 56 species (71.34%). The two zones that shared the least species were the compromise and urban zones, which shared only 34 species (51.52%). The urban zone in general had far fewer percentages of species shared with the other zones than the other three zones had between one another.

In 2011, the two islands that shared the most species (Table 16) were Three Mile and Hawk's Nest Islands (29 species, 50.43%). The two islands that shared the fewest species were

Hawk's Nest and Blueberry islands despite having the highest percentage in common (22 species, 58.67%). In all four samplings combined, the results were similar to 2011's results (Table 17). Three Mile and Hawk's Nest Islands shared the most species (47 species, 54.97%). Hawk's Nest and Blueberry shared the least species despite having the highest percentage shared (36 species, 65.45%) Three Mile and Blueberry had the lowest percentage of species shared amongst them at 50.87% and only had 44 species in common.

Each individual island experienced similar trends in sampling similarities (Tables 16-18). On each island, the most similar samplings were the 1991 and 2001 samplings (TMI: 61 species, 77.22%, HNI: 24 species, 78.69%, BI: 27 species, 84.38%). The two most dissimilar samplings of TMI (Table 18) were the 2011 and 1978 samplings (32 species, 52.89%). The most dissimilar samplings of HNI (Table 19) were the 1991 and 1978 samplings (13 species, 53.06%) and 2001 and 1978 samplings (14 species, 51.85%). The two most dissimilar samplings on BI (Table 20) were the 1991 and 1978 samplings (11 species, 44.00%) and the 2011 and 1978 samplings (13 species, 44.83%).

Table 14. Sørensen's Index of Similarity for the four zones on the three islands in 2011. This table includes the species found in the four sampling years. Values to the lower left of the diagonal represent percent similarity; values to the upper right of the diagonal represent the number of species in common between samplings.

	Species	Urban	Compromise	Productive	Protective
Urban	55	---	25	24	28
Compromise	40	52.63%	---	31	39
Productive	43	48.98%	74.70%	---	41
Protective	61	48.28%	77.23%	78.85%	---

Table 15. Sørensen's Index of Similarity for the four zones on the three islands across the four samplings.

	Species	Urban	Compromise	Productive	Protective
Urban	76	---	34	39	41
Compromise	56	51.52%	---	42	48
Productive	66	54.93%	68.85%	---	56
Protective	91	49.10%	65.31%	71.34%	---

Table 16. Sørensen's Index of Similarity for TMI, HNI, and BI from the 2011 sampling.

	Species	Three Mile	Hawk's Nest	Blueberry
Three Mile	80	---	29	27
Hawk's Nest	35	50.43%	---	22
Blueberry	40	45.00%	58.67%	---

Table 17. Sørensen's Index of Similarity for TMI, HNI, and BI from all four sampling years.

	Species	Three Mile	Hawk's Nest	Blueberry
Three Mile	117	---	47	44
Hawk's Nest	54	54.97%	---	36
Blueberry	56	50.87%	65.45%	---

Table 18. Sørensen's Index of Similarity for TMI from all four sampling years.

	Species	2011	2001	1991	1978
2011	80	---	58	54	32
2001	76	74.36%	---	61	34
1991	82	66.67%	77.22%	---	36
1978	41	52.89%	58.12%	58.54%	---

Table 19. Sørensen's Index of Similarity for HNI from all four sampling years.

	Species	2011	2001	1991	1978
2011	35	---	22	20	15
2001	33	64.71%	---	24	14
1991	28	63.49%	78.69%	---	13
1978	21	53.57%	51.85%	53.06%	---

Table 20. Sørensen's Index of Similarity for BI from all four sampling years.

	Species	2011	2001	1991	1978
2011	40	---	25	23	13
2001	32	69.44%	---	27	13
1991	32	63.89%	84.38%	---	11
1978	18	44.83%	52.00%	44.00%	---

Plants of Concern and Disturbance Rubrics

In the 2011 sampling, only three potentially invasive species were documented on Three Mile Island: *Berberis thunbergii, Poa compressa,* and *Robinia hispida*. All of these species were only found in the urban zone of Three Mile Island and were not found on Hawk's Nest or Blueberry Island. Due to their presence in the urban zone, their habitats were the most disturbed out of all the plants of concern (see Figures 8-10). Other potentially invasive species including *Cirsium vulgare* and *Phalaris arundinacea* were not found on the islands in 2011 despite being present in past collections and/or samplings.

Only one specimen of *Berberis thunbergii* was observed near the burn pile in the urban zone of Three Mile Island. No specimens were reported on Hawk's Nest or Blueberry Islands. No survey was conducted for Japanese barberry, however it was found near the *Poa compressa* in the burn pile near the main house. The barberry was not present in any of the plots.

Several specimens of *Poa compressa* were found near the TMI main house in the burn pile. The burn pile is part of the urban zone of Three Mile Island. The area was open with grass species including *Poa pratensis* spread out in the area. No specimens of *Poa compressa* were found in any other zones or on Hawk's Nest and Blueberry islands.

A few specimens of *Robinia hispida* were found in plot 232 of Three Mile Island in a cleared out vista. This vista and plot are part of the urban zone of Three Mile Island. This specimen was also in the plot in previous samplings. *R. hispida* was not found in the other zones or on Hawk's Nest and Blueberry Islands.

From the plants of concern, the only Kelsey introductions that were found on the islands in 2011 were *Halesia carolina* and *Rhododendron calendulaceum*. These species are not considered either invasive or rare in New Hampshire. Both species were found in the

Rhododendron swamp, which is part of the protective zone. Like the invasive species, they were each only found in one area on the islands and nowhere else. Since all the introduced plants were found in the protective zone, they were found in some of the least disturbed areas on the islands (Figures 8-10).

Only one *Halesia carolina* specimen was found on Three Mile Island near plot 170 in Rhododendron swamp. This tree is most likely the same specimen that was found in previous samplings (Holland and Sorrie 1989, Holland field notes). No specimens were found on Hawk's Nest or Blueberry Islands. Several specimens of *Rhododendron calendulaceum* were also found in Rhododendron swamp where they have been found in past samplings. Like the *Halesia*, no specimens were found elsewhere.

Rare species found on the islands include *Rhododendron viscosum* and *R. maximum*. Both species were found in the Rhododendron swamp. Like the introduced species, they were each found in the least disturbed areas on the islands. Several specimens were found for each species and were documented in past samplings. Unfortunately, no specimens of *Cypripedium arietinum* or *Trisetum spicatum*, both endangered, were found on any of the islands.

Two species that are not rare, potentially invasive or introduced are *Apios americana* and *Desmodium cuspidatum* (IPANE 2011 and USDA 2011). *A. americana* was found on the southern and western shores of Three Mile Island, which are part of the compromise zone. Many specimens were found scattered in the area and were found in other open areas of TMI. *D. cuspidatum* was found in the Horseshoe pit near Plot 248, which is part of the urban zone. Specimens were also found scattered around the main house, also a part of the urban zone. They were not found in any of the other zones.

Other introduced species were found on the islands during the 2011 sampling. Some of these species are considered weedy in the New England area and thus could be considered potentially invasive (USDA 2011). These are *Dactylis glomerata* (TMI Plots 246 and 248) and *Plantago major* (BI Plot 282); however, none of these species are listed as invasive on IPANE (2011). Other introduced species that are not considered weedy or invasive (IPANE 2011) are *Hieracium caespitosum* (TMI Plots 232, 245 and 246), *Schedonorus pratensis* (TMI Plots 96, 160, 245 and 246), and *Trifolium aureum* (TMI Plot 248 and HNI Plot 254).

Based on the figures below, the invasive species were mostly found in the most disturbed areas of the island. In these areas, there was some natural disturbance but much anthropogenic disturbance. This is due to the areas being in the urban zone, which is cleared in many areas on a regular basis. Conversely, the introduced and rare plants were only found in the least disturbed parts of the island. On average, the natural and anthropogenic disturbances around the invasive species were significantly higher than around the rare and introduced species.

Table 21. Table of Disturbance Assessments by species. The first rows include zones of the species' habitats, the location (area) that they were found in, and the overall assessment scores as well as the averages of the scores. Second rows are the assessments of the natural disturbances and the third rows are the assessments of the anthropogenic disturbances. Surveys ranged from 1 (no disturbance) to 5 (high disturbance).

Species Name	Zone	Area	Overall	Avg
Rhododendron calendulaceum	Protective	Rhododendron Swamp	2 1 1 2	1.5
Rhododendron maximum	Protective	Rhododendron Swamp	2 1 1 1 2	1.4
Rhododendron viscosum	Protective	Rhododendron Swamp	2 1 1 2	1.5
Halesia carolina	Protective	Rhododendron Swamp	1 2	1.5
Apios americana	Compromise	West Point	3 2 2 2 2	2.2
Poa compressa	Urban	Compost Pile	4 4 4 3 4	3.8
Robinia hispida	Urban	Plot 232	4 4 4 4 4	4
Desmodium cuspidatum	Urban	Horseshoe Pit	5 4 4	4.33

	Natural Fire	Avg	Fallen Trees	Avg	Lightning	Avg	Erosion	Avg
Rhododendron calendulaceum	1 1 1 1	1	2 2 2 2	2	1 1 1 1	1	1 1 1 1	1
Rhododendron maximum	1 1 1 1 1	1	2 2 3 2 2	2.2	1 1 1 1 1	1	1 1 1 1 2	1.2
Rhododendron viscosum	1 1 1 1	1	2 2 2 2	2	1 1 1 1	1	1 1 1 1	1
Halesia carolina	1 1	1	2 1	1.5	1 1	1	1 1	1
Apios americana	1 1 1 1 1	1	2 2 2 1 2	1.8	1 1 1 1 1	1	1 2 2 1 2	1.6
Poa compressa	1 2 4 3 3	2.6	2 2 1 1 2	1.6	1 1 1 1 2	1.2	1 1 2 2 2	1.6
Robinia hispida	1 1 1 1 1	1	1 1 1 1 1	1	1 1 1 1 1	1	1 1 1 1 1	1
Desmodium cuspidatum	1 1 1 1	1	1 1 2 2	1.5	1 1 1 1	1	4 2 2 3	2.75

	Bulldozer	Avg	People presence	Avg	Cut Logs	Avg	Trail Clearing	Avg
Rhododendron calendulaceum	1 1 1 1	1	2 2 2 2	2	1 1 1 1	1	2 1 1 2	1.5
Rhododendron maximum	1 1 1 1 1	1	2 2 1 2 2	1.8	1 1 1 1 1	1	2 1 1 1 2	1.4
Rhododendron viscosum	1 1 1 1	1	2 2 2 2	2	1 1 1 1	1	2 1 1 2	1.5
Halesia carolina	1 1	1	2 2	2	1 1	1	2 1	1.5
Apios americana	1 1 1 1 1	1	4 5 2 2 3	3.2	2 1 1 1 2	1.4	4 2 3 2 3	2.8
Poa compressa	1 1 1 1 4	1.6	4 4 5 3 5	4.2	1 3 2 2 3	2.2	4 4 4 4 2	3.6
Robinia hispida	1 3 3	2.33	4 5 2 2 4	3.4	5 2 3 3 5	3.6	5 4 3 3 5	4
Desmodium cuspidatum	5 2 1	2.67	3 5 4 5	4.25	1 1 4 4	2.5	3 5 5 5	4.5

Table 22. Table of Disturbance Assessment ranks. "% Area Disturbed" refers to the relative amount of area (~5 m^2) immediately surrounding the species that is disturbed

Rank	% Area Disturbed	Examples
1	0%	Woods that are not visited by people.
2	1% - 25%	Some foot traffic in area; Small fallen branches; Small fires
3	26% - 50%	Trail in immediate area; Lightning damage
4	51% - 75%	Mostly cleared area; large fire
5	76% - 100%	Clearings with no canopy; Main facilities

Figure 8. Graph of the natural disturbance assessments for the species of interest. Species are as follows: *Rhododendron calendulaceum*, *Rhododendron maximum*, *Rhododendron viscosum*, *Halesia carolina*, *Apios americana*, *Poa compressa*, *Robinia hispida*, and *Desmodium cuspidatum*. Surveys ranged from 1 (no disturbance) to 5 (high disturbance).

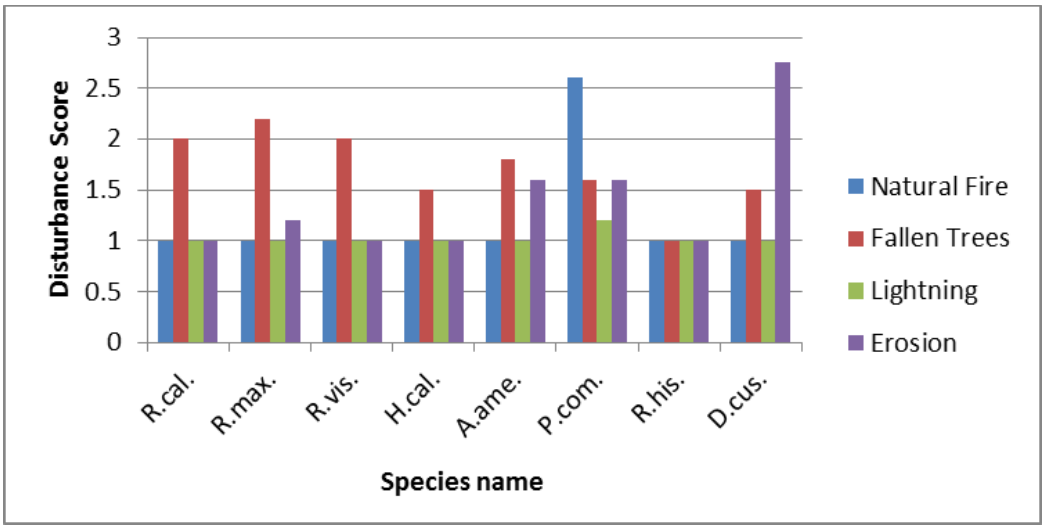


Figure 9. Graph of anthropogenic disturbance assessments for the species of interest. Species are as follows: *Rhododendron calendulaceum*, *Rhododendron maximum*, *Rhododendron viscosum*, *Halesia carolina*, *Apios americana*, *Poa compressa*, *Robinia hispida*, and *Desmodium cuspidatum*. The "People" category included the presence of campers in the area and foot traffic. Surveys ranged from 1 (no disturbance) to 5 (high disturbance).

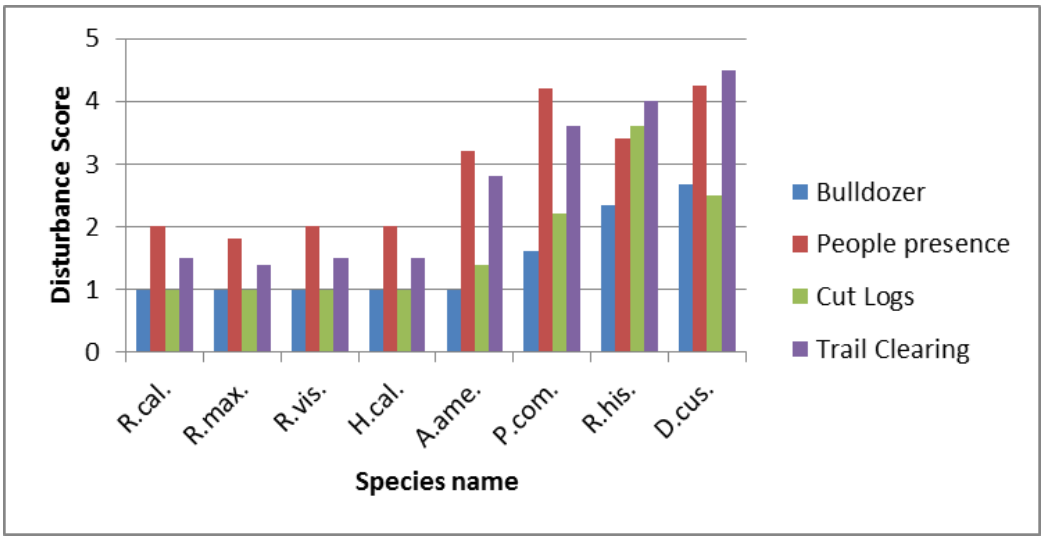
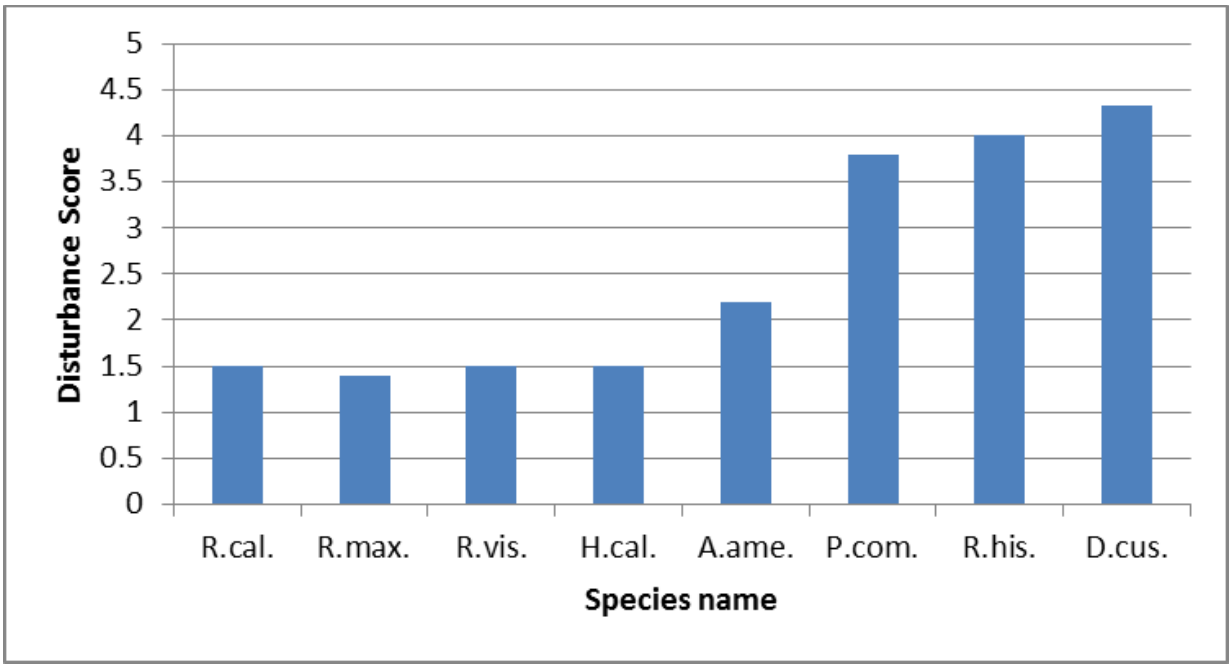


Figure 10. Graph of the overall disturbance assessments. Species are as follows: *Rhododendron calendulaceum*, *Rhododendron maximum*, *Rhododendron viscosum*, *Halesia carolina*, *Apios americana*, *Poa compressa*, *Robinia hispida*, and *Desmodium cuspidatum*. Surveys ranged from 1 (no disturbance) to 5 (high disturbance).



VI. DISCUSSION

The 2011 Sampling as compared to previous samplings

With respect to all parameters measured (Tables 5 and 8), the three islands sampled experienced changes in the vegetation over time. In the overstory, all islands except TMI experienced a steady increase in species richness (Table 5). TMI on the other hand experienced a sharp increase in the 1991 sampling, but since then the richness in the permanent plots has decreased with each subsequent sampling. This increase in richness can be attributed to a major storm that occurred in 1981 across the Lake Winnipesaukee region, which opened up the canopy and allowed light-tolerant species to colonize. The storm was a major disturbance that could have led to species composition changes. The species richness in the understory of all three islands showed no definite pattern in the four samplings (Table 10). In the 2011 sampling, the richness of TMI and BI increased since 2001 but the richness of HNI decreased by 5 species since 2001. Similarly, the evenness and diversity in both the understory and overstory of all the islands showed no definite pattern and for most measurements remained relatively constant over the years.

The Sørensen's Index of Similarity tables of each island (Tables 16-18) also suggest that each island is undergoing gradual changes in species compositions. On all three islands, the 2011 sampling was most similar to the 2001 sampling. Furthermore, the 2011 sampling was least similar to the 1978 sampling on all three islands, and each subsequent sampling was more similar to the 2011 sampling than the previous one. A similar pattern on TMI was found where

the 1978 is most similar to the 1991 sampling but less similar to each subsequent sampling. However, this pattern was not found on HNI and BI, where the most similar samplings to 1978 were the 2011 sampling and 2001 sampling respectively. These data, along with the similarity table from Bradley and Crow (Table 4) (2010), also suggest that each island on Lake Winnipesaukee has a different species composition despite their relative proximity from the mainland and each other.

Plants of Concern

Most of the plants of concern in this study were predictably found in the same areas as in previous samplings and surveys. The invasive species were found only in the urban zone while the rare species were mostly found in the protective zone. Similarly, there were no peculiar patterns found in the disturbance surveys of each species. Since the invasive species were only found in the urban zone, they experienced the most disturbance out of all the species of concern. Conversely, since the rare species were only found in the protective zone, they experienced the least disturbance out of all the species of concern.

Despite their presence on TMI, the invasive species did not seem to have a significant presence in the community in which they were found. One reason is the low number of specimens of each species. No invasive species was found in great numbers on any of the islands. The second reason is that each invasive species did not spread into more than one area. For the most part, invasive species were only found in one area, and these areas were usually the same ones mentioned in previous samplings and notes. The third reason is the fact that the invasive species were only found in the most disturbed areas of the island. Any possible effect of an invasive species can also be attributed to the disturbance in the area (Brewer 2008,

MacDougall and Turkington 2005). One example is *Poa compressa*, which has the ability to spread rapidly via rhizomes (IPANE 2003); however on TMI, the species was only found near the burn pile and did not establish in large numbers nor spread to anywhere else on the island. Two rare species, *Rhododendron viscosum* and *R. maximum*, were found on TMI in 2011. Both of these species were found in the Rhododendron swamp, which is one of the least disturbed areas of the island (Table 46).

Some species of concern were not found on any of the islands in 2011. Two potentially invasive species absent in the 2011 sampling were *Cirsium vulgare* and *Phalaris arundinacea*. Both species are supposedly cold-tolerant (Zouhar 2002, USDA 2011). Possible reasons for their recent absence may include a short growing season or competition with native species. Similarly, a couple of rare species, *Cypripedium arietinum* and *Trisetum spicatum* were also not found on the islands in 2011. The former may not have been found due to its ability to stay dormant for a period of time (Primack and Stacy 1998, Shefferson 2006). The latter's absence may be attributed to its slow seed spread (USDA 2011). Lastly, two Kelsey introductions were also not found on the island. These species are *Diervilla sessilifolia* and *Ilex glabra*. The former is native to the southeastern United States (USDA 2011) and may not have been able to survive indefinitely in the conditions of TMI. *I. glabra*, however, is native to the eastern US including New England and thus could have survived the harsh winters (Anderson 2001, USDA 2011). The plant might also be present on the islands but not in the sampling plots.

The Four Zones and the Ecological Land Use Plan

Predictably, in 2011 the least disturbed areas of the islands were found in the protective zone while the most disturbed areas of the islands were found in the urban zone. This indicates that the ecological land use plan set in motion by the camp staff has been used effectively on the islands (Holland, et al. 1983, Holland and Sorrie 1989). The lack of invasive species in the protective and productive zones can also be attributed to the land use plan. Many invasive species are found in disturbed areas; therefore these two zones may be unfit for the establishment of such invasive species. As mentioned in previous reports (Holland, et al. 1983, Holland and Sorrie 1989), the land use plan was successful in protecting natural habitats from destruction and exotic species.

Future Studies

The lack of any apparent threats of the invasive species on TMI may contradict the theories set by ecologists (D'Antonio and Dudley 1995). However, there are no studies on the invasive species on the mainland surrounding Lake Winnipesaukee, so no comparisons can be made between the mainland and islands in terms of invasive establishment and impact. Surveys on the mainland surrounding the three islands can be useful in studying the spread of the invasive species across Lake Winnipesaukee.

Despite the apparent lack of impact, the invasive species may need to be monitored further to ensure that they do not pose a threat to the island ecosystem in the future. A long-term monitoring project on the invasive species can be added to the current 10-year sampling protocol. On the other hand, a long-term survey may be useful in detecting any spread of the invasive species throughout the island. Recorders can survey the areas where the invasive

species were found to detect any spread or increase in individuals. The sampling protocol can also include additional plots where the invasive species were found to survey the understory flora in those plots over decades. Recorders can also scan the islands for the presence of invasive species in any areas other than the ones mentioned in this study.

Lastly, the overstory sampling method may need to shift from the use of ratings to the use of dbhs to measure the dominance. The reasons, as shown in Table 43, are that the values of the importance values of both methods vary among the species of TMI and HNI. Future samplings may include the ratings method for consistency with previous samplings, but they may also include dbhs as well. Overall, a gradual shift to dbhs is recommended for the overstory sampling.

VII. CONCLUSIONS AND SIGNIFICANCE OF STUDY

As mentioned earlier, island communities play an important role in the study of larger ecosystems throughout the world (MacArthur and Wilson 1967). Any patterns in the species compositions of islands can be potentially used to study similar patterns in larger ecosystems. In general, the compositions in the permanent plots of TMI, HNI, and BI demonstrated several changes in vegetation over time. In general, TMI had more species than BI and HNI (Tables 5 and 8) possibly due to its larger size. However, BI had more species than HNI (see Tables 5 and 8) despite its smaller size. Despite the latter difference, island size may still play a role in island species richness (MacArthur and Wilson 1967).

