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The effects of pale swallowwort (Vincetoxicum rossicum) on forest moth communities

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By

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ABSTRACT:

Pale swallowwort (*Vincetoxicum rossicum*) is an invasive vine that is rapidly invading northeastern forested ecosystems. Due to its broad tolerance of abiotic conditions and competitive advantage, it is perceived as a threat to native plant communities. Our study sought to determine whether or not invasion by pale swallowwort had a pronounced impact on moth (Lepidoptera) communities. We surveyed three pairs of deciduous forest plots and three pairs of coniferous forest plots. Each pair had a swallowwort plot and a plot without swallowwort. We used light traps to collect a total of 2,039 moths from 19 families and assessed differences in mean abundance, richness, and diversity. We found no differences in moth communities between canopy types or swallowwort plot types. We also assessed differences in abundance of four taxa (*Halysidota tessellaris*, *Idia aemula*, *Malacosoma americana*, and *Noctua pronuba*), which were all more abundant in deciduous canopy plots. This suggests that the scale of an invasion and the quality of habitat invaded are both important factors to note when trying to quantitatively assess their impacts on higher trophic levels.

INTRODUCTION:

Invasive species are one of the largest ecological problems facing native ecosystems today and they play a role in the extinction of native species. 20% of documented animal extinctions have invasive species as the main factor (Clavero and Garcia-Berthou 2005). Invasive plant species are able to homogenize flora (Schwartz *et al.* 2006), which has a variety of implications for native herbivores, particularly those of more specialized feeding habit (Tallamy *et al*. 2010). Invasive plants are generally able to rapidly colonize new areas and displace native vegetation, which contributes to a lack of biodiversity both plants and potentially animals in an invaded landscape (Hejda and Pysek 2009, Herrera and Dudley 2003). This invaded landscape can threaten small populations with poor genetic diversity. These effects generally render native species more susceptible to stressors such as disease, disturbance, and severe weather events (Olden *et al.* 2004).

One invasive species that is becoming prominent in the northeast is pale swallowwort (*Vincetoxicum rossicum*), which was introduced from Russia in the late 1800s. One characteristic of this species is its ability to achieve very high population densities (Sheeley and Raynal 1996). Pale swallowwort can thrive in a wide variety of abiotic conditions and is unpalatable to many native insect herbivores making it a great competitor (DiTommaso *et al.* 2005, Tallamy *et al.* 2010). It is able to colonize various forest understories and begin to displace native herbaceous species. Many of these populations are already under the stress of white-tailed deer (*Odocoileus virginianus*) overabundance (Knight *et al.* 2017). Pale swallowwort thus poses a large threat to the plants of a native forest understory and the herbivores that rely on them.

One group of insect herbivores that may be affected by invasive plant species is moths (Lepidoptera). Moths inhabit virtually any terrestrial ecosystem in North America. In North

America alone there are over 11,000 species of moths with more being described periodically (Hodges 1983). Moths play a significant role ecologically. The diet of some species of songbird and bat consists largely of caterpillars and moths, respectively (Sanz 2001, Cleveland *et al.* 2006). Moths that feed in the leaf-litter play an important role in nutrient cycling. Some families of moths have evolved specialized pollination syndromes (Boberg and Agren 2009, Boberg *et al.* 2013, Hodges 1995). Many moths have evolved specific host-plant relationships, though some are more obligate than others (Jermy 1983). This information leads us to believe that moths could potentially be good indicator taxa. Moth monitoring can prove beneficial as moth diversity has been shown to be a predictor of butterfly diversity (Beccaloni and Gaston 1995). More recent studies have discussed this relationship and suggest that moth diversity could potentially be used as an indicator of bird diversity and forest health (Blair 1999, Summerville *et al.* 2003).

The rapid spread of pale swallowwort raises questions about how native insects will respond. Pale swallowwort is known to emit allelochemicals into the soil to interfere with plant-microbe interactions, making it a good competitor (Cappuccino 2004). Pale swallowwort produces a milky sap that is toxic to native moths, as they have not evolved with the necessary adaptations to metabolize it (Douglass *et al.* 2010). Given the right conditions, it has the capacity to form dense monocultures in a forest understory, reducing the value of that habitat patch to moths. We hypothesize that presence of pale swallowwort will decrease overall moth diversity via disruption of native vegetation and nutrient regimes. We also predict that because of rapid nutrient cycling and more abundant understory vegetation, deciduous plots will be more populated than coniferous plots. The objectives of this study are to catalog the moth diversity of our locality, determine whether pale swallowwort has any effects on individuals or on overall communities, and to see whether or not canopy type effects moth diversity.

METHODS:

Site Selection

We selected six pairs of 30 x 30 m plots with similar vegetation from several sites within Mendon Ponds Park and Webster Park, which are both located in Monroe County, NY (Appendix). Monroe County has an average temperature of 20.4 ˚C in the months of June-July and an average temperature of 9.1˚C annually. Monroe County averages 34.3 inches of rain each year. Each pair of plots had similar canopy level and one plot was heavily invaded with pale swallowwort, and the other was void of pale swallowwort. Three of the pairs of plots were situated in deciduous forest dominated by red oak (*Quercus rubra)* and black cherry (*Prunus serotina*). The other three pairs were situated in coniferous forest dominated by white pine (*Pinus strobus*) and Norway spruce (*Picea albies*). Plot edge was at least 5 m away from any trail to reduce the effects of disturbance. The edges of adjacent paired plots were at least 20 m apart to ensure that moths would not be attracted to other plots.

