Brookhaven National Laboratory

NATURAL RESOURCE MANAGAMENT PLAN

ANNUAL REPORT

CALENDAR YEAR 2005

1.0 Introduction

This document summarizes activities carried out under Brookhaven National Laboratory's (BNL) Natural Resource Management Plan (NRMP) during calendar year 2005. Previous year's reports may be obtained from BNL's Cultural and Natural Resource Manager. All activities carried out under the NRMP during CY2005 will be discussed and the report will facilitate development of summary information for the Site Environmental Report for 2005.

2.0 Comprehensive Natural Resource Management Plan

The Laboratory completed and issued the Comprehensive Natural Resource Management Plan in December 2003. The development of this plan was carried out over several years with the assistance of the Technical Advisory Group (TAG) that was established to provide input to the Natural Resource Program and the Upton Ecological and Research Reserve.

This report discusses work related to actions established within the NRMP. The NRMP is a living document that will change based on the concept of adaptive management. As new information is gained and the understanding of the ecological processes within the Pine Barrens ecosystem in which BNL is situated improves, changes to the NRMP will be made. Incremental changes will be incorporated annually with the completion of the required Annual Report. All incremental changes will be addressed during the 5-year re-write of the Plan.

To facilitate updating and changing actions, each Annual Report is submitted to the TAG for review and comment. Input from the TAG will be accepted and considered for incorporation into the action items list. Currently the Action Item list consists of 65 actions (57 original actions plus 8 new actions identified in the CY2003 Report) that will be discussed in this Annual Report.

3.0 Progress

3.1 Transition Wildlife Management Plan Actions into NRMP

This was completed in December 2003 with the publishing of the current NRMP.

3.2 Annual Summary Report

An annual summary report for calendar year 2004 as required under the NRMP was written as part of the Internal Self Assessment program of the Environmental & Waste Management Services Division. The annual report for calendar year 2004 was completed by the March 31, 2005 deadline established in previous reports. The CY 2004 report was also submitted to the TAG for Review.

3.3 TAG Review of Annual Report

The CY2004 report on the NRMP was submitted to the TAG for review. No comments were received and no meeting of the TAG occurred during CY2005. The CY2005 report will be sent to the TAG with a request for comment. Comments on annual reports are to facilitate changes in the program other than those that have been identified over the past year. In addition the TAG review may result in modification to changes suggested by the Natural Resource Manager during the writing of the Annual Report.

3.4 Adaptive Management Cycle

The current report is the third Annual Report in the Adaptive Management Cycle. It is not expected to result in a need for significant changes. As actions identified in the NRMP are implemented, monitored, and reported on in the future, the need for change will be identified.

3.5 Improve Decision making through use of Innovative Tools

The use of global positioning systems (GPS) and geographic information systems (GIS) are important tools for managing various aspects in Natural Resource Management. Two new or modified layers were added to the GIS during 2005. In addition, the GIS-based technique for estimating the white-tailed deer population was further improved based on results obtained in early 2005. New vegetation maps provided by The Nature Conservancy were used for establishing forest health monitoring, and the GIS was extensively used to assist student research projects conducted during the summer 2005.

Projects using the GIS and/or GPS include tiger salamander and marbled salamander larval and metamorph surveys, hognose snake, box turtle, and spotted turtle radio telemetry surveys, Odonate (dragonfly and damselfly) surveys, vernal pool water chemistry studies, banded sunfish population estimating, and documentation of species locations from random sightings.

3.6 Maintain and Improve Relationships with Stakeholders

BNL continues to maintain good relationships with all of its stakeholders.