In particular, this study also demonstrated that the invasive species did not behave as initially predicted. First, the islands were not significantly impacted by invasive species despite the presence of species identified as invasive in other locations. Second, the species were only found in the most disturbed areas of the island and thus any possible impact they may have on the native species and ecosystems may be attributed to the disturbances. Third, the invasive species on TMI were found only in one area and did not spread across other habitats.

My hypothesis concerning invasive species was confirmed because the invasive species were only found in the most disturbed areas of the island. Conversely, my hypothesis regarding rare species was also confirmed because they were only found in the least disturbed and most protected areas of the island. However, the Kelsey introductions were mostly found in the protected areas of the island, thus disproving my hypothesis regarding them.

This study demonstrated that the compositions of TMI, HNI and BI are changing in terms of species dominance and abundance over the years. However, there may have been no significant occurrences on the islands that may lead to the introduction of exotic and invasive species. This may be attributed primarily to the ecological land use plan enacted by the Appalachian Mountain Club in 1973. The land use plan has been successful in protecting the natural communities of the three islands into 2011. Possibly, exotic and invasive species became established prior to 1973. In particular, the urban zone in general had far fewer percentages of species shared with the other zones than the other three zones had between one another. This was due to the significant difference in disturbance between the urban and protective zones.

This study emphasized the importance of an ecological land use plan for monitoring the natural habitats of an area. Enacting a long-term land use plan may play a significant role in protecting natural habitats of other ecosystems throughout the world. A land use plan can also be used to monitor and control exotic and invasive species in ecosystems. As mentioned before, plant species play important roles in maintaining ecosystems, and their protection from exotic pests and anthropogenic disturbances is vital to ecosystem health.

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APPENDIX

APPENDIX

List of plant species by family found on TMI, HNI, and BI in any of the 25 plot samplings. Names are up to date from the USDA Plant Database as of 17 January 2012.
Species with a * were only found in the 2011 plot sampling (19 new species recorded).

Acanthaceae

Justicia americana (L.) Vahl

Aceraceae

Acer pensylvanicum L.
Acer rubrum L.
Acer saccharum Marsh.

Anacardiaceae

Rhus typhina L.
Toxicodendron radicans (L.) Kuntze

Apocynaceae

Apocynum androsaemifolium L. *

Aquifoliaceae

Ilex glabra (L.) A. Gray *
Ilex mucronata (L.) Powell, Savolainen & Andrews
Ilex verticillata (L.) A. Gray

Araliaceae

Aralia nudicaulis L.

Asteraceae

Achillea millefolium L.
Antennaria howellii Greene *ssp. canadensis* (Greene) Bayer *
Erigeron strigosus Muhl. ex Willd. *
Eurybia divaricata (L.) G.L. Nesom
Eurybia macrophylla (L.) Cass.
Euthamia graminifolia (L.) Nutt.
Hieracium caespitosum Dumort. *
Hieracium pilosella L.
Oclemena acuminata (Michx.) Greene
Prenanthes trifoliolata (Cass.) Fernald
Rudbeckia hirta L. *var. pulcherrima* Farw.
Solidago altissima L. *
Solidago arguta Aiton
Solidago bicolor L.
Solidago caesia L. *
Solidago juncea Aiton
Solidago nemoralis Aiton *
Symphyotrichum lanceolatum (Willd.) G.L. Nesom
Symphyotrichum novi-belgii (L.) G.L. Nesom
Symphyotrichum puniceum (L.) Á. Löve & D. Löve *var. puniceum* *
Symphyotrichum undulatum (L.) G.L. Nesom *
Taraxacum officinale F.H. Wigg.

Betulaceae

Alnus incana (L.) Moench *ssp. rugosa* (Du Roi) R.T. Clausen
Betula alleghaniensis Britton *var. alleghaniensis*
Betula lenta L.
Betula papyrifera Marsh. *var. papyrifera*
Betula populifolia Marsh.
Ostrya virginiana (Mill.) K. Koch

Caprifoliaceae

Diervilla lonicera Mill.
Lonicera canadensis Bartram ex Marsh. *
Sambucus nigra L. *ssp. canadensis* (L.) R. Bolli
Viburnum acerifolium L.
Viburnum lentago L. *
Viburnum nudum L. *var. cassinoides* (L.) Torr. & A. Gray
Viburnum recognitum Fernald

Clusiaceae

Hypericum perforatum L.

Commelinaceae

Commelina communis L.

Cornaceae

Cornus rugosa Lam.
Nyssa sylvatica Marsh.

Cupressaceae

Juniperus communis L. *var. depressa* Pursh

Cyperaceae

Carex argyrantha Tuck.
Carex communis L.H. Bailey *var. communis*

Dennstaedtiaceae

Dennstaedtia punctilobula (Michx.) T. Moore
Pteridium aquilinum (L.) Kuhn

Dryopteridaceae

Dryopteris clintoniana (D.C. Eaton) Dowell *
Dryopteris intermedia (Muhl. Ex Willd.) A. Gray
Dryopteris marginalis (L.) A. Gray
Polystichum acrostichoides (Michx.) Schott *var. acrostichoides*

Ericaceae

Arctostaphylos uva-ursi (L.) Spreng.
Gaultheria procumbens L.
Gaylussacia baccata (Wangenh.) K. Koch
Kalmia angustifolia L.
Lyonia ligustrina (L.) DC.
Rhododendron canadense (L.) Torr
Rhododendron maximum L.
Vaccinium angustifolium Aiton
Vaccinium corymbosum L.
Vaccinium fuscatum Aiton *

Fabaceae

Robinia hispida L.-
Trifolium aureum Pollich *

Fagaceae

Fagus grandifolia Ehrh.
Quercus alba L.
Quercus rubra L.

Hamamelidaceae

Hamamelis virginiana L.

Juncaceae

Luzula multiflora (Ehrh.) Lej.

Lamiaceae

Mentha arvensis L.

Liliaceae

Lilium philadelphicum L.
Maianthemum canadense Desf.
Maianthemum racemosum (L.) Link *ssp. racemosum*
Medeola virginiana L.
Polygonatum biflorum (Walter) Elliott *var. biflorum*
Polygonatum pubescens (Willd.) Pursh
Streptopus amplexifolius (L.) DC.

Lycopodiaceae

Lycopodium complanatum L.
Lycopodium obscurum L.

Monotropaceae

Monotropa uniflora L.

Myricaceae

Comptonia peregrina (L.) J.M. Coult.
Myrica gale L.

Oleaceae

Fraxinus americana L.
Fraxinus nigra Marsh. *

Orchidaceae

Cypripedium acaule Aiton
Goodyera pubescens (Willd.) R. Br.

Orobanchaceae

Epifagus virginiana (L.) W. Bartram

Osmundaceae

Osmunda cinnamomea L.
Osmunda regalis L. *

Oxalidaceae

Oxalis stricta L. *

Pinaceae

Picea rubens Sarg.
Pinus resinosa Aiton
Pinus strobus L.
Tsuga canadensis (L.) Carrière

Plantaginaceae

Plantago major L.

Poaceae

Dactylis glomerata L.
Dichanthelium boreale (Nash) Freckmann
Poa pratensis L. *var. pratensis*
Schedonorus pratensis (Huds.) P. Beauv.

Polypodiaceae

Polypodium virginianum L.

Primulaceae

Lysimachia quadrifolia L.
Trientalis borealis Raf.

Pyrolaceae

Chimaphila maculata (L.) Pursh

Ranunculaceae

Coptis trifolia (L.) Salisb

Rosaceae

Amelanchier laevis Wiegand
Fragaria vesca ssp. americana (Porter) Staudt
Photinia melanocarpa (Michx.) K.R. Robertson & Phipps
Prunus pensylvanica L. f.
Prunus serotina Ehrh.
Rosa palustris Marsh.
Rubus allegheniensis Porter
Rubus hispidus L.
Spiraea alba Du Roi *var. latifolia* (Aiton) Dippel

Rubiaceae

Cephalanthus occidentalis L.
Galium tinctorium (L.) Scop.
Mitchella repens L.

Salicaceae

Populus grandidentata Michx.
Populus tremuloides Michx.

Scrophulariaceae

Lindernia dubia (L.) Pennell
Melampyrum lineare Desr.

Styracaceae

Halesia carolina L.

Tiliaceae

Tilia americana L.

Violaceae

Viola blanda Willd. *var. palustriformis* A. Gray *
Viola renifolia A. Gray

Vitaceae

Parthenocissus quinquefolia (L.) Planch.

Table 23. Understory mean percent cover of species by plot on TMI, HNI, and BI in 2011.

	Three Mile Island												
Species/Plot	35	50	51	53	94	96	97	108	139	142	144	160	170
Acer pensylvanicum	1.2	0.2	1.6	0	0.15	1.05	0.2	0.15	8.9	0.75	2.85	2.7	0.8
Acer rubrum	2.45	0.5	0.35	0.25	0.6	0.45	0.75	0.3	0.1	0.15	0.8	0.15	0.95
Acer saccharum	0	0	0	0	0	0	0	0	0	0	0	0	0
Achillea millefolium	0	0	0	0	0	0	0	0	0	0	0	0	0
Alnus incana ssp. rugosa	0	0	0	0	0	0	0	0	0	0	0	0	0
Amelanchier laevis	2	0	0.45	0	0	0	0	0	0	0	0	0	0
Antennaria howellii ssp. canadensis	0	0	0	0	0	0	0	0	0	0	0	0	0
Apocynum androsaemifolium	0	0	0	0	0	0	0	0	0	0	0	0	0
Aralia nudicaulis	2.9	2.3	9	11.45	7.1	13.5	2.35	2.2	12	2.55	5.25	3.8	7.6
Arctostaphylos uva-ursi	0	0	0	0	0	0	0	0	0	0	0	0	0
Betula alleghaniensis var. alleghaniensis	0.1	0	3.5	0	0	0	0	0	0	0	0	0	0.15
Betula lenta	0	0	0	0	0	0	0	0	0	0	0	0	0
Betula papyrifera	0	0	0	0	0.1	0.15	0	0	0.05	0.2	0.15	0	0
Betula populifolia	0	0	0	0	0	0	0	4.5	0	0	0	0	0
Carex argyrantha	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex communis	0	0	0	0	0	0	0	0	0	0	0	0	0
Cephalanthus occidentalis	0	0	0	0	0	0	0	0	0	0	0	0	0
Chimaphila maculata	0	0	0	0	0	0	0	0	0	0	0	0	0
Commelina communis	0	0	0	0	0	0	0	0	0	0	0	0	0
Comptonia peregrina	0	0	0	0	0	0	0	0	0	0	0	0	0
Coptis trifolia	0	0	0	0	0.45	0	0	0	0	0	0	0	0
Cornus rugosa	0	0	0	0	0	0	0	0	0	0	0	0	0
Cypripedium acaule	0	0	0.6	0	0.2	0	0	0.25	0	0	0	0	0
Dactylis glomerata	0	0	0	0	0	0	0	0	0	0	0	0	0
Dennstaedtia punctilobula	0	0	0	0	0	0	0	0	0	0	0	0	0
Dichanthelium boreale	0	0	0	0	0	0	0	0	0	0	0	0	0
Diervilla lonicera	0	0	0	0	0	0	0	0	0	0	0	0	0
Dryopteris clintoniana	0	0	0	0	0	0.7	0	0	0	0	0	0	0
Dryopteris intermedia	0	0	0	0	0	0	0	0	0	0	0	0	0
Dryopteris marginalis	0	0	0	0	0	0	0	0	0	0	0	0	0
Epifagus virginiana	0	0	0	0	0	0	0	0	0	0	0	0	0
Erigeron strigosus	0	0	0	0	0	0	0	0	0	0	0	0	0
Eurybia divaricata	0	0	0	0	0	0	0	0	0	0	0	0	0
Eurybia macrophylla	0	0	0	1.1	0	0	0	0	0	0	0	0	0
Euthamia graminifolia	0	0	0	0	0	0	0	0	0	0	0	0	0
Fagus grandifolia	0.15	0	0.05	0	1	3.5	0	1.55	0	2	2.55	13.4	5.85
Fragaria vesca ssp. americana	0	0	0	0	0	0	0	0	0	0	0	0	0
Galium tinctorium	0	0	0	0	0	0	0	0	0	0	0	0	0
Gaultheria procumbens	4.95	0.3	0.2	0	0.2	0	0	1.6	0	0.05	0	0	0
Gaylussacia baccata	9.7	0	0.4	25.5	0.9	0	0	15.5	0	0.05	0	0	0
Goodyera pubescens	0	0	0	0	0	0.1	0	0	0	0	0	0	0
Hamamelis virginiana	6.15	0.15	0.4	14.6	0.5	0	0.05	2.5	0	0	0.05	0	0.4
Hieracium caespitosum	0	0	0	0	0	0	0	0	0	0	0	0	0
Hieracium pilosella	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypericum perforatum	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 23. Understory mean percent cover of species by plot on TMI, HNI, and BI in 2011.

	Three Mile Island												
Species/Plot	35	50	51	53	94	96	97	108	139	142	144	160	170
Ilex glabra	0	0	0	0	0	0	0	0	0	0	0	0	0
Ilex mucronata	0	0	0	0	0	0	0	0	0	0	0	0	0
Ilex verticillata	0	0	0	0	0	0	0	0.6	0	0	0	0	0
Juniperus communis var. depressa	0	0	0	0	0	0	0	0	0	0	0	0	0
Justicia americana	0	0	0	0	0	0	0	0.05	0	0	0	0	0
Kalmia angustifolia	0	0	0	0	0	0	0	0.3	0	0	0	0	0
Lilium philadelphicum	0	0	0	0	0	0	0	0	0	0	0	0	0
Lindernia dubia	0	0	0	0	0	0	0	0	0	0	0	0	0
Lonicera canadensis	0	0	0	0.8	2	0	0	0	0	0	0	0	1.4
Luzula multiflora	0	0	0	0	0	0	0	0	0	0	0	0	0
Lycopodium complanatum	0	0	0	0	0	0	0	0	0	0	0	0	0
Lycopodium obscurum	0	0	0	0	0	0	0	0	0	0	0.05	0	0
Lyonia ligustrina	0	0	0	0	0	0	0	0	0	0	0	0	0
Lysimachia quadrifolia	0	0	0	0	0	0	0	0.15	0	0	0	0	0
Maianthemum canadense	9.5	0.05	12.45	4.75	0.05	0.4	0.4	5.75	0.25	2.2	1.8	0.1	0
Maianthemum racemosum ssp. racemosum	0	0	0	0	0	0	0	0	0	0	0	0	0
Medeola virginiana	0	0.15	0.6	0.4	0.2	0	0.2	0.35	0	0	0.05	0	0.2
Melampyrum lineare	0.05	0	0	0	0	0	0.05	0	0	0	0	0	0
Mentha arvensis	0	0	0	0	0	0	0	0	0	0	0	0	0
Mitchella repens	0	0	0.2	2.75	0.05	0	0.95	0.55	0.2	0	0	0.05	0
Monotropa uniflora	0	0	0	0	0	0	0	0	0	0	0	0	0
Myrica gale	0	0	0	0	0	0	0	0	0	0	0	0	0
Nyssa sylvatica	0	0	0	0	0	0	0	0	0	0	0	0	0.8
Oclemena acuminata	0	0	0	0	0	0	0	0	0	0	0	0	0
Osmunda cinnamomea	0	0	0	0	0	0	0	0	0	0	0	0	5
Osmunda regalis	0	0.1	0	0	0	0	0	0	0	0	0	0	0
Ostrya virginiana	0.45	0	0	1.5	0	0	0	0	0	0	0	0	0
Oxalis stricta	0	0	0	0	0	0	0	0	0	0	0	0	0
Parthenocissus quinquefolia	0	0	0	0	0	0	0	0	0	0	0	0	0
Photinia melanocarpa	0	0	0	1	0.8	0	0	0	0	0	0	0	0
Pinus resinosa	0	0	0	0	0	0	0	0	0	0	0	0	0
Pinus strobus	0.45	0.1	0.7	4.75	0.1	0.3	0.2	0.2	0.15	0.1	0.1	0	0.3
Plantago major	0	0	0	0	0	0	0	0	0	0	0	0	0
Poa pratensis	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygonatum biflorum	0	0	0.7	0	0	0	0	0	0	0	0	0	0
Polygonatum pubescens	0	0	0	0	0	0	0	0	0	0	0	0	0
Polypodium virginianum	0	0	0	0	0	0	0	0	0	0	0	0	0
Polystichum acrostichoides	0	0	0	0	0	0	0	0	0	0	0	0	0
Populus grandidentata	0	0	0	0	0	0	0	0	0	0	0	0	0
Prenanthes trifoliolata	0	0	0	0.35	0	0	0	0	0	0	0.05	0	0
Prunus pensylvanica	0	0	0	0	0	0	0	0	0	0	0	0	0
Prunus serotina	0	0	0	0	0	0	0	0.05	0	0	0	0	0
Pteridium aquilinum	0.1	0.5	3.2	9.9	0	0.3	4.1	3.7	0	0	0	0	8.3
Quercus alba	0	0	0	0	0	0	0	0	0	0	0	0	0
Quercus rubra	0.05	0	0.05	0.9	0	0.1	0.1	1.2	0.1	0.05	0.25	0.05	0.1

Table 23. Understory mean percent cover of species by plot on TMI, HNI, and BI in 2011.

	Three Mile Island												
Species/Plot	35	50	51	53	94	96	97	108	139	142	144	160	170
Rhododendron canadense	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhododendron maximum	0	0	0	0	0	0	0	0	0	0	0	0	0
Robinia hispida	0	0	0	0	0	0	0	0	0	0	0	0	0
Rosa palustris	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubus allegheniensis	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubus hispidus	0	0	0	0	0	0	0	0	0	0	0	0	0
Rudbeckia hirta var. pulcherrima	0	0	0	0	0	0	0	0	0	0	0	0	0
Sambucus nigra ssp. canadensis	0	0	0	0	0	0	0	0	0	0	0	0	0
Schedonorus pratensis	0	0	0	0	0	0.15	0	0	0	0	0	0.05	0
Solidago altissima	0	0	0	0	0	0	0	0	0	0	0	0	0
Solidago arguta	0	0	0	0	0	0	0	0	0	0	0	0	0
Solidago bicolor	0	0	0	0	0	0	0	0	0	0	0	0	0
Solidago caesia	0	0	0	0	0	0	0	0	0	0	0	0	0
Solidago juncea	0	0	0	0	0	0	0	0	0	0	0	0	0
Solidago nemoralis	0	0	0	0	0	0	0	0	0	0	0	0	0
Spiraea alba var. latifolia	0	0	0	0	0	0	0	0	0	0	0	0	0
Streptopus amplexifolius	0	0	0.1	0	0	0	0	0	0.5	0	0	0	0
Symphyotrichum lanceolatum	0	0	0	0	0	0	0	0	0	0	0	0	0
Symphyotrichum novi-belgii	0	0	0	0	0	0	0	0	0	0	0	0	0
Symphyotrichum puniceum var. puniceum	0	0	0	0	0	0	0	0	0	0	0	0	0
Symphyotrichum undulatum	0	0	0	0	0	0	0	0	0	0	0	0	0
Taraxacum officinale	0	0	0	0	0	0	0	0	0	0	0	0	0
Tilia americana	0	0	0	0	0	0	0	0	0	0	0	0	0
Toxicodendron radicans	0	0	0	0	0	0	0	0	0	0	0	0	0
Trientalis borealis	1.05	0.6	1.8	2.3	0.35	0.4	0.2	0.7	0.9	0.1	1.2	0.15	0.65
Trifolium aureum	0	0	0	0	0	0	0	0	0	0	0	0	0
Tsuga canadensis	3.5	2.7	0	0	0.7	0.65	8.5	1.4	0.3	33.55	0	0.05	0
Vaccinium angustifolium	14.3	0	3.8	6.5	0	0	1.3	1.85	0	0	0.25	0	0
Vaccinium corymbosum	0	0	0	1.4	0	0	0	0	0	0	0	0	0
Vaccinium fuscatum	0	0	0	0	0	0	0	0	0	0	0	0	0
Viburnum acerifolium	0.6	0	0.3	0.9	0.1	0.5	0.05	0	4.7	0	0	1.45	0
Viburnum nudum var. cassinoides	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola blanda var. palustriformis	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola renifolia	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 23. Understory mean percent cover of species by plot on TMI, HNI, and BI in 2011.

	Three Mile Island						Hawk's Nest			Blueberry		
Species/Plot	186	219	232	245	246	248	224	254	284	282	283	288
Acer pensylvanicum	0.45	0.2	1.85	7.1	2.35	3.1	0.25	0	0	0	0	0
Acer rubrum	0.05	0.1	3.5	5.1	2.25	0.1	0.2	0.25	0.1	0.25	0.35	0.25
Acer saccharum	0	0	1.55	0	0	1.3	0	0	0	0	0	0
Achillea millefolium	0	0	0.1	0	0	0	0	0	0	0	0	0
Alnus incana ssp. rugosa	0	0	0	0	0	0	0	0	0	0.5	0	0.05
Amelanchier laevis	0	0	0	0	0	0	0.05	1.5	0	0	0	0
Antennaria howellii ssp. canadensis	0	0	0	0	0	0.1	0	0	0	0	0	0
Apocynum androsaemifolium	0	0	0	0	0	0	0	0	0	0	0.1	0
Aralia nudicaulis	0.9	3.7	3.5	8.1	3.3	2.2	0	0.8	0	0	0	0
Arctostaphylos uva-ursi	0	0	0	0	0	0	0	0	0	0	0	0
Betula alleghaniensis var. alleghaniensis	0	0	0	0	0	0	0	0	0	0	0	0
Betula lenta	0	0	0	0	0	0	0	0	0	0	0	0
Betula papyrifera	0	0	0	0	0	0.05	0.35	0.15	1.5	0	0	0
Betula populifolia	0	0	0	0	0	0	0	0	0	0	0	0
Carex argyrantha	0	0	0	0	0	0	0	0	0	0	0	0
Carex communis	0	0	0	0	0	0	0	0	0	0	0	0
Cephalanthus occidentalis	0	0	0	0	0	0	0	0	0	0	0	0
Chimaphila maculata	0	0	0	0	0	0	0	0	0	0	0	0
Commelina communis	0	0	0	0	0	0	0	0	0	0	0	0
Comptonia peregrina	0	0	0	0	2.7	0	0	0	0	0	0	0
Coptis trifolia	0	0	0	0	0	0	0	0	0	0	0	0
Cornus rugosa	0	0	0	0	1	0	0	0	0	0	0	0
Cypripedium acaule	0	0	0	0	0	0	0	0	0	0	0	0
Dactylis glomerata	0	0	0	0	0.1	0.1	0	0	0	0	0	0
Dennstaedtia punctilobula	0	0	0	0	0	0	0	0	0	0	0	0
Dichanthelium boreale	0	0	0	0	0	0	0	0	0	0	0	0
Diervilla lonicera	0	0	0	0	0	0	0	0	0	0	0	0
Dryopteris clintoniana	0	0	0	0	0	0	0	0	0	0	0	0
Dryopteris intermedia	0	0	0	0	0	0	0	0	0	0	0	0
Dryopteris marginalis	0	0	0	0	0	0	0	0	0	0	0	0
Epifagus virginiana	0	0	0	0	0	0	0	0	0	0	0	0
Erigeron strigosus	0	0	2.1	0	0	0	0	0	0	0	0	0
Eurybia divaricata	0	0	0	0	0	0.1	0	0	0	0	0	0
Eurybia macrophylla	0	0	0	0	0.15	0.4	0	0	0	0	0	0
Euthamia graminifolia	0	0	0	0	0	0.05	0	0	0	0	0	0
Fagus grandifolia	7.5	2.1	0	9.65	6.3	0	0	0	0	0	0	0
Fragaria vesca ssp. americana	0	0	1.65	0	0	0	0	0	0	0	0	0
Galium tinctorium	0	0	0	0	0	0	0	0	0	0	0	0
Gaultheria procumbens	0	0	0	0	0	0	5	3.2	40.6	10.9	0	0
Gaylussacia baccata	0	0	0	2.3	4.5	0	31.2	0	0	0	8.55	19.3
Goodyera pubescens	0	0	0	0	0	0	0.1	0	0	0	0	0
Hamamelis virginiana	0	0	4.3	0	13.4	0	0	0	0	0	0	0
Hieracium caespitosum	0	0	0.3	0.05	0.15	0	0	0	0	0	0	0
Hieracium pilosella	0	0	0	0	0	0	0	0	0	0	0	0
Hypericum perforatum	0	0	0	0	0	0	0	0	0	0	0	0

Table 23. Understory mean percent cover of species by plot on TMI, HNI, and BI in 2011.

