An assessment of the Lepidoptera population in the Hammond Pond Conservation Area

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The Lepidoptera family is the second most specious order in the class insecta. It has over one hundred thousand species of butterflies and moths. Adult Lepidoptera characteristically have antennae, compound eyes, three pairs of legs and a hard exoskeleton. There are several hundred species in Massachusetts alone. (Opler, et. al).

In order to narrow down the number of species to be studied, a bait trap (labeled trap A for future reference) was set up on the south side of a bog found in the Hammond Park Conservation area. In order to attract insects, molasses based bait juice was placed in the trap and checked every several days to see if any insects were trapped. Since the trap was not set up until September 30th, most of the butterfly species in the area had already migrated south, despite of the unusually warm weather. Since moth species do not migrate, they were still present in the area t this time and were caught in significant numbers. Therefore, the study concentrated on moths.

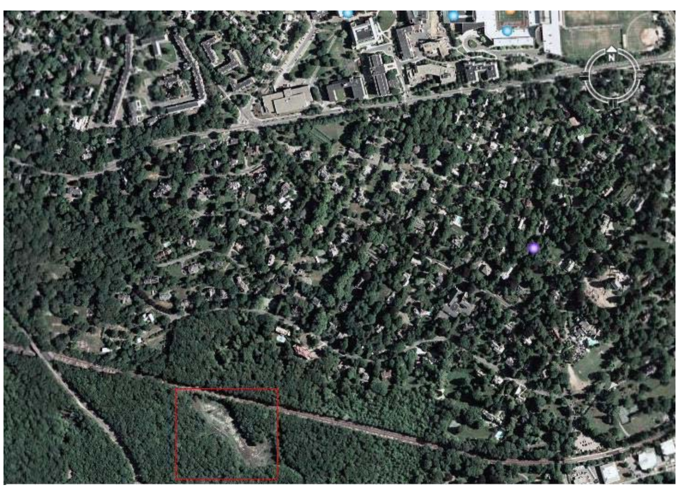

Figure 1: Red square delineates area where study was conducted in relation to the location of Boston College (at top of map).

At first, only wasps and flies were caught. After the trap had been deployed for five days some moths were captured. Moth identification can be tedious and difficult, but moths that appeared to be gypsy moths were caught. Since a considerable number of these were captured, this species was further investigated.

The gypsy moth (*Lymantria dispar*) is an exotic species that was introduced into the United States in the 1860's by Leopold Trouvelot (Rollinson, 2004). He brought the moths from Europe with the intention of starting a silk factory. He chose this particular type of moth because he thought they would be easier to maintain and feed, since they will eat almost any plant. The silk business failed, but the introduction of this foreign species was irreversible. The moths can be very detrimental to the plants and tress in the New England area. In the caterpillar stage the insect will feed on almost any tree or shrub since it is polyphagous (Duffner). The caterpillars is so destructive, it can defoliate up to 60 percent of a single tree within one year. This can debilitate the tree since it results in a reduced energy storage. This can result in increased tree vulnerability to other stress factors. This can ultimately lead to the death of the tree if this massive defoliation occurs several years in a row (Rollinson, 2004).

It is hard to determine whether the moths found were European gypsy moths or other moth from the Lymantria genus. The European gypsy moth can be easily confused with the American gypsy moth, which is not as ecologically detrimental (Nielsen, 2005). The European gypsy moth is easier to identify in the spring since the caterpillar is very distinctive. It has five pairs of blue dots and six pairs of red dots along its back side (Rollinson, 2004).

A thorough count of egg masses laid on trees, which "have a good, buff, tan color and are hard and velvety to the touch" (Duffner), is an accurate way to determine whether the gypsy moth population is at a high level, and whether there should be any cause for concern. An egg mass density threshold of 250 egg masses per acre has been considered a high enough density to justify treatment (Liebhold & Elkinton, 1989)

There are different environmental factors that regulate gypsy moth populations. When the population size is not too large, vertebrates, such as rodents, eat enough gypsy moths to keep the population under control. If the population reaches a certain level, vertebrate predation no longer has a significant impact on moth population numbers. This would result in a population explosion. At this point, microscopic organisms, such as the fungus *Entomophaga maimaiga* seem to have a considerable impact on moth larval development (Hajek, 1996; Nielsen, et. al., 2005). Some argue that the introduction *E. maimaiga* into areas that have problem populations of gypsy moths might be an effective pest control method, but there is not enough evidence to determine what effects this fungus could have on other species of plants and animals that are present in the area. A survey of the plants and animals in the Hammond Park Conservation and research of how these organisms are affected by *E. maimaiga* would help determine if this method of population control would be practical in the area.

