ABSTRACT
An area of 170 acres was surveyed at Brookhaven National Laboratory (BNL) to discover the population levels of small mammals. Using a Geographic Information System (GIS), 30 locations were selected from various vegetation types. During the first three weeks, 30 Sherman traps were set in a grid formation. For the remaining 5 weeks, 25 traps were set in either a grid or transect configuration for three consecutive nights for a total of 2,527 trap nights. The data revealed that the diversity among small mammals is low, as only 5 species were found: Mus domesticus (House Mouse), Peromyscus leucopus (White Footed Mouse), Zapus hudsonius (Eastern Jumping Mouse), Glaucomys volans (Southern Flying Squirrel), and Tamias striatus (Eastern Chipmunk). Based on the data from the mice and chipmunk captures, the ideal locations for traps appeared to be in places with little to no vegetation and a decreased-access to a food source. As food supplies increased, capture rates declined. The vegetation combination of either grass/pine/birch or blueberry/blackberry for the under-story with an over-story mix of oak/pine was the preferred area for the flying squirrels. No small mammals were captured in the grassy fields. Considering the lack of complex small mammal species observed within the ecosystem at BNL, further investigation into this lack of diversity in the small mammal population should be conducted. Different capture methods can be used, including pitfalls, to potentially increase the variety of species captured. Upcoming studies should be conducted to look at the full 5,265 acres that encompass all of BNL.

Introduction
The small mammal population is an important aspect to the ecosystem. They are distributors of seeds and a food source for larger predators. The small mammals on Long Island range from different breeds of mice, shrews, voles, vole-like, and flying squirrels (Conner 1971). A survey is an informative way to gather data on populations and diversity. The data on the small mammal population levels are reliant upon proper evaluation (Adams et al. 2009, Flowerdew et al. 2004). Since most of these small mammal species are nocturnal, overnight trapping methods are required to document them. The trapping techniques used are to ensure that the small mammals will be released uninjured once data is obtained. It is estimated that the levels of the small mammal population are low with little species diversity.

Materials and Methods
Using a Geographic Information System (GIS), 30 locations were selected in a 170-acre area at BNL during an eight-week small mammal survey. The survey was initiated on June 8th and concluded on July 30th, 2009. Vegetation varied across all sites. Trapping was conducted three consecutive nights each week. Each trap was baited with a combination of peanut butter, rolled oats, and broccoli that was rolled into a ball and placed in the back of each trap. Weather conditions were recorded to see if weather had an effect on trapping. At each trapping location, a data log was placed every Monday and remained at a new site. The last week, the data loggers were pulled on Friday. Weather conditions were recorded every morning before traps were checked at each site, making note of any extreme weather conditions that occurred the previous night.

Every site had a formation which determined how the traps were setup. Each week sites were set with Sherman traps (H. B. Sherman Inc., Tallahassee, Fl.; 23.0 cm x 7.7 cm x 9.1 cm.) that were placed in a grid or transect configuration always positioned 5 m apart. For this survey there were a total of 2,347 trapping nights. The GPS point and headings were taken at each site, with the headings in degrees in two cardinal directions for the grid configuration and only one heading for a transect. In consideration to the small mammals during the warm weather months of June and July, the sites were deployed on Monday after 5 pm when temperatures were 65 degrees or higher. Under 65 degrees, traps were set up between 3 pm and 5 pm. Every Tuesday through Thursday morning, the traps were checked between 6:45-9:45 am and closed for the day to prevent small mammals from being trapped during the heat of the day. In the late afternoons, the traps were reopened and rebaited, if necessary. Every Thursday morning, the traps were removed after they were checked for captures.

All animals were weighed and photographed. Most of the small mammals were sexed and shaved on the either the left or right hindquarters so they would be easily identifiable upon recapture. The exception were reopened and rebaited, if necessary. Every Thursday morning, the traps were removed after they were checked for captures.