	Three Mile Island						Hawk's Nest			Blueberry		
Species/Plot	186	219	232	245	246	248	224	254	284	282	283	288
Ilex glabra	0	0	0	0	0	0	0	0	0	0.1	0	0
Ilex mucronata	0	0	0	0	0	0	0	0	0	0	0	0
Ilex verticillata	0	0	0.05	0	0	0	0	0	0	0	0	0
Juniperus communis var. depressa	0	0	0	0	0	0	0	0	0	0	0	0
Justicia americana	0	0	0	0	0	0	0	0	5.7	0	0	0
Kalmia angustifolia	0	0	0	0	0	0	0	0	0	0	0	5.8
Lilium philadelphicum	0	0	0	0	0	0	0	0	0	0	0	0
Lindernia dubia	0	0	0	0	0	0	0	0	0	0.05	0	0
Lonicera canadensis	0	0	0	0	0	0	0	0	0	0	0	0
Luzula multiflora	0	0	0	0	0	0	0	0	0	0	0	0
Lycopodium complanatum	0	0	0	0	0	0	0	0	0	0	0	0
Lycopodium obscurum	0	0	0	0	0	0	0	0	0	0	0	0
Lyonia ligustrina	0	0	0	0	0	0	0	0	0	0	0	0.45
Lysimachia quadrifolia	0	0	0	0	0	0	0	1.55	0.05	0.05	0	0
Maianthemum canadense	0.05	0	5.5	6.15	3.75	1.45	0.1	0	0	0	0.05	0
Maianthemum racemosum ssp. racemos	0	0	2.6	0	0.2	0.1	0	0	0	0	0	0
Medeola virginiana	0	0	0	0	0	0	0	0	0.15	0	0	0
Melampyrum lineare	0	0	0	0	0.2	0.05	0	0	0	0	0.05	2
Mentha arvensis	0	0	0	0	0	0.05	0	0	0	0	0	0
Mitchella repens	0.05	0	0	0	0.05	0	0	1.2	0	0	0	0
Monotropa uniflora	0	0	0	0	0	0	0	0	0	0	0	0
Myrica gale	0	0	0	0	0	0	0	0	0	0	0	0
Nyssa sylvatica	0	0	0	0	0	0	0	0	0	0	0	0.3
Oclemena acuminata	0	0	0	0	0	0	0	0	0	0	0	0
Osmunda cinnamomea	0	0	0	0	0	0	0	0	0	0	0	0
Osmunda regalis	0	0	0	0	0	0	0	0	0	0	0	0
Ostrya virginiana	0	0	10.1	0	7.1	0	0	0	0	0	0	0
Oxalis stricta	0	0	0	0	0	0.05	0	0	0	0	0	0
Parthenocissus quinquefolia	0	0	1.05	0	0	0	0	0	0	0	0	0
Photinia melanocarpa	0	0	0	0	0	0	0	0.15	0.05	0	0	0
Pinus resinosa	0	0	0	0	0	0	0	0	0	0	0	0
Pinus strobus	0	0.1	1.75	0.05	0.5	0.1	0.2	0	0	0	0.05	0
Plantago major	0	0	0	0	0	0	0	0	0	1	0	0
Poa pratensis	0	0	0	0	0	0	0	0	0	0	0	0
Polygonatum biflorum	0	0	0	0	0	0	0	0	0	0	0	0
Polygonatum pubescens	0	0	0.95	0	0	0	0	0	0	0	0	0
Polypodium virginianum	0	0	0	0	0	0	0	0	0	0	0	0
Polystichum acrostichoides	0	0	0	0	0	0	0	0	0	0	0	0
Populus grandidentata	0	0	0	0	0.2	0	0	0	0	0	0	0
Prenanthes trifoliolata	0	0	0.65	0	0.1	0.05	0	0	0	0	0	0
Prunus pensylvanica	0	0	0	0	0	0	0	0	0	0	0	0
Prunus serotina	0	0	0	0	0	0	0	0	0	0	0	0
Pteridium aquilinum	0.3	0	3.2	1.7	3.4	0	2.5	0	0	0	0	0
Quercus alba	0	0	0	0	0	0	0	0.05	0.1	0	0	0
Quercus rubra	0.15	0.05	0	0	0	0	0	0	0	0	0	0

Table 23. Understory mean percent cover of species by plot on TMI, HNI, and BI in 2011.

	Three Mile Island						Hawk's Nest			Blueberry		
Species/Plot	186	219	232	245	246	248	224	254	284	282	283	288
Rhododendron canadense	0	0	0	0	0	0	0	0	0	0	0	0
Rhododendron maximum	0	0	0	0	0	0	0	0	0	0	0	0
Robinia hispida	0	0	0.6	0	0	0	0	0	0	0	0	0
Rosa palustris	0	0	0	0	0	0	0	0	0	0	0	1
Rubus allegheniensis	0	0	0	0	0	0	0	0	0	0	0	0
Rubus hispidus	0	0	3.2	0	0	0	0	0	0	0	0	0
Rudbeckia hirta var. pulcherrima	0	0	0	0	0	0	0	0	0	0	0	0
Sambucus nigra ssp. canadensis	0	0	0	0	0	0	0	0	0	0	0	0
Schedonorus pratensis	0	0	0	0.05	0.1	0	0	0	0	0	0	0
Solidago altissima	0	0	0.1	0	0	0	0	0	0	0	0	0
Solidago arguta	0	0	0	0	0	0	0	0	0	0	0	0
Solidago bicolor	0	0	0	0	0	0	0	0	0	0	0	0
Solidago caesia	0	0	0	0	0	0.1	0	0	0	0.15	0	0
Solidago juncea	0	0	0	0	0	0.05	0	0	0	0	0	0
Solidago nemoralis	0	0	1.1	0	0	0.1	0	0	0	6.1	0	0
Spiraea alba var. latifolia	0	0	0	0	0	0	0	0	0	0	0	0
Streptopus amplexifolius	0	0	0.45	0	0.35	0.5	0	0	0	0.2	0	0
Symphyotrichum lanceolatum	0	0	0	0	0	0	0	0	0	0	0	0
Symphyotrichum novi-belgii	0	0	0	0	0	0	0	0	0	0	0	0
Symphyotrichum puniceum var. puniceur	0	0	0	0	0.2	0	0	0	0	0	0	0
Symphyotrichum undulatum	0	0	0	0	0	0.05	0	0	0	0	0	0
Taraxacum officinale	0	0	0	0	0	0	0	0	0	2	0	0
Tilia americana	0	0	0	0	0	2.55	0	0	0	0	0	0
Toxicodendron radicans	0	0	0.9	0	0	0	0	0.3	0	0	0	0
Trientalis borealis	0.1	0	0	0.7	0.1	0	0.3	0	0	0	0	0.05
Trifolium aureum	0	0	0	0	0	0.05	0	0.4	0	0	0	0
Tsuga canadensis	0.1	0.05	0	0	0.1	0	0.3	0	14.8	1.5	0.35	0.05
Vaccinium angustifolium	0	0	0	0.3	0	0	3.8	0	0	5	0.3	1
Vaccinium corymbosum	0	0	0	0	0	0	0	0	0	0	0.05	0
Vaccinium fuscatum	0	0	0	0	0	0	2.5	0	0	15.3	0	0
Viburnum acerifolium	0.2	0	0.05	4	7.2	1.8	0	0	0	0	0	0
Viburnum nudum var. cassinoides	0	0	0	0	0	0	0	0	0	0	0	0
Viola blanda var. palustriformis	0	0	0	0	0	0.15	0	0	0	0	0	0
Viola renifolia	0	0	0	0	0	0	0	0	0	0	0	0

Table 24. Total understory mean percent covers by island in 2011.

Species/Island	TMI	Hawk	Blue	TOTAL
Acer pensylvanicum	35.60	0.25	0.00	35.85
Acer rubrum	18.90	0.55	0.85	20.30
Acer saccharum	2.85	0.00	0.00	2.85
Achillea millefolium	0.10	0.00	0.00	0.10
Alnus incana ssp. rugosa	0.00	0.00	0.55	0.55
Amelanchier laevis	2.45	1.55	0.00	4.00
Antennaria howellii ssp. canadensis	0.10	0.00	0.00	0.10
Apocynum androsaemifolium	0.00	0.00	0.10	0.10
Aralia nudicaulis	103.70	0.80	0.00	104.50
Arctostaphylos uva-ursi	0.00	0.00	0.00	0.00
Betula alleghaniensis var. alleghaniensis	3.75	0.00	0.00	3.75
Betula lenta	0.00	0.00	0.00	0.00
Betula papyrifera	0.70	2.00	0.00	2.70
Betula populifolia	4.50	0.00	0.00	4.50
Carex argyrantha	0.00	0.00	0.00	0.00
Carex communis	0.00	0.00	0.00	0.00
Cephalanthus occidentalis	0.00	0.00	0.00	0.00
Chimaphila maculata	0.00	0.00	0.00	0.00
Commelina communis	0.00	0.00	0.00	0.00
Comptonia peregrina	2.70	0.00	0.00	2.70
Coptis trifolia	0.45	0.00	0.00	0.45
Cornus rugosa	1.00	0.00	0.00	1.00
Cypripedium acaule	1.05	0.00	0.00	1.05
Dactylis glomerata	0.20	0.00	0.00	0.20
Dennstaedtia punctilobula	0.00	0.00	0.00	0.00
Dichanthelium boreale	0.00	0.00	0.00	0.00
Diervilla lonicera	0.00	0.00	0.00	0.00
Dryopteris clintoniana	0.70	0.00	0.00	0.70
Dryopteris intermedia	0.00	0.00	0.00	0.00
Dryopteris marginalis	0.00	0.00	0.00	0.00
Epifagus virginiana	0.00	0.00	0.00	0.00
Erigeron strigosus	2.10	0.00	0.00	2.10
Eurybia divaricata	0.10	0.00	0.00	0.10
Eurybia macrophylla	1.65	0.00	0.00	1.65
Euthamia graminifolia	0.05	0.00	0.00	0.05
Fagus grandifolia	55.60	0.00	0.00	55.60
Fragaria vesca ssp. americana	1.65	0.00	0.00	1.65
Galium tinctorium	0.00	0.00	0.00	0.00
Gaultheria procumbens	7.30	48.80	10.90	67.00
Gaylussacia baccata	58.85	31.20	27.85	117.90
Goodyera pubescens	0.10	0.10	0.00	0.20
Hamamelis virginiana	42.50	0.00	0.00	42.50
Hieracium caespitosum	0.50	0.00	0.00	0.50
Hieracium pilosella	0.00	0.00	0.00	0.00
Hypericum perforatum	0.00	0.00	0.00	0.00

Table 24. Total understory mean percent covers by island in 2011.

Species/Island	TMI	Hawk	Blue	TOTAL
Ilex glabra	0.00	0.00	0.10	0.10
Ilex mucronata	0.00	0.00	0.00	0.00
Ilex verticillata	0.65	0.00	0.00	0.65
Juniperus communis var. depressa	0.00	0.00	0.00	0.00
Justicia americana	0.05	5.70	0.00	5.75
Kalmia angustifolia	0.30	0.00	5.80	6.10
Lilium philadelphicum	0.00	0.00	0.00	0.00
Lindernia dubia	0.00	0.00	0.05	0.05
Lonicera canadensis	4.20	0.00	0.00	4.20
Luzula multiflora	0.00	0.00	0.00	0.00
Lycopodium complanatum	0.00	0.00	0.00	0.00
Lycopodium obscurum	0.05	0.00	0.00	0.05
Lyonia ligustrina	0.00	0.00	0.45	0.45
Lysimachia quadrifolia	0.15	1.60	0.05	1.80
Maianthemum canadense	54.60	0.10	0.05	54.75
Maianthemum racemosum ssp. racemos	2.90	0.00	0.00	2.90
Medeola virginiana	2.15	0.15	0.00	2.30
Melampyrum lineare	0.35	0.00	2.05	2.40
Mentha arvensis	0.05	0.00	0.00	0.05
Mitchella repens	4.85	1.20	0.00	6.05
Monotropa uniflora	0.00	0.00	0.00	0.00
Myrica gale	0.00	0.00	0.00	0.00
Nyssa sylvatica	0.80	0.00	0.30	1.10
Oclemena acuminata	0.00	0.00	0.00	0.00
Osmunda cinnamomea	5.00	0.00	0.00	5.00
Osmunda regalis	0.10	0.00	0.00	0.10
Ostrya virginiana	19.15	0.00	0.00	19.15
Oxalis stricta	0.05	0.00	0.00	0.05
Parthenocissus quinquefolia	1.05	0.00	0.00	1.05
Photinia melanocarpa	1.80	0.20	0.00	2.00
Pinus resinosa	0.00	0.00	0.00	0.00
Pinus strobus	9.95	0.20	0.05	10.20
Plantago major	0.00	0.00	1.00	1.00
Poa pratensis	0.00	0.00	0.00	0.00
Polygonatum biflorum	0.70	0.00	0.00	0.70
Polygonatum pubescens	0.95	0.00	0.00	0.95
Polypodium virginianum	0.00	0.00	0.00	0.00
Polystichum acrostichoides	0.00	0.00	0.00	0.00
Populus grandidentata	0.20	0.00	0.00	0.20
Prenanthes trifoliolata	1.20	0.00	0.00	1.20
Prunus pensylvanica	0.00	0.00	0.00	0.00
Prunus serotina	0.05	0.00	0.00	0.05
Pteridium aquilinum	38.70	2.50	0.00	41.20
Quercus alba	0.00	0.15	0.00	0.15
Quercus rubra	3.15	0.00	0.00	3.15

Table 24. Total understory mean percent covers by island in 2011.

Species/Island	TMI	Hawk	Blue	TOTAL
Rhododendron canadense	0.00	0.00	0.00	0.00
Rhododendron maximum	0.00	0.00	0.00	0.00
Robinia hispida	0.60	0.00	0.00	0.60
Rosa palustris	0.00	0.00	1.00	1.00
Rubus allegheniensis	0.00	0.00	0.00	0.00
Rubus hispidus	3.20	0.00	0.00	3.20
Rudbeckia hirta var. pulcherrima	0.00	0.00	0.00	0.00
Sambucus nigra ssp. canadensis	0.00	0.00	0.00	0.00
Schedonorus pratensis	0.35	0.00	0.00	0.35
Solidago altissima	0.10	0.00	0.00	0.10
Solidago arguta	0.00	0.00	0.00	0.00
Solidago bicolor	0.00	0.00	0.00	0.00
Solidago caesia	0.10	0.00	0.15	0.25
Solidago juncea	0.05	0.00	0.00	0.05
Solidago nemoralis	1.20	0.00	6.10	7.30
Spiraea alba var. latifolia	0.00	0.00	0.00	0.00
Streptopus amplexifolius	1.90	0.00	0.20	2.10
Symphyotrichum lanceolatum	0.00	0.00	0.00	0.00
Symphyotrichum novi-belgii	0.00	0.00	0.00	0.00
Symphyotrichum puniceum var. puniceu	0.20	0.00	0.00	0.20
Symphyotrichum undulatum	0.05	0.00	0.00	0.05
Taraxacum officinale	0.00	0.00	2.00	2.00
Tilia americana	2.55	0.00	0.00	2.55
Toxicodendron radicans	0.90	0.30	0.00	1.20
Trientalis borealis	11.30	0.30	0.05	11.65
Trifolium aureum	0.05	0.40	0.00	0.45
Tsuga canadensis	51.60	15.10	1.90	68.60
Vaccinium angustifolium	28.30	3.80	6.30	38.40
Vaccinium corymbosum	1.40	0.00	0.05	1.45
Vaccinium fuscatum	0.00	2.50	15.30	17.80
Viburnum acerifolium	21.85	0.00	0.00	21.85
Viburnum nudum var. cassinoides	0.00	0.00	0.00	0.00
Viola blanda var. palustriformis	0.15	0.00	0.00	0.15
Viola renifolia	0.00	0.00	0.00	0.00

Table 25: Understory Importance Values for Three Mile Island in 2011. Importance values (IV) are calculated as the sum of relative percent cover and relative frequency.

TMI	Percent Cover		Frequency		
Species	Total	Relative	Total	Relative	IV
Acer pensylvanicum	35.60	5.667	18	5.732	11.400
Acer rubrum	18.90	3.009	19	6.051	9.060
Acer saccharum	2.85	0.454	2	0.637	1.091
Achillea millefolium	0.10	0.016	1	0.318	0.334
Alnus incana ssp. rugosa	0.00	0.000	0	0.000	0.000
Amelanchier laevis	2.45	0.390	2	0.637	1.027
Antennaria howellii ssp. canadensis	0.10	0.016	1	0.318	0.334
Apocynum androsaemifolium	0.00	0.000	0	0.000	0.000
Aralia nudicaulis	103.70	16.509	19	6.051	22.560
Arctostaphylos uva-ursi	0.00	0.000	0	0.000	0.000
Betula alleghaniensis var. alleghaniensis	3.75	0.597	3	0.955	1.552
Betula lenta	0.00	0.000	0	0.000	0.000
Betula papyrifera	0.70	0.111	6	1.911	2.022
Betula populifolia	4.50	0.716	1	0.318	1.035
Carex argyrantha	0.00	0.000	0	0.000	0.000
Carex communis	0.00	0.000	0	0.000	0.000
Cephalanthus occidentalis	0.00	0.000	0	0.000	0.000
Chimaphila maculata	0.00	0.000	0	0.000	0.000
Commelina communis	0.00	0.000	0	0.000	0.000
Comptonia peregrina	2.70	0.430	1	0.318	0.748
Coptis trifolia	0.45	0.072	1	0.318	0.390
Cornus rugosa	1.00	0.159	1	0.318	0.478
Cypripedium acaule	1.05	0.167	3	0.955	1.123
Dactylis glomerata	0.20	0.032	2	0.637	0.669
Dennstaedtia punctilobula	0.00	0.000	0	0.000	0.000
Dichanthelium boreale	0.00	0.000	0	0.000	0.000
Diervilla lonicera	0.00	0.000	0	0.000	0.000
Dryopteris clintoniana	0.70	0.111	1	0.318	0.430
Dryopteris intermedia	0.00	0.000	0	0.000	0.000
Dryopteris marginalis	0.00	0.000	0	0.000	0.000
Epifagus virginiana	0.00	0.000	0	0.000	0.000
Erigeron strigosus	2.10	0.334	1	0.318	0.653
Eurybia divaricata	0.10	0.016	1	0.318	0.334
Eurybia macrophylla	1.65	0.263	3	0.955	1.218
Euthamia graminifolia	0.05	0.008	1	0.318	0.326
Fagus grandifolia	55.60	8.851	13	4.140	12.992
Fragaria vesca ssp. americana	1.65	0.263	1	0.318	0.581
Galium tinctorium	0.00	0.000	0	0.000	0.000
Gaultheria procumbens	7.30	1.162	6	1.911	3.073
Gaylussacia baccata	58.85	9.369	8	2.548	11.917
Goodyera pubescens	0.10	0.016	1	0.318	0.334
Hamamelis virginiana	42.50	6.766	11	3.503	10.269

Table 25: Understory Importance Values for Three Mile Island in 2011. Importance values (IV) are calculated as the sum of relative percent cover and relative frequency.

TMI	Percent Cover		Frequency		
Species	Total	Relative	Total	Relative	IV
Hieracium caespitosum	0.50	0.080	3	0.955	1.035
Hieracium pilosella	0.00	0.000	0	0.000	0.000
Hypericum perforatum	0.00	0.000	0	0.000	0.000
Ilex glabra	0.00	0.000	0	0.000	0.000
Ilex mucronata	0.00	0.000	0	0.000	0.000
Ilex verticillata	0.65	0.103	2	0.637	0.740
Juniperus communis var. depressa	0.00	0.000	0	0.000	0.000
Justicia americana	0.05	0.008	1	0.318	0.326
Kalmia angustifolia	0.30	0.048	1	0.318	0.366
Lilium philadelphicum	0.00	0.000	0	0.000	0.000
Lindernia dubia	0.00	0.000	0	0.000	0.000
Lonicera canadensis	4.20	0.669	3	0.955	1.624
Luzula multiflora	0.00	0.000	0	0.000	0.000
Lycopodium complanatum	0.00	0.000	0	0.000	0.000
Lycopodium obscurum	0.05	0.008	1	0.318	0.326
Lyonia ligustrina	0.00	0.000	0	0.000	0.000
Lysimachia quadrifolia	0.15	0.024	1	0.318	0.342
Maianthemum canadense	54.60	8.692	17	5.414	14.106
Maianthemum racemosum ssp. racemosum	2.90	0.462	3	0.955	1.417
Medeola virginiana	2.15	0.342	8	2.548	2.890
Melampyrum lineare	0.35	0.056	4	1.274	1.330
Mentha arvensis	0.05	0.008	1	0.318	0.326
Mitchella repens	4.85	0.772	9	2.866	3.638
Monotropa uniflora	0.00	0.000	0	0.000	0.000
Myrica gale	0.00	0.000	0	0.000	0.000
Nyssa sylvatica	0.80	0.127	1	0.318	0.446
Oclemena acuminata	0.00	0.000	0	0.000	0.000
Osmunda cinnamomea	5.00	0.796	1	0.318	1.114
Osmunda regalis	0.10	0.016	1	0.318	0.334
Ostrya virginiana	19.15	3.049	4	1.274	4.323
Oxalis stricta	0.05	0.008	1	0.318	0.326
Parthenocissus quinquefolia	1.05	0.167	1	0.318	0.486
Photinia melanocarpa	1.80	0.287	2	0.637	0.923
Pinus resinosa	0.00	0.000	0	0.000	0.000
Pinus strobus	9.95	1.584	17	5.414	6.998
Plantago major	0.00	0.000	0	0.000	0.000
Poa pratensis	0.00	0.000	0	0.000	0.000
Polygonatum biflorum	0.70	0.111	1	0.318	0.430
Polygonatum pubescens	0.95	0.151	1	0.318	0.470
Polypodium virginianum	0.00	0.000	0	0.000	0.000
Polystichum acrostichoides	0.00	0.000	0	0.000	0.000
Populus grandidentata	0.20	0.032	1	0.318	0.350

Table 25: Understory Importance Values for Three Mile Island in 2011. Importance values (IV) are calculated as the sum of relative percent cover and relative frequency.

TMI	Percent Cover		Frequency		
Species	Total	Relative	Total	Relative	IV
Prenanthes trifoliolata	1.20	0.191	5	1.592	1.783
Prunus pensylvanica	0.00	0.000	0	0.000	0.000
Prunus serotina	0.05	0.008	1	0.318	0.326
Pteridium aquilinum	38.70	6.161	12	3.822	9.983
Quercus alba	0.00	0.000	0	0.000	0.000
Quercus rubra	3.15	0.501	13	4.140	4.642
Rhododendron canadense	0.00	0.000	0	0.000	0.000
Rhododendron maximum	0.00	0.000	0	0.000	0.000
Robinia hispida	0.60	0.096	1	0.318	0.414
Rosa palustris	0.00	0.000	0	0.000	0.000
Rubus allegheniensis	0.00	0.000	0	0.000	0.000
Rubus hispidus	3.20	0.509	1	0.318	0.828
Rudbeckia hirta var. pulcherrima	0.00	0.000	0	0.000	0.000
Sambucus nigra ssp. canadensis	0.00	0.000	0	0.000	0.000
Schedonorus pratensis	0.35	0.056	4	1.274	1.330
Solidago altissima	0.10	0.016	1	0.318	0.334
Solidago arguta	0.00	0.000	0	0.000	0.000
Solidago bicolor	0.00	0.000	0	0.000	0.000
Solidago caesia	0.10	0.016	1	0.318	0.334
Solidago juncea	0.05	0.008	1	0.318	0.326
Solidago nemoralis	1.20	0.191	2	0.637	0.828
Spiraea alba var. latifolia	0.00	0.000	0	0.000	0.000
Streptopus amplexifolius	1.90	0.302	5	1.592	1.895
Symphyotrichum lanceolatum	0.00	0.000	0	0.000	0.000
Symphyotrichum novi-belgii	0.00	0.000	0	0.000	0.000
Symphyotrichum puniceum var. puniceum	0.20	0.032	1	0.318	0.350
Symphyotrichum undulatum	0.05	0.008	1	0.318	0.326
Taraxacum officinale	0.00	0.000	0	0.000	0.000
Tilia americana	2.55	0.406	1	0.318	0.724
Toxicodendron radicans	0.90	0.143	1	0.318	0.462
Trientalis borealis	11.30	1.799	16	5.096	6.894
Trifolium aureum	0.05	0.008	1	0.318	0.326
Tsuga canadensis	51.60	8.215	12	3.822	12.036
Vaccinium angustifolium	28.30	4.505	7	2.229	6.735
Vaccinium corymbosum	1.40	0.223	1	0.318	0.541
Vaccinium fuscatum	0.00	0.000	0	0.000	0.000
Viburnum acerifolium	21.85	3.478	13	4.140	7.619
Viburnum nudum var. cassinoides	0.00	0.000	0	0.000	0.000
Viola blanda var. palustriformis	0.15	0.024	1	0.318	0.342
Viola renifolia	0.00	0.000	0	0.000	0.000
Total	628.15	100.000	314	100.000	200.000

Table 26: Understory Importance Values for Hawk's Nest Island in 2011. Importance values (IV) are calculated as the sum of relative percent cover and relative frequency.

HNI	Percent Cover		Frequency		
Species	Total	Relative	Total	Relative	IV
Acer pensylvanicum	0.25	0.209	1	2.941	3.150
Acer rubrum	0.55	0.460	3	8.824	9.284
Acer saccharum	0.00	0.000	0	0.000	0.000
Achillea millefolium	0.00	0.000	0	0.000	0.000
Alnus incana ssp. rugosa	0.00	0.000	0	0.000	0.000
Amelanchier laevis	1.55	1.298	2	5.882	7.180
Antennaria howellii ssp. canadensis	0.00	0.000	0	0.000	0.000
Apocynum androsaemifolium	0.00	0.000	0	0.000	0.000
Aralia nudicaulis	0.80	0.670	1	2.941	3.611
Arctostaphylos uva-ursi	0.00	0.000	0	0.000	0.000
Betula alleghaniensis var. alleghaniensis	0.00	0.000	0	0.000	0.000
Betula lenta	0.00	0.000	0	0.000	0.000
Betula papyrifera	2.00	1.674	3	8.824	10.498
Betula populifolia	0.00	0.000	0	0.000	0.000
Carex argyrantha	0.00	0.000	0	0.000	0.000
Carex communis	0.00	0.000	0	0.000	0.000
Cephalanthus occidentalis	0.00	0.000	0	0.000	0.000
Chimaphila maculata	0.00	0.000	0	0.000	0.000
Commelina communis	0.00	0.000	0	0.000	0.000
Comptonia peregrina	0.00	0.000	0	0.000	0.000
Coptis trifolia	0.00	0.000	0	0.000	0.000
Cornus rugosa	0.00	0.000	0	0.000	0.000
Cypripedium acaule	0.00	0.000	0	0.000	0.000
Dactylis glomerata	0.00	0.000	0	0.000	0.000
Dennstaedtia punctilobula	0.00	0.000	0	0.000	0.000
Dichanthelium boreale	0.00	0.000	0	0.000	0.000
Diervilla lonicera	0.00	0.000	0	0.000	0.000
Dryopteris clintoniana	0.00	0.000	0	0.000	0.000
Dryopteris intermedia	0.00	0.000	0	0.000	0.000
Dryopteris marginalis	0.00	0.000	0	0.000	0.000
Epifagus virginiana	0.00	0.000	0	0.000	0.000
Erigeron strigosus	0.00	0.000	0	0.000	0.000
Eurybia divaricata	0.00	0.000	0	0.000	0.000
Eurybia macrophylla	0.00	0.000	0	0.000	0.000
Euthamia graminifolia	0.00	0.000	0	0.000	0.000
Fagus grandifolia	0.00	0.000	0	0.000	0.000
Fragaria vesca ssp. americana	0.00	0.000	0	0.000	0.000
Galium tinctorium	0.00	0.000	0	0.000	0.000
Gaultheria procumbens	48.80	40.854	3	8.824	49.677
Gaylussacia baccata	31.20	26.120	1	2.941	29.061
Goodyera pubescens	0.10	0.084	1	2.941	3.025
Hamamelis virginiana	0.00	0.000	0	0.000	0.000

Table 26: Understory Importance Values for Hawk's Nest Island in 2011. Importance values (IV) are calculated as the sum of relative percent cover and relative frequency.