Vegetation Sampling

Five 5 x 5 m sub plots were sampled in each plot. These subplots were situated in the center and four corners of the plot with one lying in the center. The corner subplots were 7.5m from each edge of the larger plot to reduce edge effects. Within each subplot, we identified and measured the DBH of all trees taller than 1.5m. We estimated percent cover of four strata (ground (0-0.6m), shrub (0.6m-1.8m), subcanopy (1.8m-5m), and canopy (>5m)) and used a densiometer to estimate canopy cover in each subplot. In the center of each subplot, a 1 x 1 m quadrat was placed in which we estimated percent cover by vegetation type: pale swallowwort (*Vincetoxicum rossicum*), garlic mustard (*Alliaria petiolata*), wisteria (*Wisteria sinensis*), detritus, mosses, grasses & herbs, trees & shrubs, decaying wood & fungi, and bare ground. These vegetation types were adapted from Thorn *et al.* (2015). Lastly, a total species richness estimate was measured for each subpolot and 1 x 1 m quadrat.

Moth Sampling

We collected moths through use of 15w actinic 12-volt ‘Heath type’ model traps (Anglian Lepidopterist Supplies) powered by a standard 14Ah 12-volt car battery. We sampled each pair of plots three times throughout June and July for a total of 36 trap-nights. While the traps ran, specimens were ushered into a jar containing ethyl acetate for preservation. For each sampling period, average temperature, average wind speed, average humidity, and total precipitation are recorded. We did not collect moths if our desired meteorological conditions were not met. Average temperature could not be below 15.5˚C, average wind speed must not exceed 15 mph, and sampling was not to occur on nights with high ambient moonlight. Sampling protocol regarding meteorological conditions were adapted from Summerville *et al.* (2003). We identified collected specimens to the lowest taxonomic level possible.

Statistical Analyses

Total moth abundance, richness, and Shannon-Weiner Diversity was quantified for each trap-night. We used Factorial ANOVA and Kruskal-Wallis tests to test our hypotheses (Minitab 17). The factors for our ANOVAs and were treatment, canopy type, and their interaction. The Kruskal-Wallis was used because the number of families dataset could not be transformed to meet the assumptions of normality. The overall abundance values were log transformed and the overall richness values were square root transformed to meet the assumptions of normality.

Four species (*Halysidota tessellaris*, *Idia aemula*, *Malacosoma americana,* and *Noctua pronuba*) were selected for further analysis due to their high abundance throughout our sampling period. All species were log transformed except *I. aemula* which was square root transformed to meet the assumptions of normality. They were assessed using factorial ANOVA to see if there were any differences in abundance of each species with swallowwort presence or canopy type.

RESULTS:

We collected a total of 2039 moths across 270 different species. Moths came from 19 different families. We observed that mean abundance, richness, and diversity was slightly higher in control plots as opposed to swallowwort plots. These factors were also slightly higher in oak-cherry rather than pine-spruce plots (Figure 3). These differences were not statistically significant, however.

Our ANOVA with richness as a response variable showed no significant differences between control and swallowwort plots (p=0.196). We also found no significant difference between oak and pine plots (p=0.242). There was no significant interaction between the two factors (p=0.513) (Table 1). Our ANOVA with abundance as a response variable showed no significant difference between control and swallowwort plots (p=0.194). We also found no significant difference between oak and pine plots (p=0.252). There was no significant interaction between our two factors (p=0.503) (Table 1). Our ANOVA with Shannon-Weiner diversity (H') as a response variable showed no significant difference between control and swallowwort plots (p=0.233). We also found no significant difference between oak and pine plots (p=0.270). There was no significant interaction between our two factors (p=0.423) (Table 1).

Our Kruskall-Wallis Test for number of families showed no significant difference in the number of families occurring in plots with different canopy types ($p=0.646$). It also showed no significant difference between control and swallowwort plots ($p=0.296$) (Tables 2&3).

Mean number of families per sample did not significantly differ between control and treatment plots. Of the 19 families observed, 11 occurred in all types of plots. Moths from the families Notodontidae (prominents), Saturniidae (silkworm moths), and Tineidae (fungus moths) only occurred in control plots with Notodontidae and Saturniidae exclusively occurring in oak-cherry control plots. Moths from the families Attevidae (needleminer moths), Cosmopterigidae (cosmet moths), Elachistidae (grass miner moths), Nolidae (nolas), and Ypsolophidae (falcate-winged moths) only occurred in swallowwort plots with all of the aforementioned families only being found in pine-spruce swallowwort plots.

ANOVAs that looked at four individual species demonstrate significant differences in abundance by canopy type ($p<0.05$). Each species was more abundant in deciduous plots. We found no significant differences in occurrence due to swallowwort presence ($p>0.05$). There were no significant interactions for any of the species ($p>0.05$) (Table 4).