The Upton Reserve serves to maintain relationships between BNL, DOE, and the U.S. Fish & Wildlife Service through continued cooperation in the management of the Upton

Reserve and funded research, while developing the transition of Upton Reserve management and research to a new not-for-profit foundation. As the Department of Energy funding was reaching its agreed end date, the DOE, Pine Barrens Commission, and the Laboratory worked to establish a not-for-profit organization to carry-on the work of the Upton Reserve. The Foundation for Ecological Research in the Northeast (FERN) was incorporated in New York on Nov. 25, 2003 and implemented the first ever forest health monitoring of the Central Pine Barrens in CY2005 using funding secured in CY2004. FERN's board of directors represent interests of BNL, The Nature Conservancy, Stony Brook University, and Dowling College with board seats for up to 15 members. FERN and the Natural Resource Program at BNL are closely allied to ensure sound operation of the Upton Reserve and to encourage the use of the Reserve and BNL for ecological research.

3.7 Peconic River Flow Monitoring

Peconic River flow is measured at several locations including above the outfall (HE), down river at the East Firebreak (HMn), and near the boundary of the Laboratory (HQ). In addition flows from the central wetlands are monitored before they enter the Peconic River station at the East Firebreak (HMs), and flows from the STP are measured prior to discharge into the Peconic River. Flow data is presented in Figure 1. The chart shows three peaks. The January 2005 peak is likely due to snow fall (18 inches) the previous week. The April 2005 peak is due to removal of diversion dam, associated with the cleanup, at the STP outfall. Finally, the peak in October 2005 coincides with a record 22 inches of precipitation that occurred that month. The area experienced drought in 2005 and little or no flow occurred in a significant portion of the river onsite and stretches of the river offsite as well. As mentioned above heavy rains in October restored flows.

3.8 Water Quality Monitoring

Water quality is monitored as a requirement of BNL's State Pollutant Discharge and Elimination System (SPDES) permit. Water quality is measured at various outfalls including the STP discharge to the Peconic River and at several recharge basins that receive stormwater and/or once through cooling water. Results are reported to the NYSDEC on a monthly basis and summarized in the Site Environmental Report each year. The Site Environmental Report may be viewed via the Internet at http://www.bnl.gov/esd/SER.asp. Sampling in 2005 did not indicate any concerns for threatened or endangered species within basins or the Peconic River.