Two types of bait traps were utilized to capture insects. One type had an inner cone that prevented most insects from escaping. If the trap was not checked for several days, all of the insects originally caught seemed to remain within the trap even if all the bait juice had evaporated. The other type of trap used was exactly the same, except

Figure 2: Picture of the type of trap utilized during the study

it lacked an inner cone. If this trap was left unchecked for several days and the bait juice evaporated, most of the insects that had previously been seen inside the trap would be missing when the trap was checked again. At this time, only a few flies would remain inside the trap. The moths were probably able to escape due to their behavioral reaction to stop flying when they feel threatened (Laaksonen, et. al. 2006). As a result, they fall to the ground. If they fall through the hole at the bottom of the trap, they were very likely to escape. At one point, a moth was seen when it escaped from the trap. Therefore, in the spring, only traps with inner cones will be used during experimentation to eliminate this additional variable.

The traps were hung from trees and suspended 3-4 ft above the ground. This is the height at which Lepidoptera tend to fly (Rollinson, 2004). Each of the three rings that connected the trap to the bottom, wooden platform was connected to a rock using string. The rock was then strategically placed on the ground to provide stability for the trap. The same was done with the other two rings that connect the trap with the wooden platform. This was done to prevent the wind from violently moving the trap, so the bait juice would not spill as a result of movement. This technique was very effective because bait juice was still seen in the plates after strong storms had affected the area.

The bait juice utilized for this study included half a cup of beer, 1 cup of molasses, 1 cup of white sugar, ½ cup brown sugar, ¼ cup of honey, ¼ of a medium sized apple, and half a packet of yeast. All the ingredients were mixed together and kept in a sealed container at room temperature for one week to allow fermentation to take place (Laaksonen, et, al). Once fermentation had set in, the juice was kept refrigerated for longer preservation. A white, Styrofoam plate was placed on the wooden platform of the traps. It was help in place with Velcro. Juice was added using a water bottle until it was about ¼ of an inch deep. Half a cup of juice was used on each plate every time the traps were re-baited. Twigs or small pebbles were placed on the plate in order for the moths to have a place to rest so it could consume the juice.

There are different types of bait juices that can be utilized in Lepidoptera trapping experiments. However, “There are no direct comparisons of formulations of sweet baits or quantitative efforts to optimize bait effectiveness in attracting Lepidoptera, although they appear to lure a wide variety of moths and butterflies,” (Landolt, 1995). In his experiment, Landolt utilizes a bait juice derived from de-ionized water, fruit pectin, brewer’s yeast, honey, molasses, and jaggery (unrefined palm sugar). No specific measurements are mentioned because the experiment utilized different concentrations of these ingredients to test for the effectiveness of the juices based on the concentration. Another type of juice that can be used in Lepidoptera traps is banana based. Two to three over ripe bananas were added to a mix of 1 cup brown sugar, ½ cup prune juice, ½ packet of yeast. It was allowed to ferment for 1-2 days. Even though the juice was prepared, there was not time to test out the effectiveness of this type of juice this semester.

Lepidoptera can be classified into two groups based on their diet. The ones that consume nectar from any type of flower are called generalists. The ones that only feed on specific types of plants are called specialists. Several articles were found to compare oviposition behavior of these two types of Lepidoptera (Wiklund, 1981), but no articles were found that directly correlated feeding habits to adult body size.

Three more traps were set up in the bog area in places that were more likely to be hit by direct sunlight for a longer period of time during the day. Another trap (Trap 1) was set on the west side of the bog which would presumably receive direct sunlight approximately from sunrise until noon. A second trap (Trap 2) was deployed on the east side of the bog which would presumably receive direct sunlight after noon until sunset. Coincidentally, there was a tree in the middle of the bog, and a trap (trap 3) was set up there. It was assumed this trap would receive direct sunlight for the longest period of time, from sunrise until sunset.

