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Wildlife Ecology Research

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Wildlife Ecology Research is a residental program of the Huyck Preserve and Biological Research Station in upstate New York. Students are introduced to a diverse array of wildlife and research techniques by ecologists from around the country. The program culminates in small group research projects students develop and implement from hypothesis to final paper.

Open to rising junior and senior high school students

Session I: June 30-July 21, 2013

Session II: July 28- August 18, 2013

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A final record of our scientific journey

Dawn O'Neal, Ph.D.
Wildlife Ecology Research Program Director
Director of Conservation Education and Research at the Huyck Preserve

Summer 2012 I set out, with the help of several guest instructors and project mentors, with the intent of teaching ecological research to a group of high school students interested in biology and the natural world. In the end, it was less instruction and more scientific journey. Together we delved into eco-immunology with Dr. Devin Zysling (Cornell University) where we learned how to assess avian immune function using bacterial killing assays; discovered the finer points of fungus and mold identification with Dr. John Haines (former NYS Museum mycologist); considered how to measure the effects of climate change with Dr. George Robinson, (SUNY Albany); had the opportunity to eat dirt and learn how soils influence the forest we see with Dr. Sue Beatty (Portland State Univ.); spent an evening collecting and identifying moths with Huyck Grant recipient Ashley Olzelski (CUNY Staten Island); successfully found a running stream during a drought and measured its water quality using macro-invertebrates with Dr. Mary Beth Kolozsvary (Siena College); and conducted surveys of both small mammal and avian populations at the Huyck Preserve. We ended our journey with a whirlwind of data collection for independent research projects which culminated in magnificent oral presentations. I am reminded constantly by the staff at the Huyck Preserve that I cried with pride.

As with most scientific research, however, when the dust settles what we are left with are a handful of data points that we cobble together to submit for publication. And so, it is with great pleasure that I introduce the first issue of the Journal of Wildlife Ecology Research. Enclosed is the final record of a summer scientific research conducted by a truly amazing group of students. The projects here were chosen by each student based on their scientific interests or an ecological technique they wanted to master. In 2012, students studied a wide range of topics from the finer points of pond ecology, to predatory-prey interactions, avian populations changes, and invasive species effects on forest regeneration. It is my hope for the budding scientists feature here, that these projects are only the beginning in a rich future of scientific research.

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Zooplankton population changes from day to night in Lincoln Pond and Lake Myosotis

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Abstract

Many types of zooplankton undergo diurnal vertical migration due to a broad range of influential factors including depth of the water source, vegetation, and variation in predator fish populations at different depths throughout the day. I investigated this migratory behavior in two connected water sources, Lincoln Pond and Lake Myosotis, at the Huyck Preserve and Biological Research Station in Rensselaerville, NY to determine how the abundance of copepods and cladocerans changed over the course of a day and how these populations and their abundance differed between these two water sources with their varying depths and plant and animal species compositions. I surveyed the two water sources early in the morning and at night at the surface using a tow net. I found significant evidence of migratory patterns in Lincoln Pond with more individuals at the surface of the pond at night compared to day time surveys but no significant diurnal variation in populations in Lake Myosotis.

Introduction

Zooplankton occupy low trophic levels in aquatic food chains and are an important source of food for fish and other organisms (Kenney and Burne 2000). Zooplankton are very sensitive to changes in environmental conditions and are known to respond quickly to those changes (Lougheed and Chow-Fraser 2002). Due to this sensitivity, zooplankton can be used as water quality indicators.

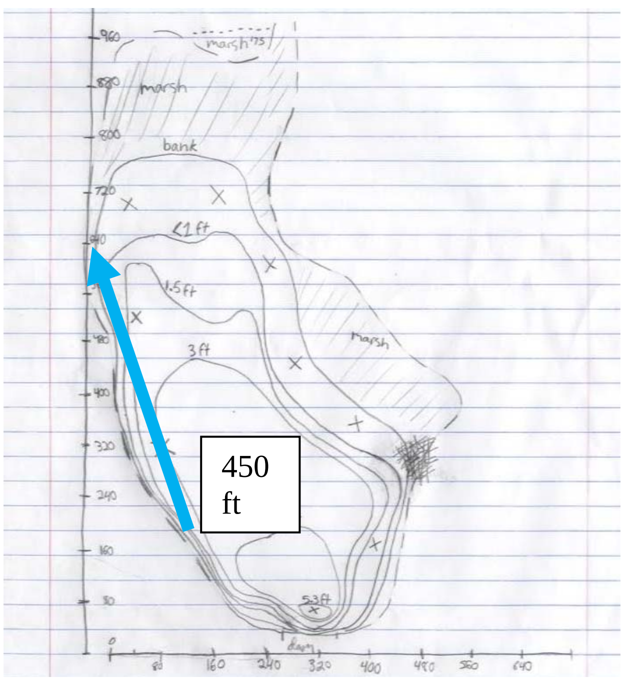

Figure 1. Lincoln Pond

Many types of plankton in a range of aquatic environments undergo diel, or diurnal, vertical migration. Plankton that exhibit this behavior typically move from deeper in the water column to the surface over night and return to deeper water by the following day. Diel vertical migration of plankton has been shown to be affected by trade-offs such as the balance between having better sources of food at the surface and being visible to predators, and the balance between warmer temperatures and the dangers of damaging, intense UV light (Dodson 2012). Very few specifics are known about the behavior due to the broad range of influential factors, differences seen in different locations, and the amount of variation existing between species and their respective behaviors (Pennak 1953).

To gather data on the abundance and behavior of zooplankton, I conducted a survey of Cladocerans and Copepods, two of the most common groups of freshwater plankton in the northeast United States, in Lincoln Pond and Lake Myosotis noting the differences between samples taken twelve hours apart. Differences in the temporal

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changes and overall abundance were expected between the pond and the lake due to differences in the depth, vegetation, and potentially predatory fish populations.

Methods

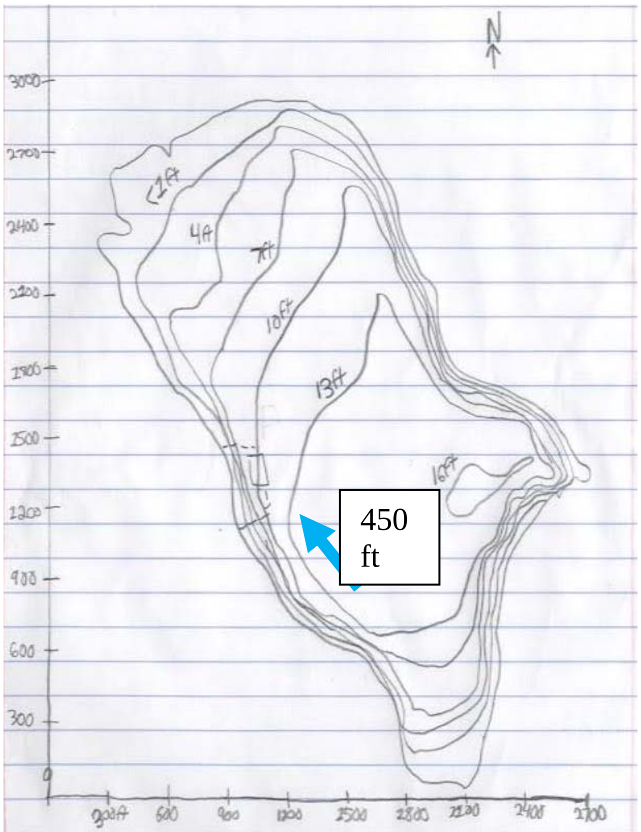

Figure 2. Lake Myosotis

Plankton samples are typically taken by using a van Dorn bottle, a technique used for sampling at specific depths, or by tow netting, a technique used for surface sampling. To sample for zooplankton I used the technique of tow netting, or towing a very fine mesh net behind a kayak on the surface of the water of the pond or the lake. Samples were taken 12 hours apart at 11am and 11pm. I executed the tows 6 feet from the bank of the body of water, to avoid emergent vegetation in Lincoln Pond and to avoid rocks in Lake Myosotis. Each tow was approximately 400-500 feet long, see figures 1 and 2 for details, to gather the netted organisms in a 50mL container. Each sample was mixed with 75% ethyl alcohol to kill the organisms and slow the rate of decomposition long enough to gather the data. The samples were then poured into a gridded petri dish and examined under a microscope to determine how many of the two chosen study types of plankton were present. Due to time constraints, later samples were only partially counted and then the numbers were extrapolated to reflect the whole sample.