HNI	Percent Cover		Frequency		
Species	Total	Relative	Total	Relative	IV
Hieracium caespitosum	0.00	0.000	0	0.000	0.000
Hieracium pilosella	0.00	0.000	0	0.000	0.000
Hypericum perforatum	0.00	0.000	0	0.000	0.000
Ilex glabra	0.00	0.000	0	0.000	0.000
Ilex mucronata	0.00	0.000	0	0.000	0.000
Ilex verticillata	0.00	0.000	0	0.000	0.000
Juniperus communis var. depressa	0.00	0.000	0	0.000	0.000
Justicia americana	5.70	4.772	1	2.941	7.713
Kalmia angustifolia	0.00	0.000	0	0.000	0.000
Lilium philadelphicum	0.00	0.000	0	0.000	0.000
Lindernia dubia	0.00	0.000	0	0.000	0.000
Lonicera canadensis	0.00	0.000	0	0.000	0.000
Luzula multiflora	0.00	0.000	0	0.000	0.000
Lycopodium complanatum	0.00	0.000	0	0.000	0.000
Lycopodium obscurum	0.00	0.000	0	0.000	0.000
Lyonia ligustrina	0.00	0.000	0	0.000	0.000
Lysimachia quadrifolia	1.60	1.339	2	5.882	7.222
Maianthemum canadense	0.10	0.084	1	2.941	3.025
Maianthemum racemosum ssp. racemosum	0.00	0.000	0	0.000	0.000
Medeola virginiana	0.15	0.126	1	2.941	3.067
Melampyrum lineare	0.00	0.000	0	0.000	0.000
Mentha arvensis	0.00	0.000	0	0.000	0.000
Mitchella repens	1.20	1.005	1	2.941	3.946
Monotropa uniflora	0.00	0.000	0	0.000	0.000
Myrica gale	0.00	0.000	0	0.000	0.000
Nyssa sylvatica	0.00	0.000	0	0.000	0.000
Oclemena acuminata	0.00	0.000	0	0.000	0.000
Osmunda cinnamomea	0.00	0.000	0	0.000	0.000
Osmunda regalis	0.00	0.000	0	0.000	0.000
Ostrya virginiana	0.00	0.000	0	0.000	0.000
Oxalis stricta	0.00	0.000	0	0.000	0.000
Parthenocissus quinquefolia	0.00	0.000	0	0.000	0.000
Photinia melanocarpa	0.20	0.167	2	5.882	6.050
Pinus resinosa	0.00	0.000	0	0.000	0.000
Pinus strobus	0.20	0.167	1	2.941	3.109
Plantago major	0.00	0.000	0	0.000	0.000
Poa pratensis	0.00	0.000	0	0.000	0.000
Polygonatum biflorum	0.00	0.000	0	0.000	0.000
Polygonatum pubescens	0.00	0.000	0	0.000	0.000
Polypodium virginianum	0.00	0.000	0	0.000	0.000
Polystichum acrostichoides	0.00	0.000	0	0.000	0.000
Populus grandidentata	0.00	0.000	0	0.000	0.000

Table 26: Understory Importance Values for Hawk's Nest Island in 2011. Importance values (IV) are calculated as the sum of relative percent cover and relative frequency.

HNI	Percent Cover		Frequency		
Species	Total	Relative	Total	Relative	IV
Prenanthes trifoliolata	0.00	0.000	0	0.000	0.000
Prunus pensylvanica	0.00	0.000	0	0.000	0.000
Prunus serotina	0.00	0.000	0	0.000	0.000
Pteridium aquilinum	2.50	2.093	1	2.941	5.034
Quercus alba	0.15	0.126	2	5.882	6.008
Quercus rubra	0.00	0.000	0	0.000	0.000
Rhododendron canadense	0.00	0.000	0	0.000	0.000
Rhododendron maximum	0.00	0.000	0	0.000	0.000
Robinia hispida	0.00	0.000	0	0.000	0.000
Rosa palustris	0.00	0.000	0	0.000	0.000
Rubus allegheniensis	0.00	0.000	0	0.000	0.000
Rubus hispidus	0.00	0.000	0	0.000	0.000
Rudbeckia hirta var. pulcherrima	0.00	0.000	0	0.000	0.000
Sambucus nigra ssp. canadensis	0.00	0.000	0	0.000	0.000
Schedonorus pratensis	0.00	0.000	0	0.000	0.000
Solidago altissima	0.00	0.000	0	0.000	0.000
Solidago arguta	0.00	0.000	0	0.000	0.000
Solidago bicolor	0.00	0.000	0	0.000	0.000
Solidago caesia	0.00	0.000	0	0.000	0.000
Solidago juncea	0.00	0.000	0	0.000	0.000
Solidago nemoralis	0.00	0.000	0	0.000	0.000
Spiraea alba var. latifolia	0.00	0.000	0	0.000	0.000
Streptopus amplexifolius	0.00	0.000	0	0.000	0.000
Symphyotrichum lanceolatum	0.00	0.000	0	0.000	0.000
Symphyotrichum novi-belgii	0.00	0.000	0	0.000	0.000
Symphyotrichum puniceum var. puniceum	0.00	0.000	0	0.000	0.000
Symphyotrichum undulatum	0.00	0.000	0	0.000	0.000
Taraxacum officinale	0.00	0.000	0	0.000	0.000
Tilia americana	0.00	0.000	0	0.000	0.000
Toxicodendron radicans	0.30	0.251	1	2.941	3.192
Trientalis borealis	0.30	0.251	1	2.941	3.192
Trifolium aureum	0.40	0.335	1	2.941	3.276
Tsuga canadensis	15.10	12.641	2	5.882	18.524
Vaccinium angustifolium	3.80	3.181	1	2.941	6.122
Vaccinium corymbosum	0.00	0.000	0	0.000	0.000
Vaccinium fuscatum	2.50	2.093	1	2.941	5.034
Viburnum acerifolium	0.00	0.000	0	0.000	0.000
Viburnum nudum var. cassinoides	0.00	0.000	0	0.000	0.000
Viola blanda var. palustriformis	0.00	0.000	0	0.000	0.000
Viola renifolia	0.00	0.000	0	0.000	0.000
Total	119.45	100.000	34	100.000	200.000

Table 27: Understory Importance Values for Blueberry Island in 2011. Importance values (IV) are calculated as the sum of relative percent cover and relative frequency.

BI	Percent Cover		Frequency		
Species	Total	Relative	Total	Relative	IV
Acer pensylvanicum	0.00	0.000	0	0.000	0.000
Acer rubrum	0.85	1.022	3	8.824	9.845
Acer saccharum	0.00	0.000	0	0.000	0.000
Achillea millefolium	0.00	0.000	0	0.000	0.000
Alnus incana ssp. rugosa	0.55	0.661	2	5.882	6.543
Amelanchier laevis	0.00	0.000	0	0.000	0.000
Antennaria howellii ssp. canadensis	0.00	0.000	0	0.000	0.000
Apocynum androsaemifolium	0.10	0.120	1	2.941	3.061
Aralia nudicaulis	0.00	0.000	0	0.000	0.000
Arctostaphylos uva-ursi	0.00	0.000	0	0.000	0.000
Betula alleghaniensis var. alleghaniensis	0.00	0.000	0	0.000	0.000
Betula lenta	0.00	0.000	0	0.000	0.000
Betula papyrifera	0.00	0.000	0	0.000	0.000
Betula populifolia	0.00	0.000	0	0.000	0.000
Carex argyrantha	0.00	0.000	0	0.000	0.000
Carex communis	0.00	0.000	0	0.000	0.000
Cephalanthus occidentalis	0.00	0.000	0	0.000	0.000
Chimaphila maculata	0.00	0.000	0	0.000	0.000
Commelina communis	0.00	0.000	0	0.000	0.000
Comptonia peregrina	0.00	0.000	0	0.000	0.000
Coptis trifolia	0.00	0.000	0	0.000	0.000
Cornus rugosa	0.00	0.000	0	0.000	0.000
Cypripedium acaule	0.00	0.000	0	0.000	0.000
Dactylis glomerata	0.00	0.000	0	0.000	0.000
Dennstaedtia punctilobula	0.00	0.000	0	0.000	0.000
Dichanthelium boreale	0.00	0.000	0	0.000	0.000
Diervilla lonicera	0.00	0.000	0	0.000	0.000
Dryopteris clintoniana	0.00	0.000	0	0.000	0.000
Dryopteris intermedia	0.00	0.000	0	0.000	0.000
Dryopteris marginalis	0.00	0.000	0	0.000	0.000
Epifagus virginiana	0.00	0.000	0	0.000	0.000
Erigeron strigosus	0.00	0.000	0	0.000	0.000
Eurybia divaricata	0.00	0.000	0	0.000	0.000
Eurybia macrophylla	0.00	0.000	0	0.000	0.000
Euthamia graminifolia	0.00	0.000	0	0.000	0.000
Fagus grandifolia	0.00	0.000	0	0.000	0.000
Fragaria vesca ssp. americana	0.00	0.000	0	0.000	0.000
Galium tinctorium	0.00	0.000	0	0.000	0.000
Gaultheria procumbens	10.90	13.101	1	2.941	16.042
Gaylussacia baccata	27.85	33.474	2	5.882	39.356
Goodyera pubescens	0.00	0.000	0	0.000	0.000
Hamamelis virginiana	0.00	0.000	0	0.000	0.000

Table 27: Understory Importance Values for Blueberry Island in 2011. Importance values (IV) are calculated as the sum of relative percent cover and relative frequency.

BI	Percent Cover		Frequency		
Species	Total	Relative	Total	Relative	IV
Hieracium caespitosum	0.00	0.000	0	0.000	0.000
Hieracium pilosella	0.00	0.000	0	0.000	0.000
Hypericum perforatum	0.00	0.000	0	0.000	0.000
Ilex glabra	0.10	0.120	1	2.941	3.061
Ilex mucronata	0.00	0.000	0	0.000	0.000
Ilex verticillata	0.00	0.000	0	0.000	0.000
Juniperus communis var. depressa	0.00	0.000	0	0.000	0.000
Justicia americana	0.00	0.000	0	0.000	0.000
Kalmia angustifolia	5.80	6.971	1	2.941	9.912
Lilium philadelphicum	0.00	0.000	0	0.000	0.000
Lindernia dubia	0.05	0.060	1	2.941	3.001
Lonicera canadensis	0.00	0.000	0	0.000	0.000
Luzula multiflora	0.00	0.000	0	0.000	0.000
Lycopodium complanatum	0.00	0.000	0	0.000	0.000
Lycopodium obscurum	0.00	0.000	0	0.000	0.000
Lyonia ligustrina	0.45	0.541	1	2.941	3.482
Lysimachia quadrifolia	0.05	0.060	1	2.941	3.001
Maianthemum canadense	0.05	0.060	1	2.941	3.001
Maianthemum racemosum ssp. racemosum	0.00	0.000	0	0.000	0.000
Medeola virginiana	0.00	0.000	0	0.000	0.000
Melampyrum lineare	2.05	2.464	2	5.882	8.346
Mentha arvensis	0.00	0.000	0	0.000	0.000
Mitchella repens	0.00	0.000	0	0.000	0.000
Monotropa uniflora	0.00	0.000	0	0.000	0.000
Myrica gale	0.00	0.000	0	0.000	0.000
Nyssa sylvatica	0.30	0.361	1	2.941	3.302
Oclemena acuminata	0.00	0.000	0	0.000	0.000
Osmunda cinnamomea	0.00	0.000	0	0.000	0.000
Osmunda regalis	0.00	0.000	0	0.000	0.000
Ostrya virginiana	0.00	0.000	0	0.000	0.000
Oxalis stricta	0.00	0.000	0	0.000	0.000
Parthenocissus quinquefolia	0.00	0.000	0	0.000	0.000
Photinia melanocarpa	0.00	0.000	0	0.000	0.000
Pinus resinosa	0.00	0.000	0	0.000	0.000
Pinus strobus	0.05	0.060	1	2.941	3.001
Plantago major	1.00	1.202	1	2.941	4.143
Poa pratensis	0.00	0.000	0	0.000	0.000
Polygonatum biflorum	0.00	0.000	0	0.000	0.000
Polygonatum pubescens	0.00	0.000	0	0.000	0.000
Polypodium virginianum	0.00	0.000	0	0.000	0.000
Polystichum acrostichoides	0.00	0.000	0	0.000	0.000
Populus grandidentata	0.00	0.000	0	0.000	0.000

Table 27: Understory Importance Values for Blueberry Island in 2011. Importance values (IV) are calculated as the sum of relative percent cover and relative frequency.

BI	Percent Cover		Frequency		
Species	Total	Relative	Total	Relative	IV
Prenanthes trifoliolata	0.00	0.000	0	0.000	0.000
Prunus pensylvanica	0.00	0.000	0	0.000	0.000
Prunus serotina	0.00	0.000	0	0.000	0.000
Pteridium aquilinum	0.00	0.000	0	0.000	0.000
Quercus alba	0.00	0.000	0	0.000	0.000
Quercus rubra	0.00	0.000	0	0.000	0.000
Rhododendron canadense	0.00	0.000	0	0.000	0.000
Rhododendron maximum	0.00	0.000	0	0.000	0.000
Robinia hispida	0.00	0.000	0	0.000	0.000
Rosa palustris	1.00	1.202	1	2.941	4.143
Rubus allegheniensis	0.00	0.000	0	0.000	0.000
Rubus hispidus	0.00	0.000	0	0.000	0.000
Rudbeckia hirta var. pulcherrima	0.00	0.000	0	0.000	0.000
Sambucus nigra ssp. canadensis	0.00	0.000	0	0.000	0.000
Schedonorus pratensis	0.00	0.000	0	0.000	0.000
Solidago altissima	0.00	0.000	0	0.000	0.000
Solidago arguta	0.00	0.000	0	0.000	0.000
Solidago bicolor	0.00	0.000	0	0.000	0.000
Solidago caesia	0.15	0.180	1	2.941	3.121
Solidago juncea	0.00	0.000	0	0.000	0.000
Solidago nemoralis	6.10	7.332	1	2.941	10.273
Spiraea alba var. latifolia	0.00	0.000	0	0.000	0.000
Streptopus amplexifolius	0.20	0.240	1	2.941	3.182
Symphyotrichum lanceolatum	0.00	0.000	0	0.000	0.000
Symphyotrichum novi-belgii	0.00	0.000	0	0.000	0.000
Symphyotrichum puniceum var. puniceum	0.00	0.000	0	0.000	0.000
Symphyotrichum undulatum	0.00	0.000	0	0.000	0.000
Taraxacum officinale	2.00	2.404	1	2.941	5.345
Tilia americana	0.00	0.000	0	0.000	0.000
Toxicodendron radicans	0.00	0.000	0	0.000	0.000
Trientalis borealis	0.05	0.060	1	2.941	3.001
Trifolium aureum	0.00	0.000	0	0.000	0.000
Tsuga canadensis	1.90	2.284	3	8.824	11.107
Vaccinium angustifolium	6.30	7.572	3	8.824	16.396
Vaccinium corymbosum	0.05	0.060	1	2.941	3.001
Vaccinium fuscatum	15.30	18.389	1	2.941	21.331
Viburnum acerifolium	0.00	0.000	0	0.000	0.000
Viburnum nudum var. cassinoides	0.00	0.000	0	0.000	0.000
Viola blanda var. palustriformis	0.00	0.000	0	0.000	0.000
Viola renifolia	0.00	0.000	0	0.000	0.000
Total	83.20	100.000	34	100.000	200.000

Table 28: Understory Importance Values for all three islands. Importance values (IV) are calculated as the sum of relative percent cover and relative frequency.

OVERALL	Percent Cover		Frequency		
Species	Total	Relative	Total	Relative	IV
Acer pensylvanicum	35.85	4.315	19	4.974	9.289
Acer rubrum	20.30	2.443	25	6.545	8.988
Acer saccharum	2.85	0.343	2	0.524	0.867
Achillea millefolium	0.10	0.012	1	0.262	0.274
Alnus incana ssp. rugosa	0.55	0.066	2	0.524	0.590
Amelanchier laevis	4.00	0.481	4	1.047	1.529
Antennaria howellii ssp. canadensis	0.10	0.012	1	0.262	0.274
Apocynum androsaemifolium	0.10	0.012	1	0.262	0.274
Aralia nudicaulis	104.50	12.578	20	5.236	17.814
Arctostaphylos uva-ursi	0.00	0.000	0	0.000	0.000
Betula alleghaniensis var. alleghaniensis	3.75	0.451	3	0.785	1.237
Betula lenta	0.00	0.000	0	0.000	0.000
Betula papyrifera	2.70	0.325	9	2.356	2.681
Betula populifolia	4.50	0.542	1	0.262	0.803
Carex argyrantha	0.00	0.000	0	0.000	0.000
Carex communis	0.00	0.000	0	0.000	0.000
Cephalanthus occidentalis	0.00	0.000	0	0.000	0.000
Chimaphila maculata	0.00	0.000	0	0.000	0.000
Commelina communis	0.00	0.000	0	0.000	0.000
Comptonia peregrina	2.70	0.325	1	0.262	0.587
Coptis trifolia	0.45	0.054	1	0.262	0.316
Cornus rugosa	1.00	0.120	1	0.262	0.382
Cypripedium acaule	1.05	0.126	3	0.785	0.912
Dactylis glomerata	0.20	0.024	2	0.524	0.548
Dennstaedtia punctilobula	0.00	0.000	0	0.000	0.000
Dichanthelium boreale	0.00	0.000	0	0.000	0.000
Diervilla lonicera	0.00	0.000	0	0.000	0.000
Dryopteris clintoniana	0.70	0.084	1	0.262	0.346
Dryopteris intermedia	0.00	0.000	0	0.000	0.000
Dryopteris marginalis	0.00	0.000	0	0.000	0.000
Epifagus virginiana	0.00	0.000	0	0.000	0.000
Erigeron strigosus	2.10	0.253	1	0.262	0.515
Eurybia divaricata	0.10	0.012	1	0.262	0.274
Eurybia macrophylla	1.65	0.199	3	0.785	0.984
Euthamia graminifolia	0.05	0.006	1	0.262	0.268
Fagus grandifolia	55.60	6.692	13	3.403	10.095
Fragaria vesca ssp. americana	1.65	0.199	1	0.262	0.460
Galium tinctorium	0.00	0.000	0	0.000	0.000
Gaultheria procumbens	67.00	8.065	10	2.618	10.682
Gaylussacia baccata	117.90	14.191	11	2.880	17.071
Goodyera pubescens	0.20	0.024	2	0.524	0.548
Hamamelis virginiana	42.50	5.116	11	2.880	7.995

Table 28: Understory Importance Values for all three islands in 2011. Importance values (IV) are calculated as the sum of relative percent cover and relative frequency.

OVERALL	Percent Cover		Frequency		
Species	Total	Relative	Total	Relative	IV
Hieracium caespitosum	0.50	0.060	3	0.785	0.846
Hieracium pilosella	0.00	0.000	0	0.000	0.000
Hypericum perforatum	0.00	0.000	0	0.000	0.000
Ilex glabra	0.10	0.012	1	0.262	0.274
Ilex mucronata	0.00	0.000	0	0.000	0.000
Ilex verticillata	0.65	0.078	2	0.524	0.602
Juniperus communis var. depressa	0.00	0.000	0	0.000	0.000
Justicia americana	5.75	0.692	2	0.524	1.216
Kalmia angustifolia	6.10	0.734	2	0.524	1.258
Lilium philadelphicum	0.00	0.000	0	0.000	0.000
Lindernia dubia	0.05	0.006	1	0.262	0.268
Lonicera canadensis	4.20	0.506	3	0.785	1.291
Luzula multiflora	0.00	0.000	0	0.000	0.000
Lycopodium complanatum	0.00	0.000	0	0.000	0.000
Lycopodium obscurum	0.05	0.006	1	0.262	0.268
Lyonia ligustrina	0.45	0.054	1	0.262	0.316
Lysimachia quadrifolia	1.80	0.217	4	1.047	1.264
Maianthemum canadense	54.75	6.590	19	4.974	11.564
Maianthemum racemosum ssp. racemosum	2.90	0.349	3	0.785	1.134
Medeola virginiana	2.30	0.277	9	2.356	2.633
Melampyrum lineare	2.40	0.289	6	1.571	1.860
Mentha arvensis	0.05	0.006	1	0.262	0.268
Mitchella repens	6.05	0.728	10	2.618	3.346
Monotropa uniflora	0.00	0.000	0	0.000	0.000
Myrica gale	0.00	0.000	0	0.000	0.000
Nyssa sylvatica	1.10	0.132	2	0.524	0.656
Oclemena acuminata	0.00	0.000	0	0.000	0.000
Osmunda cinnamomea	5.00	0.602	1	0.262	0.864
Osmunda regalis	0.10	0.012	1	0.262	0.274
Ostrya virginiana	19.15	2.305	4	1.047	3.352
Oxalis stricta	0.05	0.006	1	0.262	0.268
Parthenocissus quinquefolia	1.05	0.126	1	0.262	0.388
Photinia melanocarpa	2.00	0.241	4	1.047	1.288
Pinus resinosa	0.00	0.000	0	0.000	0.000
Pinus strobus	10.20	1.228	19	4.974	6.202
Plantago major	1.00	0.120	1	0.262	0.382
Poa pratensis	0.00	0.000	0	0.000	0.000
Polygonatum biflorum	0.70	0.084	1	0.262	0.346
Polygonatum pubescens	0.95	0.114	1	0.262	0.376
Polypodium virginianum	0.00	0.000	0	0.000	0.000
Polystichum acrostichoides	0.00	0.000	0	0.000	0.000
Populus grandidentata	0.20	0.024	1	0.262	0.286

Table 28: Understory Importance Values for all three islands in 2011. Importance values (IV) are calculated as the sum of relative percent cover and relative frequency.

OVERALL	Percent Cover		Frequency		
Species	Total	Relative	Total	Relative	IV
Prenanthes trifoliolata	1.20	0.144	5	1.309	1.453
Prunus pensylvanica	0.00	0.000	0	0.000	0.000
Prunus serotina	0.05	0.006	1	0.262	0.268
Pteridium aquilinum	41.20	4.959	13	3.403	8.362
Quercus alba	0.15	0.018	2	0.524	0.542
Quercus rubra	3.15	0.379	13	3.403	3.782
Rhododendron canadense	0.00	0.000	0	0.000	0.000
Rhododendron maximum	0.00	0.000	0	0.000	0.000
Robinia hispida	0.60	0.072	1	0.262	0.334
Rosa palustris	1.00	0.120	1	0.262	0.382
Rubus allegheniensis	0.00	0.000	0	0.000	0.000
Rubus hispidus	3.20	0.385	1	0.262	0.647
Rudbeckia hirta var. pulcherrima	0.00	0.000	0	0.000	0.000
Sambucus nigra ssp. canadensis	0.00	0.000	0	0.000	0.000
Schedonorus pratensis	0.35	0.042	4	1.047	1.089
Solidago altissima	0.10	0.012	1	0.262	0.274
Solidago arguta	0.00	0.000	0	0.000	0.000
Solidago bicolor	0.00	0.000	0	0.000	0.000
Solidago caesia	0.25	0.030	2	0.524	0.554
Solidago juncea	0.05	0.006	1	0.262	0.268
Solidago nemoralis	7.30	0.879	3	0.785	1.664
Spiraea alba var. latifolia	0.00	0.000	0	0.000	0.000
Streptopus amplexifolius	2.10	0.253	6	1.571	1.823
Symphyotrichum lanceolatum	0.00	0.000	0	0.000	0.000
Symphyotrichum novi-belgii	0.00	0.000	0	0.000	0.000
Symphyotrichum puniceum var. puniceum	0.20	0.024	1	0.262	0.286
Symphyotrichum undulatum	0.05	0.006	1	0.262	0.268
Taraxacum officinale	2.00	0.241	1	0.262	0.503
Tilia americana	2.55	0.307	1	0.262	0.569
Toxicodendron radicans	1.20	0.144	2	0.524	0.668
Trientalis borealis	11.65	1.402	18	4.712	6.114
Trifolium aureum	0.45	0.054	2	0.524	0.578
Tsuga canadensis	68.60	8.257	17	4.450	12.707
Vaccinium angustifolium	38.40	4.622	11	2.880	7.502
Vaccinium corymbosum	1.45	0.175	2	0.524	0.698
Vaccinium fuscatum	17.80	2.143	2	0.524	2.666
Viburnum acerifolium	21.85	2.630	13	3.403	6.033
Viburnum nudum var. cassinoides	0.00	0.000	0	0.000	0.000
Viola blanda var. palustriformis	0.15	0.018	1	0.262	0.280
Viola renifolia	0.00	0.000	0	0.000	0.000
Total	830.80	100.000	382	100.000	200.000

Table 29. Number of individuals sampled in overstory plots on TMI, HNI, and BI in 2011.