The results show that the population is not as diverse as it should be. Considering that there is a wide range of vegetation types, including an array of under-story with over-story combinations, there should have been an assortment of mice, voles, and shrews in addition to the species that were captured. In a study done for the specific captures of shrews, the trapping method used was pitfalls (Brooks and Doyle 2001). There were 3,000 trap nights in the Southern Flying Squirrel species. The capture rate was 2.5%, which is a low rate. This was due to the trapping methods being used, which were not effective enough. The small mammal population is low, as only 5 species were found: Mus domesticus (House Mouse), Peromyscus leucopus (White Footed Mouse), Zapus hudsonius (Eastern Jumping Mouse), Glaucomys volans (Southern Flying Squirrel), and Tamias striatus (Eastern Chipmunk). Based on the data from the mice and chipmunk captures, the ideal locations for traps appeared to be in places with little to no vegetation and a decreased-access to a food source. As food supplies increased, capture rates declined. The vegetation combination of either grass/pine/birch or blueberry/blackberry for the under-story with an over-story mix of oak/pine was the preferred area for the flying squirrels. No small mammals were captured in the grassy fields. Considering the lack of complex small mammal species observed within the ecosystem at BNL, further investigation into this lack of diversity in the small mammal population should be conducted. Different capture methods can be used, including pitfalls, to potentially increase the variety of species captured. Upcoming studies should be conducted to look at the full 5,265 acres that encompass all of BNL.

Table 1 Sites, Week and Night Deployed, Trap Amounts, Trap Nights, and Sites Raided

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1</td>
<td>Site 2</td>
<td>Site 3</td>
<td>Site 4</td>
</tr>
<tr>
<td>30 traps</td>
<td>30 traps</td>
<td>30 traps</td>
<td>30 traps</td>
</tr>
</tbody>
</table>

Conclusions
The animal with tag #8 was caught three times, while two others were only caught once each (ear tag # 9 and #11). Weather conditions ranged from heavy rainfall to clear skies, and appeared to have an apparent effect on captures. The capture of three of the five species were caught in the worst weather conditions of the survey period.

In another study on four different methods of trapping, Longworth traps, large and small Sherman traps, and pitfalls were tested to distinguish each technique (Anthony et al. 2005). Most captures were with the pitfalls, with the majority being shrews. All of the other three had a greater species diversity and less captures (Anthony et al. 2005, Brooks, & Doyle 2001).

In the areas that consisted of a huckleberry and blueberry combination under-story, only Southern Flying Squirrel (G. volans) were captures, this being one of their food sources (Conner 1971). All of the different species captured feed on a variety of material, including leaves, insects, seeds, nuts, and fruits when in season.

Further research should be conducted to include all 5,265 acres of encompass BNL. There are different trapping methods that are required to effectively increase the species captured. These trapping techniques need to include the use of pitfalls in association with Sherman traps. By increasing both the nights per week and the use of pitfalls in addition to the Sherman traps, the diversity of the small mammal species captured would be increased. Also it ought to be established what the population levels are during the three other seasons of the year to obtain a full-year of data that covers the distribution of food sources.

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I would like to thank my mentor Jennifer Highe, Dr. Timothy Green, Richi Lagattuta, Mike Sturgeon, Dr. Candace Foley, Nita Leonard, Dr. Thomas Garden, Jordan Hay and my fellow interns: Bradley Backwell & Kyle Muson for making this internship possible. I would like to also thank the organizations that were involved: Suffolk County Community College, NSF-STEM, C-STEP, Department of Energy, OEP, and Brookhaven National Laboratory.

References
Rebaiting Sherman traps at one of the sites.

A House Mouse that was captured a site #13.

A Southern Flying Squirrel climbing in a Pitch Pine tree after being released.

A House Mouse that was captured at site #13.

Southern Flying Squirrel caught at site #16.

Placement of a trap at site #22.

