# Pitfall and Bee Bowl Trapping Results from the Long-term Brendan Byrne State Forest Research Site in New Jersey.


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## INTRODUCTION

Insect diversity has been an understudied science since Thomas Say the "Father of American Entomology" made it an official field of study. The field is so large and so deep that it is difficult to understand a completely new world that is mostly invisible to the human eye. This insect study was conducted at Brendan Byrne State Forest at the "Colletti" site (Figure 1), a regenerating white cedar bog where four different treatments (Figure 2)were originally used to control deer browsing and competing vegetation: a) electric fence/herbicide (ET); b) no deer control/herbicide (CT); c) Hinder/herbicide (HT), and d) a control/control (CUT)]. These treatments resulted in significant differences in vegetation and ground cover structures, which we believe have implications for the bog's fauna (primarily insects in this study). In the New Jersey Pinelands, Atlantic white-cedar bogs have been largely underrepresented in entomological surveys.

Three types of insect traps were used in collecting data, two of which data were processed. These two traps are bee bowls and pit falls, sample target insect species in different ways. Bee bowls are a very simple sampling method which is used to *attract* flying insects such as Diptera, Hymenoptera, and Thysanoptera. Pitfalls are mainly used to collect insects (or other creatures) that are crawling in the ground cover such as Coleoptera and land Hymenoptera.

The sampling done at the Colletti site is only the beginning of a more intense insect survey. The pilot project was conducted three weeks for the pitfall trapping (VII/30/08 -VIII/5/08, VIII/5/08 – VIII/11/08, IV/26/09 – V/3/09,) and one day for the bee bowls (VII/31/08.) Plans call for more pitfalls and bee bowls to be set out during the rest of the year. We will be further processing the data to taxonomic family and species, not just order. This will give us a better idea of the ecology of faunal communities in these regenerating cedar bogs, along with the impact of the different treatments.

FIGURE 2(above)-Treatments at Colletti site:
4 is the Control/Control
3 is the Hinder/Herbicide
2 is the Control/Herbicide
1a/1b are the Electric fence/Herbicide
*(The fence was removed from area 1b in 2000 to determine if deer browse had any effect on the established stand No effect was found, and the remaining fence around 1a was removed in 2003).*

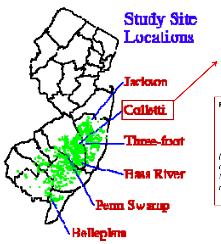


FIGURE 1(above)-Location of all long-term study sites including Colletti.

## METHODOLOGY

A total of nine transect lines (total of bee bowls=40, total of pitfall traps=40) were placed in the four treatments at the Colletti site (Brendan Byrne State Forest). The ET treatment had three insect transect lines and the other three treatments CT, HT, and CUT had two. For the ET treatment, the first transect had three bee bowls and pitfall traps and the second transect had six. Each trap was set every twenty ft. The third transect had a trap after the first twenty ft. For the CT, HT, and CUT treatments, traps were placed and flagged every twenty feet. This went on for a hundred feet, having five traps per transect line, ten traps per treatment, and thirty traps total. Overall there were forty traps including the ET treatment. Determining where traps were going to be placed on the hummock and/or the hollows depended on the time of year. When the bog was flooded, the pitfalls were placed in the hummocks and the bee bowls were placed on top of the hummocks. When the bog was not flooded, we alternated putting the traps in the hummocks and the hollows.

The standard recommendation for bee bowls is to use different color bowls to try and attract different insects. However in previous studies conducted blue bowls overall attracted more diversity, thus we used blue bee bowls solely. The diameter of the bee bowls are five inches. Soapy water was placed in the bee bowls in the beginning of the day and collected at the end of the day. The purpose of the soap is to break the surface water tension so insects fall into the water instead of floating on top. The sample had to be collected at the end of the day because the soapy water is not a preservative. Once collected the sample was put into 70% ethanol for storage. The pitfalls were left out for a week each time. "Environmentally friendly" (propylene glycol) anti-freeze was put into the cups, which serves as a killing agent and preservative. The size of the pit falls were sixteen ounces in volume and had a diameter of three and one-half inches. After a week expired, the samples were collected and put into 70% ethanol.