DISCUSSION:

Presence of pale swallowwort had no effect on overall moth abundance in both oak and pine plots. This differs from our expectation and may have something to do with our study system. Several studies have concluded that Lepidopteran abundance and richness is negatively impacted by non-native vegetation (Burghardt *et al.* 2010, Valtonen *et al.* 2006). This is not always the case however. A study of sphingid moths in the tropics observed no differences in moth pollinator abundance among invaded sites where tree removal had occurred (Ghazoul

2004). The findings of Alison *et al.* (2017) suggest that tree and shrub species play an important role in maintaining insect diversity for species that occur in late successional habitats. Our findings could be in part due to the fact that the only difference between control and treatment plots was presence of pale swallowwort. Plots did not vary in vegetation type, and trees and shrubs characteristic of late successional forests occurred in both. The late successional setting of our plots could account for many of the moth species observed, and changes seemingly monumental as the complete invasion of the herbaceous stratum may have less effect than anticipated. Future studies on other types of ecosystems and successional settings may give a more detailed answer as to which factors impact moths the most.

Another point is that swallowwort can make forest understories achieve higher production rates than uninvaded sites. This new dense vegetation could potentially create a hiding spot for moths to evade bat predators. The lack of change observed may be due to a competing factors, as Rainho *et al.* (2010) found that dense vegetation reduces the ability of insectivorous bats to detect prey. Further support for this idea of competing factors comes from Pleasants and Bitzer (1999) who found that a prairie dwelling moth, *Ostrinia nubilalis*, prefers dense vegetation for aggregation sites over natural prairie vegetation. Though swallowwort may be unpalatable to moths and displace native hostplants, it can provide protection that is otherwise unavailable to them and this could explain the lack of differences in abundance.

There was no statistical evidence to support a decrease in species richness or diversity of moths in swallowwort plots. This is likely due to the factors mentioned previously that trees and shrubs, which tend to support the majority of late successional forest moths (Alison *et al.* 2017), are relatively unaffected by pale swallowwort invasion as opposed to herbaceous species. Though the effects of pale swallowwort on established trees and shrubs may be negligible, the plant will likely prove problematic as spread increases and trees and shrubs start to die off, as the effects of allelopathy could impact regenerating woody vegetation (Cappuccino *et al.* 2004). Moth communities could be faced with a number of selective pressures in the future that could potentially impact community composition such as, availability of larval hostplants, access to mates, and protection from predators. As pale swallowwort continues to spread moths may have to fly long distances to find suitable patches of host plants to colonize and some moth distributions may become relatively patchy. Further work could be done to examine how pale swallowwort impacts nutrient cycling and how it could potentially impact moth communities through stunted regeneration of forests.

The four species that we tested also did not show any significant differences in abundance between control and treatment plots. *Halysidota tessellaris*, *Idia aemula*, and *Malacosoma americana* rely primarily on trees and shrubs as host plants so they remained relatively unaffected by herb stratum invasion (Holland 1968). *Noctua pronuba* develops on herbaceous vegetation yet showed no decrease in abundance in swallowwort plots. Noctuids such as *Noctua pronuba* are able to fly long distances, so it is possible that the current invasion in our study areas has not gotten to a point where it could significantly impact the population of this species (Alerstam *et al.* 2011).

There was no evidence to support any significant differences in moth abundance, moth richness, moth diversity, or mean number of moth families per sample between oak-cherry and pine-spruce moth communities. This differs from our expectations due to the perceived lack of herbaceous species typical of coniferous forests. There was considerable overlap of common species found in deciduous forest plots suggesting that many tree and shrub feeding species of our area are generalist in habit and/or moths foraging or looking for mates may travel beyond suitable habitat with readily available hostplants (Berneys and Minkenberg 1997).

In contrast to community metrics, all four of the species evaluated separately were significantly higher in abundance in oak-cherry plots. This was to be expected as *Halysidota tessellaris* and *Malacosoma americana* typically oviposit on deciduous trees (Holland 1968). *Idia aemula* has been found to feed on dead leaves on the forest floor in addition to live needles of coniferous trees. It is likely the higher abundance in deciduous plots is due to the high density of leaves on the forest floor and the species may prefer this as a food source to live needles (Hohn and Wagner 2000). Lastly, *Noctua pronuba* was more abundant in deciduous plots which can be attributed to their abundance of herbaceous host plants (Cappuccino *et al.* 2004).

Conclusions

Pale swallowwort is continuing to spread throughout the Great Lakes region. Our study has shown that moth communities in forested ecosystems may be resistant to change due to the spread of pale swallowwort. This may be because they are lagging in response to this recent invasion, or that a large portion of the moths in our study systems do not rely on herbaceous vegetation and are generalists. Moths that are specialists should be naturally few in number and would require much larger sample sizes to adequately detect and draw conclusions from. It is possible that previously, moth populations had abundant food sources and instead were mainly checked by predation rather than competition for food and space. Pale swallowwort presence may reduce predation which is the reason that swallowwort seemed to have little to no effect on moth communities. If this were the case it would seem as though swallowwort presence should increase abundance of tree and shrub feeding moths, however there may be some indirect ecological interactions that would stabilize the population. Ecologists should proceed with caution and monitor moth as well as other insect populations to notice changes over time. As trees begin to fall and are slow to regenerate due to the added competitive stress of pale swallowwort's allelopathy, the impacts of the plant on moth communities may become more pronounced.

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TABLES & FIGURES:

Table 1. Factorial ANOVA (Minitab 17) results comparing log abundance, square root richness, and Shannon-weiner Diversity (H') across factors treatment and canopy type. Results were tested at an alpha of 0.05 level of significance. No interaction was found.