This is a Southern Flying Squirrel on the either the left or right hindquarters so they would be easily identifiable upon recapture. The exception were reopened and rebaited, if necessary. Every Thursday morning, the traps were removed after they were checked for captures.
ABSTRACT

An area of 170 acres encompassing a variety of vegetation types was surveyed at Brookhaven National Laboratory (BNL) to discover the population levels of small mammals. Using a Geographic Information System (GIS) 30 locations were chosen in various vegetation types. During the first three weeks, 30 Sherman traps were used in a grid formation. In the remaining 5 weeks, 25 traps were placed in either a grid or transect formation for three consecutive nights for a total of 2,327 trap nights. The data revealed that the species diversity among small mammals is low, as only 5 species were found: Mus domesticus (House Mouse), Peromyscus leucopus (White Footed Mouse), Zapus hudsonsius (Meadow Jumping Mouse), Glaucomys volans (Southern Flying Squirrel), Tamias striatus (Eastern Chipmunk). Any other species were classified as "Other" in the tables. Based on the data the mice and chipmunk captures, the ideal locations for traps appeared to be in places with little to no vegetation and a dense access to a food source as their food supply increased, there were less captures. While the vegetation combination of either grass/greenbrier or huckleberry/blueberry for the under-story with an over-story mix of oak/maple/pine was the preferred area for the small mammals, no small mammals were captured in the grassy fields. Considering the lack of complex small mammalian species observed within the study, further investigation into this shift of diversity in the mammalian populations should be conducted. Different capturing methods can be used, including pitfalls along with the Sherman traps, to increase the variety of species captured. Upcoming studies should be conducted to look in the full 5260 acres that encompasses all of BNL.

Materials & Methods

Using a Geographic Information System (GIS), 30 locations were selected for study in a 170-acre area for BNL for an eight-week small mammal survey. It was initiated on June 8th and concluded on July 30th, 2009. Each site varied in vegetation involving the under-story and over-story. Trapping was conducted three consecutive nights each week. Each trap was baited with a combination of peanut butter, rolled oats, and birdseed that was rolled into a ball and placed in the back of each trap.

Weather conditions were recorded every morning before traps were checked at each site, making note of any extreme weather conditions that occurred the previous night. Every site had a formation in which the traps were setup. The first week, two sites were set at 30 feet Sherman traps (H. B. Sherman Inc., Tallahassee, FL). 21 x 21 cm x 6 ft that were placed in a grid formation of 5 x 5 that were always positioned 2 m apart. When amounts of traps declined the grid arrangement was 5 x 5. There were different quantities of traps used at certain sites (Table 1). The strips of locations were alternated between grids and transect configurations. For this survey there was a total of 2,347 trapping nights.

By recording the position on GPS along with the headings at all sites other researchers can duplicate this study. After each site was setup the headings in two cardinal directions were recorded in grid configuration while only one heading was recorded for each transect. There were 29 locations where a total of 30 traps were taken on top 1 and the micropsychometric consideration to the small mammals during the warm weather months of June and July, the sites were initially setup on Mondays after 5 pm when temperatures were 65 degrees or higher; otherwise under 65 degrees they were setup between 3 and 5 pm. Every Tuesday through Thursday morning the traps were checked between 6:45-9:45 am and closed for the day to prevent small mammals from being trapped during the heat of the day. In the afternoons each Monday through Wednesday, the traps were reopened and rebuilt, if necessary. Every Thursday morning the traps were removed, after which they were checked for captures.

Each capture was marked to identify recaptures in the future. Every individual caught was initially weighed, after which they were photographed. Each of the small mammals were sexed and shown on the either the left or right hindquarters so they would be easily identifiable upon recapture. The exception was the Southern Flying Squirrel (G. volans) as part of a different study, flying squirrels were given a numbered ear tag.