Results

Notable differences did occur between the day and night samples in both the lake and the pond, as well as differences between the lake and pond samples taken at the same time. In Lincoln Pond, there an almost 7000 increase in the total number of Copepods and Cladocerans between day and night samples (Table 1-2, Figure 3). Samples taken from Lake Myosotis displayed a 1713 decrease in total number of individuals captured between day and night samples (Figures 3-4, Figure 3). Lincoln Pond overall has high abundance of macroinvertebrates, particularly water mites and scuds, during both day and night sampling (Table 1-2).

Table 1. Number of Copepods, Cladocera, and other invertebrates (mostly mites and scuds) taken from Lincoln Pond during the day.

Lincoln Pond, Day Sample

Name	mL alcohol	mL pond	Time	Temp (F)
Mixed Sample 1	5	45	12:00 AM	81
Copepods	**Cladocera**	**Other Inverts**	**Plankton Total**	**Total**
320	149	17	469	17

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Table 2. Number of Copepods, Cladocera, and other invertebrates (mostly mites and scuds) taken from Lincoln Pond at night.

Lincoln Pond, Night Sample

Name	mL alcohol	mL pond	Time	Temp (F)
Sample 1	21	50	9:55 PM	81.3
Copepods	**Cladocera**	**Other Inverts**	**Plankton Total**	**Total**
2488	4637	29	7125	7154

Table 3 Number of Copepods, Cladocera, and other invertebrates (mostly mites and scuds) taken from Lake Myosotis during the day.

Lake Myosotis, Day Sample

Name	mL alcohol	mL pond	Time	Temp (F)
Sample 1	21	50	11:28 AM	81.7
Copepods	**Cladocera**	**Other Inverts**	**Plankton Total**	**Total**
1373	5459	1	6832	6833

Table 4 Number of Copepods, Cladocera, and other invertebrates (mostly mites and scuds) taken from Lake Myosotis at night.

Lake Myosotis, Night Sample

Name	mL alcohol	mL pond	Time	Temp (F)
Sample 1	21	50	11:28 AM	81.7
Copepods	**Cladocera**	**Other Inverts**	**Plankton Total**	**Total**
984	4135	0	5119	5119

Discussion

The total abundance of zooplankton in Lincoln Pond increased by 6656 individuals while the abundance in Lake Myosotis decreased by 1713. The data from Lincoln Pond supports the hypothesis that the zooplankton living there undergo diel vertical migration. Cladocera, known to exhibit migratory behavior in other locations (Pennak 1953), had the largest difference in abundance in Lincoln Pond.

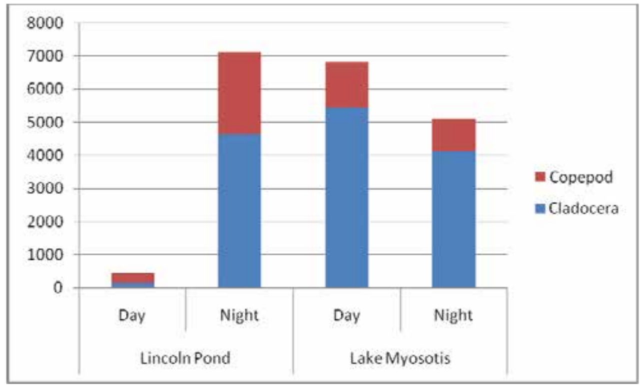

Figure 3. Changes in zooplankton abundance in Lincoln Pond and Lake Myosotis from day to night. There were more zooplankton found in Lincoln Pond at night while Lake Myosotis showed a decrease in zooplankton abundance. The large number of copepods found in the Lincloln Pond night sample suggests diel migration in this species.

The data from Lake Myosotis indicates that plankton populations in that location do not migrate at all, or that some even migrate deeper in the water column during the night. The difference between the day and night samples from Lake Myosotis is not as large as the difference seen between the two Lincoln Pond samples and may be completely due to sampling or counting errors.

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The Density of White Tailed Deer in Relation to Predator Abundance

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Abstract

The relationship between deer and their predators are essential in understanding the overabundance of deer in an ecosystem. Deer overabundance has led to serious problems in both the natural world and human society. Overgrazing by deer has led to a severely decimated plant population and serious economic losses in industries such as forestry and agriculture. In this experiment, we tested if the Huyck Preserve had an overabundance of deer and if this large population was due in part to lack of coyotes. In order to test this hypothesis, we estimated deer population numbers using the fecal accumulation method in which areas of the forest were sectioned off and the number of deer pellet piles in each region was counted. We then used baited hunting cameras to get estimates of the coyote population on the Preserve. Predator and prey population estimates were conducted in an Eastern Hemlock plantation and a mixed deciduous forest and we found that the number of deer pellets were much higher in the Hemlock plantation (602.89 deer/mile squared) then the mixed deciduous forest (8.5 deer/mile squared). No predators were captured on our cameras. No predators were seen, suggesting that there were no natural predators within the preserve to control the deer population.

Introduction

White tailed deer are very versatile herbivores that have dwelled all over the country for countless years. In recent years the population and density of white tailed deer has dramatically increased (Cote et al., 2004). Numerous studies have been dedicated to the dynamics of deer populations, and the sharp increase in their density throughout the world (Forchhammer, 1998). Their population has increased in such great numbers that damage to forests and ecosystems have been noted by several experiments (reviewed in Cote, 2004). Scientists have speculated this growth is due to a change in climate and a decreased pressure of hunting. Additionally the elimination of natural predators such as wolves (*Canis Lupis*) and Eastern cougars (*Puma cougua*) has lessened the predation pressure upon the deer in America and New York (Cote, 2004). Coyotes(*Canis Latrans*) and bobcats (*Lynx rufus*) are now said to be the main predator of deer, though it is noted that they are not as effective as wolves in controlling deer population (Cooke, 1971). They have a tendency to prey upon fawns or scavenge, and seldom take down full grown healthy deer. Now that there are virtually no predators are present to stifle deer growth, the population of their species has exploded in recent years.