The sampling for the bee bowls was done on VII/31/08. The pit fall sampling was done for three weeks during VII/30/08 -VIII/5/08, VIII/5/08 – VIII/11/08, IV/26/09 – V/3/09 (Figures 3 & 4). The collected samples were kept labeled by individual trap for each treatment. They were all sorted to taxonomic order and placed into different vials. Identification was done by using an Olympus SZ-ST (SZ 40) dissecting microscope. Some traps however were destroyed by large mammals (possibly raccoons and deer) and no data could be collected. Other traps were flooded, and were still sorted but with a potential loss of data. The numbers of individuals by taxonomic classification and treatment were used in statistical analysis.

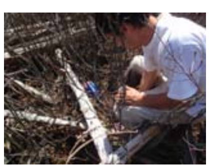

FIGURE 3 & 4 (above and left )-Collecting samples and replacing pitfall traps at Colletti site .

## ABSTRACT


**The long-term research site in the Brendan Byrne State Forest, New Jersey was one of four sites fully re-measured in the summer of 2008 – 18 years since the experiments began. This site had received four different treatment combinations designed to control deer and competing vegetation: electric fence/herbicide, Hinder/herbicide, no deer control/herbicide, and a control/control. These treatments have been documented to produce significant vegetation/ground cover structural differences. Pitfall traps and bee bowls were placed at sample points across all treatments (n=10 for each, 40 total). The sampling was done in 2008 and 2009.**

**The goal of pitfall traps is to see what types of insects are occurring in the ground cover. Bee bowls capture flying insects. The insects that were caught in both traps were separated to taxonomic order and lower when possible. The faunal diversity reflects in some ways the vegetation and ground structure differences produced by the various treatments and show the impacts of deer and competing vegetation on other ecosystem levels.**

**The pitfall trap results to date show a lot of insect order diversity (and diversity within the order) represented across all four treatments. The high variability (partly due to low sampling regimes) may be masking significant inter-treatment differences. We believe there still may be yield significant inter-treatment species differences but we need to collect more data this summer and also identify current samples to the family level. This trend to date is also reflected in the non-insect invertebrates. A vertebrate: short-tailed shrews *(Blarina brevicauda)* were captured in pitfalls, however, were only found in the ET and CT treatments (the majority were found in ET).**

**The bee bowl sampling in the control/herbicide treatment collected the most bees, Diptera, Thysanoptera and had the only Collembola out of all treatments. The Hinder/herbicide treatment collected the least amount of bees and Diptera.**


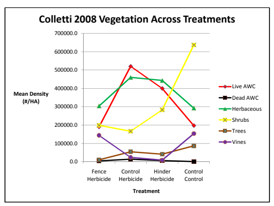


FIGURE 5 Vegetation components for 2008 by treatment at Colletti site.

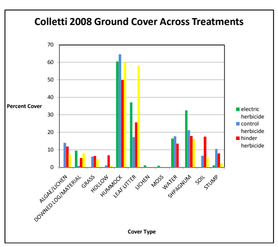


FIGURE 6 Ground coverages for 2008 by treatment at Colletti site.

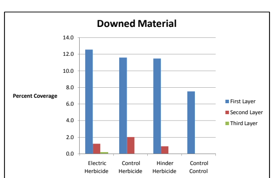


FIGURE 7 Downed material layers for 2008 by treatment at Colletti site.

## FUTURE WORK

**In the future we will continue more sampling with pitfall and bee bowl traps. We also have two malaise traps set up: one at the Three-foot site in conjunction with Dr. Jon Gelhaus, Greg Cowper, and Jason Weintraub of the Philadelphia Academy of Natural Sciences. The other malaise trap is set in the Electric fence/herbicide treatment at the Colletti site. Recently we purchased two canopy malaise traps that will be set high in the mature cedar canopy at the Colletti site.**

## REFERENCES


Droege, Sam. 2008. Tips on How to Use Bee Bowls to Collect Bees. Found at: http://online.sfsu.edu/~beeplot/pdfs/bee%20bowl%20%20tip%20sheet1.pdf.