Log abundance	*df*	*MS*	*F*	*p-value*
Canopy type	1	0.10552	1.36	0.252
Treatment	1	0.13636	1.76	0.194
Interaction	1	0.03553	0.46	0.503
Sqrt Richness				
Canopy type	1	2.0441	1.42	0.242
Treatment	1	2.5043	1.74	0.196
Interaction	1	0.6287	0.44	0.513
Diversity (H')				
Canopy type	1	1.8925	1.54	0.223
Treatment	1	1.5417	1.26	0.270
Interaction	1	0.8076	0.66	0.423

Tables 2&3. Kruskal-Wallis test results for number of families per sample across factors canopy type and treatment. Results were tested at an alpha of 0.05 level of significance.

Canopy Type	*N*	*Median*	*Average rank*	*Z*
Oak-Cherry	18	7.000	19.3	0.46
Pine-Spruce	18	7.000	17.7	-0.46
Overall	36		18.5	

Treatment	*N*	*Median*	*Average rank*	*Z*
Control	18	7.000	20.3	1.04
Swallowwort	18	7.000	16.7	-1.04
Overall	36		18.5	

Table 4. Factorial ANOVA (Minitab 17) results comparing log+1 transformed abundance of *Halysidota tessellaris*, square root transformed abundance of *Idia aemula,* and log+1 transformed abundance of *Malacosoma americana* and *Noctua pronuba* across factors canopy type and treatment. Results were tested at an alpha of 0.05 level of significance. No interaction was found.

H. tessellaris	*df*	*MS*	*F*	*p-value*
Canopy type	1	0.48424	23.01	0.001
Treatment	1	0.07766	3.69	0.091
Interaction	1	0.04960	2.36	0.163
Idia aemula				
Canopy type	1	4.06172	8.78	0.018
Treatment	1	0.08805	0.19	0.674
Interaction	1	0.27469	0.59	0.463
M. americana				
Canopy type	1	0.91187	8.62	0.019
Treatment	1	0.04890	0.46	0.516
Interaction	1	0.02728	0.26	0.625
Noctua pronuba				
Canopy type	1	0.34892	14.47	0.005
Treatment	1	0.03144	1.30	0.287
Interaction	1	0.02412	0.64	0.446

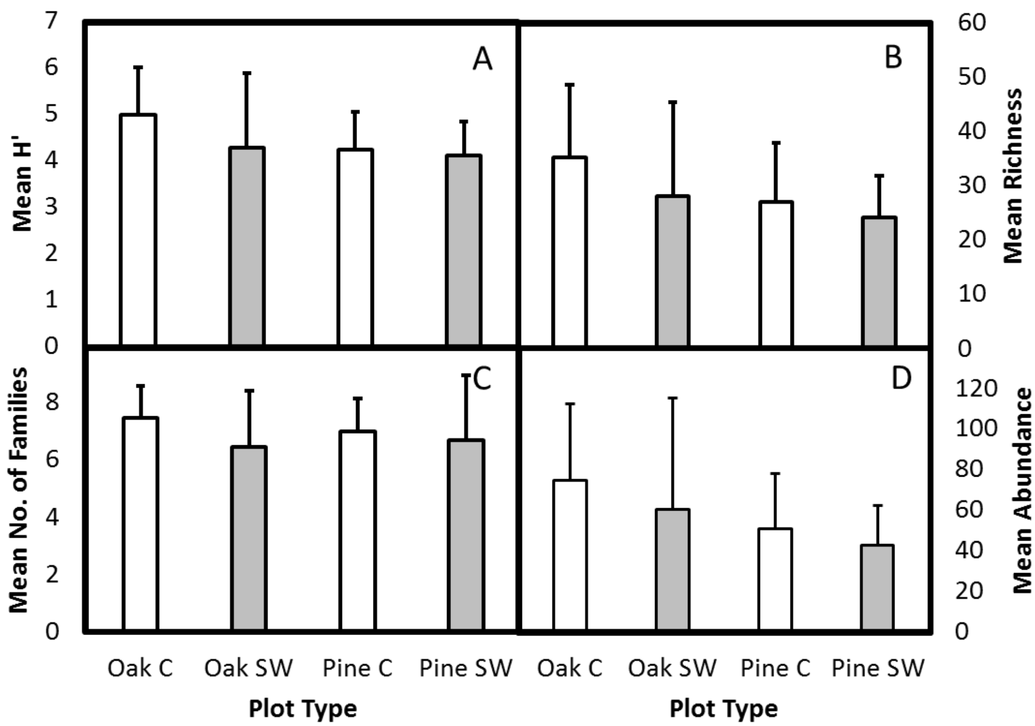


Figure 1. From top left clockwise: Mean and standard deviation Shannon-Weiner Diversity, species richness, abundance, and number of families per plot compared across all four plot types.