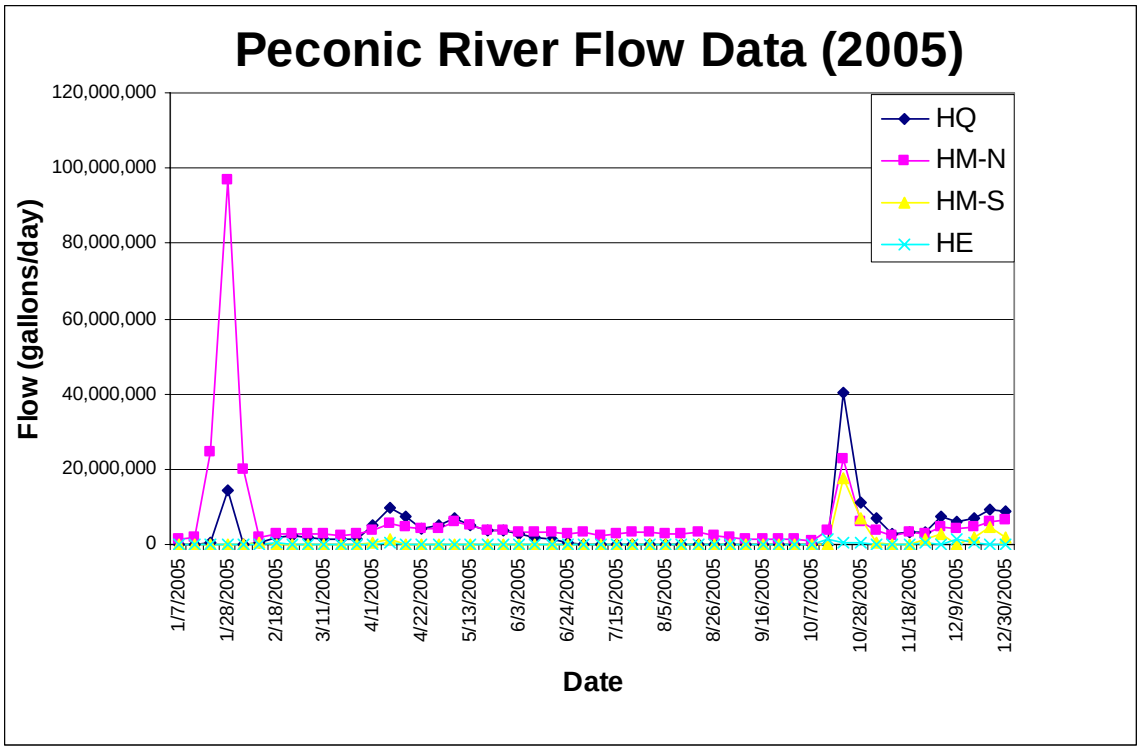

Figure 1. Peconic River flow data for 2005.

3.9 Fish Sampling Peconic River

A population assessment of the onsite portion of the Peconic River was not completed in 2005 due to the clean-up operations that occurred along the river from the STP to Manor Road area. During the clean-up, which started in mid-2004 and was completed in May 2005, water was diverted around large areas of the river, temporarily removing habitat for fish. Flows were permanently returned to the river in April 2005 and sufficient time had not passed to allow re-colonization of the onsite portions of the river. Additionally, the area experienced a drought in 2005 that resulted in many onsite and offsite sections of the river drying up by late July.

Data from previous sampling that took place before the River was remediated will be used for comparison when population assessments resume in 2006.

Because fish populations have not recovered and the clean up of the onsite portions of the river has resulted in many fish being removed from the on site portion of the river, the moratorium on destructive sampling under the Environmental Monitoring Plan will be maintained for up to three more years.

In 2004, prior to the start of the Peconic River remediation project, a search for banded sunfish took place. A total of 193 banded sunfish were captured from both onsite and offsite portions of the river and release in a protected pond. A summer intern conducted an assessment of the banded sunfish population in 2005. This assessment involved the collection of approximately 1200 fish that were identified and measured. Figure 2 provides a distribution of sizes from this survey. The study conservatively estimated a

population of between 96,000 to 107,000 fish in the pond. A copy of the poster, prepared as part of the internship, is attached to this report. Due to the drought the pond nearly dried up toward the end of the summer. A rescue effort to save a small number of fish and return them to the Peconic River was conducted. Approximately 250 banded sunfish were released to the river between the STP and the east firebreak. The pond did not completely dry and 2-3 thousand fish are thought to have survived when the pond returned to normal water levels in October 2005.