	Three Mile Island												
Species Name/Plot	35	50	51	53	94	96	97	108	139	142	144	160	170
Acer pensylvanicum	83	21	143	1	28	60	14	14	81	74	86	13	14
Acer rubrum	13	17	56	33	8	17	7	16	40	22	24	23	28
Acer saccharum	0	0	3	0	0	0	3	0	0	0	0	0	0
Alnus incana ssp. rugosa	0	0	0	73	0	0	0	13	0	0	0	0	0
Amelanchier laevis	4	0	8	36	0	0	0	7	0	0	0	0	0
Betula alleghaniensis var. alleghaniensis	0	0	0	0	0	0	0	0	0	0	0	0	0
Betula lenta	0	0	0	0	0	0	0	0	0	0	0	0	6
Betula papyrifera	0	0	0	2	2	0	2	0	14	0	0	0	0
Betula populifolia	0	0	0	4	0	0	0	5	0	0	0	0	0
Cephalanthus occidentalis	0	0	0	0	0	0	0	0	0	0	0	0	0
Fagus grandifolia	50	30	8	10	6	12	46	11	14	12	58	107	72
Fraxinus americana	0	0	0	0	0	2	0	0	0	0	0	0	0
Fraxinus nigra	0	0	0	0	0	0	0	0	0	0	0	0	0
Gaylussacia baccata	1	0	0	0	0	0	0	0	0	0	0	0	0
Halesia carolina	0	0	0	0	0	0	0	0	0	0	0	0	0
Hamamelis virginiana	79	63	118	216	26	5	4	163	1	0	0	16	70
Ilex mucronata	0	0	0	0	0	0	0	0	0	0	0	0	0
Ilex verticillata	1	0	0	0	0	0	0	64	0	0	0	0	2
Lyonia ligustrina	0	0	0	0	0	0	0	0	0	0	0	0	0
Myrica gale	0	0	0	0	0	0	0	0	0	0	0	0	0
Nyssa sylvatica	0	18	0	0	0	0	0	0	0	0	0	0	3
Ostrya virginiana	1	0	0	0	0	0	0	0	0	0	0	2	0
Picea rubens	0	0	0	0	0	0	0	0	0	0	0	0	0
Pinus resinosa	1	1	1	5	0	4	4	0	0	0	0	0	0
Pinus strobus	39	17	29	22	7	10	13	40	13	4	12	12	5
Populus grandidentata	1	0	0	0	0	0	0	0	4	0	0	0	4
Populus tremuloides	0	0	0	0	0	0	0	0	0	0	0	0	0
Prunus pensylvanica	0	0	0	0	0	0	0	0	0	0	0	0	0
Prunus serotina	0	0	0	0	1	0	0	0	0	0	0	0	0
Quercus alba	0	0	0	0	0	0	0	0	0	0	0	0	0
Quercus rubra	25	17	31	14	9	10	6	6	4	20	28	18	13
Rhododendron canadense	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhododendron maximum	0	0	0	0	0	0	0	0	0	0	0	0	2
Rhus typhina	0	0	0	0	0	0	0	0	0	0	0	0	0
Robinia hispida	0	0	0	0	0	0	0	0	0	0	0	0	0
Rosa palustris	0	0	0	0	0	0	0	0	0	0	0	0	0
Sambucus nigra ssp. canadensis	0	0	0	0	0	0	0	0	0	0	0	0	0
Spiraea alba var. latifolia	0	0	0	0	0	0	0	0	0	0	0	0	0
Tilia americana	0	0	0	0	0	0	0	0	0	0	0	0	0
Tsuga canadensis	24	34	20	23	92	19	17	19	21	189	101	17	3
Vaccinium corymbosum	0	0	3	19	0	0	0	60	0	0	0	0	1
Vaccinium fuscatum	0	22	0	0	6	0	0	37	0	0	3	0	4
Viburnum acerifolium	0	0	8	12	0	0	2	0	5	2	0	3	0
Viburnum lentago	0	1	0	16	0	0	0	0	0	0	0	0	0
Viburnum nudum var. cassinoides	0	0	0	0	0	0	0	0	0	0	0	0	0
Viburnum recognitum	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 29. Number of individuals sampled in overstory plots on TMI, HNI, and BI in 2011.

	Three Mile Island						Hawk's Nest			Blueberry		
Species Name/Plot	186	219	232	245	246	248	224	254	284	282	283	288
Acer pensylvanicum	23	14	72	32	51	28	0	0	0	0	0	0
Acer rubrum	13	14	58	73	16	29	13	0	15	18	6	8
Acer saccharum	0	4	28	1	5	8	0	0	0	0	0	0
Alnus incana ssp. rugosa	0	0	0	57	0	0	31	0	101	39	0	23
Amelanchier laevis	0	0	0	0	0	0	7	0	45	0	2	24
Betula alleghaniensis var. alleghaniensis	0	0	0	0	0	0	0	0	0	0	0	0
Betula lenta	0	0	3	0	0	0	0	0	0	0	0	0
Betula papyrifera	3	0	0	7	0	0	0	0	10	0	21	0
Betula populifolia	0	0	4	0	0	0	3	0	66	58	0	69
Cephalanthus occidentalis	0	0	0	0	0	0	0	0	0	0	0	0
Fagus grandifolia	62	107	17	54	36	10	0	0	0	0	1	0
Fraxinus americana	0	0	0	0	0	0	0	0	0	0	0	0
Fraxinus nigra	0	0	0	0	0	0	0	0	0	0	0	3
Gaylussacia baccata	0	0	0	0	0	0	0	0	0	3	0	0
Halesia carolina	0	0	0	0	0	0	0	0	0	0	0	0
Hamamelis virginiana	0	2	56	169	178	63	33	0	26	0	0	5
Ilex mucronata	0	0	0	0	0	0	0	0	0	820	0	0
Ilex verticillata	0	0	0	0	0	0	0	0	0	18	0	2
Lyonia ligustrina	0	0	0	0	0	0	0	0	56	16	11	7
Myrica gale	0	0	0	0	0	0	0	0	0	0	0	0
Nyssa sylvatica	0	0	0	0	0	0	1	0	0	15	18	15
Ostrya virginiana	0	18	42	4	71	117	0	0	0	0	0	0
Picea rubens	0	0	0	0	0	0	0	0	0	0	0	1
Pinus resinosa	0	0	0	0	0	15	19	7	11	0	12	1
Pinus strobus	5	1	52	7	16	26	14	7	29	1	27	2
Populus grandidentata	0	0	0	0	6	1	0	0	0	0	0	0
Populus tremuloides	0	0	0	0	0	0	0	0	0	0	0	1
Prunus pensylvanica	0	0	0	0	0	0	0	0	0	0	0	0
Prunus serotina	0	0	8	0	0	0	0	0	0	0	0	0
Quercus alba	0	0	0	0	0	0	0	0	0	0	0	0
Quercus rubra	10	5	13	7	11	13	7	12	33	1	0	1
Rhododendron canadense	0	0	0	0	0	0	0	0	1	0	0	0
Rhododendron maximum	0	0	0	0	0	0	0	0	0	0	0	0
Rhus typhina	0	0	0	0	0	0	0	0	0	0	0	0
Robinia hispida	0	0	1	0	0	0	0	0	0	0	0	0
Rosa palustris	0	0	0	0	0	0	0	0	2	2	0	0
Sambucus nigra ssp. canadensis	0	0	0	0	0	0	0	0	0	0	0	0
Spiraea alba var. latifolia	0	0	0	0	0	0	0	0	0	7	0	0
Tilia americana	0	0	3	0	0	1	0	0	0	0	0	0
Tsuga canadensis	21	7	5	8	2	2	53	71	5	2	29	13
Vaccinium corymbosum	0	0	0	0	0	0	0	0	27	1068	0	0
Vaccinium fuscatum	0	0	0	8	0	0	53	0	0	702	36	290
Viburnum acerifolium	1	0	8	0	2	1	0	0	0	0	0	0
Viburnum lentago	0	0	0	0	0	0	0	0	0	2	0	53
Viburnum nudum var. cassinoides	0	0	0	0	0	0	31	0	11	5	0	0
Viburnum recognitum	0	0	0	0	0	0	1	0	5	0	0	0

Table 30. Total numbers of woody individuals by island in 2011.

Species Name/Island	TMI	Hawk	Blue	TOTAL
Acer pensylvanicum	852	0	0	852
Acer rubrum	507	28	32	567
Acer saccharum	52	0	0	52
Alnus incana ssp. rugosa	143	132	62	337
Amelanchier laevis	55	52	26	133
Betula alleghaniensis var. alleghaniensis	0	0	0	0
Betula lenta	9	0	0	9
Betula papyrifera	30	10	21	61
Betula populifolia	13	69	127	209
Cephalanthus occidentalis	0	0	0	0
Fagus grandifolia	722	0	1	723
Fraxinus americana	2	0	0	2
Fraxinus nigra	0	0	3	3
Gaylussacia baccata	1	0	3	4
Halesia carolina	0	0	0	0
Hamamelis virginiana	1229	59	5	1293
Ilex mucronata	0	0	820	820
Ilex verticillata	67	0	20	87
Lyonia ligustrina	0	56	34	90
Myrica gale	0	0	0	0
Nyssa sylvatica	21	1	48	70
Ostrya virginiana	255	0	0	255
Picea rubens	0	0	1	1
Pinus resinosa	31	37	13	81
Pinus strobus	330	50	30	410
Populus grandidentata	16	0	0	16
Populus tremuloides	0	0	1	1
Prunus pensylvanica	0	0	0	0
Prunus serotina	9	0	0	9
Quercus alba	0	0	0	0
Quercus rubra	260	52	2	314
Rhododendron canadense	0	1	0	1
Rhododendron maximum	2	0	0	2
Rhus typhina	0	0	0	0
Robinia hispida	1	0	0	1
Rosa palustris	0	2	2	4
Sambucus nigra ssp. canadensis	0	0	0	0
Spiraea alba var. latifolia	0	0	7	7
Tilia americana	4	0	0	4
Tsuga canadensis	624	129	44	797
Vaccinium corymbosum	83	27	1068	1178
Vaccinium fuscatum	80	53	1028	1161
Viburnum acerifolium	44	0	0	44
Viburnum lentago	17	0	55	72
Viburnum nudum var. cassinoides	0	42	5	47
Viburnum recognitum	0	6	0	6

Table 31. Overstory total ratings data by plot on TMI, HNI, and BI in 2011.

	Three Mile Island												
Species Name/Plot	35	50	51	53	94	96	97	108	139	142	144	160	170
Acer pensylvanicum	90	32	163	1	48	69	19	19	108	91	91	13	14
Acer rubrum	25	50	62	64	19	34	15	37	75	41	41	48	50
Acer saccharum	0	0	3	0	0	0	7	0	0	0	0	0	0
Alnus incana ssp. rugosa	0	0	0	78	0	0	0	16	0	0	0	0	0
Amelanchier laevis	4	0	8	36	0	0	0	10	0	0	0	0	0
Betula alleghaniensis var. alleghaniensis	0	0	0	0	0	0	0	0	0	0	0	0	0
Betula lenta	0	0	0	0	0	0	0	0	0	0	0	0	10
Betula papyrifera	0	0	0	3	6	0	4	0	29	0	0	0	0
Betula populifolia	0	0	0	6	0	0	0	8	0	0	0	0	0
Cephalanthus occidentalis	0	0	0	0	0	0	0	0	0	0	0	0	0
Fagus grandifolia	62	48	9	11	6	19	68	13	17	15	62	148	89
Fraxinus americana	0	0	0	0	0	5	0	0	0	0	0	0	0
Fraxinus nigra	0	0	0	0	0	0	0	0	0	0	0	0	0
Gaylussacia baccata	1	0	0	0	0	0	0	0	0	0	0	0	0
Halesia carolina	0	0	0	0	0	0	0	0	0	0	0	0	0
Hamamelis virginiana	79	64	133	226	38	5	7	210	1	0	0	16	72
Ilex mucronata	0	0	0	0	0	0	0	0	0	0	0	0	0
Ilex verticillata	1	0	0	0	0	0	0	86	0	0	0	0	2
Lyonia ligustrina	0	0	0	0	0	0	0	0	0	0	0	0	0
Myrica gale	0	0	0	0	0	0	0	0	0	0	0	0	0
Nyssa sylvatica	0	23	0	0	0	0	0	0	0	0	0	0	5
Ostrya virginiana	1	0	0	0	0	0	0	0	0	0	0	4	0
Picea rubens	0	0	0	0	0	0	0	0	0	0	0	0	0
Pinus resinosa	4	2	3	10	0	13	7	0	0	0	0	0	0
Pinus strobus	88	27	66	46	25	39	47	81	31	13	30	18	12
Populus grandidentata	1	0	0	0	0	0	0	0	10	0	0	0	12
Populus tremuloides	0	0	0	0	0	0	0	0	0	0	0	0	0
Prunus pensylvanica	0	0	0	0	0	0	0	0	0	0	0	0	0
Prunus serotina	0	0	0	0	2	0	0	0	0	0	0	0	0
Quercus alba	0	0	0	0	0	0	0	0	0	0	0	0	0
Quercus rubra	70	54	79	41	28	26	20	18	11	54	81	60	36
Rhododendron canadense	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhododendron maximum	0	0	0	0	0	0	0	0	0	0	0	0	3
Rhus typhina	0	0	0	0	0	0	0	0	0	0	0	0	0
Robinia hispida	0	0	0	0	0	0	0	0	0	0	0	0	0
Rosa palustris	0	0	0	0	0	0	0	0	0	0	0	0	0
Sambucus nigra ssp. canadensis	0	0	0	0	0	0	0	0	0	0	0	0	0
Spiraea alba var. latifolia	0	0	0	0	0	0	0	0	0	0	0	0	0
Tilia americana	0	0	0	0	0	0	0	0	0	0	0	0	0
Tsuga canadensis	27	41	30	26	189	48	46	50	33	224	117	21	7
Vaccinium corymbosum	0	0	3	19	0	0	0	60	0	0	0	0	1
Vaccinium fuscatum	0	22	0	0	6	0	0	45	0	0	3	0	4
Viburnum acerifolium	0	0	8	12	0	0	2	0	5	2	0	3	0
Viburnum lentago	0	1	0	16	0	0	0	0	0	0	0	0	0
Viburnum nudum var. cassinoides	0	0	0	0	0	0	0	0	0	0	0	0	0
Viburnum recognitum	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 31. Overstory total ratings data by plot on TMI, HNI, and BI in 2011.

	Three Mile Island						Hawk's Nest			Blueberry		
Species Name/Plot	186	219	232	245	246	248	224	254	284	282	283	288
Acer pensylvanicum	33	14	76	38	58	28	0	0	0	0	0	0
Acer rubrum	32	36	85	114	28	36	18	0	25	42	12	15
Acer saccharum	0	9	36	1	11	21	0	0	0	0	0	0
Alnus incana ssp. rugosa	0	0	0	57	0	0	31	0	115	52	0	29
Amelanchier laevis	0	0	0	0	0	0	8	0	46	0	4	38
Betula alleghaniensis var. alleghaniensis	0	0	0	0	0	0	0	0	0	0	0	0
Betula lenta	0	0	3	0	0	0	0	0	0	0	0	0
Betula papyrifera	4	0	0	14	0	0	0	0	10	0	31	0
Betula populifolia	0	0	5	0	0	0	3	0	82	91	0	118
Cephalanthus occidentalis	0	0	0	0	0	0	0	0	0	0	0	0
Fagus grandifolia	93	174	25	84	59	12	0	0	0	0	3	0
Fraxinus americana	0	0	0	0	0	0	0	0	0	0	0	0
Fraxinus nigra	0	0	0	0	0	0	0	0	0	0	0	7
Gaylussacia baccata	0	0	0	0	0	0	0	0	0	3	0	0
Halesia carolina	0	0	0	0	0	0	0	0	0	0	0	0
Hamamelis virginiana	0	2	61	200	187	63	33	0	27	0	0	5
Ilex mucronata	0	0	0	0	0	0	0	0	0	820	0	0
Ilex verticillata	0	0	0	0	0	0	0	0	0	18	0	2
Lyonia ligustrina	0	0	0	0	0	0	0	0	56	19	14	9
Myrica gale	0	0	0	0	0	0	0	0	0	0	0	0
Nyssa sylvatica	0	0	0	0	0	0	1	0	0	37	21	16
Ostrya virginiana	0	41	54	5	86	143	0	0	0	0	0	0
Picea rubens	0	0	0	0	0	0	0	0	0	0	0	4
Pinus resinosa	0	0	0	0	0	28	49	21	28	0	39	4
Pinus strobus	12	3	61	9	31	45	40	25	69	4	94	8
Populus grandidentata	0	0	0	0	8	1	0	0	0	0	0	0
Populus tremuloides	0	0	0	0	0	0	0	0	0	0	0	4
Prunus pensylvanica	0	0	0	0	0	0	0	0	0	0	0	0
Prunus serotina	0	0	10	0	0	0	0	0	0	0	0	0
Quercus alba	0	0	0	0	0	0	0	0	0	0	0	0
Quercus rubra	32	20	49	28	34	42	20	34	39	1	0	4
Rhododendron canadense	0	0	0	0	0	0	0	0	1	0	0	0
Rhododendron maximum	0	0	0	0	0	0	0	0	0	0	0	0
Rhus typhina	0	0	0	0	0	0	0	0	0	0	0	0
Robinia hispida	0	0	1	0	0	0	0	0	0	0	0	0
Rosa palustris	0	0	0	0	0	0	0	0	2	2	0	0
Sambucus nigra ssp. canadensis	0	0	0	0	0	0	0	0	0	0	0	0
Spiraea alba var. latifolia	0	0	0	0	0	0	0	0	0	7	0	0
Tilia americana	0	0	9	0	0	1	0	0	0	0	0	0
Tsuga canadensis	51	10	5	18	2	2	134	156	11	6	90	42
Vaccinium corymbosum	0	0	0	0	0	0	0	0	27	1158	0	0
Vaccinium fuscatum	0	0	0	8	0	0	53	0	0	702	36	296
Viburnum acerifolium	1	0	8	0	2	1	0	0	0	0	0	0
Viburnum lentago	0	0	0	0	0	0	0	0	0	2	0	58
Viburnum nudum var. cassinoides	0	0	0	0	0	0	31	0	11	5	0	0
Viburnum recognitum	0	0	0	0	0	0	1	0	5	0	0	0

Table 32. Overstory total ratings data by island on TMI, HNI, and BI in 2011.

Species Name/Island	TMI	Hawk	Blue	TOTAL
Acer pensylvanicum	1005	0	0	1005
Acer rubrum	892	43	69	1004
Acer saccharum	88	0	0	88
Alnus incana ssp. rugosa	151	146	81	378
Amelanchier laevis	58	54	42	154
Betula alleghaniensis var. alleghaniensis	0	0	0	0
Betula lenta	13	0	0	13
Betula papyrifera	60	10	31	101
Betula populifolia	19	85	209	313
Cephalanthus occidentalis	0	0	0	0
Fagus grandifolia	1014	0	3	1017
Fraxinus americana	5	0	0	5
Fraxinus nigra	0	0	7	7
Gaylussacia baccata	1	0	3	4
Halesia carolina	0	0	0	0
Hamamelis virginiana	1364	60	5	1429
Ilex mucronata	0	0	820	820
Ilex verticillata	89	0	20	109
Lyonia ligustrina	0	56	42	98
Myrica gale	0	0	0	0
Nyssa sylvatica	28	1	74	103
Ostrya virginiana	334	0	0	334
Picea rubens	0	0	4	4
Pinus resinosa	67	98	43	208
Pinus strobus	684	134	106	924
Populus grandidentata	32	0	0	32
Populus tremuloides	0	0	4	4
Prunus pensylvanica	0	0	0	0
Prunus serotina	12	0	0	12
Quercus alba	0	0	0	0
Quercus rubra	783	93	5	881
Rhododendron canadense	0	1	0	1
Rhododendron maximum	3	0	0	3
Rhus typhina	0	0	0	0
Robinia hispida	1	0	0	1
Rosa palustris	0	2	2	4
Sambucus nigra ssp. canadensis	0	0	0	0
Spiraea alba var. latifolia	0	0	7	7
Tilia americana	10	0	0	10
Tsuga canadensis	947	301	138	1386
Vaccinium corymbosum	83	27	1158	1268
Vaccinium fuscatum	88	53	1034	1175
Viburnum acerifolium	44	0	0	44
Viburnum lentago	17	0	60	77
Viburnum nudum var. cassinoides	0	42	5	47
Viburnum recognitum	0	6	0	6

Table 33. Overstory relative density, frequency and dominance data on TMI across the four samplings. Relative dominance was calculated using the following formula: (x rating species q/x ratings of all species) x 100. Relative density: (# individual species q)/(total # individuals of all species) x 100. Relative frequency: ((frequency of plots species was found in/total frequency of all species) * 100).

	Relative Density					Relative Dominance					Relative Frequency			
Species	**1978**	**1991**	**2001**	**2011**		**1978**	**1991**	**2001**	**2011**		**1978**	**1991**	**2001**	**2011**
Acer pensylvanicum	11.96	14.95	16.92	15.60		4.56	2.19	2.59	2.73		10.37	8.82	9.05	9.05
Acer rubrum	9.47	14.79	8.94	9.28		6.09	3.17	4.11	4.08		9.15	9.31	9.05	9.05
Acer saccharum	2.99	0.72	1.50	0.95		5.91	3.99	3.81	3.92		5.49	2.94	3.81	3.33
Alnus incana ssp. rugosa	0.00	3.09	3.27	2.62		0.00	1.89	2.04	2.45		0.00	1.47	1.90	1.43
Amelanchier laevis	0.00	0.53	0.55	1.01		0.00	1.83	2.12	2.44		0.00	1.47	0.95	1.90
Betula alleghaniensis var. alleghani	0.00	0.03	0.00	0.00		0.00	3.65	0.00	0.00		0.00	0.49	0.00	0.00
Betula lenta	2.17	0.43	0.04	0.16		6.11	4.68	6.87	3.35		1.83	1.47	0.48	0.95
Betula papyrifera	5.12	1.54	2.12	0.55		8.40	4.25	3.74	4.63		9.76	5.88	5.71	2.86
Betula populifolia	0.00	0.37	0.17	0.24		0.00	2.48	2.21	3.39		0.00	0.49	0.95	1.43
Cephalanthus occidentalis	0.00	0.03	0.00	0.00		0.00	1.83	0.00	0.00		0.00	0.49	0.00	0.00
Fagus grandifolia	13.28	7.79	11.58	13.22		5.70	2.84	3.01	3.25		10.37	7.84	8.57	9.05
Fraxinus americana	0.00	0.11	0.02	0.04		0.00	4.11	1.96	5.79		0.00	1.47	0.48	0.48
Gaylussacia baccata	0.00	0.21	0.35	0.02		0.00	1.83	1.96	2.32		0.00	0.49	0.95	0.48
Halesia carolina	0.00	0.03	0.00	0.00		0.00	3.65	0.00	0.00		0.00	0.49	0.00	0.00
Hamamelis virginiana	8.61	21.57	21.19	22.51		4.02	1.86	2.12	2.57		7.93	7.84	7.62	7.62
Ilex mucronata	0.00	2.45	2.38	0.00		0.00	1.83	1.96	0.00		0.00	0.49	0.48	0.00
Ilex verticillata	0.00	0.00	0.11	1.23		0.00	0.00	1.96	3.08		0.00	0.00	0.95	1.43
Lyonia ligustrina	0.00	0.05	0.55	0.00		0.00	1.83	1.96	0.00		0.00	0.49	0.95	0.00
Nyssa sylvatica	0.14	0.72	0.37	0.38		8.32	2.37	2.89	3.09		1.22	1.96	1.43	0.95
Ostrya virginiana	2.90	3.78	4.10	4.67		3.71	2.32	2.63	3.03		1.83	2.45	1.90	3.33
Pinus resinosa	2.22	0.96	1.09	0.57		6.69	3.20	4.51	5.01		5.49	3.92	4.29	3.33
Pinus strobus	15.63	8.54	7.68	6.04		6.45	3.31	4.24	4.80		11.59	9.31	8.57	9.05
Populus grandidentata	0.00	0.32	0.26	0.29		0.00	4.57	6.70	4.63		0.00	1.96	1.43	2.38
Populus tremuloides	0.50	0.05	0.04	0.00		9.65	4.57	3.92	0.00		1.83	0.49	0.48	0.00
Prunus pensylvanica	0.00	0.08	0.00	0.00		0.00	1.83	0.00	0.00		0.00	0.49	0.00	0.00
Prunus serotina	0.09	0.21	0.31	0.16		4.68	2.06	2.24	3.09		1.22	1.47	1.90	0.95
Quercus alba	0.00	0.13	0.02	0.00		0.00	4.75	7.85	0.00		0.00	0.98	0.48	0.00
Quercus rubra	14.09	7.32	7.11	4.76		7.98	5.31	6.29	6.98		11.59	8.82	9.05	9.05
Rhododendron maximum	0.00	0.00	0.00	0.04		0.00	0.00	0.00	3.48		0.00	0.00	0.00	0.48
Rhus typhina	0.00	0.19	0.00	0.00		0.00	1.83	0.00	0.00		0.00	0.49	0.00	0.00
Robinia hispida	0.00	2.50	0.20	0.05		0.00	1.83	1.96	3.09		0.00	0.49	0.48	0.95
Sambucus nigra ssp. canadensis	0.00	0.03	0.00	0.00		0.00	1.83	0.00	0.00		0.00	0.49	0.00	0.00
Tilia americana	0.14	0.27	0.09	0.07		6.24	2.92	4.41	5.79		0.61	0.49	0.95	0.95
Tsuga canadensis	10.69	4.26	5.65	11.43		5.50	3.94	4.04	3.52		9.76	6.86	8.57	9.05
Vaccinium corymbosum	0.00	0.69	2.09	1.52		0.00	1.83	1.96	2.32		0.00	2.45	3.33	1.90
Vaccinium fuscatum	0.00	0.00	0.00	1.46		0.00	0.00	0.00	2.55		0.00	0.00	0.00	2.86
Viburnum acerifolium	0.00	0.93	0.68	0.81		0.00	1.83	1.96	2.32		0.00	3.43	3.81	4.76
Viburnum lentago	0.00	0.00	0.00	0.31		0.00	0.00	0.00	2.32		0.00	0.00	0.00	0.95
Viburnum nudum var. cassinoides	0.00	0.35	0.63	0.00		0.00	1.83	1.96	0.00		0.00	1.47	1.43	0.00
TOTALS	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00

Table 34. Overstory importance values on TMI (values for 1978, 1991 and 2001 from Holland and Clapham 2012).