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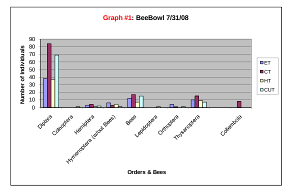
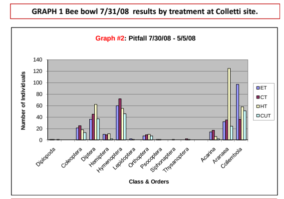
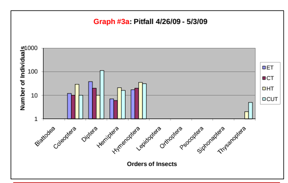


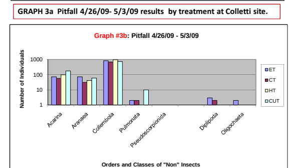

GRAPH 1 Bee bowl 7/31/08 results by treatment at Colletti site.




GRAPH 2 Pitfall 7/30/08- 8/5/08 results by treatment at Colletti site.




GRAPH 3a Pitfall 4/26/09- 5/3/09 results by treatment at Colletti site.




GRAPH 3b Pitfall 4/26/09- 5/3/09 results by treatment at Colletti site.

## RESULTS/DISCUSSION/CONCLUSIONS

**VII/31/08 Bee Bowl (Graph #1)**

Nine orders, 352 insects, and eight non-insect invertebrates were collected total. The Diptera had the highest concentration in CT (84) and the lowest in HT (37), which can be interpreted as something occurring in the microhabitats that the different treatments provide. Only one Coleoptera collected in CUT and one Lepidoptera larva were captured in HT. Four other orders were captured in roughly equivalent numbers to each other: Hemiptera (range = 3), Orthoptera (range = 4), Thysanoptera (range = 8), and Hymenoptera, without bees (range = 5). The eight non-insect invertebrates were Collembola that only appeared in the CT treatment. Fifty-one bees were collected for the day. Most (17) were found in CT and the least (7) found in HT. The difference between the highest and lowest counts for the bees is probably not significant at the order level. Overall, there were no major finds with the bee bowls. During this time, sweet pepper-bush *(Clethra alnifolia)* was in bloom, a highly valued nectar source for many pollinator insects. This could have resulted in a loss of capture success rate with such a low number of insects collected, specifically bees.

**VII/30/08 – VIII/5/08 Pitfall (Graph #2)**

One class, twelve orders, 564 insects, and 500 non-insect invertebrates were collected in total. Three Short-tailed shrews *(Blarina brevicauda)* were also collected, two in ET and one in CT. The Diptera had the highest concentration in HT(62) and the lowest and second lowest in ET (36) and CUT (37). The Hymenoptera had the highest concentration in CT (72) and the lowest in CUT (46). The differences among these orders in the different treatments show again that the different microhabitats in the treatments may be more attractive habitat for certain orders than others. All other insect orders showed no significant differences between highest and lowest densities: Coleoptera (range = 12), Hemiptera (range = 9), Lepidoptera (range = 2), Orthoptera (range = 3), Psocoptera (range = 1), Siphonaptera (range = 1), Thysanoptera (range = 2). There were no Psocoptera and Lepidoptera in the HT and CUT treatments. Only one Siphonaptera was found in CT, but it is assumed that it came from the shrew. There was no Thysanoptera found in HT and CUT. For the non-insect invertebrates, the Acarina were almost homogeneous across treatments (range = 11). However, there was a significant difference in the amount of Araenae collected in the HT treatment (125) with the next highest being in CT (35). A few wolf spiders (Lycosidae) had their young on them as they fell into the pitfalls. The Collembola in ET was by far more numerous than the other three treatments having ninety-seven individuals. The next highest concentration is HT with fifty-eight, and the lowest treatment was CT with thirty-six. The only class found was Diplipoda which occurred once in all the treatments except HT.