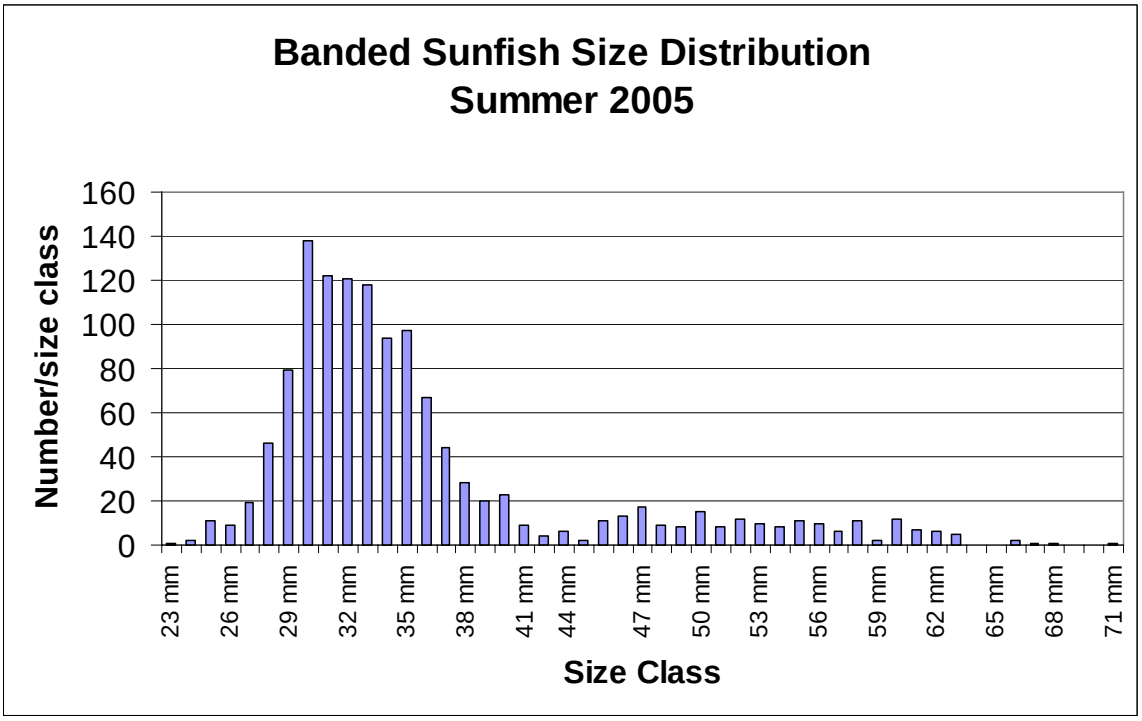

Figure 2. Size class distribution of banded sunfish measured in summer 2005.

3.10 Deer Management

The need for deer population management continues to be an issue for BNL. Discussions on various deer management issues are provided below.

There has been no change in deer management in 2005 except for updated estimates based on new census techniques.

3.10.1 Issue and Decision Paper on Deer Management

No further effort was placed on this action in 2005. Effective management of deer will continue to be an issue that at some point must be addressed not only by the Laboratory but also local landowners, the state, county, and towns.

3.10.2 Environmental Assessment for Deer Management

Once an issue and decision paper is finalized and approved, the need for an EA can be re-evaluated.

3.10.3 Implement Deer Management

No further work has been done on this action in 2005.

3.10.4 Deer Population Estimation

Deer population estimates were conducted in both spring (prior to birth of fawns) and in the fall (after birth of fawns and while bucks had antlers). Figure 2 shows the population trend over the past five years. Population levels are considered to be above the ecosystems carrying capacity and their effects on the ecosystem are still evident.