Species	1978	1991	2001	2011
Acer pensylvanicum	26.89	25.97	28.56	27.38
Acer rubrum	24.71	27.28	22.09	22.41
Acer saccharum	14.39	7.65	9.12	8.21
Alnus incana ssp. rugosa	0.00	6.45	7.22	6.49
Amelanchier laevis	0.00	3.83	3.62	5.36
Betula alleghaniensis var. alleghaniensis	0.00	4.17	0.00	0.00
Betula lenta	10.12	6.58	7.39	4.46
Betula papyrifera	23.27	11.68	11.57	8.04
Betula populifolia	0.00	3.34	3.33	5.05
Cephalanthus occidentalis	0.00	2.34	0.00	0.00
Fagus grandifolia	29.34	18.48	23.16	25.52
Fraxinus americana	0.00	5.69	2.46	6.30
Gaylussacia baccata	0.00	2.53	3.26	2.81
Halesia carolina	0.00	4.17	0.00	0.00
Hamamelis virginiana	20.56	31.27	30.94	32.70
Ilex mucronata	0.00	4.76	4.81	0.00
Ilex verticillata	0.00	0.00	3.02	5.73
Lyonia ligustrina	0.00	2.37	3.46	0.00
Nyssa sylvatica	9.68	5.05	4.68	4.43
Ostrya virginiana	8.43	8.54	8.63	11.04
Pinus resinosa	14.39	8.08	9.89	8.91
Pinus strobus	33.67	21.16	20.49	19.89
Populus grandidentata	0.00	6.85	8.39	7.31
Populus tremuloides	11.97	5.11	4.44	0.00
Prunus pensylvanica	0.00	2.40	0.00	0.00
Prunus serotina	5.99	3.74	4.45	4.21
Quercus alba	0.00	5.86	8.35	0.00
Quercus rubra	33.65	21.45	22.45	20.79
Rhododendron maximum	0.00	0.00	0.00	3.99
Rhus typhina	0.00	2.50	0.00	0.00
Robinia hispida	0.00	4.82	2.63	4.10
Sambucus nigra ssp. canadensis	0.00	2.34	0.00	0.00
Tilia americana	6.99	3.68	5.45	6.82
Tsuga canadensis	25.95	15.06	18.26	23.99
Vaccinium corymbosum	0.00	4.97	7.39	5.74
Vaccinium fuscatum	0.00	0.00	0.00	6.87
Viburnum acerifolium	0.00	6.19	6.45	7.88
Viburnum lentago	0.00	0.00	0.00	3.58
Viburnum nudum var. cassinoides	0.00	3.64	4.02	0.00
TOTALS	300.00	300.00	300.00	300.00

Table 35. Overstory relative density, frequency and dominance data on HNI across the four samplings (values for 1978, 1991 and 2001 from Holland and Clapham 2012).

	Relative Density				Relative Dominance				Relative Frequency			
Species	**1978**	**1991**	**2001**	**2011**	**1978**	**1991**	**2001**	**2011**	**1978**	**1991**	**2001**	**2011**
Acer pensylvanicum	0.57	0.21	0.00	0.00	5.07	3.90	0.00	0.00	5.26	3.33	0.00	0.00
Acer rubrum	2.27	1.04	4.27	3.47	6.33	10.13	6.09	6.30	10.53	3.33	6.25	6.06
Acer saccharum	0.57	1.66	0.00	0.00	10.14	4.87	0.00	0.00	5.26	6.67	0.00	0.00
Alnus incana ssp. rugosa	0.00	11.59	12.96	16.38	0.00	3.90	4.06	4.54	0.00	6.67	6.25	6.06
Amelanchier laevis	0.57	6.42	4.12	6.45	5.07	3.90	4.06	4.26	5.26	6.67	9.38	6.06
Betula lenta	2.27	0.00	0.00	0.00	6.33	0.00	0.00	0.00	5.26	0.00	0.00	0.00
Betula papyrifera	1.70	1.24	0.61	1.24	8.45	9.74	11.17	4.10	5.26	10.00	6.25	3.03
Betula populifolia	6.82	7.66	10.21	8.56	5.07	4.42	4.06	5.05	5.26	3.33	3.13	6.06
Gaylussacia baccata	0.00	0.00	1.52	0.00	0.00	0.00	4.06	0.00	0.00	0.00	3.13	0.00
Hamamelis virginiana	1.70	2.69	4.12	7.32	5.07	3.90	4.06	4.17	5.26	6.67	6.25	6.06
Lyonia ligustrina	0.00	13.87	8.23	6.95	0.00	3.90	4.06	4.10	0.00	3.33	6.25	3.03
Nyssa sylvatica	0.00	0.00	0.00	0.12	0.00	0.00	0.00	4.10	0.00	0.00	0.00	3.03
Pinus resinosa	17.61	7.87	6.40	4.59	12.91	10.97	13.54	10.86	10.53	10.00	9.38	9.09
Pinus strobus	26.70	8.49	8.23	6.20	13.80	11.02	11.06	10.99	15.79	10.00	9.38	9.09
Populus tremuloides	0.00	0.62	0.00	0.00	0.00	3.90	0.00	0.00	0.00	3.33	0.00	0.00
Quercus rubra	10.80	7.87	5.49	6.45	12.54	8.00	10.95	7.34	15.79	10.00	9.38	9.09
Rhododendron canadense	0.00	0.00	0.00	0.12	0.00	0.00	0.00	4.10	0.00	0.00	0.00	3.03
Rosa palustris	0.00	0.00	0.00	0.25	0.00	0.00	0.00	4.10	0.00	0.00	0.00	3.03
Tsuga canadensis	28.41	27.33	25.30	16.00	9.22	9.68	10.62	9.57	10.53	10.00	9.38	9.09
Vaccinium corymbosum	0.00	0.00	0.91	3.35	0.00	0.00	4.06	4.10	0.00	0.00	6.25	3.03
Vaccinium fuscatum	0.00	0.00	0.00	6.58	0.00	0.00	0.00	4.10	0.00	0.00	0.00	3.03
Viburnum nudum var. cassinoides	0.00	1.04	6.71	5.21	0.00	3.90	4.06	4.10	0.00	3.33	6.25	6.06
Viburnum recognitum	0.00	0.41	0.91	0.74	0.00	3.90	4.06	4.10	0.00	3.33	3.13	6.06
TOTALS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 36. Overstory importance values on HNI (values for 1978, 1991 and 2001 from Holland and Clapham 2012).

Species	**1978**	**1991**	**2001**	**2011**
Acer pensylvanicum	10.90	7.44	0.00	0.00
Acer rubrum	19.13	14.50	16.61	15.83
Acer saccharum	15.97	13.19	0.00	0.00
Alnus incana ssp. rugosa	0.00	22.16	23.27	26.97
Amelanchier laevis	10.90	16.98	17.55	16.77
Betula lenta	13.87	0.00	0.00	0.00
Betula papyrifera	15.41	20.98	18.03	8.37
Betula populifolia	17.15	15.42	17.40	19.67
Gaylussacia baccata	0.00	0.00	8.71	0.00
Hamamelis virginiana	12.04	13.25	14.43	17.55
Lyonia ligustrina	0.00	21.10	18.54	14.08
Nyssa sylvatica	0.00	0.00	0.00	7.26
Pinus resinosa	41.05	28.84	29.32	24.55
Pinus strobus	56.30	29.51	28.67	26.29
Populus tremuloides	0.00	7.85	0.00	0.00
Quercus rubra	39.12	25.86	25.81	22.88
Rhododendron canadense	0.00	0.00	0.00	7.26
Rosa palustris	0.00	0.00	0.00	7.38
Tsuga canadensis	48.16	47.01	45.30	34.67
Vaccinium corymbosum	0.00	0.00	11.23	10.48
Vaccinium fuscatum	0.00	0.00	0.00	13.71
Viburnum nudum var. cassinoides	0.00	8.26	17.02	15.37
Viburnum recognitum	0.00	7.64	8.10	10.91
TOTALS	300.00	300.00	300.00	300.00

Table 37. Overstory relative density, frequency and dominance data on BI across the four samplings (values for 1978, 1991 and 2001 from Holland and Clapham 2012).

	Relative Density				Relative Dominance				Relative Frequency			
Species	**1978**	**1991**	**2001**	**2011**	**1978**	**1991**	**2001**	**2011**	**1978**	**1991**	**2001**	**2011**
Acer pensylvanicum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acer rubrum	12.16	1.47	1.37	0.93	14.33	5.86	5.48	4.59	12.50	9.09	6.52	6.82
Acer saccharum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alnus incana ssp. rugosa	4.05	1.98	3.47	1.79	5.16	3.35	2.78	2.78	6.25	6.06	6.52	4.55
Amelanchier laevis	0.00	0.97	1.30	0.75	0.00	3.51	3.63	3.44	0.00	6.06	6.52	4.55
Betula papyrifera	5.41	0.18	0.07	0.61	11.61	9.21	5.56	3.14	6.25	3.03	4.35	2.27
Betula populifolia	13.51	4.73	4.23	3.67	9.29	4.52	3.92	3.50	18.75	9.09	6.52	4.55
Fagus grandifolia	1.35	0.00	0.04	0.03	5.16	0.00	5.56	6.39	6.25	0.00	2.17	2.27
Fraxinus nigra	0.00	0.00	0.00	0.09	0.00	0.00	0.00	4.97	0.00	0.00	0.00	2.27
Gaylussica baccata	0.00	0.00	0.04	0.09	0.00	0.00	2.78	2.13	0.00	0.00	2.17	2.27
Hamamelis virginiana	2.70	0.28	0.18	0.14	5.16	3.35	2.78	2.13	6.25	3.03	2.17	2.27
Ilex mucronata	0.00	16.18	26.99	23.71	0.00	3.35	2.78	2.13	0.00	3.03	2.17	2.27
Ilex verticillata	0.00	11.49	22.65	0.58	0.00	3.35	2.78	2.13	0.00	3.03	6.52	4.55
Lyonia ligustrina	0.00	0.92	6.48	0.98	0.00	3.35	2.78	2.63	0.00	3.03	4.35	6.82
Myrica gale	0.00	18.80	0.69	0.00	0.00	3.35	2.78	0.00	0.00	3.03	2.17	0.00
Nyssa sylvatica	6.76	0.51	0.76	1.39	6.19	8.22	5.69	3.28	12.50	6.06	6.52	6.82
Picea rubens	1.35	0.09	0.18	0.03	15.48	8.37	7.22	8.52	6.25	3.03	4.35	2.27
Pinus resinosa	0.00	0.83	0.51	0.38	0.00	8.93	8.34	7.04	0.00	9.09	4.35	4.55
Pinus strobus	22.97	1.42	1.01	0.87	9.71	10.58	8.83	7.52	6.25	6.06	4.35	6.82
Populus grandidentata	0.00	0.09	0.07	0.00	0.00	6.70	4.17	0.00	0.00	3.03	2.17	0.00
Populus tremuloides	0.00	0.00	0.00	0.03	0.00	0.00	0.00	8.52	0.00	0.00	0.00	2.27
Prunus pensylvanica	0.00	0.37	0.62	0.00	0.00	3.35	2.78	0.00	0.00	6.06	2.17	0.00
Prunus serotina	0.00	0.00	0.51	0.00	0.00	0.00	4.17	0.00	0.00	0.00	2.17	0.00
Quercus rubra	0.00	0.00	0.00	0.06	0.00	0.00	0.00	5.32	0.00	0.00	0.00	4.55
Rosa palustris	0.00	0.00	0.00	0.06	0.00	0.00	0.00	2.13	0.00	0.00	0.00	2.27
Spiraea alba var. latifolia	0.00	0.00	0.36	0.20	0.00	0.00	2.78	2.13	0.00	0.00	2.17	2.27
Tilia americana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tsuga canadensis	22.97	2.21	1.52	1.27	12.75	7.32	6.75	6.68	12.50	9.09	6.52	6.82
Vaccinium corymbosum	6.76	37.50	23.59	30.88	5.16	3.35	2.91	2.31	6.25	9.09	6.52	2.27
Vaccinium fuscatum	0.00	0.00	0.00	29.73	0.00	0.00	0.00	2.14	0.00	0.00	0.00	6.82
Viburnum lentago	0.00	0.00	0.00	1.59	0.00	0.00	0.00	2.32	0.00	0.00	0.00	4.55
Viburnum nudum var. cassinoides	0.00	0.00	3.36	0.14	0.00	0.00	2.78	2.13	0.00	0.00	6.52	2.27
TOTALS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 38. Overstory importance values on BI (values for 1978, 1991 and 2001 from Holland and Clapham 2012).

Species	1978	1991	2001	2011
Acer pensylvanicum	0.00	0.00	0.00	0.00
Acer rubrum	38.99	16.42	13.38	12.33
Acer saccharum	0.00	0.00	0.00	0.00
Alnus incana ssp. rugosa	15.46	11.38	12.77	9.12
Amelanchier laevis	0.00	10.53	11.45	8.74
Betula papyrifera	23.26	12.42	9.98	6.02
Betula populifolia	41.55	18.34	14.67	11.72
Fagus grandifolia	12.76	0.00	7.77	8.69
Fraxinus nigra	0.00	0.00	0.00	7.33
Gaylussica baccata	0.00	0.00	4.99	4.49
Hamamelis virginiana	14.11	6.65	5.13	4.55
Ilex mucronata	0.00	22.55	31.94	28.11
Ilex verticillata	0.00	17.87	31.95	7.25
Lyonia ligustrina	0.00	7.30	13.60	10.43
Myrica gale	0.00	25.17	5.64	0.00
Nyssa sylvatica	25.45	14.78	12.97	11.49
Picea rubens	23.08	11.49	11.75	10.82
Pinus resinosa	0.00	18.85	13.19	11.96
Pinus strobus	38.94	18.07	14.19	15.21
Populus grandidentata	0.00	9.82	6.41	0.00
Populus tremuloides	0.00	0.00	0.00	10.82
Prunus pensylvanica	0.00	9.78	5.57	0.00
Prunus serotina	0.00	0.00	6.85	0.00
Quercus rubra	0.00	0.00	0.00	9.93
Rosa palustris	0.00	0.00	0.00	4.46
Spiraea alba var. latifolia	0.00	0.00	5.31	4.60
Tilia americana	0.00	0.00	0.00	0.00
Tsuga canadensis	48.22	18.62	14.79	14.77
Vaccinium corymbosum	18.17	49.94	33.02	35.47
Vaccinium fuscatum	0.00	0.00	0.00	38.69
Viburnum lentago	0.00	0.00	0.00	8.46
Viburnum nudum var. cassinoides	0.00	0.00	12.66	4.55
TOTALS	300.00	300.00	300.00	300.00

Table 39. Overstory total DBH data by plot on TMI and HNI in 2011.

	Three Mile Island										
Species Name/Plot	35	50	51	53	94	96	97	108	139	142	144
Acer pensylvanicum	22.183	23.191	36.905	1.638	37.526	53.955	57.164	29.486	36.655	25.593	19.838
Acer rubrum	43.825	125.830	38.313	74.216	58.587	45.080	41.191	80.759	68.648	41.008	44.277
Acer saccharum	0.000	0.000	2.836	0.000	0.000	0.000	43.668	0.000	0.000	0.000	0.000
Alnus incana ssp. rugosa	0.000	0.000	0.000	21.429	0.000	0.000	0.000	8.686	0.000	0.000	0.000
Amelanchier laevis	3.275	0.000	4.632	9.826	0.000	0.000	0.000	6.928	0.000	0.000	0.000
Betula allegheniensis	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Betula lenta	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Betula papyrifera	0.000	0.000	0.000	18.340	52.420	0.000	29.600	0.000	74.720	0.000	0.000
Betula populifolia	0.000	0.000	0.000	10.815	0.000	0.000	0.000	16.453	0.000	0.000	0.000
Fagus grandifolia	44.860	64.597	8.770	9.338	4.011	29.911	48.278	30.612	8.195	9.526	24.319
Fraxinus americana	0.000	0.000	0.000	0.000	0.000	27.182	0.000	0.000	0.000	0.000	0.000
Gaylussacia baccata	1.638	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hamamelis virginiana	17.834	19.811	26.414	35.639	14.073	6.148	6.635	31.195	1.638	0.000	0.000
Ilex mucronata	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ilex verticillata	1.638	0.000	0.000	0.000	0.000	0.000	0.000	18.346	0.000	0.000	0.000
Lyonia ligustrina	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Myrica gale	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nyssa sylvatica	0.000	29.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ostrya virginiana	1.638	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Picea rubens	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pinus resinosa	46.384	17.753	35.917	39.710	0.000	85.235	35.269	0.000	0.000	0.000	0.000
Pinus strobus	129.913	72.435	135.911	112.431	120.967	166.433	167.809	91.189	98.391	108.139	95.303
Populus grandidentata	3.386	0.000	0.000	0.000	0.000	0.000	0.000	0.000	49.272	0.000	0.000
Populus tremuloides	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Prunus pensylvanica	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Prunus serotina	0.000	0.000	0.000	0.000	6.773	0.000	0.000	0.000	0.000	0.000	0.000
Quercus rubra	118.442	150.454	137.578	111.884	104.307	68.440	100.273	52.938	65.038	139.077	158.128
Rhododendron canadense	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rhododendron maximum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rhus typhina	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Robinia hispida	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rosa palustris	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sambucus nigra ssp. canadensis	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tilia americana	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tsuga canadensis	31.644	31.953	43.153	30.762	155.769	123.470	98.084	120.876	50.987	59.222	200.780
Vaccinium corymbosum	0.000	0.000	2.836	7.138	0.000	0.000	0.000	12.685	0.000	0.000	0.000
Vaccinium fuscatum	0.000	7.681	0.000	0.000	4.011	0.000	0.000	13.915	0.000	0.000	2.836
Viburnum acerifolium	0.000	0.000	4.632	5.673	0.000	0.000	2.316	0.000	3.662	2.316	0.000
Viburnum lentago	0.000	1.638	0.000	6.550	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Viburnum nudum var. cassinoides	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Viburnum recognitum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 39. Overstory total DBH data by plot on TMI and HNI in 2011.

	Three Mile Island								Hawk's Nest		
Species Name/Plot	160	170	186	219	232	245	246	248	224	254	284
Acer pensylvanicum	7.290	7.572	26.484	66.913	17.058	26.976	15.174	9.318	0.000	0.000	0.000
Acer rubrum	68.803	65.260	72.069	64.655	55.305	72.698	34.073	21.553	31.198	0.000	50.766
Acer saccharum	0.000	0.000	0.000	26.124	12.106	1.638	33.272	58.877	0.000	0.000	0.000
Alnus incana ssp. rugosa	0.000	0.000	0.000	0.000	0.000	18.779	0.000	0.000	10.473	0.000	20.719
Amelanchier laevis	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.513	0.000	11.290
Betula allegheniensis	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Betula lenta	0.000	37.710	0.000	0.000	2.836	0.000	0.000	0.000	0.000	0.000	0.000
Betula papyrifera	0.000	0.000	13.087	0.000	0.000	38.686	0.000	0.000	0.000	0.000	5.178
Betula populifolia	0.000	0.000	0.000	0.000	6.368	0.000	0.000	0.000	2.836	0.000	19.857
Fagus grandifolia	84.533	69.114	74.617	94.611	13.997	72.518	55.176	13.573	0.000	0.000	0.000
Fraxinus americana	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gaylussacia baccata	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hamamelis virginiana	8.965	18.605	0.000	2.316	17.531	28.294	24.460	15.573	9.407	0.000	8.822
Ilex mucronata	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ilex verticillata	0.000	2.316	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lyonia ligustrina	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.255
Myrica gale	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nyssa sylvatica	0.000	11.499	0.000	0.000	0.000	0.000	0.000	0.000	1.638	0.000	0.000
Ostrya virginiana	11.740	0.000	0.000	40.988	25.602	5.074	18.060	38.493	0.000	0.000	0.000
Picea rubens	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pinus resinosa	0.000	0.000	0.000	0.000	0.000	0.000	0.000	42.447	115.966	62.493	90.221
Pinus strobus	58.517	76.580	37.263	24.732	46.485	17.052	82.225	52.374	127.607	102.476	134.344
Populus grandidentata	0.000	52.692	0.000	0.000	0.000	0.000	29.984	1.638	0.000	0.000	0.000
Populus tremuloides	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Prunus pensylvanica	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Prunus serotina	0.000	0.000	0.000	0.000	18.504	0.000	0.000	0.000	0.000	0.000	0.000
Quercus rubra	135.522	127.768	132.743	118.841	151.286	115.049	111.892	139.559	73.273	99.802	47.592
Rhododendron canadense	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.638
Rhododendron maximum	0.000	7.568	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rhus typhina	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Robinia hispida	0.000	0.000	0.000	0.000	1.638	0.000	0.000	0.000	0.000	0.000	0.000
Rosa palustris	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.316
Sambucus nigra ssp. canadensis	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tilia americana	0.000	0.000	0.000	0.000	40.754	0.000	0.000	1.638	0.000	0.000	0.000
Tsuga canadensis	31.894	50.865	100.935	47.920	6.360	79.681	2.316	3.487	175.584	197.112	47.435
Vaccinium corymbosum	0.000	1.638	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.509
Vaccinium fuscatum	0.000	3.275	0.000	0.000	0.000	4.632	0.000	0.000	13.864	0.000	0.000
Viburnum acerifolium	2.836	0.000	1.638	0.000	4.632	0.000	2.316	1.638	0.000	0.000	0.000
Viburnum lentago	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Viburnum nudum var. cassinoides	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	9.118	0.000	5.431
Viburnum recognitum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.638	0.000	3.662

Table 40. Total Overstory DBH data by island for TMI and HNI.

Species Name/Island	TMI	Hawk	TOTAL
Acer pensylvanicum	520.918	0.000	520.918
Acer rubrum	1116.152	81.963	1198.115
Acer saccharum	178.521	0.000	178.521
Alnus incana ssp. rugosa	48.894	31.192	80.087
Amelanchier laevis	24.660	17.803	42.463
Betula allegheniensis	0.000	0.000	0.000
Betula lenta	40.547	0.000	40.547
Betula papyrifera	226.853	5.178	232.031
Betula populifolia	33.635	22.693	56.329
Fagus grandifolia	760.555	0.000	760.555
Fraxinus americana	27.182	0.000	27.182
Gaylussacia baccata	1.638	0.000	1.638
Hamamelis virginiana	275.129	18.229	293.358
Ilex mucronata	0.000	0.000	0.000
Ilex verticillata	22.299	0.000	22.299
Lyonia ligustrina	0.000	12.255	12.255
Myrica gale	0.000	0.000	0.000
Nyssa sylvatica	40.624	1.638	42.262
Ostrya virginiana	141.595	0.000	141.595
Picea rubens	0.000	0.000	0.000
Pinus resinosa	302.715	268.680	571.396
Pinus strobus	1694.149	364.427	2058.576
Populus grandidentata	136.972	0.000	136.972
Populus tremuloides	0.000	0.000	0.000
Prunus pensylvanica	0.000	0.000	0.000
Prunus serotina	25.277	0.000	25.277
Quercus rubra	2239.216	220.666	2459.883
Rhododendron canadense	0.000	1.638	1.638
Rhododendron maximum	7.568	0.000	7.568
Rhus typhina	0.000	0.000	0.000
Robinia hispida	1.638	0.000	1.638
Rosa palustris	0.000	2.316	2.316
Sambucus nigra ssp. canadensis	0.000	0.000	0.000
Tilia americana	42.391	0.000	42.391
Tsuga canadensis	1270.158	420.130	1690.289
Vaccinium corymbosum	24.297	8.509	32.806
Vaccinium fuscatum	36.351	13.864	50.214
Viburnum acerifolium	31.657	0.000	31.657
Viburnum lentago	8.188	0.000	8.188
Viburnum nudum var. cassinoides	0.000	14.549	14.549
Viburnum recognitum	0.000	5.299	5.299

Table 41. Overstory basal areas by plot on TMI and HNI in 2011.
Basal area = (DBH^2*0.7458)/10000 (cm^2/m^2) (Brewer and McCann 1982).