This overabundance of deer has proved as a detriment to forestry, agriculture, and transportation (Cote,2004). It has lead to a high spread of diseases amongst deer and a decreased number in sapling growth (Cote, 2004). Often the deer will selectively browse by eating saplings, such as sugar maples over other younger trees. By doing this deer may reduce the biodiversity in forests by depleting understory growth and abundance of different types of trees or shrubs (Pierson, 2011). Programs have been implemented to control deer population, but we believe that natural predation is what is really needed to keep the population of deer from spiraling out of control. New York has had a history of elevated population of deer, and many deer have been observed at the Huyck Preserve in Rensslaerville, NY. This

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Preserve also has a strict no hunting policy, making it an ideal location for deer to thrive. We decided to conduct an experiment to determine the density of the white tailed deer on the preserve. We believe that the Preserve lacks sufficient natural predators, and therefore will have an overabundant white tailed deer population. We hoped that the results of this experiment would depict the continuing problem of increased deer density in America and help to influence management practices at the Preserve.

Methods

In this study we attempted to determine the white tailed deer density of the Edmund Niles Huyck Preserve, a non-profit nature preserve located in Rensslaerville, New York. Through extensive research, we decided that the best way to measure deer density would be through the technique known as pellet grouping. The pellet grouping survey is an effective method designed to estimate deer density from the amount of fecal debris deposited over a known period of time within a fixed area (Mayhew, 2003). By following the general methods of Mayhew (2003) in the Pellet Group Survey of Michigan, we hoped to get an accurate estimate of the number of deer dwelling within the preserve.

We chose two different habitat types including an Eastern Hemlock plantation and a mixed deciduous forest. We chose the mixed deciduous as one of our sites due to the numerous scientific papers that have studied and suggested that white tailed deer prefer such habitats (Augustine, 1998) (Bailey,1981). Additionally we chose the Eastern Hemlock plantation because upon previous observation of the area we noted that many deer pellet piles were present.

Once our two areas were chosen, we selected areas of land located a minimum of ten meters off the trails of the preserve. We measured out five 15x15 meter plots within each of the two habitats, giving us a total of ten plots. The plots were created with 5 meters of space in between, where any pellets found would not be counted. The plots were marked with blue flags at the corners to indicate their locations. The plots were then all raked so that no deer pellet piles (those containing ten or more pellets) could be distinguished.

The plots were studied for the length of three days, from 15th to the 18th of July 2012. At the end of each day the plots were examined and checked for deep pellets piles. Any piles that were located were noted with a white flag, and recorded in the data table. After checking all the plots in the habitat, these flags would be removed and the pellet piles would be dispersed so that fecal droppings would not be counted again the following day.

After all the data was gathered, the following equation was deployed to determine deer density in the preserve:

$$\text{\# of deer/km}^2 = \left(\frac{\text{\# pellet group/km}^2}{(\text{\# days between visits}) \times (\text{defecation rate})} \right) \times 1{,}000{,}000$$

We used the defecation rate of 13.47 based on other studies that have been done in the Northeast (Mayhew, 2003).

Afterwards, on July 18th the habitat with the highest number of pellets (Eastern Hemlock plantation) was baited with various types of meat such as chicken and beef to attract potential predators. Bushnell and Cudlleback digital cameras were set up to capture images of any carnivores that might be drawn to the meat at night. The cameras were picked up on the 19th of July and examined for their images. They were then returned to their previous locations for the remainder of the night for a second trial, and gathered again on the morning of the 20th of July.

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Results

At the end of the three days the numbers of the deer pellets were totaled in their respective habitats. It was found that 71 deer pellets were located in the Hemlock forest over the course of three days. However only 1 deer pellet pile was found in the mixed deciduous forest.

In the Hemlock plantation, it was found that the majority of pellet piles were found in Plots 3-5, where less decaying and fallen trees were. As shown in Table 1 the majority of pellets in the Hemlock region were found in plot 5, which had a total of 30 pellet piles found. The Plot with the least amount of deer piles in the Hemlock region with a total of 2 piles was found in Plot 1. The piles were also found nearby other piles, most often in groups of two or three. The mixed deciduous was located on a more rugged terrain of altering elevations, and was covered in more vegetation and leaf litter. Only one pellet group was found in plot 10.(Table 2.)

To calculate the deer density, we used the equation noted in the METHODS section of this paper. The number of deer pellet piles was divided by the total distance of the area measured, which was calculated to be 1125 meters squared. This was found by finding the area of the five plots in the Hemlock plantation. As a result, a number of 71 pellets was divided by 1125, giving a total of .0631 per meter squared. Following the equation .0631 was then multiplied by 1 million, and divided by 3(number of days) and multiplied by 13.47 (defecation rate), giving a number of 1561.49 deer per km squared. This number was then converted into miles giving us the number of deer per miles squared (602.89 deer). Note that this number is an estimate and not a precise number.

Additionally the same procedure was followed for plots 6-10 to determine the average deer density in the mixed deciduous forest. It was found that an average of 22 deer per km squared dwell in the mixed deciduous or 8.5 deer per square mile.

From the two cameras deployed in the Hemlock plantation, we did not capture any type of predator. The meat and bait was left untouched for both nights.

Table 1 Hemlock Forest (Three Days Total)

Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
2	6	14	19	30
Total= 71				

Table 2 Mixed Deciduous (Three Days Total)

Plot 6	Plot 7	Plot 8	Plot 9	Plot 10
				1
Total= 1				

Discussion

The data we received from this experiment supported our hypothesis that the lack of predation leads to an overabundance of deer. In the Eastern Hemlock plantation, there were a very high number of pellet piles in comparison to the mixed deciduous region. From the great difference in numbers between these two regions, it can be inferred that deer on this preserve prefer areas characteristic of the Eastern Hemlock plantation. This would include areas that are sparsely vegetated with very little understory. The forest floor of the mixed deciduous forest is barely visible underneath the heavy understory and leaf litter. The mixed deciduous region selected for this experiment was also at a higher elevation. White tail deer prefer gentle terrain which includes areas with low slopes and lower elevation (Lingle 2002).

These data suggest that there may be

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an enormous population of white tailed deer on the preserve. According to other research, a "healthy" deer density varies from habitat to habitat. It is generally thought that above 30 deer per square mile is considered unsustainable. (Pierson, 2011). Anything typically above this density will result in deer with smaller racks, reduce the versatility of seedlings, or result in a disease outbreak among deer. This is because with the over abundance of deer, more plant biomass will be needed to sustain the population. Higher deer populations will result in a decreased amount of biomass in saplings and other vegetation, which will then lead to less food being available to the deer. The deer may either become prone to diseases, or a massive starvation will ensue until the deer population is once again stabilized.

If the deer population on the Preserve is anywhere in the range of 600 deer per square mile, which we calculated for Hemlock plantation, the ecosystem stability could be in great peril. Such an amazingly high number strongly suggests that the deer population in the preserve mirrors the problem that much of the rest of the country faces. We could probably expect that in some time in the future evidence of understory damage will soon be depicted. Additionally, the estimated high white tailed deer population on the preserve could result in a possible outbreak of disease or mass starvation due to its high carrying capacity.

The fact that no predators were seen by the camera also strongly suggests that no natural predators are present to control the population. Despite the fact that bait was deployed, no carnivores at any time approached the cameras or meat. This suggests to us that we were correct in our hypothesis. The lack of natural predators created an elevated and unstable number of white tailed deer. If natural predators such as wolves were present, we would expect to see a more controlled population. The predator *Canis lupis* is known to feed primarily on deer, making up 79-98 percent of their consumption biomass (Fuller, 1989). This suggests that if wolves were introduced to the preserve, the density of the deer might decrease back to a sustainable level.