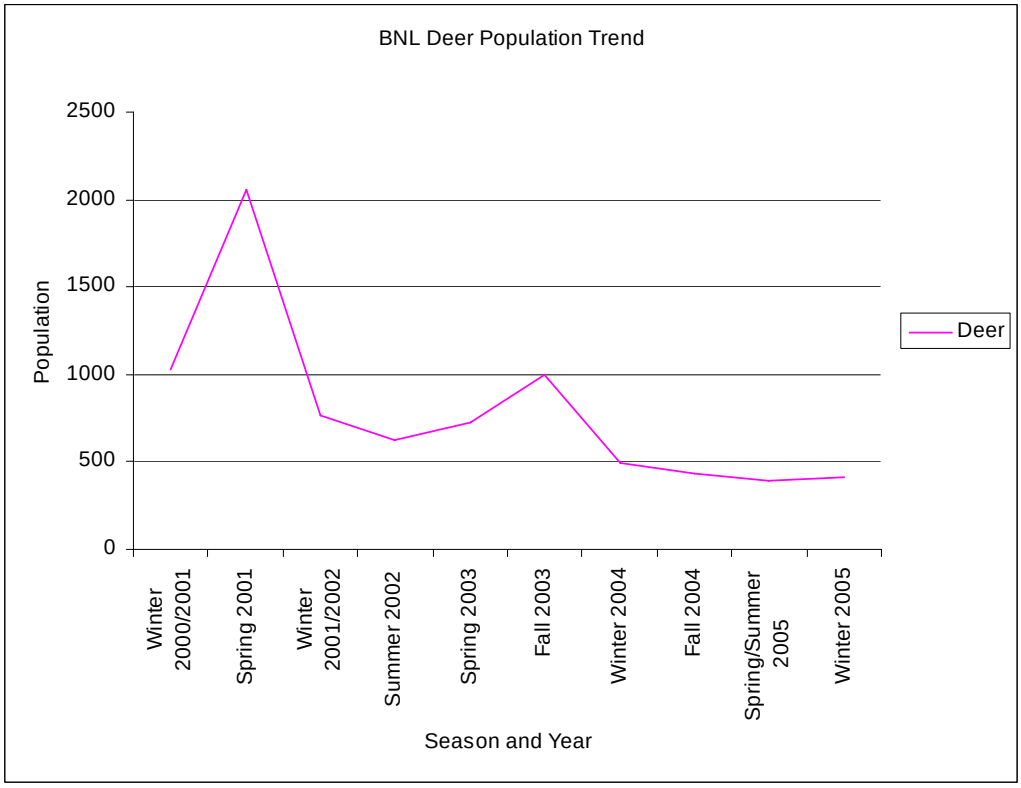

Figure 3. Trend in population estimates of white-tailed deer between 2001 and 2005. Note: Spring 2001 estimate is high due to limited data.

3.11 Special Status Species

BNL is home to a number of plants and animals that are considered special status species including the New York State endangered tiger salamander and Persius duskywing, and the state threatened banded sunfish, swamp darter, frosted elfin butterfly and northern harrier (Table 3). Endangered and threatened plants include the crested fringed orchid,

stargrass, and stiff goldenrod. There is also a relatively long list of species of special concern, and rare or vulnerable plants. Under the NRMP the Lab is working to identify areas that may be suitable habitat for species on this list.

In addition to the list in Table 3, species like the wild turkey and Canada goose are also of interest due to their prominence and potential to interact with humans. Information on these species is maintained simply to be aware of potential issues that may arise.

3.11.1 Maintain Special Status Species List

Table 3 is the most recent update of the special status species list. A threatened damselfly species, the pine barrens bluet (*Ennalagman recurvatum*) was placed on the list in 2005 after it was confirmed to exist onsite. Table 3 contains all species identified onsite since the mid-1980s.

3.11.2 Identify Habitats of Special Status Species

When special status species are identified as being present on the BNL site, their habitats are also identified. If applicable, surveys for the correct habitat take place with surveys for the species in question occurring within the appropriate habitat and information concerning presence or absence of the species is recorded and maintained in BNL's GIS. Currently surveys for four species take place at least annually, they are the tiger salamander, banded sunfish, swamp darter, and frosted elfin. Since the pine barrens bluet was identified to be present onsite in 2005, surveys for this species will be added in 2006.

3.11.3 Tiger Salamander

The eastern tiger salamander, a New York endangered species, is locally abundant on the BNL site. This species has been documented using at least 22 of the 27 ponds or pond systems on site. During the development of the NRMP pond designations were modified to lessen the confusion between confirmed (TS) and unconfirmed (ts) habitat.

3.11.3.1 Tiger Salamander Annual Egg Mass Surveys

Annual egg mass surveys were conducted between the end of December and mid-April. During 2005, egg masses were documented in TS-6, TS- A6 complex, TS-A7 complex, TS-7, TS-9, and TS-10. While historically more ponds have egg masses documented, weather conditions in 2005 prevented many surveys due to ice on the pond surfaces. Simply because egg masses were not found in a confirmed tiger salamander pond does not imply that reproduction did not take place. This is evidenced by the presence of larval tiger salamanders in ponds where egg masses were not detected.

Table 3. New York State Threatened, Endangered, and Species of Special Concern.