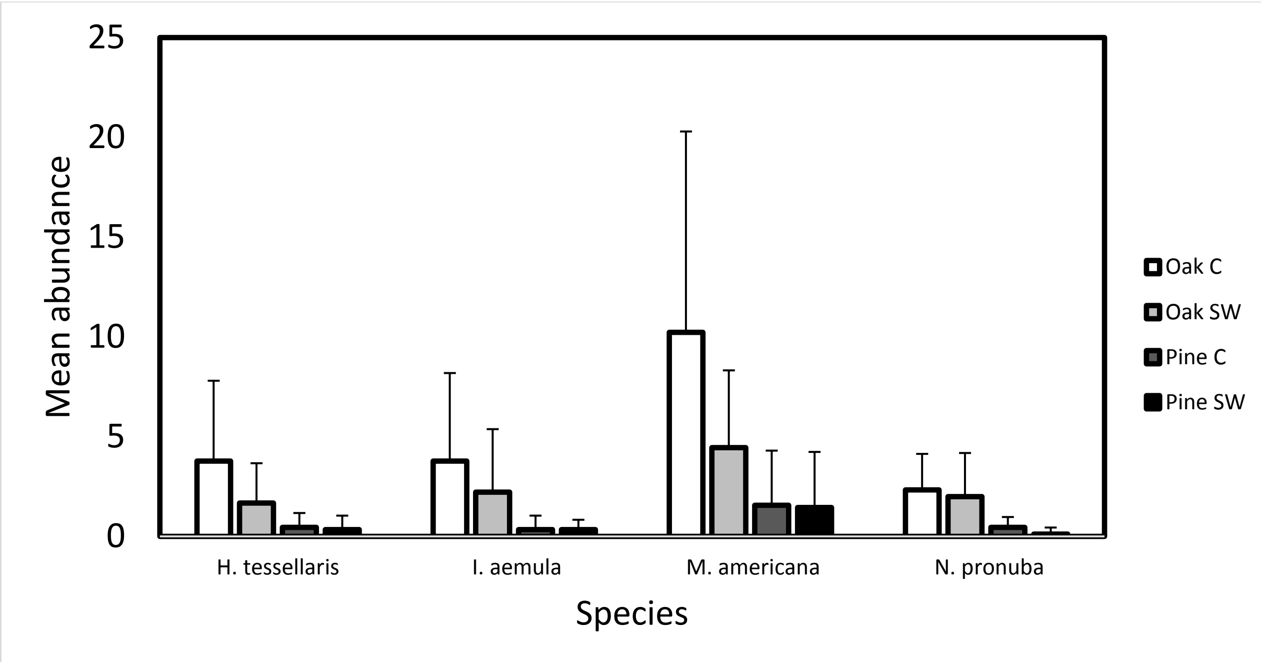
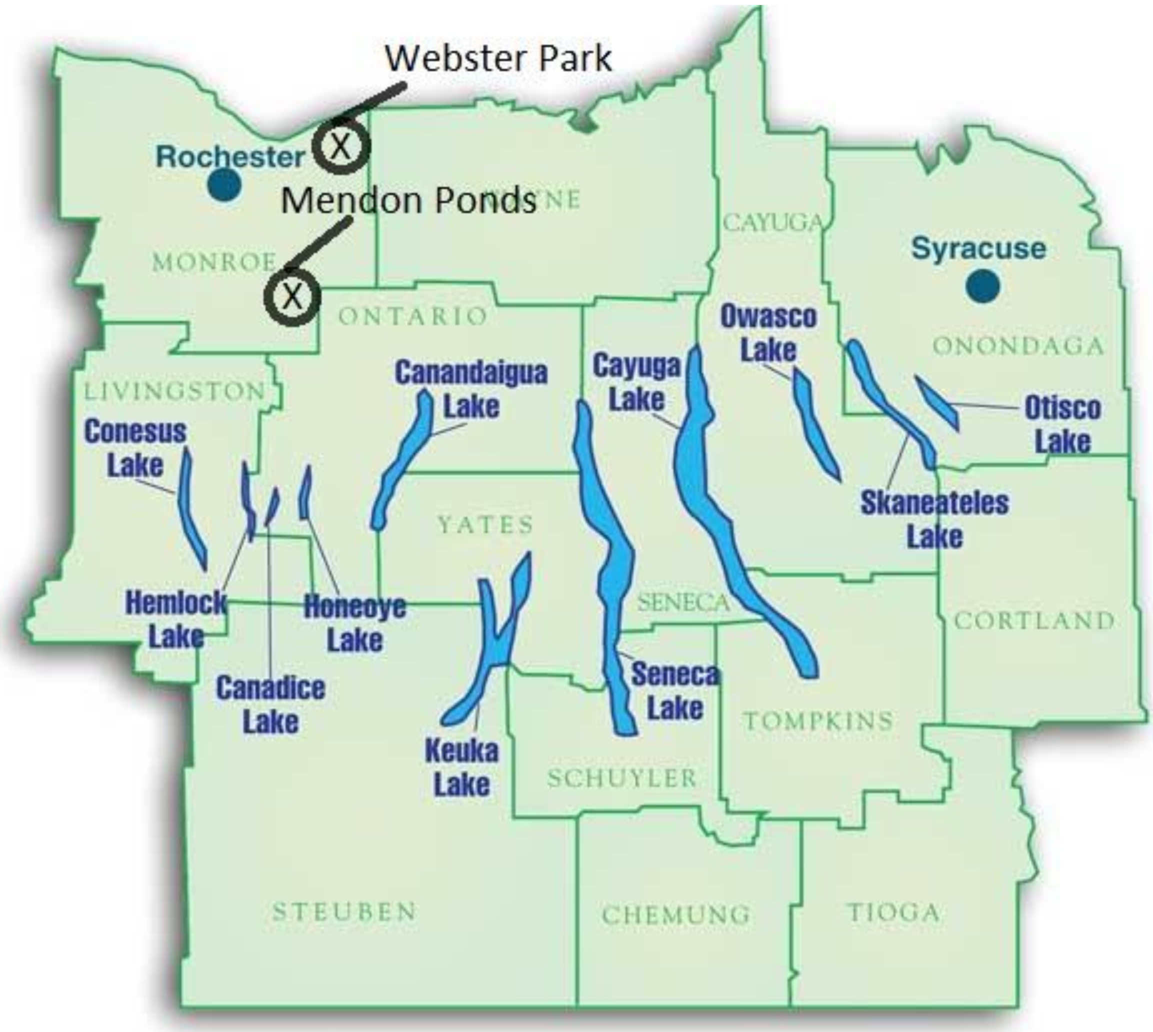