There are many potential sources of error in our data. Heterogeneity could exist in the environment which could lead to non-random use of the area (Bailey et. al 1981). This problem could have affected the data collected from the mixed deciduous area which had a very diverse terrain thus making certain areas more preferential for the deer than others. Another potential source of error could be that we failed to rake all the piles in the plots thus resulting in an inaccurate number for how much the deer defecated daily. Also in the matter of deer pellet piles there was some difficulty in distinguishing deer pellets from rabbit pellets. It is possible rabbit pellets may have been mistaken for fawn pellets, and giving us a false reading on the calculated deer density. However, the raw number of deer pellets found still suggests that there is at least some overabundance of deer.

The end results of our data indicate a dangerously high density of white tailed deer on the Preserve due to the lack of natural predators in the area. overabundance has become a serious issue for both the natural world and human society. Only predators can effectively control deer densities so that they are compatible with plant abundance (Cote, 1981). In terms of human society, the abundance of deer has been detrimental. Deer damages to household and agriculture in the United States totaled to $351 million in 1991 (Cote, 1981). Therefore predation is essential in keeping deer numbers manageable. In the future, we believe that the Preserve may experience a damaged ecosystem as deer overconsume saplings, and target some

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species more than others. Eventually, an outbreak in disease or starvation will occur if action is not taken to control the deer's elevated population. Only through restoring the deer's natural predators on the preserve will the population of the deer be effectively managed.

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A survey of the Huyck Preserve's Avian Population after 26 Years of Change

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Abstract

Animal populations change because of alterations in the environment at a small or large scale. We surveyed the avian population at the Edmund Niles High Preserve in July 2012 to determine if 26 years of environmental change may have altered the avian population since it was last surveyed in 1986. Ten mist nets were set up around Lake Myosotis , an area with an abundance of birds. We found that the majority of birds living around Lake Myosotis were Catbirds and Song Sparrows while all of the other species were found in lower numbers suggesting a loss of biodiversity. Two new avian species were found near Lake Myosotis, the Baltimore Oriole and the Cedar Waxwing.

Introduction

Environmental changes have been affecting populations for many years. Pollution, habitat fragmentation, and climate change are major factors that can determine an increase or decrease in biodiversity and abundance of species (Loreau et al. 2001). Changes in the environment can also alter a species' phenology, physiology, habitat, and behavior such as migration (Both et al. 2005). Changes in avian populations, presence and absence of species are easily recognizable through mist net surveys. In order to detect these changes, we conducted a bird survey at the Huyck Preserve in Rensselaerville New York near Lake Myosotis. The avian population has not been monitored since 1986 raising the question, could environmental changes over the past 26 years effect the avian population at the Huyck Preserve?

Methods

In order to survey the avian population in the Huyck Preserve, we placed mist nets along Lake Myosotis on Lake Trail (West). Ten mist nets were placed at least thirty meters apart in places that a variety of birds were expected to fly through. The day before our survey began we placed bird seed in front of the nets. For three days, the nets were opened from 5:00 to 11:00 AM. Every net was baited again with wild bird seed in order to attract as many birds as possible. Depending on the volume of birds caught in the nets, they were checked every 15-30 minutes. When a bird was found, we noted the net and time of capture. They were then removed and processed. Processing included: determining the species, measuring their wing and tail, looking for a cloacal protuberance or brood patch to determine sex, weighing them, painting their wing to identify recaptures, and writing down any other notes that could later be helpful.

Results

We found that the majority of birds living around Lake Myosotis were Catbirds and Song Sparrows (Figure 1). A total of twenty-four Catbirds were trapped in the nets and seventeen Song Sparrows were found. All of the other species were found in lower numbers ranging from one to six individuals per species. The ratio of males to females was almost the same, while there were only two juveniles found (Figure 1).

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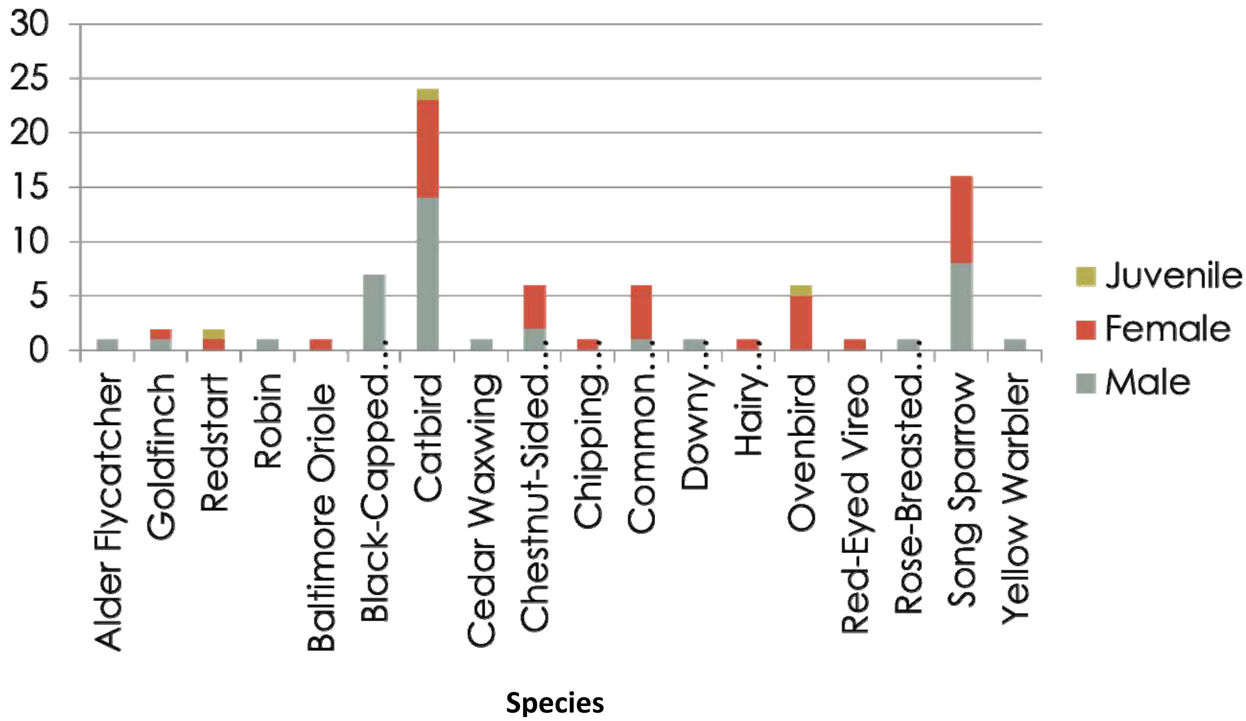

Figure 1. The number of avian species captured around Lake Myosotis over a three day period. The x-axis shows all of the species we have collected and the y-axis represents the number of birds captured. Sexes and age are identified by red (female), blue (male), and green (juvenile)

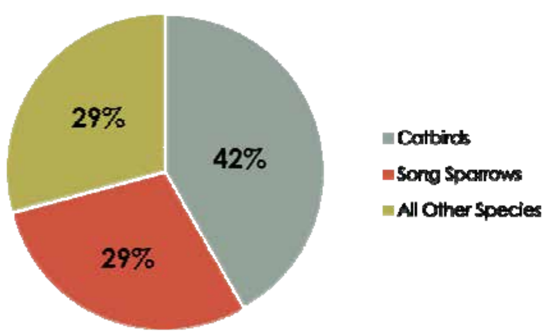

Figure 2. The abundance of avian species inhabiting the Lake Myosotis habitat. Each percentage number represents the estimated population of the most prevalent species based out of one hundred.