Common Name	Scientific Name	State Status
Insects		
Frosted elfin	*Callophrys iris*	T
Mottled duskywing	*Erynnis martialis*	SC
Persius duskywing	*Erynnis persius persius*	E
Pine barrens bluet	*Ennalagma recurvatum*	T
Fish		
Banded sunfish	*Enniacanthus obesus*	T
Swamp darter	*Etheostoma fusiforme*	T
Amphibians		
Eastern tiger salamander	*Ambystoma tigrinum tigrinum*	E
Marbled salamander	*Ambystoma opacum*	SC
Eastern spadefoot toad	*Scaphiopus holbrookii*	SC
Reptiles		
Spotted turtle	*Clemmys guttata*	SC
Eastern box turtle	*Terrapene carolina*	SC
Worm snake	*Carphophis amoenus*	SC
Eastern hognose snake	*Heterodon platyrhinos*	SC
Birds		
Horned lark	*Eremophila alpestris*	SC
Whip-poor-will	*Caprimulgus vociferus*	SC
Vesper sparrow	*Pooecetes gramineus*	SC
Grasshopper sparrow	*Ammodramus savannarum*	SC
Northern harrier	*Circus cyaneus*	T
Cooper's hawk	*Accipiter cooperii*	SC
Plants		
Stargrass	*Aletris farinosa*	T
Butterfly weed	*Asclepias tuberosa*	V
Spotted wintergreen	*Chimaphila maculata*	V
Flowering dogwood	*Cornus florida*	V
Pink lady's slipper	*Cypripedium acaule*	V
Winterberry	*Ilex verticillata*	V
Sheep laurel	*Kalmia angustifolia*	V
Narrow-leafed bush clover	*Lespedeza augustifolia*	R
Ground pine	*Lycopodium obscurum*	V
Bayberry	*Myrica pensylvanica*	V
Cinnamon fern	*Osmunda cinnamomera*	V
Clayton's fern	*Osmunda claytoniana*	V
Royal fern	*Osmunda regalis*	V
Crested fringed orchid	*Plantathera cristata*	E
Swamp azalea	*Rhododendron viscosum*	V
Long-beaked bald-rush	*Rhynchospora scirpoides*	R
Stiff goldenrod	*Solidago rigida*	T
New York fern	*Thelypteris novaboracensis*	V
Marsh fern	*Thelypteris palustris*	V
Virginia chain-fern	*Woodwardia virginica*	V

Notes:
* information based on 6 NYCRR Part 182, 6 NYCRR Part 193, and BNL survey data.
No federally listed threatened or endangered species are known to occur at BNL.
E = endangered, T = threatened, SC = species of special concern, R = rare, V = exploitably vulnerable

3.11.3.2 Tiger Salamander Larval Surveys

Larval surveys are conducted at ponds that have egg mass production during the spring breeding season, as well as the following summer when larvae are large enough to be sampled via seining. Of the ponds listed above in 2005, larvae were identified at TS-A7, TS-7, TS-9, and TS-A6 complex. In addition to these ponds larvae were also identified at TS-13a, TS-1, and TS-2. The absence of larvae at a pond with egg masses does not preclude them from being there. Most ponds are difficult to enter and capture larvae due to debris (sticks and branches) on the pond bottom. Many of the ponds on site dried down during 2005 and metamorphs likely emerged early or not at all.

In 2005, extensive sampling of Zeke's pond occurred for banded sunfish population surveys, no tiger salamander larvae were identified. As mentioned above the pond nearly dried up at the end of the summer in 2005. This likely sets the stage for tiger salamander production to occur in 2006. Summer surveys in 2006 should document the presence/absence of the tiger salamander in Zeke's Pond following drought conditions.

3.11.3.3 New Pond at RHIC

A new pond was constructed in the RHIC ring between August and December 2002. Native vegetation emerged during the spring and summer months in 2005. Egg masses were identified in this pond, which is part of the TS-A6 complex. No larvae were documented during the summer months. The pond will continue to be surveyed for both egg masses and larvae.