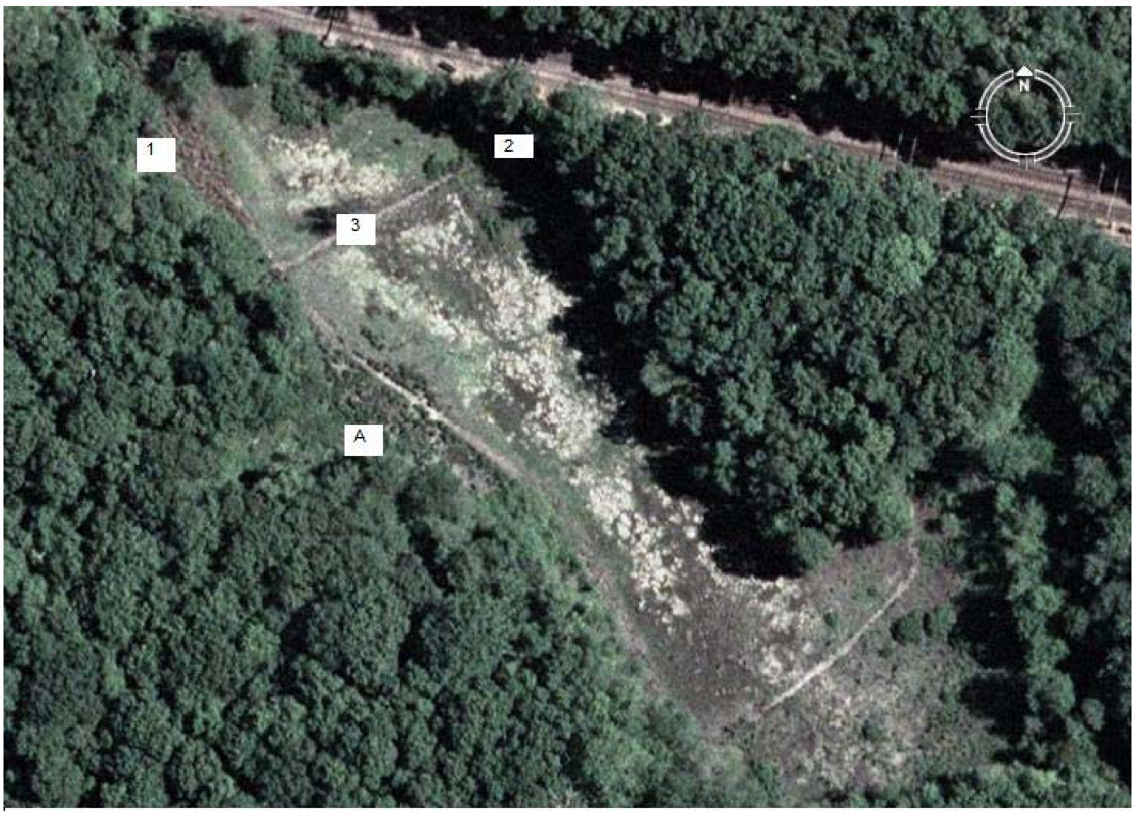

Figure 3: Location of traps (1-3 and A) within the bog.

Since trap A was set up without taking direct sunlight exposure into consideration, it was placed in an area that did not receive much sunlight because of shading due to surrounding shrubbery. It was evident less sunlight hit the trap because significantly fewer insects were captured in comparison

Figure 4: Alternate view of the bog area where the study was conducted

to the amount of insects captured in other traps in the same amount of time. Therefore, this trap was removed at the end of October. Since live wasps were still in the trap when it was dismounted, it was placed in a trash bag and frozen so the insects would die. Once the insects were dead, the trap was cleaned and the animals were classified and examined.

The insects retrieved from trap A were sorted into three categories: wasps, flies, and moths. One moth from each species was pinned using the method outlined in the manual of the insect collection kit manufactured by Bioquip Products, Inc. If it was evident that more than one moth of the same species had been captured, only one moth was pinned. A total of 9 significantly different moths were pined. Presumably they were all different species. The exact amount of total moths trapped will be counted in the spring. Approximately 300 moths have already been captured. All the moths captured were saved and stored in containers specific to the trap they came from. This was done to maintain a correlation between the location of the bog where the traps were set and what kind of insects were captured.

Figure 5: Example of a pinned moth.

Even though exact light exposure received by each trap was not kept track of, it was evident which traps received more light. Trap 3 was seen to capture significantly more insects than either trap 1 or trap 1. Also, the juice in the plate of trap 3 evaporated at a noticeably faster rate. These two factors indicated that this trap received more sunlight during the day. It was concluded that trap 1 received the least amount of sunlight daily because the least amount of insects were captured, and the least amount of juice evaporation was noted. Trap 1 was removed in the middle of November, and the insects collected were classified in the same way the insects from trap A were classified.

At times when both traps had the same amount of juice, Trap 2 seemed to capture more insects than trap 1. Since the insects from trap 2 could escape more easily than the insects caught in trap 1, they did not remain inside the trap if all the bait juice in the plate evaporated by the time the traps were checked again. This decrease of insects in the trap was probably due to the lack of an inner cone. In future experiments the trap lacking an inner cone will not be utilized since escape is more likely. Trap 2 and 3 were removed in early December. Sorting and classification of the insects trapped was the same as the sorting of insects from trap A and trap 1.