We found that the most abundant species inhabiting the Lake Myosotis habitat is Catbirds (Figure 2). The percentage of Song Sparrows and the percentage of all other avian species are equal.

Discussion

After mist netting around Lake Myosotis for three days, eighty birds were found in total. Seventy-one percent of the birds we captured were either Song Sparrows or Catbirds while the remaining twenty-nine percent were all the other species of birds that we captured. After comparing our data to the Huyck Preserve's most recent species inventory(Wyman 1988), we found two new species of birds that were not previously observed at the Huyck Preserve, the Baltimore Oriole and

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Cedar Waxwing, supporting our hypothesis that there would be changes in the species of the birds since the last inventory in 1986.

In addition to supporting our hypothesis, the data we collected also suggests a large percentage of the birds we processed were only two species, the Catbird and the Song Sparrow, indicating a lack of biodiversity around Lake Myosotis. Decreasing biodiversity can be negative because holes in the food web will begin to form and one species could begin to take over the habitat.

However, we may see this lack of biodiversity because the mist nets we set up could have been slightly biased to the Song Sparrows and Catbirds. The bait we sprinkled was only seed and birds that eat insects would not be attracted to it. The mist nets were set on the ground and we did not use a lure, so tree-top birds did not fly into our nets. We were not able to trap shore birds because our nets were placed too far inland. Future researchers should consider trapping over a longer period of time and trapping during different times of the day, like the evening, and baiting using multiple types of bait and lures to broaden the observed species of birds on the preserve.

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Aquatic and Semi-Aquatic Organisms as Indicators of Water Quality

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Introduction

Water is a critical resource for all organisms regardless of species or habitat. Water quality has been studied for decades in an attempt to understand its role in aquatic and neighboring ecosystems (Vannote *et al.* 1980, Wallace *et al.* 1996, Whittier and Hughes 1998). Many studies have developed biotic indices in an attempt to assess the quality of an aquatic ecosystem using what can be found in it (Seilheimer and Chow-Fraser 2006, Whittier and Hughes 1998, Whittier *et al.* 2007). Biotic indices are used as a quick way to assess the quality of an ecosystem using the abundance, presence, and pollution and disturbance tolerance of the organisms it supports (Whittier and Hughes 1998).

Biotic indices are an established method of accessing stream quality (Whittier and Hughes 1998, Stroud 2012). They are often used over an extended period of time on a single stream as a way to monitor its health (Vannote *et al.* 1980). Since the indexed value of a stream is dependent on the organisms present, a change in the index value indicates that a change in the ecosystem of the stream (Seilheimer and Chow-Fraser 2006, Whittier and Hughes 1998, Whittier *et al.* 2007). In this way indexes can be used to detect and diagnose the causes of stress on an aquatic ecosystem by looking at what organisms have emerged and disappeared over time.

In recent years some work has been done to develop a biotic index for still water or lentic ecosystems in order to track their health in the same way (Whittier *et al.* 2007). For lentic waters one of the most stressful times of year is the summer. They experience high water temperatures, low water levels, and low dissolved oxygen levels. These stresses can have an enormous impact on the abundance of resident species. Therefore, biotic indexes could be used to determine and monitor the health of a still water body (Whittier and Hughes 1998).

The purpose of this research is to apply various existing biotic indices to a shallow lentic pond in order to determine their potential use as well as to assess the general health of the pond.

Lincoln Pond is a shallow body of water bordered by Hemlock forest on one side and mixed deciduous on the other, within the Huyck preserve in Rensselaerville, New York. Many organisms inhabit this pond seasonally and year round (Wyman 1988). These organisms are dependent on the quality of the water in which they live and vary in sensitivity to pollution and other changes in the quality of their habitat (Stroud 2012, Whittier *et al.* 2007) Because of this; they can be used as a means to determine the overall water quality of water bodies such as Lincoln Pond. Using the abundance of resident macorinvertebrate, fish, and amphibian species, this study attempted to determine the water quality of Lincoln Pond.

Methods:

Field Sampling

The quality of habitat of Lincoln pond was analyzed using a variety of techniques including water chemistry testing and organism sampling.

Water chemistry was sampled before dawn using a small jar near the surface and near the bottom of the pond approximately 1m from shore. The sample sites were randomly selected around the perimeter of the pond and representative of the varying shoreline habitats present. The bottle was sealed and submerged, then slowly opened at the desired depth and allowed to fill. The

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bottle was then sealed and brought to the surface. Once removed, the sample was tested for its dissolved oxygen (DO) concentration and pH value. The DO concentration was measured first using a Vernier DO probe (DO-BTA), as the sample's DO content began to change as soon as the container was opened. Next the pH value was measured using a Vernier pH Sensor (PH-BTA) and recorded. Both sensors ran through a data logger (LabPro) and were interpreted by LoggerPro software on a laptop computer.

Macroinvertebrates were sampled using dip netting at representative near shore habitat types within the pond. A net was drawn in from 1m offshore along the bottom of the pond at random locations to sample bottom-dwelling macroinvertebrates. The mud in this net was transferred into a large holding tray which was picked and sorted through for 20 minutes. All captured macroinvertebrates was transferred to plastic egg cartons. Fine mesh plankton net was also used to sample macroinvertebrates. It was swept near shore in arcs from a ten foot long pole. The collected sample was examined for the presence of macroinvertebrates.

Fish populations were sampled using minnow traps placed around the perimeter of the pond in locations where they were most likely to be successful. The traps were left for 24 hours and then their contents were sorted, counted and recorded

Amphibian populations were sampled at random locations by inspection and dip netting. At each location frogs within a 1 m transect perpendicular to shore were counted and recorded. Then, a dip net was used to sample the mud at the bottom of the pond in order to capture other amphibians such as salamanders, newts, and tadpoles. The net was drawn along the bottom towards the shore starting from 1-2 m offshore. The amphibians were separated from the mud, sorted, and recorded.

Data Analysis

Three pollution tolerance indices were calculated to determine water quality in Lincoln Pond. The first was based on macroinvertebrates, the second was based only on fish, and the third was based on fish and amphibians. The macroinvertebrate index was based on the information provided by Stroud Wildlife Research Center’s website, and the fish and fish/amphibian indices were based on the Whittier papers, 1998 and 2007 respectively. For all three biotic indices, the pollution tolerance coefficients for each species were multiplied by the abundance of that species. The multiplied value for each species was totaled, and divided by the total number of individuals sampled (Stroud 2012).

The fish biotic index was modified using the following equation to convert it to a 0-10 scale similar to the macroinvertebrate and fish/amphibian index.

Results

Water chemistry

Dissolved Oxygen levels ranged from 1.9 mg/L to 6.1 mg/L and were generally low at all locations around the pond. They were always higher at the surface than at the bottom as expected (Table 1). The pH of the pond varied between 7.73 and 8.99 across sample days and locations (Likens *et al.* 1976). Samples taken at locations near the dam showed the most change across the sampled days (Table 2, Figure 1).

Table 1. Dissolved oxygen levels (mg/L; mean ± standard deviation) at 5 sample locations in Lincoln Pond in 2012.

Sample Location	July 16th	July 17th	July 19th
Surface	5.32 ± 0.98	5.18 ± 1.00	5.36 ± 0.60
Bottom	4.62 ± 1.65	4.18 ± 1.11	4.00 ± 1.47

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Table 2. pH levels at 5 sample locations in Lincoln Pond in 2012.