3.11.3.4 Cover Board Surveys on one TS Pond

Coverboard surveys were discontinued in 2004, but several boards were left around both TS-7 and TS-10 to provide shelter for emerging metamorphs. Flooding in October 2005 shifted cover boards throughout the area around both ponds. Drift fence surveys of TS-6, TS-7, and TS-A7 either continued or were started in 2004. Coverboards are occasionally checked when other work is being conducted around various ponds. They are simply used as alternative habitat for various reptile and amphibian species.

3.11.3.5 TS-A7 Restoration of Meadow Marsh

Restoration was completed in 2003. This pond is currently being monitored as part of a long-term study of tiger salamanders being conducted by the State University of New York at Binghamton to compare its use by tiger salamanders to typical use of coastal plain ponds by salamanders. Drift fencing was installed in 2004 and egg mass, larval, and metamorph surveys have been routinely conducted. Several metamorphic tiger salamanders have been captured, tagged using radio transmitters and followed to determine the extent of their migration. This work will continue through 2006 into early 2007 to gain a better understanding of tiger salamander biology.

3.11.3.6 TS-W6b Pond Remediation ER Program

The TS-W6B Pond is located on the northwest edge of the Former Hazardous Waste Management Facility (FHWMF). The clean up and restoration of the wetland began during fall 2004. Areas within the wetland with cesium-137 contaminant levels above 67 pCi/g were excavated. Much of the vegetation within the fenced area of the wetland was removed to allow access to the wetland in order to remove the contaminated sediment. Because excavation did not remove as much material as originally planned, fill material was not brought into the wetland. The area was restored using native plants and the success of the effort is being tracked to ensure that the vegetation survives. All work on this wetland was completed in September 2005 and was conducted under a wetlands equivalency permit issued by the NYSDEC. Tiger salamander egg mass surveys were to resume in 2006.

3.11.4 Banded Sunfish

The banded sunfish (*Enneacanthus obesus*) is a New York threatened species that inhabits backwater areas of the Peconic River and Zeke's Pond. Substantial effort was expended from April through mid-November 2004 to capture as many banded sunfish as possible from the Peconic River ahead of and during the remediation effort. During the onsite portion of the remediation, a total of 147 banded sunfish were rescued and placed in Zeke's Pond until such time as the habitat in the Peconic River is suitable for returning the fish. A total of 46 additional banded sunfish were rescued from the offsite portion of the River. As mentioned above in section 3.9 surveys of Zeke's Pond during summer 2005 provided indication that the Banded Sunfish was breeding and surviving well in the pond. Drought conditions in 2005 resulted in a marked decrease in populations, but numerous fish survived and restoration of a large population of fish in 2006 is expected.

3.11.4.1 Peconic River Flow Monitoring HMn

As mentioned above in section 3.7 Peconic River flows are recorded at numerous locations including at HMn. Flow is important for the survival of the banded sunfish in the Peconic River system.

3.11.4.2 OU V Peconic River Remediation Program

The Peconic River clean up began in April 2004 and concluded in May 2005. As mentioned above, flows from the upstream portion of the river were diverted downstream past the east boundary of the Laboratory. This was done to facilitate the clean up. Short sections of the river were isolated using temporary dams and pumps to decrease the amount of water present in any given area being excavated. Besides capturing banded sunfish, staff and volunteers captured other fish, frogs, turtles, and snakes moving them either upstream or down stream out of the way of the project. Upon conclusion of clean-up operations, the river was re-contoured and native vegetation taken from the river ahead of the clean-up was restored to the river. An evaluation of the revegetation efforts indicated that the restoration was, in most areas, better than 85% effective. The onsite area at the east boundary requires replanting and several areas on and offsite must have

the invasive plant phragmites removed by hand. This work will take place starting in spring 2006.