There were only five different species caught, the three mice species on the House Mouse (M. domesticus), the White Footed Mouse (P. leucopus), Meadow Jumping Mouse (Z. hudsonsius), the other two species were the Southern Flying Squirrel (G. volans) and the Eastern Chipmunk (T. striatus). Two other species not categorized as small mammals that were captured were labeled as "Other" (Table 7). All animals were captured in only 15 of the 30 sites visited (Figure 1). There were a total of 22 captures throughout the study area at BNL. There were no captures of shrews, voles, or moles in the same area being studied. Every capture of the House Mouse (M. domesticus) occurred in a location with a variable environment, different from the others. There were two adult males, one adult female and one oneunkown. The White Footed Mouse (P. leucopus) was caught in areas with similar over-story trees. Of the seven captured six were made, five adults and one juvenile, the last one was not Yet, but had the weight of a juvenile. There was only one Meadow Jumping Mouse (Z. hudsonsius) captured during this study, escaped before being sexed, but according to its weight was a juvenile. The Southern Flying Squirrel (G. volans) captures were in diverse surroundings that were all on the edge of two different types of forms. Of those caught five were males, four adults and one juvenile, and two adult females. Only one Eastern Chipmunk (T. striatus) was captured throughout this study and escaped before being sexed. There were two other captures that were neither small mammal species caught in this study.

The only documented recaptures were that of the Southern Flying Squirrel (G. volans), ear tag #8 was caught three times in this study, while two others were only caught once each, ear tag #9 and #11. Weather conditions ranging from heavy rainfall to clear skies for the overnight had no affect on captures. The capture of three of the five species were caught in the worse of these conditions as well as one non small mammal species.

There were two at 10 sites by a bigger mammal of unknown species, presumably a raccoon, that snatched the traps. Sometimes only part of a tail had been hit, but most times all traps had been attacked, which happened 15 times. Of those 10 sites 5 were hit twice while the other 5 were attacked only once.

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I would like to thank my mentor Jennifer Higbie, Dr. Candice Foley and Nina Loehndth, Dr. Thomas Gordon and Jordan Hay for making it possible for me being here. I would also like to thank the organizations that were involved Suffolk County Community College, NSF-STEM, C-STEP, Dept of Energy and Brookhaven National Laboratory.

Conclusion

The results show that the population is not as diverse as it should be. Considering that there is a wide range of vegetation types, including an array of under-story with over-story combinations, there should have been an assortment of moles, voles, and shrews caught in addition to the species that were captured. In a study done for the specific captures of shrews the trapping method used was pitfalls (Brooks and Doyle 2001). There were 3,800 trap nights in that study successfully capturing 2,214 small mammals of nine different species, but only 341 were actually observed (Brooks and Doyle 2001). The percentage of captures, 56%, as compared to the results of this study of capturing 20 small mammals in 2,347 trap nights was less than 1% (0.08%).

In another study on four different methods of trapping; Longworth traps, large and small Sherman traps, and pitfalls, were tested to distinguish each technique (Anthony et al. 2005). Most captures were with the pitfalls with the majority being shrews, all of the other three had a greater species diversity and less captures (Anthony et al. 2005, Doyle et al. 2005).

In the areas that consisted of a huckleberry and blueberry combination under-story had only Southern Flying Squirrel (G. volans) captures, this being true of their food sources (Connor 2001). All of the different species captured feed on a variety of material, including larvae, insects, seeds, nuts, and fruits when in season.

During this study it was revealed that the Southern Flying Squirrel (G. volans) exhibited new learned behaviors. Sherman traps were used in a different study, their last but lacking birdseed, had placed take the same localities of this study resulting in five recaptures of the Southern Flying Squirrel (G. volans). Once these sites were separated the recaptures stopped.

Further research would be conducted to include all 555 acres that encompasses BNL. There are different trapping methods that are required to effectively increase the species captured. These capturing techniques need to include the use of pitfalls in association with Sherman traps. The duration of any new research is supposed to continue at eight weeks with the extension to four or five nights of trapping at each location. With increasing both the nights per week of trapping and types of traps used would obtain greater information and the diversity of the small mammal species captured. Also it ought to be established what the population levels are during the three other seasons of the year, to obtain a full year of data that covers the fluctuation of food sources.