Sample Location	July 16th	July 17th	July 19th
Surface	7.74 ± 0.40	8.21 ± 0.65	8.31 ± 0.69
Bottom	7.73 ± 0.40	7.83 ± 0.45	7.94 ± 0.54

Biotic indices

Representatives from eight groups of macroinvertebrates were captured (order or family level). The greatest numbers of macroinvertebrates captured were scuds (Appendix 1). Four different species of fish were collected with largemouth bass in largest abundance (Appendix 2). Three species of frogs were captured, but only two were able to be used in the fish/amphibian index because there was no value assigned for Pickerel frogs (Whittier *et al.* 2007). Pickerel frogs were in highest abundance and all were tadpoles or recent metamorphs (Appendix 3). All three biotic indices reported a similar value for water quality (Seilheimer and Chow-Fraser 2006, Whittier and Hughes 1998, Whittier *et al.* 2007) (Table 3).

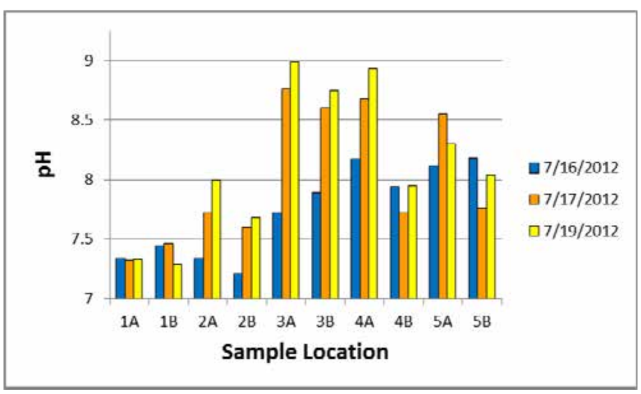

Figure 1. pH values at five sample locations around Lincoln Pond. (A=surface; B=bottom). locations around Lincoln Pond. (A=surface; B=bottom).

Table 3. Biotic indices of water quality using macroinvertebrates, fish, and fish and amphibians calculated for Lincoln Pond in July 2012 on a scale of 1-10.

Taxonomic Group	Macro-invertebrates	Fish	Fish/ Amphibians
Index	5.71	5.80	5.10

Discussion

Water chemistry

Due in large part to the drought experienced this summer the water level of Lincoln Pond is exceptionally low. Being a highly eutrophic lake, it has a very deep layer of accumulated sediment. The large and gradual drop in the water level has now begun to expose the weed beds that originally helped increase the oxygen levels present in the near shore water (Wyman 1988). These plants are now dying off en mass and are decomposing. The bacteria that decompose the plant matter in and on the floor of the pond now significantly take away from the available dissolved oxygen resource. This is supported by the data as the DO levels at the bottom of the sample locations were consistently lower than at the surface.

There is a dramatic shift in the pH levels after the 16th especially on the surface of the pond. The 16th was also the day that construction on the pond picked up. Large volumes of rocks were dumped and arranged to reinforce the bank below the dam. Some of the dust created by this process was observed to have settled on the surface of the pond. Rock dust can contain water soluble compounds that can make a solution more basic by the equations below.

$$\mathbf{CaCO_3 + H_2O \longrightarrow CO_2 + Ca(OH)_2}$$
$$\mathbf{Ca(OH)_2 \longleftrightarrow Ca^{2+} + 2OH^-}$$

Biotic indices

On a scale from 1-10 all three biotic indices reported the same value at about the middle of the scale. This means that the pond

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water quality is neither excellent nor horrible but rather somewhere in the middle. The pond does not support many very sensitive organisms but instead favors more tolerant organisms at the time of measure (Seilheimer and Chow-Fraser 2006, Whittier and Hughes 1998, Whittier *et al.* 2007). Due to the time of year of sampling there were not many amphibians in the water at the time (Wyman 1988). It was observed that two days before sampling large numbers of toadlets moved out of the pond. Other amphibians such as Spring Peepers and Wood Frogs likely also use the pond for breeding but at other times of year than the sampling period of this study. Therefore in order to have more diversity of amphibians for use on the index sampling would have to occur more and different times of year. The indices, not including the one developed for fish only, were developed for moving or lotic water and not for ponds. However, all the indices came out to be a similar value. This suggests that lotic indices can be used with reasonable accuracy for lentic waters (Seilheimer and Chow-Fraser 2006, Whittier and Hughes 1998, Whittier *et al.* 2007).

Acknowledgements

This research would not have been possible if not for the resources, wealth of knowledge, and opportunities provided by the staff, researchers, students, speakers and volunteers of the Huyck Preserve and Biological Research Station. I would like to especially thank Dr. Mary-Beth Kolozsvary and Dr. Dawn O'Neal for their seemingly endless patience, coaching, insight, and passion for developing all of those in the 2012 Wildlife Ecology Research Program into accomplished field biologists with meaningful and presentable works in a week or less. The skills I learned in this camp will last a lifetime. Thank you all again for making this unparallel experience possible.

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Appendices

Appendix 1. Macroinvertebrate species caught, their abundance and their tolerance values.

Species	Abundance	Tolerance Value
Plecoptera (Stoneflies)	3	1
Zygoptera (Damselflies)	21	7
Coleoptera (Beetles)	15	4.6
Chironimidae (Midges)	6	6
Amphipoda (Scud)	58	6
Decapoda (Crayfish)	13	5
Hirudinea (Leeches)	3	8
Gastropoda (Snails)	4	7

Appendix 2. Fish species caught, their abundance, and their tolerance values. The first tolerance value reported is the fish/amphibian index value, and the second is the fish only index value.

Species	Abundance	Tolerance Value
Esox niger (Chain Pickerel)	5	- or 7.5
Lepomis Gibbosus (Pumpkinseed Sunfish)	6	7.9 or 10
Micropterus salmoides (Large-mouth Bass)	11	5.9 or 9.17
Perca flavescens (Yellow Perch)	1	7.4 or 7.5

Appendix 3. Amphibian species caught, their abundance, and their tolerance values.

Species	Abundance	Tolerance Value
Rana clamitans (Green Frog)	4 Adult	9.17
Rana catesbeiana (Bullfrog)	1 Adult 1 Tadpole	6.6
Rana palustris (Pickerel Frog)	13 recent metamorphs 29 tadpoles	-

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Oriental Bittersweet's Effect on the Native Seedling and Saplings Emergence

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Abstract

Oriental Bittersweet has grasped the attention of ecologists across the United States. From its rapid growth rate and entangling coil, the bittersweet vine has taken over swathes of open fields and forestland across almost 33 states, making it one of the most prolific invasive species to date. Oriental Bittersweet does particularly well in open, sunlit areas and because Bittersweet has been noted to out compete native species, it poses a difficult question as to how the vine will affect forest regeneration in disturbed areas. This experiment addressed this question by examining over seventeen 10x10 plots in disturbed forest areas that are in the process of regenerating. These plots were placed in collapsing pine plantations and in dying mixed deciduous forests; both related by the excessive amount of light hitting the forest floor due to fallen trees. It was predicted that if the Oriental Bittersweet shades and prevents plants from accessing light, the number of tree seedlings and saplings in open canopy areas with high densities of bittersweet will be less than that of those with lower densities. My results followed the general trend, that in high areas of bittersweet young tree populations were lower than those in a bittersweet free area. These results demonstrate that bittersweet negatively affects regeneration and may drastically alter ecosystem dynamics in these habitats.