In order to obtain a better assessment of the moth population in the conservation area, it would be interesting to carry out a mark and recapture study. There are many types of mark and recapture methods that would be utilized. One of these methods is mutilation. In this process, the target insect is chilled using CO_2 gas. As a result, its metabolism slows down and so does the animal. This makes it easier to work with the insect (Hagler and Jackson, 2001). Characteristic marks are made on the wings using nail clippers. These should be noticeable enough to distinguish the insect among others, but not so large that the insect’s ability to fly or function is impaired (Querci, 1936). This method is good for long term studies. However, since it is a very tedious and time consuming process, it is not practical when the objective is to mark a large amount of insects.

Another method of marking insects uses water insoluble paints. The insect is chilled the same way previously described. Instead of making marks by clipping the wings, dots of different colored paints are put on the wings. Paints and inks can be applied to individual insects using toothpicks, insect pins, fine-tipped pens, or fine-haired brushes. The markings should be obvious enough to make future recognition of the insect possible, but it should not so obvious that it interferes with the animal’s natural camouflage, (Hagles and Jackson, 2001). Again, the problem with this method is that it is tedious and time consuming. It is not very practical when working with a large amount of insects.

Another mark and recapture method commonly used for insect studies utilizes as a marker green UV dust commonly used in crime scenes. This green dust was among the first dusts to be used in studies of this sort (Polivka, 1949). This dust is almost invisible under normal light, but it is easily detected under UV light (Stern and Mueller, 1968). The most common commercial dust used to mark insects is Day-Glo. It is available in different colors and can be seen with the naked eye, but it can be more easily detected when marked insects are placed under a UV light (Hagler and Jackson, 2001).

The advantage of using this method is that it is easy to mark many insects in a short amount of time with relatively little effort. A different colored dust can be added to each trap. This way it is evident which insects visit which traps. The disadvantage of this method is that it is inefficient for long term studies since the dust falls off more easily. To make the dust more adhesive, it can be mixed with gelatin, gum paste powder, or flour so the dust particles stick to the insect for a longer period of time (Hagler & Jackson, 2001).

In the spring, three different bait juices will be utilized. Each one will be used to bait one trap. Each trap will be traced with a characteristic colored UV powder (e.g. the trap containing banana-based bait juice will be traced with blue powder). Moths trapped will be released throughout the duration of the experiment, which will only last about two weeks. This way, the powder will be an effective and reliable marker since traces will still be found on insects marked by it after two weeks. It will be noted if moths of different species only have powder of a single color on their bodies, or if they have more than one colored powder. The moths that only have one color of powder will presumably have a restricted diet, while insects that have various colors of powder will presumably be generalists. Adult body size, determined by measuring the wing span, will be correlated to the type of diet the animal appears to follow. Hopefully, a correlation between diet and body size will be established.

UV light traps will also be deployed. Baits may not attract all the species, but they do attract many species that are not attracted to light (Laaksonen, et. al.). By complimenting the bait trap captures with light trap captures, a more thorough survey of moth populations in the area will be obtained. Also, the anatomical features (like the presence and length of a proboscis) of the moths captured in light traps will be contrasted with the features of moths captured in bait traps. Body size will also be compared.

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Date and description of meetings with mentor

Date	Topics discussed
19-Sep	Potential species investigation
26-Sep	Butterfly migratory patterns
4-Oct	Bog area trap setup
10-Oct	Live monarch
17-Oct	Butterfly disecting/pinning kit
24-Oct	MEETING CANCELLED
31-Oct	UV light traps
7-Nov	Mark and recapture
14-Nov	Different types of baits
21-Nov	Thanks Giving, no meeting
28-Nov	Project direction
5-Dec	Paper details

Date, description and time spend on field investigation

Date	Time	Description
25-Sep	1:30 - 3pm	House sparrow observation at Hillside
30-Sep	9am-12pm	Trap A setup
	4-5pm	Trap check
2-Oct	9-10am	Trap check; juice addition
10-Oct	7:30-10pm	Monarch butterfly pinning
12-Oct	10-11am	Trap check, juice addition
22-Oct	1-4pm	Trap 1 and 2 setup; Trap A collected
26-Oct	2-3pm	Traps checked; juice added
	3-6pm	Classification, pinning of insects found in Trap A
29-Oct	2-3pm	Baited traps
30-Oct	2-5pm	Trap 3 deployed; traps 1 & 2 checked/ baited
2-Nov	1-3pm	Trap check/finished emptying frozen trap
11-Nov	1-3pm	Trap check and relocation (moved trap 1 to where trap 3 was, collected trap 3 for specimen examination)
19-Nov	9pm-12am	Bait juice preparation
27-Nov	3-5 pm	Insect pinning, classification
30-Nov	1-3pm	Trap check, baiting
10-Dec	1-4pm	Remaining traps removed, insect removal and classification

No thorough dates and times were kept for the time spent doing literary research, and so no table is included. On average, three hours/week were spent searching for and analyzing literature.