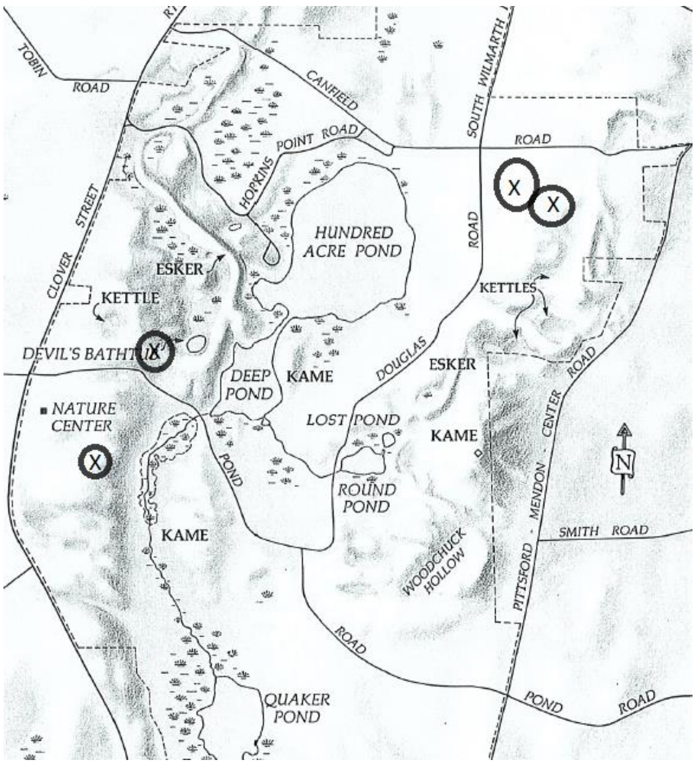
Figure 2. Mean and standard deviation abundance of selected taxa across plot types.

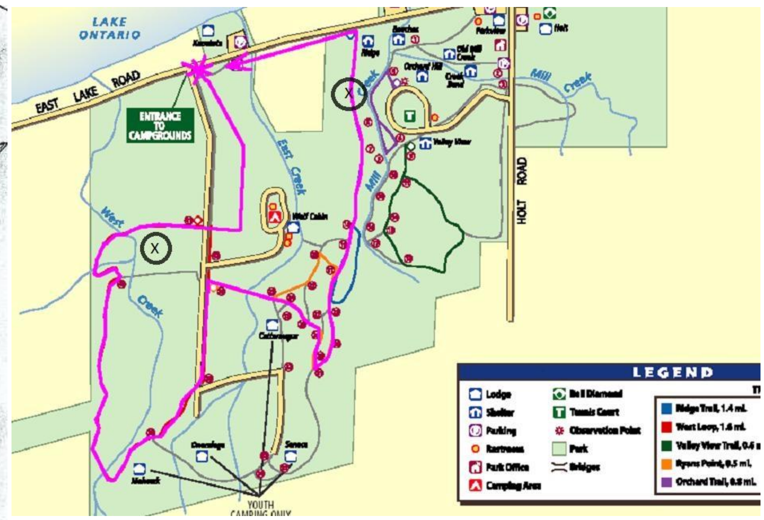
APPENDIX:

Appendix A. Locations where moth sampling occurred. The first map shows the locations of the parks sampled with respect to the Finger Lakes region in New York State. Each park is denoted by an “x”.



Maps showing the locations of each pair of plots. The left map shows Mendon Ponds Park located in Honeoye Falls, NY and the right map shows Webster Park located in Webster, NY. Each pair of plots is denoted by an "x".





Appendix B. Catalog of all moths sampled throughout the project with total abundance of all 36 samples and presence in either park included. Please note that the moths listed were only those that could be identified to species. This table represents 1686 of the 2039 moths collected this sampling period.

Family	Species	Total	Mendon	Webster
Attevidae	Atteva aurea	1		X
Cosmopterigidae	Limnaecia phragmitella	2		X
Crambidae	Agriphila ruricolellus	6	X	
	Anageshna primordialis	1	X	
	Blepharomastix ranalis	19	X	X
	Chrysoteuchia topiarius	4	X	
	Crambus agitatellus	39	X	X
	Crambus albellus	72	X	X
	Crambus saltuellus	1	X	
	Crocidophora tuberculalis	2	X	X
	Desmia funeralis	5	X	X
	Desmia maculalis	3	X	
	Diacme adipaloides	1	X	
	Diacme elealis	1	X	
	Eurrhypara hortulata	2	X	
	Fissicrambus mutabilis	1	X	
	Herpetogramma pertextalis	23	X	X
	Lipocosmodes fuliginosalis	3	X	
	Loxostege stricticalis	1		X
	Loxostegopsis merrickalis	1	X	
	Microcrambus biguttellus	1	X	
	Microcrambus elegans	1	X	
	Neodactria luteollelus	1	X	
	Ostrinia nubilalis	2	X	X
	Palpita kimballi	3	X	
	Palpita magniferalis	2		X
	Pantographa limata	1	X	
	Peripasta caeculalis	1		X
	Pyrausta acrionalis	1		X
	Scoparia basalis	3	X	X
	Scoparia biplagalis	1	X	
	Udea rubigalis	1		X
Erebidae	Amolita fessa	1		X
	Bleptina caradrinalis	29	X	X