Introduction

The Oriental bittersweet (Celastrus orbiculatus, O. bittersweet), a bright green liana with rounded leaves, was introduced from Southeast Asia to the Eastern Seaboard in 1870 as an ornamental plant. Over the next century, the Oriental bittersweet spread throughout thirty-three states by bird dispersal and hybridization with the native bittersweet (Dukes 2009 and McNab 2002). Due to global climate change and the temperature rise, the liana's potential habitat is constantly expanding (Leicht 2005). The increased levels of carbon dioxide in the atmosphere also enhance the growth of various vine species more than the growth of trees (Londre and Schnitzer 2006). Oriental bittersweet has become an invasive species that out competes many native plants. Invasive species are threats to existing ecosystems because their populations may explode by having few predators and detrimental parasites. They may offset the balance of the ecosystem by occupying an empty niche by using up nutrients and shelter. Invasive species may also accelerate nutrient decomposition and nitrogen loss for the area, diminishing the vital ingredients for growth for the native species (Ashton 2005). This species can wrap around trees and bring them down with their weight. O. bittersweet grows 16 times faster than the native liana vine, the American bittersweet, because it responds faster to bright red light during the day (Dukes 2009; Leicht and Silander 2006). O. bittersweet responds well to sunlight but is able to "sit and wait" in the understory until a gap in the canopy opens up (Leicht and Silander 2005). The invasive species can then take advantage to the extra amount of light and overtake the neighboring plants. By hindering the native species´ ability to thrive, an invasive species can leave an ecosystem in ruins.

New canopy gaps drastically change in a forest ecosystem because the understory can be exposed to an immense amount of sunlight. This sunlight is essential to the growth of tree seedlings, saplings, and understory brush. However, Oriental bittersweet may pose a threat to the regenerating ecosystem. Areas that have less tree cover are more susceptible to invasive species (Berger 1993). The Oriental bittersweet may respond to the increased light and cover the native species, preventing them from photosynthesizing. Since it is a vine, O. bittersweet does not need to focus on secondary growth in the lateral meristems and can direct most of the growth to the apical meristem, the tip of the plant. Its fast apical meristem growth allows it to wrap around adjacent plants for structural support. Oriental bittersweet can grow at a faster rate than many other plants. Forest regeneration will be hindered when the invasive species outcompetes the native seedlings and pushing them to death which leaves a portion of the forest will be devoid of canopy trees.

The Edmund Huyck Preserve is susceptible to the spread of the Oriental bittersweet. Over the past few years, O. bittersweet abundance has increased, but no one knows for certain the benefits and/or the disadvantages of the new predominance of a non-indigenous species. O. bittersweet has reached almost every type of habitat in the Preserve with a notable population in two key habitats on the Preserve, an 80 year old red pine plantation in the old racetrack on Preserve grounds and the flood plains comprised of mixed deciduous forest adjacent to Lake Myosotis. The red pine plantation, planted in the mid 20s is currently dying due to its advanced age. The fallen red pines create huge gaps in the canopy, giving opportunities for new organisms to grow. We are interested in the growth of the different types of tree species in the emerging forest and if the presence of O. bittersweet is an impediment to the native saplings and seedlings. The mixed deciduous flood plain has natural gaps, created both by dying trees and flooding, and we ask the same questions for these open canopy areas . If the Oriental bittersweet shades and prevents native plants from accessing light, the number of native tree seedlings and saplings in open canopy areas with high densities of bittersweet will be less than that of those with lower densities.

Methods

We categorized O. bittersweet into three levels of densities (high, medium, low/none) to see if bittersweet abundance had any effect on the emerging seedlings and saplings of the open canopy areas in the red pine forest and the mixed deciduous forest. Ideally, bittersweet densities were evenly spaced throughout each transect. Both the red pine forest and the mixed deciduous forest had three replicates for the three density levels of bittersweet, for a total of 18 transects. Each transect was 10 meters by 10 meters, most of which were squares, but some were adjusted to achieve the proper bittersweet density. To accommodate the random densities of bittersweet, transects were not spaced by intervals. In order to maintain consistency, a single person judged the density levels over all transects on sunny, cloudless days. All of our transects were plotted in areas that we defined as open canopy, where at least 50% of the forest floor was light filled. We recorded the number seedlings and saplings of each species. Saplings were defined as trees above the waist but not yet canopy height. Seedlings were all trees under the waistline. Seedlings and saplings covered or entwined by O. bittersweet were recorded separately. We only differentiated seedlings from saplings in the red pine forest.

Results

Generally, in the red pine forest, plots with high bittersweet density contained fewer plant seedlings and saplings (Figures 1 and 2) and higher seedling biodiversity in

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the low and medium density plots (Figure 1). Only the Duckfoot maple and the ash seedlings were present in the high densities of bittersweet. The most common species of seedlings in the red pine forest was ash, Norwegian spruce, and red pines (Figure 1). By far, the most abundant species of saplings was the Norwegian spruce (Figure 2). In mixed deciduous forest, beech seedlings and saplings were the only species to follow the general trend of low numbers in high density plots (Figure 3). Instead, many different species, such as sugar maple and basswood seedlings, were present in low density bittersweet plots but were not present in the medium density plots (Figure 3). Conversely, ash tree seedlings were most abundant in the medium density areas (Figure 3). We have no data on saplings in the mixed deciduous forest.

Discussion

As predicted, seedling abundance was greatly reduced by increased bittersweet density, particularly in the red pine forest. In the red pine forest, the species of seedlings that were significantly affected by the bittersweet were the beech and Norwegian spruce: the higher the bittersweet density, the lower the number of beech and Norwegian spruce seedlings (Figure 1 and 2).. In mixed deciduous forest, we saw a similar trend regarding beech species, with decreased densities as O. bittersweet density increased (Figure 3). We did, however, see a peculiar trend in both forest plots regarding ash density, with higher numbers of this species in medium bittersweet plots compared to low and high bittersweet plots.

In areas of high oriental bittersweet, we noticed that most of the forest floor was too shaded for seedlings and saplings to grow. Native plants could not survive without receiving the proper amount of light for photosynthesis. The oriental bittersweet may have also used up much the available nutrients in the forest floor, preventing the

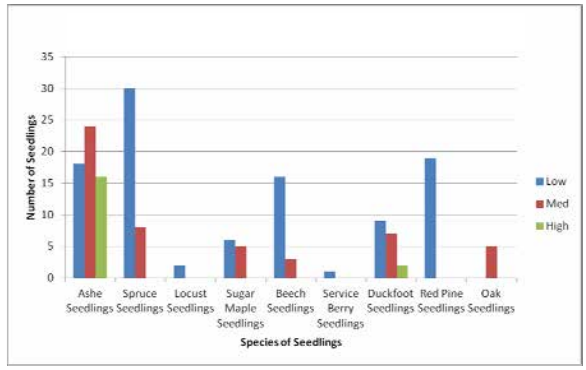

Figure 1. Number of Seedlings in the Red Pine Forest across sites with low (blue), medium (red), and high (green) bittersweet density. As predicted, the number of seedlings counted across species declined as bittersweet density increased.

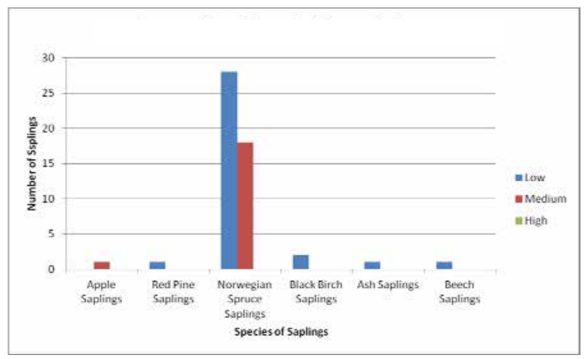

Figure 2. Number of saplings in the Red Pine Forest by bittersweet density. Sapling biodiversity declined with bittersweet density as predicted.