	Three Mile Island										
Species Name/Plot	35	50	51	53	94	96	97	108	139	142	144
Acer pensylvanicum	0.0367	0.0401	0.1016	0.0002	0.1050	0.2171	0.2437	0.0648	0.1002	0.0489	0.0293
Acer rubrum	0.1432	1.1808	0.1095	0.4108	0.2560	0.1516	0.1265	0.4864	0.3515	0.1254	0.1462
Acer saccharum	0.0000	0.0000	0.0006	0.0000	0.0000	0.0000	0.1422	0.0000	0.0000	0.0000	0.0000
Alnus incana ssp. rugosa	0.0000	0.0000	0.0000	0.0342	0.0000	0.0000	0.0000	0.0056	0.0000	0.0000	0.0000
Amelanchier laevis	0.0008	0.0000	0.0016	0.0072	0.0000	0.0000	0.0000	0.0036	0.0000	0.0000	0.0000
Betula allegheniensis	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Betula lenta	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Betula papyrifera	0.0000	0.0000	0.0000	0.0251	0.2049	0.0000	0.0653	0.0000	0.4164	0.0000	0.0000
Betula populifolia	0.0000	0.0000	0.0000	0.0087	0.0000	0.0000	0.0000	0.0202	0.0000	0.0000	0.0000
Fagus grandifolia	0.1501	0.3112	0.0057	0.0065	0.0012	0.0667	0.1738	0.0699	0.0050	0.0068	0.0441
Fraxinus americana	0.0000	0.0000	0.0000	0.0000	0.0000	0.0551	0.0000	0.0000	0.0000	0.0000	0.0000
Gaultheria procumbens	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Gaylussacia baccata	0.0237	0.0293	0.0520	0.0947	0.0148	0.0028	0.0033	0.0726	0.0002	0.0000	0.0000
Hamamelis virginiana	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ilex mucronata	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0251	0.0000	0.0000	0.0000
Ilex verticillata	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Lyonia ligustrina	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Myrica gale	0.0000	0.0633	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nyssa sylvatica	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ostrya virginiana	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Picea rubens	0.1605	0.0235	0.0962	0.1176	0.0000	0.5418	0.0928	0.0000	0.0000	0.0000	0.0000
Pinus resinosa	1.2587	0.3913	1.3776	0.9427	1.0913	2.0659	2.1002	0.6202	0.7220	0.8721	0.6774
Pinus strobus	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1811	0.0000	0.0000
Populus grandidentata	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Populus tremuloides	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Prunus pensylvanica	0.0000	0.0000	0.0000	0.0000	0.0034	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Prunus serotina	1.0462	1.6882	1.4116	0.9336	0.8114	0.3493	0.7499	0.2090	0.3155	1.4426	1.8648
Quercus rubra	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Rhododendron canadense	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Rhododendron maximum	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Rhus typhina	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Robinia hispida	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Rosa palustris	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Sambucus nigra ssp. canadensis	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tilia americana	0.0747	0.0761	0.1389	0.0706	1.8096	1.1370	0.7175	1.0897	0.1939	0.2616	3.0065
Tsuga canadensis	0.0000	0.0000	0.0006	0.0038	0.0000	0.0000	0.0000	0.0120	0.0000	0.0000	0.0000
Vaccinium corymbosum	0.0000	0.0044	0.0000	0.0000	0.0012	0.0000	0.0000	0.0144	0.0000	0.0000	0.0006
Vaccinium fuscatum	0.0000	0.0000	0.0016	0.0024	0.0000	0.0000	0.0004	0.0000	0.0010	0.0004	0.0000
Viburnum acerifolium	0.0000	0.0002	0.0000	0.0032	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Viburnum lentago	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Viburnum nudum var. cassinoides	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Viburnum recognitum	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 41. Overstory basal areas by plot on TMI and HNI in 2011.

	Three Mile Island								Hawk's Nest		
Species Name/Plot	160	170	186	219	232	245	246	248	224	254	284
Acer pensylvanicum	0.0040	0.0043	0.0523	0.3339	0.0217	0.0543	0.0172	0.0065	0.0000	0.0000	0.0000
Acer rubrum	0.3531	0.3176	0.3874	0.3118	0.2281	0.3942	0.0866	0.0346	0.0726	0.0000	0.1922
Acer saccharum	0.0000	0.0000	0.0000	0.0509	0.0109	0.0002	0.0826	0.2585	0.0000	0.0000	0.0000
Alnus incana ssp. rugosa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0263	0.0000	0.0000	0.0082	0.0000	0.0320
Amelanchier laevis	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0032	0.0000	0.0095
Betula allegheniensis	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Betula lenta	0.0000	0.1061	0.0000	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Betula papyrifera	0.0000	0.0000	0.0128	0.0000	0.0000	0.1116	0.0000	0.0000	0.0000	0.0000	0.0020
Betula populifolia	0.0000	0.0000	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	0.0006	0.0000	0.0294
Fagus grandifolia	0.5329	0.3563	0.4152	0.6676	0.0146	0.3922	0.2270	0.0137	0.0000	0.0000	0.0000
Fraxinus americana	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Gaultheria procumbens	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Gaylussacia baccata	0.0060	0.0258	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Hamamelis virginiana	0.0000	0.0000	0.0000	0.0004	0.0229	0.0597	0.0446	0.0181	0.0066	0.0000	0.0058
Ilex mucronata	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ilex verticillata	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Lyonia ligustrina	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0112
Myrica gale	0.0000	0.0099	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nyssa sylvatica	0.0103	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000
Ostrya virginiana	0.0000	0.0000	0.0000	0.1253	0.0489	0.0019	0.0243	0.1105	0.0000	0.0000	0.0000
Picea rubens	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pinus resinosa	0.2554	0.4374	0.0000	0.0000	0.0000	0.0000	0.0000	0.1344	1.0030	0.2913	0.6071
Pinus strobus	0.0000	0.2071	0.1036	0.0456	0.1612	0.0217	0.5042	0.2046	1.2144	0.7832	1.3460
Populus grandidentata	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0671	0.0002	0.0000	0.0000	0.0000
Populus tremuloides	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Prunus pensylvanica	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Prunus serotina	1.3697	1.2175	0.0000	0.0000	0.0255	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Quercus rubra	0.0000	0.0000	1.3141	1.0533	1.7069	0.9872	0.9337	1.4526	0.4004	0.7428	0.1689
Rhododendron canadense	0.0000	0.0043	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
Rhododendron maximum	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Rhus typhina	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Robinia hispida	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Rosa palustris	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004
Sambucus nigra ssp. canadensis	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tilia americana	0.0759	0.1930	0.0000	0.0000	0.1239	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000
Tsuga canadensis	0.0000	0.0002	0.7598	0.1713	0.0030	0.4735	0.0004	0.0009	2.2993	2.8977	0.1678
Vaccinium corymbosum	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0054
Vaccinium fuscatum	0.0006	0.0000	0.0000	0.0000	0.0000	0.0016	0.0000	0.0000	0.0143	0.0000	0.0000
Viburnum acerifolium	0.0000	0.0000	0.0002	0.0000	0.0016	0.0000	0.0004	0.0002	0.0000	0.0000	0.0000
Viburnum lentago	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Viburnum nudum var. cassinoides	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0062	0.0000	0.0022
Viburnum recognitum	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0010

Table 42. Total overstory basal areas of overstory vegetation on TMI and HNI in 2011.

Species Name/Island	TMI	Hawk	TOTAL
Acer pensylvanicum	1.482	0.0000	1.482
Acer rubrum	5.601	0.2648	5.866
Acer saccharum	0.546	0.0000	0.546
Alnus incana ssp. rugosa	0.066	0.0402	0.106
Amelanchier laevis	0.013	0.0127	0.026
Betula allegheniensis	0.000	0.0000	0.000
Betula lenta	0.107	0.0000	0.107
Betula papyrifera	0.836	0.0020	0.838
Betula populifolia	0.032	0.0300	0.062
Fagus grandifolia	3.461	0.0000	3.461
Fraxinus americana	0.055	0.0000	0.055
Gaultheria procumbens	0.000	0.0008	0.001
Gaylussacia baccata	0.471	0.0000	0.471
Hamamelis virginiana	0.000	0.0000	0.000
Ilex mucronata	0.026	0.0000	0.026
Ilex verticillata	0.000	0.0112	0.011
Lyonia ligustrina	0.000	0.0000	0.000
Myrica gale	0.073	0.0002	0.073
Nyssa sylvatica	0.321	0.0000	0.321
Ostrya virginiana	0.000	0.0000	0.000
Picea rubens	1.167	1.9013	3.068
Pinus resinosa	13.853	3.3437	17.197
Pinus strobus	0.456	0.0000	0.456
Populus grandidentata	0.000	0.0000	0.000
Populus tremuloides	0.000	0.0000	0.000
Prunus pensylvanica	0.029	0.0000	0.029
Prunus serotina	20.857	1.3122	22.169
Quercus rubra	0.000	0.0002	0.000
Rhododendron canadense	0.004	0.0000	0.004
Rhododendron maximum	0.000	0.0000	0.000
Rhus typhina	0.000	0.0000	0.000
Robinia hispida	0.000	0.0004	0.000
Rosa palustris	0.000	0.0000	0.000
Sambucus nigra ssp. canadensis	0.124	0.0000	0.124
Tilia americana	10.254	5.3647	15.618
Tsuga canadensis	0.017	0.0054	0.022
Vaccinium corymbosum	0.023	0.0143	0.037
Vaccinium fuscatum	0.009	0.0000	0.009
Viburnum acerifolium	0.003	0.0000	0.003
Viburnum lentago	0.000	0.0084	0.008
Viburnum nudum var. cassinoides	0.000	0.0012	0.001
Viburnum recognitum	0.000	0.0012	0.0012

Table 43. Overstory importance values for TMI and HNI using ratings and DBHs in 2011.

Three Mile Island	Importance Values			Hawk's Nest	Importance Values	
Species	Ratings	DBHs		Species	Ratings	DBHs
Acer pensylvanicum	27.38	27.12		Acer rubrum	15.83	11.68
Acer rubrum	22.41	27.68		Alnus incana ssp. rugosa	26.97	22.76
Acer saccharum	8.21	5.20		Amelanchier laevis	16.77	12.62
Alnus incana ssp. rugosa	6.49	4.16		Betula papyrifera	8.37	4.29
Amelanchier laevis	5.36	2.93		Betula populifolia	19.67	14.86
Betula lenta	4.46	1.30		Hamamelis virginiana	17.55	13.48
Betula papyrifera	8.04	4.80		Lyonia ligustrina	14.08	10.07
Betula populifolia	5.05	1.72		Nyssa sylvatica	7.26	3.16
Fagus grandifolia	25.52	28.05		Pinus resinosa	24.55	29.11
Fraxinus americana	6.30	0.60		Pinus strobus	26.29	42.42
Gaylussacia baccata	2.81	0.49		Quercus rubra	22.88	26.19
Hamamelis virginiana	32.70	30.91		Rhododendron canadense	7.26	3.16
Ilex verticillata	5.73	2.70		Rosa palustris	7.38	3.28
Nyssa sylvatica	4.43	1.46		Tsuga canadensis	34.67	68.62
Ostrya virginiana	11.04	8.54		Vaccinium corymbosum	10.48	6.42
Pinus resinosa	8.91	5.85		Vaccinium fuscatum	13.71	9.72
Pinus strobus	19.89	38.22		Viburnum nudum var. cassinoides	15.37	11.34
Populus grandidentata	7.31	3.44		Viburnum recognitum	10.91	6.81
Prunus serotina	4.21	1.17		Totals of IVs/Average of Ratios	300.00	300.00
Quercus rubra	20.79	48.64				
Rhododendron maximum	3.99	0.52				
Robinia hispida	4.10	1.01				
Tilia americana	6.82	1.23				
Tsuga canadensis	23.99	37.60				
Vaccinium corymbosum	5.74	3.45				
Vaccinium fuscatum	6.87	4.36				
Viburnum acerifolium	7.88	5.58				
Viburnum lentago	3.58	1.27				
Totals of IVs/Average of Ratios	300.00	300.00				

Footnote: The importance values calculated from ratings and dbhs were somewhat variable from one another. The only species that showed a wide range of values was *Fraxinus americana* on TMI. One reason for the discrepancies is that ratings are subjective depending on the recorder, whereas DBHs are a more objective measurement of the woody species' sizes. Another reason is that the ratings use a discrete range of integers from 1 to 4, whereas dbhs use a more continuous range from 0.00 cm up to 50.00+ cm. It is difficult to tell which one is more reliable due to the significant differences in data. However it may be easier to use the ratings method since it has been consistently used in all the samplings. This would ensure that the comparisons among samplings are also consistent with regards to future samplings. Another possibility is to use both measures of dominance in future samplings but gradually move towards the DBH method.

Table 44. Dominant Understory Species by importance values on TMI, HNI, and BI. These species are in alphabetical order for each island and sampling year.

	2011	2001	1991	1978
TMI	Aralia nudicaulis	Aralia nudicaulis	Aralia nudicaulis	Acer pensylvanicum
	Fagus grandifolia	Fagus grandifolia	Gaylussacia baccata	Aralia nudicaulis
	Gaylussacia baccata	Gaylussacia baccata	Mainthemum canadense	Gaylussacia baccata
	Maianthemum canadense	Hamamelis virginiana	Pteridium aquilinum	Pteridium aquilinum
	Tsuga canadensis	Pteridium aquilinum	Vaccinium angustifolium	Vaccinium angustifolium
Hawk's	Gaultheria procumbens	Gaylussacia baccata	Gaylussacia baccata	Aralia nudicaulis
	Gaylussacia baccata	Pinus strobus	Kalmia angustifolia	Gaylussacia baccata
	Tsuga canadensis	Vaccinium angustifolium	Vaccinium angustifolium	Vaccinium corymbosum
Blueberry	Gaylussacia baccata	Gaylussacia baccata	Gaylussacia baccata	Cephalantus occidentalus
	Vaccinium angustifolium	Ilex verticillata	Myrica gale	Vaccinium angustifolium
	Vaccinium fuscatum	Myrica gale	Vaccinium angustifolium	Vaccinium corymbosum
All Islands	Aralia nudicaulis	Aralia nudicaulis	Aralia nudicaulis	Aralia nudicaulis
	Gaultheria procumbens	Fagus grandifolia	Gaylussacia baccata	Gaylussacia baccata
	Gaylussacia baccata	Gaylussacia baccata	Maianthemum canadense	Pteridium aquilinum
	Maianthemum canadense	Pteridium aquilinum	Pteridium aquilinum	Vaccinium angustifolium
	Tsuga canadensis	Tsuga canadensis	Vaccinium angustifolium	Vaccinium corymbosum

Figure 11: Understory dominant species by importance values in 1978. Values are represented by percentages of the total importance value of all five species.

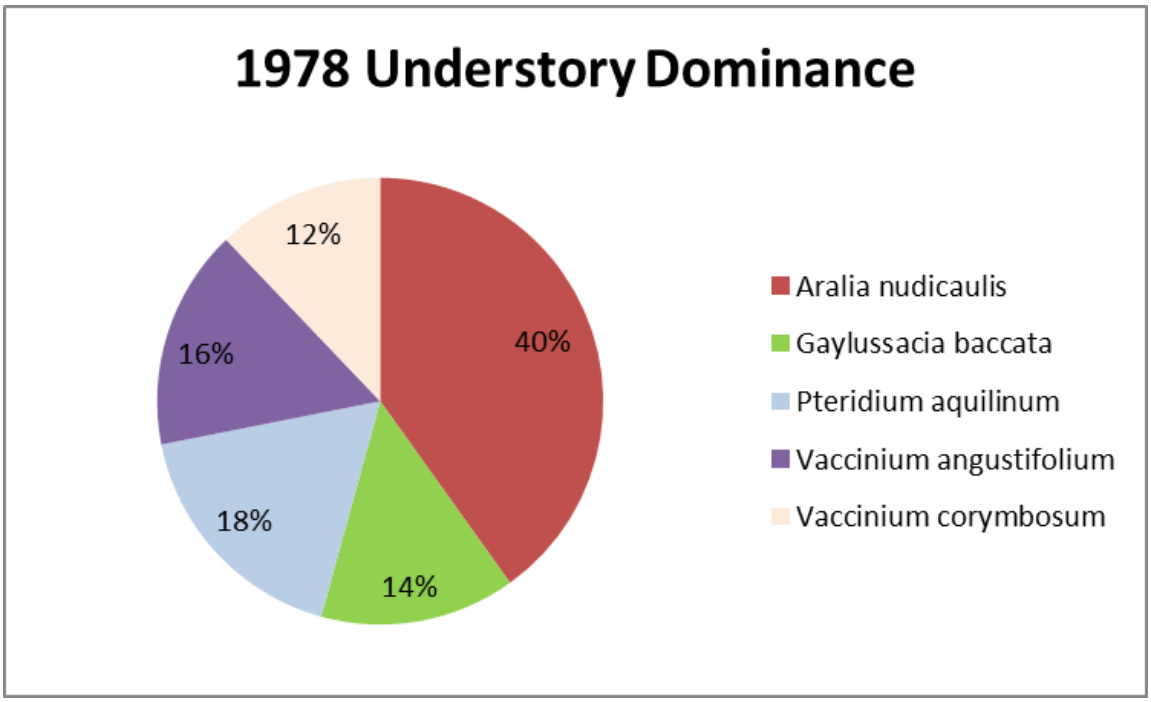


Figure 12: Understory dominant species by importance values in 1991. Values are represented by percentages of the total importance value of all five species.

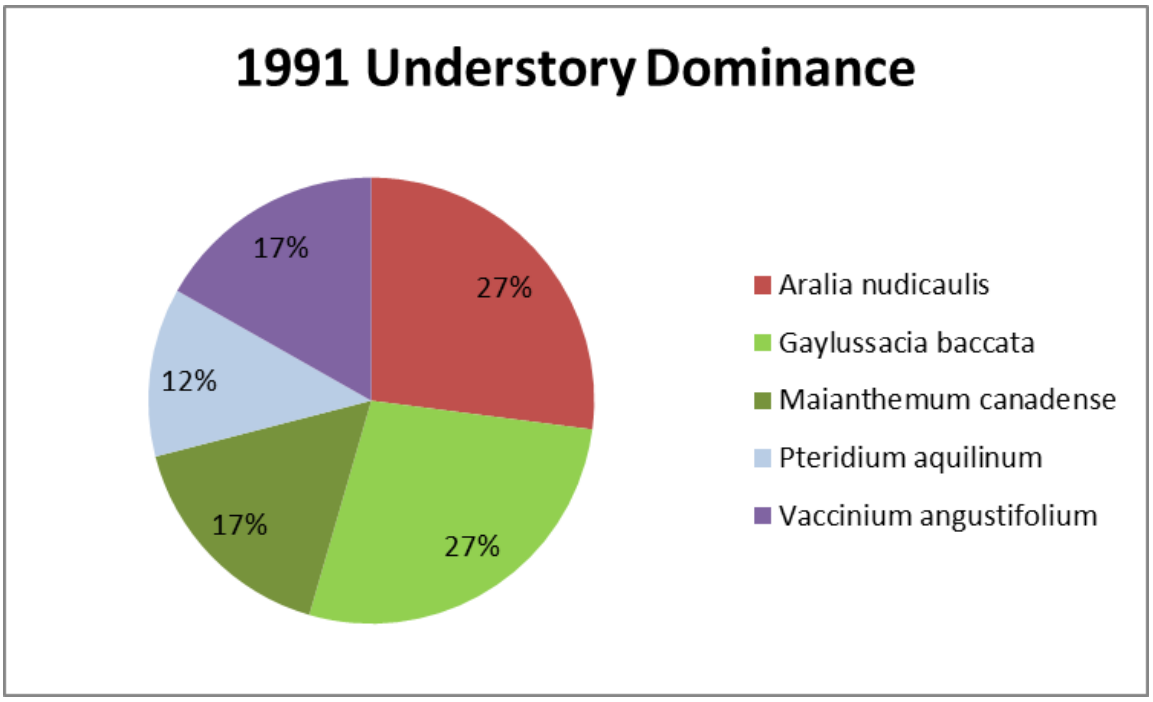


Figure 13: Understory dominant species by importance values in 2001. Values are represented by percentages of the total importance value of all five species.

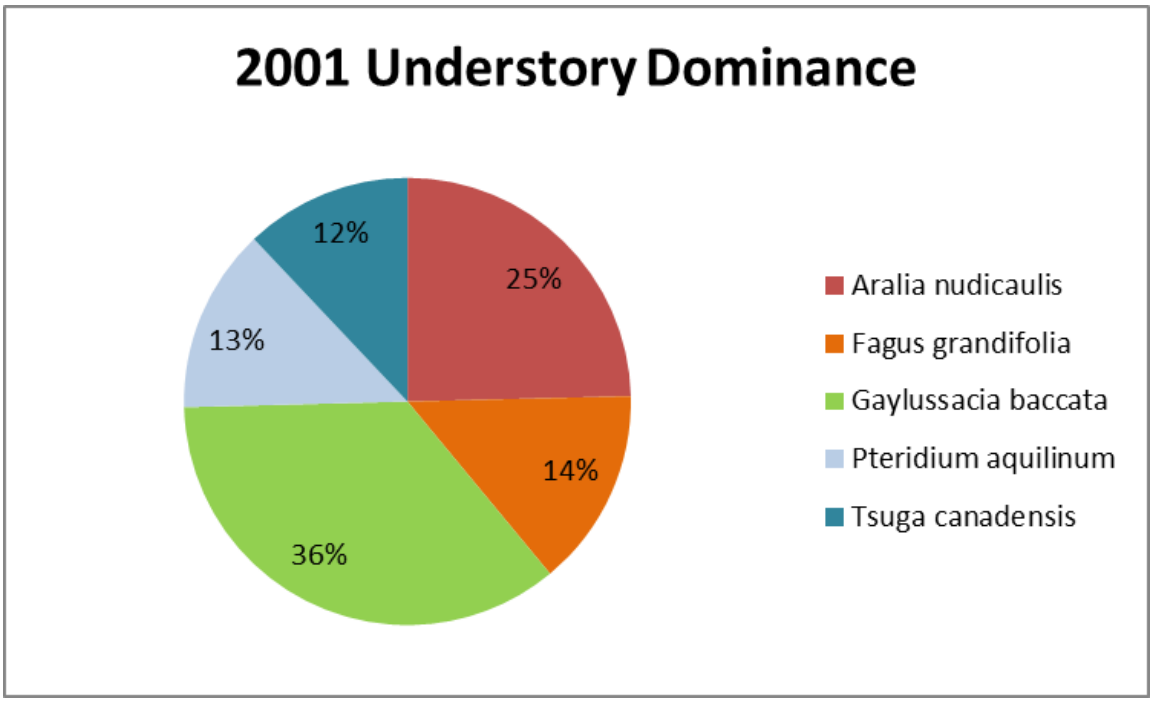


Figure 14: Understory dominant species by importance values in 2011. Values are represented by percentages of the total importance value of all five species.

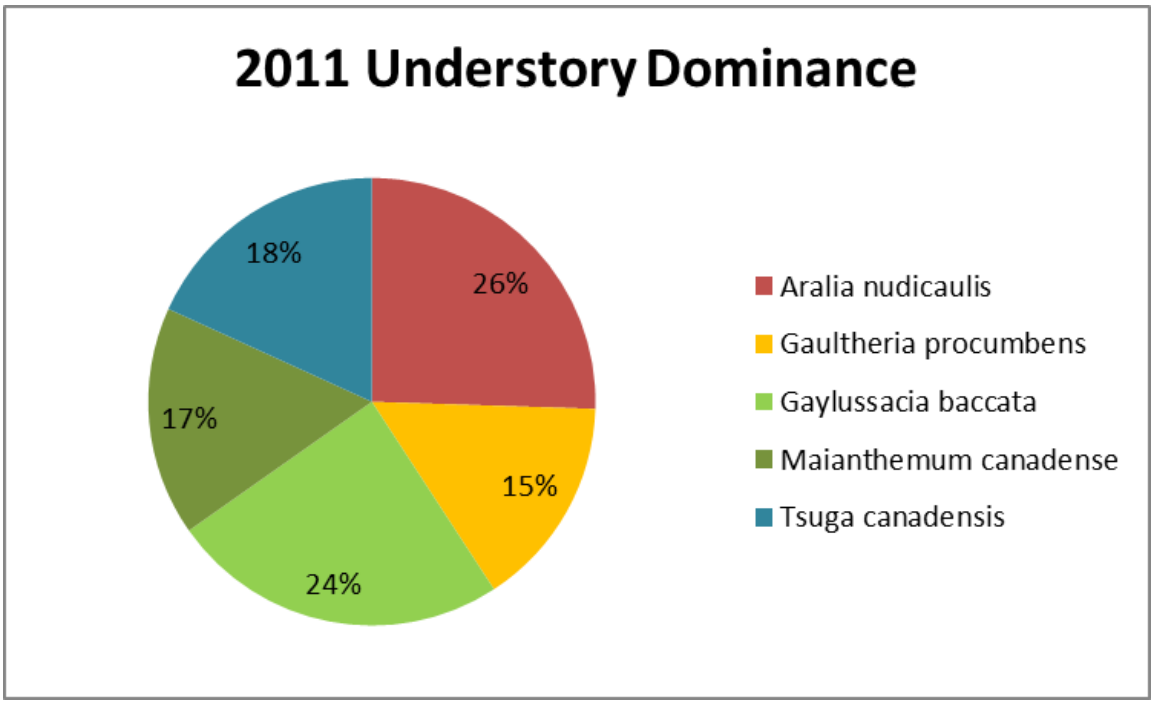


Table 45. Dominant Overstory Species based upon importance values including relative frequency, relative dominance (based on ratings), and relative density on TMI, HNI, and BI. These species are in alphabetical order for each island and sampling year (1978, 1991 and 2001 data from Holland and Clapham 2012).