**VIII/5/08 – VIII/11/08 Pitfall**

This week's results were extremely compromised, because of flooding, and will not be analyzed. Every trap except a few was overflowing because of the rainfall. However, the traps were still collected and sorted out without mixing the traps in the same treatment together. Also, Trap #21 was attacked by a mammal in the HT treatment. The specimens are in poor condition, due to the water mixing with the anti-freeze and diluting the preservative ability of the anti-freeze. They are still being kept in 70% ethanol for experts to examine – if they can be identified. Under these conditions, there is one class, eleven orders, 766 insects, and 1017 non-insect invertebrates, resulting in 719 more individuals than the previous week's sample which was uncompromised.

**IV/26/09 – V/3/09 Pitfall (Graph #3a and #3b)**

This was the last week of pitfall trapping. One trap (#28) was attacked by a mammal in the HT treatment again and the sample lost. This week provided us with two classes, thirteen orders, 407 insects, and 3829 non-insect invertebrates. A Short-tailed shrew was caught in CT trap #14. We collected three new orders that had not been caught in previous trapping. One Blattodean was captured in the HT treatment, one Pseudoscorpion was captured in the ET treatment, and Pulmonata were located in all the treatments except for HT. Two Pulmonata were found in ET and CT and ten were found in the CUT, making it very possible that CUT conditions favor Pulmonata. Coleoptera was more abundant by nineteen individuals in HT. Diptera were by far more abundant in CUT, resulting in 112 individuals. The next highest individual count was thirty-eight in ET. All the Diptera caught in this week's sample are in the same family, Sciaridae (aka Dark-winged fungus gnats). One of their peaks is in early spring and apparently conditions are perfect for them in CUT. A total of fifty Hemiptera were caught, mostly nymphs. 74% of the Hemiptera was found in HT and CUT. Likewise, 64% of the Hymenoptera were located in the same two treatments. No Lepidoptera were found in ET and HT, and only one of each found in CT and CUT. No Psocoptera were found in ET and CUT and only one of each found in CT and HT. No Thysanoptera were found in ET. Not one Orthoptera was caught this week. It still may be too early for the species living in cedar bogs to be present. The majority of Acarina were located in CUT. 65% of Aranaea were in ET and CUT. Collembola can be considered homogeneous across treatments. The total for Collembola caught during this week was 3195 individuals, with most of them being in HT (955) and the least in CT (679.) Diplipoda were found in all treatments and the only Oligochaeta was in ET (2.) This sample had by far more individuals captured (4236) versus previous weeks sampled however, diversity is lower. We only had one family of Diptera for the week- much less than previous weeks sampled, which averaged twelve families.

### DISCUSSION/CONCLUSION

Overall, the data show that time of year and seasonality play an important role in location where the traps were placed and the fluctuations of insects per trap and per treatment. A certain order of insects may be more abundant in one treatment in late summer and less abundant in early spring or vice versa. An example of fluctuations can be seen with Diptera in spring, where the CUT treatment produced 67% of the total Diptera while in late summer, the Diptera in CUT only accounted for 21% of the total. An example of the season playing a role is in the ET treatment where throughout the year ET is moist and has shade, while other treatments dry up some parts of the year and do not have enough shade. Furthermore, the deciduous plants that dominate some of these treatments provide certain insects with more food and shelter, while the cedars do the same for other treatments and other insects. Nothing too obvious stands out with the results gathered and no certain clear trends have appeared to this point. There are apparent differences in vegetation and ground cover structures (Figures 5-7) which suggest that there are big differences among insect diversity and populations, but the initial results here do not yet support that conclusion. Sorting the insects only to order may not be precise enough to draw conclusions. The insects collected need to be identified more precisely -- at least to family. Identification to the Hymenoptera order alone lumps all ants, wasps, bees, etc. together, masking possible significant sub-order/family/species differences. One trap can be close to an ant colony and have only ants while another trap will just have wasps, but sorting them to order will clump them together and only be labeled as Hymenoptera. A similar problem is that just looking at the Collembola show that there are hundreds of one family in one trap in the same treatment, but there are hundreds of another family in another trap only twenty feet away. With continued collecting and more careful identification (to family at least) we could reach more conclusive results.

Sciaridae

Pseudoscorpion

Hebrus spp.

Rhyparochromidae

Saldidae

Saldoida spp.

Veliidae