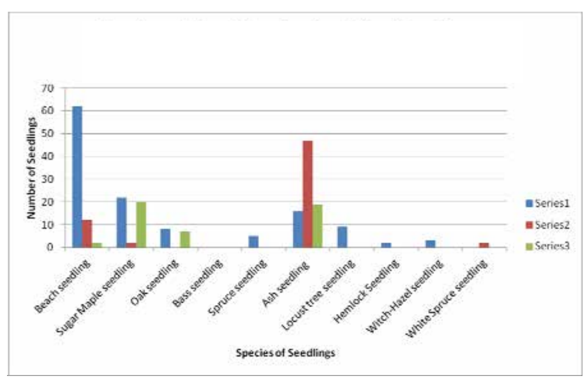

Figure 3. Number of seedlings in the mixed deciduous forest. Seedling number generally declined across species with increasing bittersweet density.

natives from using them. However, in the mixed deciduous forest, we did not account for the density of other native understory plants. Some mixed deciduous transects had more ferns, raspberry bushes, and grape vines than others. These understory plants block some of the sunlight to the forest floor too. On the other hand, all the red pine forest transects had little understory plants, so bittersweet was one of the few factors of shade for the seedlings and saplings. The lack of understory vegetation in the red pine forest could explain why the red pine seedlings and saplings numbers followed our hypothesis more closely than those in the mixed deciduous did.

There could be many improvements and future considerations for this research. There were some errors during the process of our data collection. We did not start distinguishing seedlings and saplings until we got to the red pine plantations. In addition, our definition of open canopy was very liberal (at least 50% of sunlight filtered through canopy). To further enhance this study, we should quantify the amount of light filtered with a Cajanus tube to more accurately define the type of canopy observed. We could also quantify the density of the Oriental bittersweet by biomass or surface area, rather than using the three general levels of low, medium, high. Some of our data had high standard deviation errors, which could be solved by including more transects. Many species of seedlings, such as the hemlock and witch-hazel, showed up only a couple times throughout our transects, therefore, we could not make a significant conclusion with that data. We could double or triple the numbers for each type of transect to reduce the standard deviation and obtain more data for the species that were uncommon. To avoid confounding variables in the future, we would suggest plotting transects in areas where there are minimal amounts of dense native understory vegetation (ie. Ferns, raspberry bushes, grape vines). Another factor of error was that we only found two areas, rather than three, of high bittersweet in the red pine forest. The oriental bittersweet densities have shown a negative correlation with densities of the native seedlings and saplings. The higher density of bittersweet prevents the native seedlings and saplings from establishing as a result of reductions in access to light (for photosynthesis) and nutrients. The beech seedlings and saplings and the Norwegian spruce seedlings and saplings all show a decline in number as more bittersweet takes over their environment. The ash seedlings´ deviation from the trend provides an interesting future research question.

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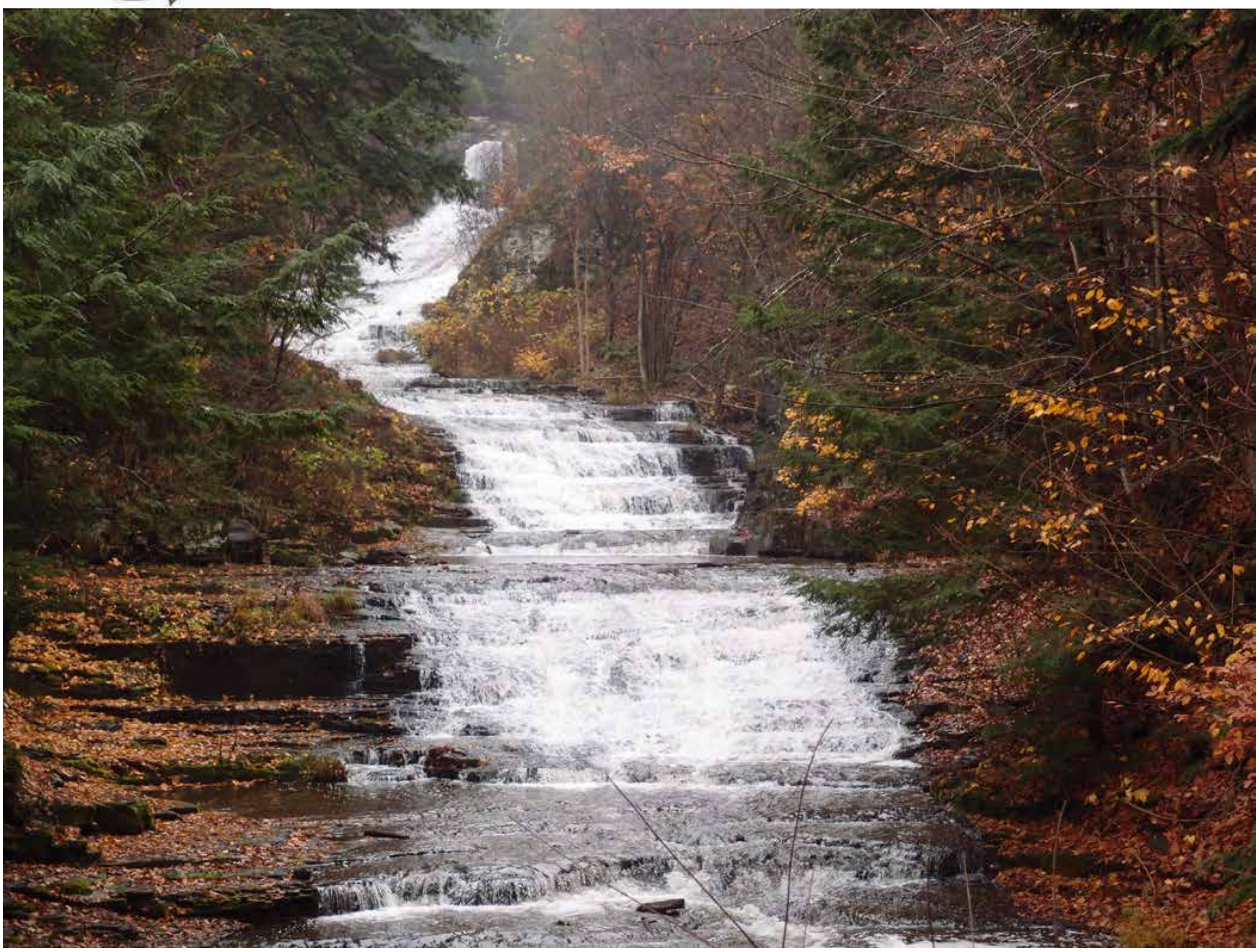

Located in beautiful Rensselaerville, NY 30 miles southwest of Albany, NY, the Huyck Preserve is a non-profit organization dedicated to preservation, education, and research. The 2000 acre Preserve is home to over 500 plant and animal species and is made up of more than ten different habitat types from hardwood and conifer forests to meadowlands and marshes. Our Biological Research Sttaion has supported research continuously for over 70 years. The Preserve's history as a research insitution makes us an ideal location for involving students in scientific research.

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