	Caenurgina erechtea	1		X
	Catocala blandula	1		X
	Catocala coccinata	1	X	
	Catocala grynea	1		X
	Chytolita morbidalis	12	X	X
	Chytolita petrealis	7	X	X
	Cyncia tenera	2	X	
	Dasychira ragans	1	X	
	Dyspyralis illocata	1	X	
	Dyspyralis nigellus	1		X
	Grammia anna	1	X	
	Grammia virgo	4	X	X
	Halysidota tessellaris	56	X	X
	Haploa clymene	1		X
	Haploa confusa	3	X	X
	Haploa contigua	4	X	
	Haploa lecontei	21	X	X
	Hypena bijugalis	1		X
	Hypena edictalis	1		X
	Hypena madefactalis	2	X	X
	Hypena manalis	3	X	
	Hypenodes caducus	1	X	
	Hypoprepia fucosa	8	X	
	Hypoprepia miniata	1	X	
	Idia aemula	59	X	X
	Idia rotundalis	6	X	
	Idia rubricalis	1		X
	Lacsoria ambigualis	5	X	X
	Ledaea perditalis	1	X	
	Lymantria dispar	8	X	X
	Macrochilo litophora	2	X	
	Panopoda carneicosta	1	X	
	Panopoda rufimargo	5	X	
	Phalaenophana pyramusalis	36	X	X
	Phalaenostola eumelusalis	5		X
	Phalaenostola larentioides	4	X	X
	Phragmatobia lineata	1		X
	Pyrrharctica isabella	28	X	
	Pyspyralis illocata	1	X	
	Renia discoloralis	2	X	
	Renia factiosalis	7	X	X

	Renia flavipunctalis	30	X	X
	Scolecocampa liburna	4	X	X
	Spilosoma virginica	6	X	
	Tetranolita mynesalis	2	X	
	Virbia aurantiaca	29	X	X
	Virbia ferruginosa	1	X	
	Zale minerea	1		X
	Zanclognatha cruralis	7	X	X
	Zanclognatha jacchusalis	7	X	X
	Zanclognatha laevigata	12	X	X
	Zanclognatha lituralis	4	X	X
	Zanclognatha pedipilalis	65	X	X
	Zanclognatha protumnusalis	59	X	X
Gelechiidae	Anacampsis innocuella	2	X	
	Arthrips mouffectella	1		X
	Battaristis concinusella	1	X	
	Dichomeris ochripalpella	3	X	
	Neotelephusa sequax	3	X	X
	Telephusa latifasciella	5	X	X
Geometridae	Anavitrinella pampinaria	18	X	X
	Anticlea vasiliata	1	X	
	Besma endropiona	1	X	
	Biston betularia	4	X	
	Cabera variolaria	1	X	
	Caripeta piniata	1	X	
	Cleora sublunaria	1	X	
	Coryphista meadii	3	X	
	Costaconvexa centrostrigaria	40	X	X
	Digrammia gnophosaria	1		X
	Digrammia mellistrigata	1	X	
	Digrammia ocellinata	26	X	X
	Ectropis crepuscularia	11	X	X
	Epirrhoe alternata	12	X	
	Eulithis diversilineata	9	X	X
	Eulithis gracilineata	3	X	X
	Euphyia intermediata	4	X	
	Eupithecia columbiata	1	X	
	Eupithecia miserulata	4	X	
	Eusarca confusaria	11	X	X
	Eustroma semiatrata	1		X

	Heliomata cycladata	6	X	
	Homochlodes frittalaria	1	X	
	Hydrelia inornata	1	X	
	Hypagyrtis piniata	10	X	X
	Idaea dimidiata	7	X	X
	Iridopsis ephyraria	3	X	X
	Iridopsis humoria	2		X
	Iridopsis larvaria	4	X	
	Lambdina fiscellaria	1	X	
	Lobocleta ossularia	7	X	
	Lomographa glomeraria	2	X	
	Lomographa vestaliata	10	X	X
	Lytrosis unitaria	8	X	
	Macaria aemulataria	1		X
	Macaria fissinotata	1	X	
	Macaria pinostrobata	1		X
	Melanophia canadaria	3	X	X
	Melanophia signitaria	2	X	
	Metanema inatomaria	1		X
	Metarranthis sp.	1	X	
	Nematocampa resistaria	14	X	X
	Nemoria bistriaria	5	X	X
	Nemoria rubrifrontaria	2	X	
	Palatene olyzonaria	1		X
	Pero morrisonaria	30	X	X
	Plagodis phlagosaria	1	X	
	Pleuroprucha insularia	2	X	
	Proboarmia porcelaria	1		X
	Prochoerodes lineola	3	X	
	Protoboarmia porcelaria	2	X	X
	Rheumaptera prunivorata	2	X	
	Scopula cacuminaria	1	X	
	Scopula inductata	1	X	
	Scopula junctaria	1		X
	Scopula limboundata	12	X	X
	Selenia kentaria	1	X	
	Speranza pustularia	71	X	X
	Sporgania magnoliata	2	X	
	Tacparia atropunctata	1	X	
	Tetracis crocallata	2	X	
	Xanthorhoe ferrugata	1	X	