	2011	2001	1991	1978
TMI	Acer pensylvanicum	Acer pensylvanicum	Acer pensylvanicum	Acer pensylvanicum
	Acer rubrum	Acer rubrum	Acer rubrum	Fagus grandifolia
	Fagus grandifolia	Fagus grandifolia	Hamamelis virginiana	Pinus strobus
	Hamamelis virginiana	Hamamelis virginiana	Pinus strobus	Quercus rubra
	Tsuga canadensis	Quercus rubra	Quercus rubra	Tsuga canadensis
Hawk's	Alnus incana ssp. rugosa	Alnus incana ssp. rugosa	Alnus incana ssp. rugosa	Acer rubrum
	Pinus resinosa	Pinus resinosa	Pinus resinosa	Pinus resinosa
	Pinus strobus	Pinus strobus	Pinus strobus	Pinus strobus
	Quercus rubra	Quercus rubra	Quercus rubra	Quercus rubra
	Tsuga canadensis	Tsuga canadensis	Tsuga canadensis	Tsuga canadensis
Blueberry	Ilex mucronata	Ilex mucronata	Ilex mucronata	Acer rubrum
	Vaccinium corymbosum	Ilex verticillata	Myrica gale	Betula populifolia
	Vaccinium fuscatum	Vaccinium corymbosum	Vaccinium corymbosum	Tsuga canadensis
All Islands	Acer rubrum	Acer rubrum	Acer rubrum	Acer rubrum
	Hamamelis virginiana	Hamamelis virginiana	Hamamelis virginiana	Betula papyrifera
	Pinus strobus	Pinus resinosa	Pinus resinosa	Betula populifolia
	Quercus rubra	Pinus strobus	Pinus strobus	Pinus resinosa
	Tsuga canadensis	Quercus rubra	Quercus rubra	Pinus strobus
	Vaccinium corymbosum	Tsuga canadensis	Tsuga canadensis	Quercus rubra
	Vaccinium fuscatum	Vaccinium corymbosum	Vaccinium corymbosum	Tsuga canadensis

Table 46. Dominant Overstory Species based on dominance values calculated from dbhs on TMI and HNI in 2011. These species are in alphabetical order for each island.

TMI	Acer pensylvanicum
	Acer rubrum
	Fagus grandifolia
	Pinus strobus
	Quercus rubra
	Tsuga canadensis
Hawk's	Pinus resinosa
	Pinus strobus
	Quercus rubra
	Tsuga canadensis
All Islands	Acer rubrum
	Fagus grandifolia
	Pinus resinosa
	Pinus strobus
	Quercus rubra
	Tsuga canadensis

Figure 15: Overstory dominant species by importance values in 1978. Values are represented by percentages of the total importance value of all five species.

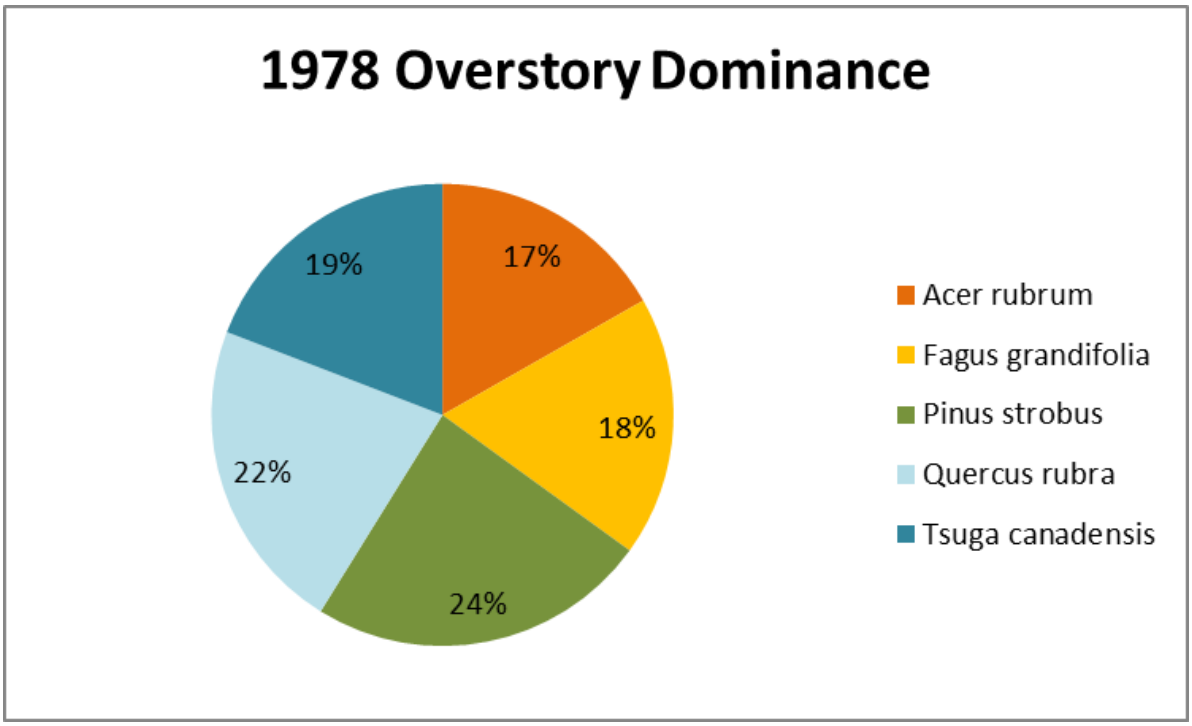


Figure 16: Overstory dominant species by importance values in 1991. Values are represented by percentages of the total importance value of all five species.

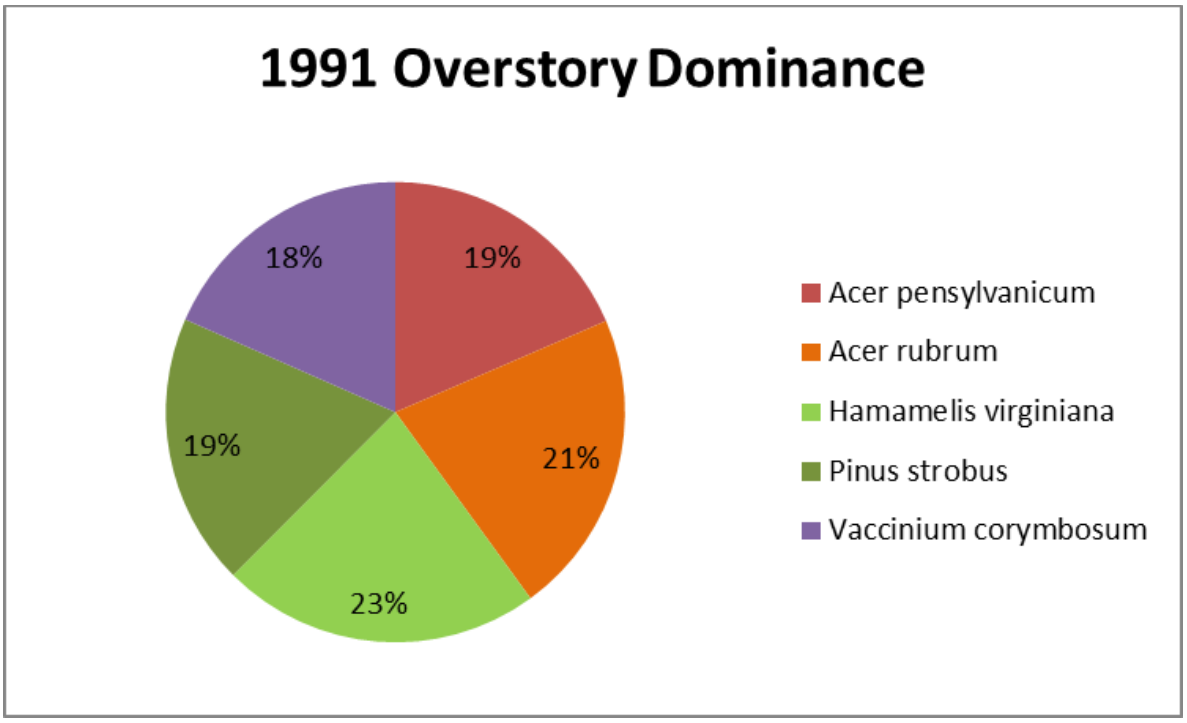


Figure 17: Overstory dominant species by importance values in 2001. Values are represented by percentages of the total importance value of all five species.

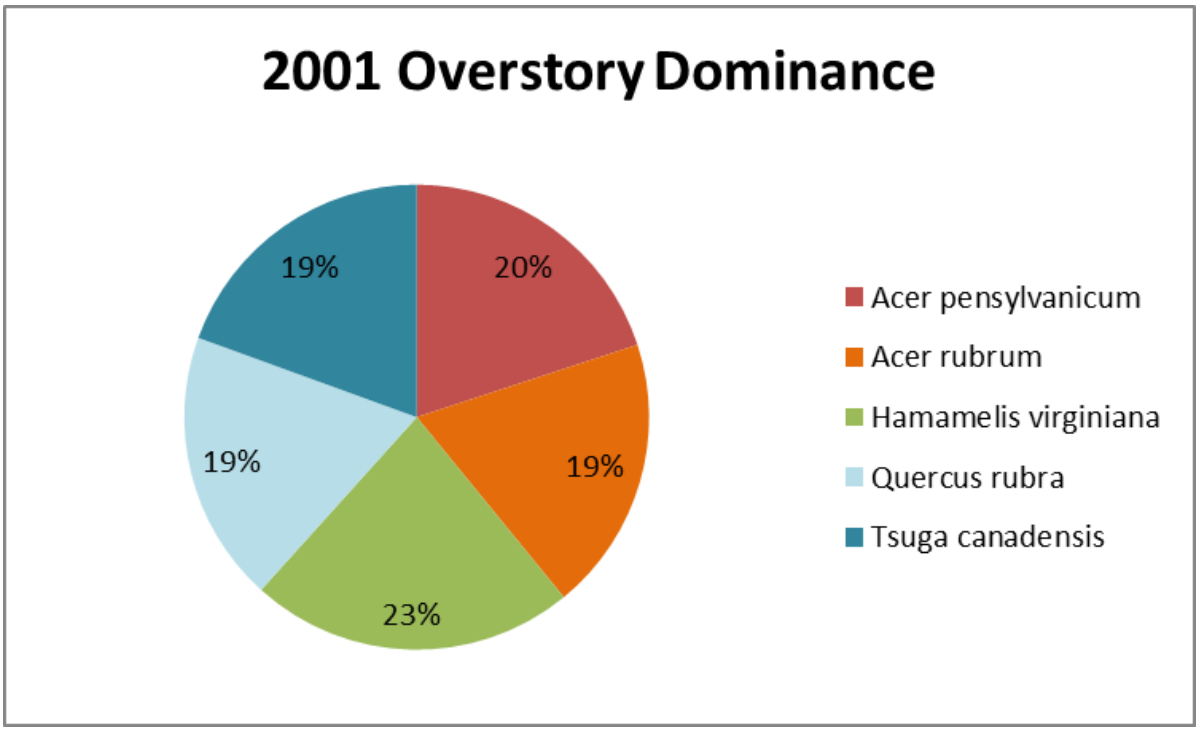


Figure 18: Overstory dominant species by importance values in 2011. Values are represented by percentages of the total importance value of all five species.

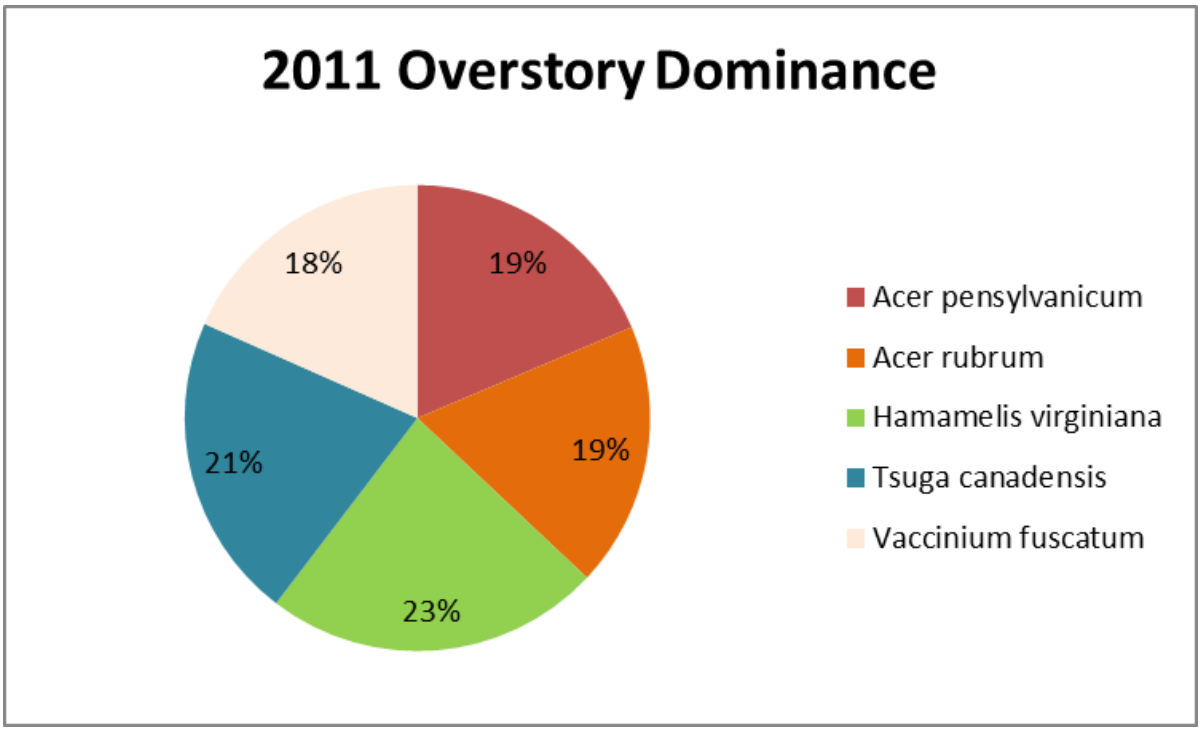


Figure 19. PCO graph of the overstory abundance data. Graph designed using PERMANOVA+ for PRIMER v6 software.

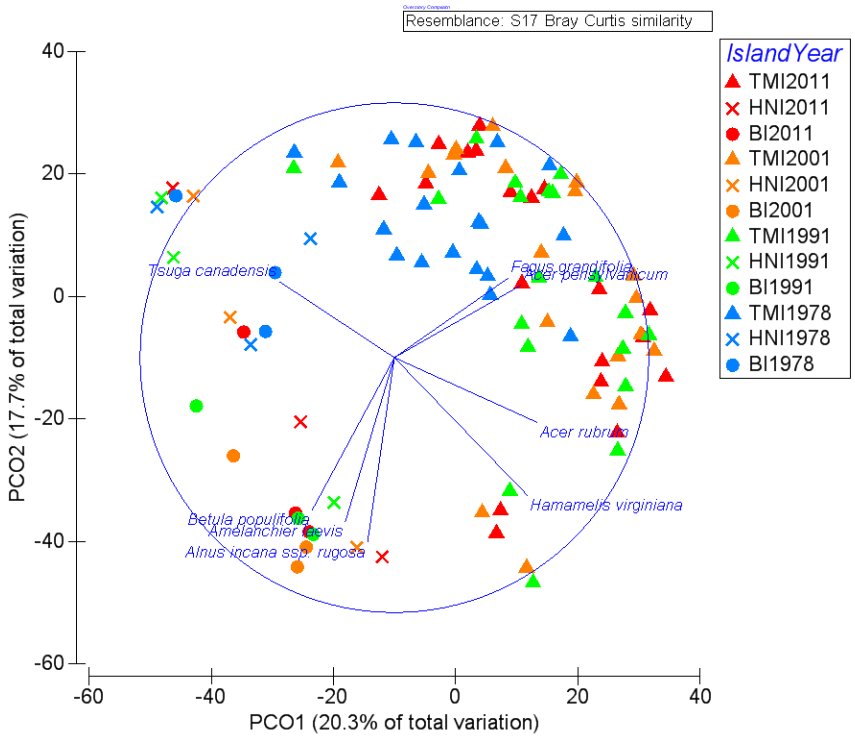


Figure 20. PCO graph of the understory abundance data. Graph designed using PERMANOVA+ for PRIMER v6 software. The species on the left is *Gaylussacia baccata.*

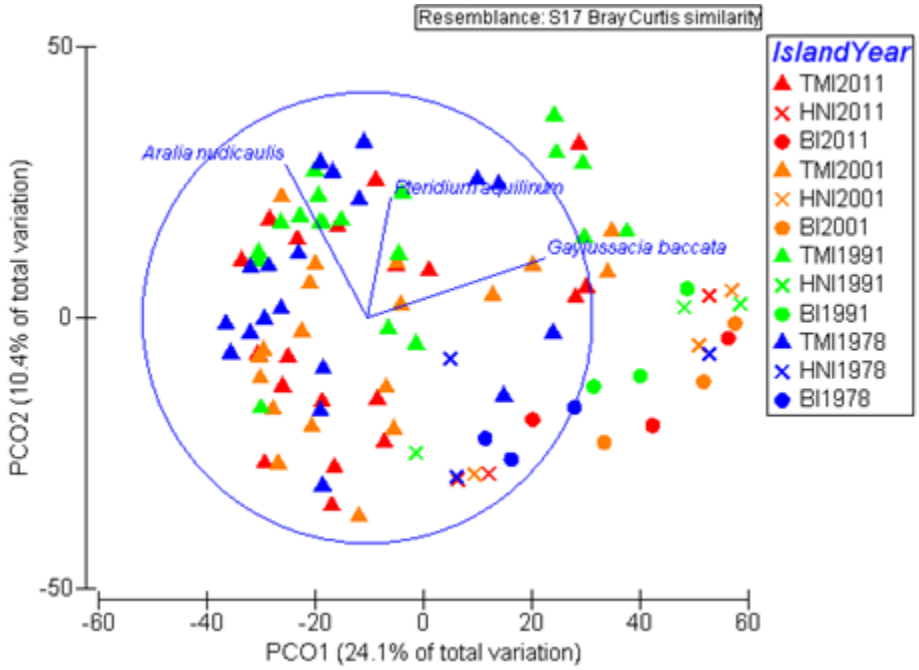


Figure 21. Understory sample-based species accumulation curve (Mao Tau rarefaction), re-scaled as a function of the number of plants species per plant individuals sampled. 95% confidence intervals are shown for the samplings of 1978, 1991 and 2011.

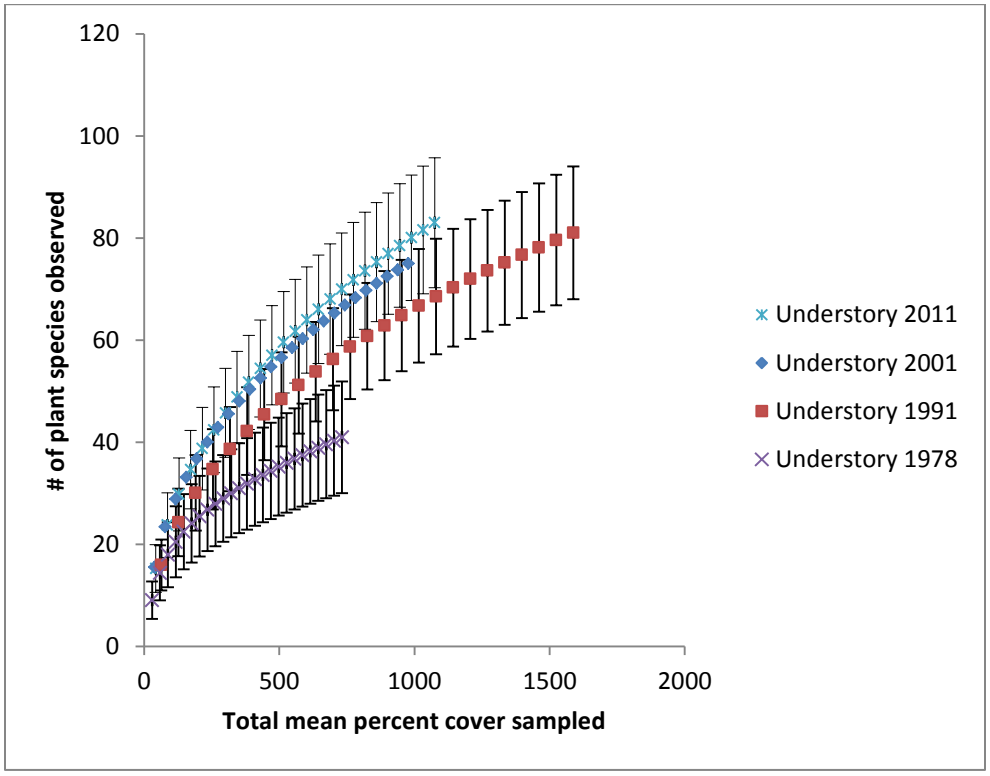
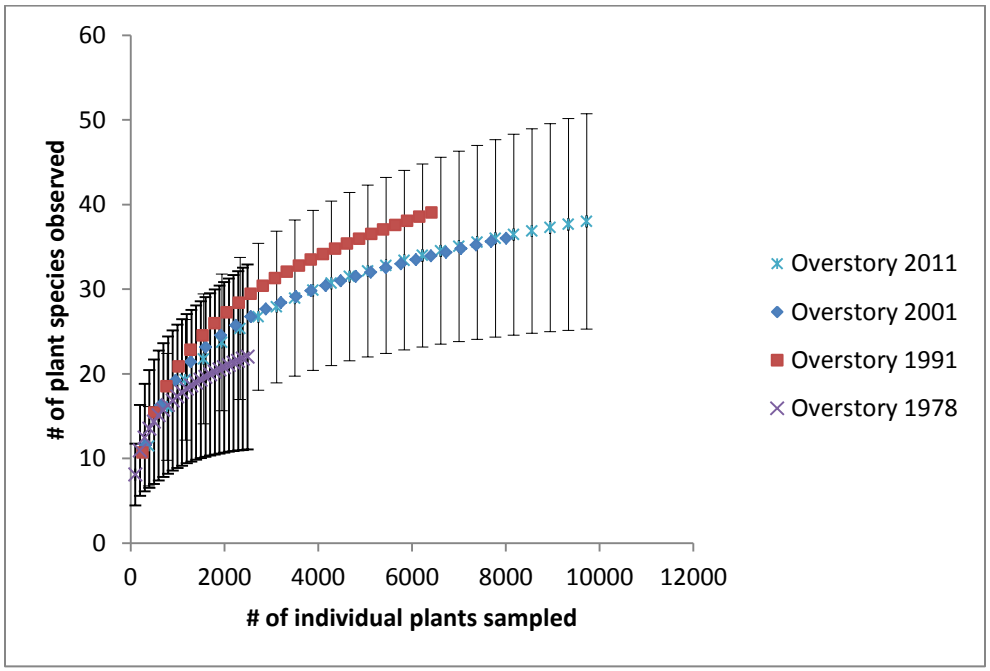


Figure 22. Overstory sample-based species accumulation curve (Mao Tau rarefaction).



Figures 21 and 22 in the Appendices are graphs of the Mao-Tau rarefaction curves pulled from the analyzed data for both the understory and overstory. Also included in the figures are the 95% confidence intervals determined by EstimateS as well for both the 2011 and 1978 samplings to determine the possible range of error in the samplings.

In the understory graph, all the rarefactions in the graph do not completely level out towards the right. This indicates that the possible number of species sampled could have been greater if more individuals were sampled on each island. This can be attributed to the total number of species sampled in all four years, 128 species. The 1978 rarefaction is the lowest in the graph due to the lower number of individuals and species sampled compared to later samplings. The error bars of the 2011 and 1978 samplings indicate that there was little similarity in the four samplings. The 1978 and 1991 samplings do not fall under the intervals of 2011, and all other samplings do not fall under the intervals of 1978. Another possibility is that the understory has developed over the years and the composition has shifted as a result.

In the overstory graph, all rarefactions flatten to the right, indicating that the samples were thorough in the overstory and that very few species would have been found in further samplings. The 1978 rarefaction is the lowest and shortest due to the smaller number of individuals and species present in that sampling. Unlike the understory graph, all four samplings fall into both 2011 and 1978's error ranges, indicating that they were similar. In particular, the 2011 and 2001 rarefactions overlap with each other, suggesting that the compositions of both samplings were almost the same.

Sample disturbance rubric used on the field for species of concern.

Three Mile Island
Disturbance Evaluation

Name: _____ Date: _____
Plot #: _____

Please rate the following categories from least disturbed (1) to most disturbed (5)

Overall Disturbance:	(Least)	1	2	3	4	5	(Most)

Natural Disturbances:

Fire	(Least)	1	2	3	4	5	(Most)
Fallen Trees	(Least)	1	2	3	4	5	(Most)
Lightning	(Least)	1	2	3	4	5	(Most)
Erosion	(Least)	1	2	3	4	5	(Most)
Other: _____		1	2	3	4	5	

Comments: _____
_____
_____

Anthropogenic (Human caused) Disturbances:

Bulldozer/Heavy Equipment	1	2	3	4	5
People presence/Foot Traffic	1	2	3	4	5
Cut Logs	1	2	3	4	5
Trail Clearing	1	2	3	4	5
Other: _____	1	2	3	4	5

Comments: _____
_____
_____

VITA

Mark Winkler was born and raised in Bartlett, TN. He went to school in Bartlett as well until his graduation from Bartlett High School in 2006. He spent quite a bit of time in the Boy Scouts of America program, from which he earned the Arrow of Light and the Eagle Scout rank. From his time in scouts he developed a love for the outdoors. This love came into fruition when he went to the University of Mississippi and switched from a Mathematics major to a Bachelor of Science degree in the Biological Sciences. He graduated from Ole Miss in 2010, and then continued at Ole Miss to earn his Master's Degree in Biological Sciences.