	Xanthorhoe labradorensis	1	X	
Lasiocampidae	Malacosoma americana	159	X	X
	Phyllodesma americana	3	X	X
Limacodidae	Isa textula	11	X	X
	Tortricidia flexulosa	2	X	
Noctuidae	Abrostola urentis	3	X	
	Acronicta increta	4	X	
	Acronicta innotata	2		X
	Acronicta interrupta	1	X	
	Agrotis ipsilon	7	X	X
	Amphipyra pyramidoides	3	X	
	Apamea amputatrix	1	X	
	Apamea verbascoides	1	X	
	Argyrogramma verruca	1	X	
	Baileya ophthylmica	1	X	
	Balsa labecula	1		X
	Calophagia lunula	1	X	
	Chytonix palliatricula	4	X	
	Colocasia propinquilinea	10	X	X
	Condica vecors	1	X	
	Condica videns	1	X	
	Cosmia calami	15	X	
	Eudryas grata	2	X	
	Eueretagrotis perattentus	1	X	
	Eueretagrotis sigmoides	1	X	
	Euxoa obeliscoides	1		X
	Feltia subgothica	1		X
	Hyppa xylinoides	1		X
	Lacinipolia meditata	16	X	X
	Lacinipolia olivaceae	1		X
	Loscopia velata	1	X	
	Noctua pronuba	44	X	X
	Orthodes cynica	1	X	
	Papaipema inquaesita	1	X	
	Platypolia mactata	1	X	
	Ponometia erastrioides	2		X
	Protolampra brunneicollis	4	X	
	Psaphida styracis	1	X	
	Pseudorhodes vecors	2	X	
	Rachiplusia ou	2	X	
	Raphia frater	1	X	

	Striacosta albicosta	3		X
	Sutyna privata	2	X	
	Syngrapha rectangula	1	X	
	Trichoiplusia ni	2	X	
	Xylotype acadia	1		X
Nolidae	Meganola miniscula	1	X	
Notodontidae	Nadata gibbosa	1	X	
Oecophoridae	Epicallima argenticinctella	4		X
Pyralidae	Acrobasis angusella	1	X	
	Acrobasis caryae	1	X	
	Acrobasis indigenella	6	X	X
	Acrobasis juglandis	1	X	
	Aglossa caprina	2	X	
	Aglossa costiferalis	5	X	X
	Anageshna primordialis	1	X	
	Condylolomia participalis	2	X	
	Eulogia ochrifrontella	2	X	
	Macalla zelleri	1		X
	Pococera asperatella	1	X	
	Pyla fusca	2	X	
	Telethusia ovalis	1	X	
	Tosale oviplagalis	10	X	X
Saturniidae	Actias luna	1	X	
Sphingidae	Ceratomia undulosa	1		X
	Paonias excaecata	1	X	
	Paonias myops	2	X	
	Smerinthus jamaicensis	2	X	
Tineidae	Monotropis pavlovski	1		X
	Monopis spilotella	1	X	
	Tinea apicimacuella	1	X	
Tortricidae	Acleris chalybeana	2	X	
	Acleris fragariana	1		X
	Acleris fuscana	1	X	
	Acleris nigrolinea	1	X	
	Acleris semipurpurana	4	X	
	Acleris subnivana	2	X	
	Acleris variana	1	X	
	Adoxophyes negundana	2	X	
	Agonopterix robiniella	1	X	
	Archips forvidana	2	X	
	Archips purpurana	2	X	X

	Archips semiferana	2	X	
	Argyrotaenia alisellana	3	X	
	Argyrotaenia quadrifasciana	2	X	
	Argyrotaenia quercifoliana	6	X	
	Argyrotaenia velutinana	2	X	X
	Catastega aceriella	1	X	
	Cenopis diluticostana	1		X
	Cenopis pettitana	2		X
	Cenopis reticulatana	1		X
	Choristoneura conflictana	2	X	X
	Choristoneura fractivittana	5	X	X
	Choristoneura fumiferana	1		X
	Choristoneura rosaceana	12	X	X
	Clepsis peritana	5	X	
	Cochylis aurorana	3		X
	Cochylis hospes	3		X
	Cydia latiferreana	16		X
	Decodes blasiplagana	8	X	X
	Endotheria hebesana	2	X	
	Epiblema tripartitana	1	X	
	Hulda impudens	7	X	X
	Olethreutes fasciatana	13	X	X
	Olethreutes glaciana	1	X	
	Olethreutes nigranum	1	X	
	Orthotaenia undulana	4	X	X
	Panderis limitata	1	X	
	Phaneta raracana	1		X
	Platynota idaensalis	1	X	
	Pseudosciaphila duplex	2	X	X
	Ptheochroa birdana	2	X	
	Sparaganothis sulphureana	5		X
	Syndemis afflictana	3	X	
	Thyraylia bana	2	X	X
Ypsolophidae	Ypsolopha dentella	1		X