3.11.5 Frosted Elfin

The frosted elfin (*Callophrys iridis*) is a small orange-brown butterfly that is dependent on wild lupine. Historically, the frosted elfin was found along the south boundary and LIRR right of way at the south east corner of the Lab. This area is typified by soil disturbance that enhances habitat for wild lupine that in turn provides habitat for the butterfly.

3.11.5.1 Confirm Presence/Absence of Frosted Elfin

The NYSDEC and the NY Heritage program have sent a field biologist to Long Island in 2002 and 2003. The historic area of occurrence has been surveyed each year. In 2002 the area had a healthy population of wild lupine but no evidence of the frosted elfin. In 2003 cooler temperatures in May and June resulted in poor production of flowers in the Lupine. Poor production of lupine persisted in 2004 with no evidence of the frosted elfin. In 2005 the number of lupine plants appeared to improve with additional populations of the plant being found along the north firebreak road, but no evidence of the butterfly was found.

3.11.5.2 Establish Monitoring Protocols for Frosted Elfin

BNL has participated with the NYSDEC and NY Heritage during their surveys, but should develop monitoring protocols for onsite use. A better understanding of the life history of this butterfly is needed in order to establish effective protocols. No additional information on this has been forthcoming. At this point only surveys of host plants appear to be effective.

3.11.5.3 Maintain and Enhance Habitat for Frosted Elfin

Wild lupine likes disturbed soil areas as is found along the south firebreak at the southeast corner of the Lab. Disturbance of the primary area of lupine in the spring of 2005 prior to growth by the plant seems to have stimulated growth and better establishment of the plant. Additionally, as mentioned above another small cluster of lupine was identified along the north firebreak road.

3.11.5.4 Habitat assessment for Lupine

Areas that were planted with wild lupine in Spring 2003 were evaluated in 2004. New plants that were noticed in several areas of the RHIC ring in 2003 appeared to be absent in 2004. No new plants were seen along the east firebreak in 2004 but additional plants were located along the north firebreak in 2005. Deer are known to browse on lupine and may be responsible for the loss of newly established plants.

3.12 Habitat Enhancement other species

Several species of birds have been targeted for improvements in nesting habitat. These include the eastern blue bird, kestrel, and wood duck. As information is gained on other species of special interest, habitat improvement needs will be identified and implemented as necessary.

3.12.1 Bird nests/boxes

Nest boxes are important for many species of birds because of the lack of proper habitat. This is particularly true of birds that utilize cavities for nesting. The eastern bluebird is one of the better know birds for which nest boxes are important. BNL currently has 48 boxes distributed across the site in appropriate habitat (open fields near forested areas). Each year over the past three years at least 19 of the 48 boxes have been used by the eastern bluebird. This amount of usage is above average compared to other areas on Long Island that are being monitored. House wrens, tree swallows, chickadees, and tufted titmouse also use the bluebird boxes (Table 4).

Wood duck and kestrel boxes are on an annual schedule and are visited by volunteers to prepare the boxes for use in the spring and clean them in the fall. To date two years of monitoring suggest very limited use of wood duck boxes and apparently no use of kestrel boxes is occurring. A volunteer continues to monitor the bluebird boxes several times each year.

Table 4 Results of Bluebird Nest Box Monitoring 2001 - 2004

Summary of Nesting Success							
Year	# of Boxes	Empty/other	Bluebird	House Wren	Tree Swallow	Chickadee	Tufted Titmouse
2001	37	17	19	6	1		
2002	46	19	19	6	6	2	
2003	46	27	21	2	4		2
2004	48	12	22	6	6		
2005	53	14	30	6	6	1	

3.12.2 Surveys and Monitoring

Conducting surveys and routine monitoring allows BNL to identify, track, and trend population status for a number of species. New surveys for reptiles and amphibians, Odonata (damselflies and dragonflies), and incidental reporting of other species during routine activities results in a better understanding of which species are present. The following discussions will touch on the results of various surveys and monitoring in 2005.

3.12.3 Develop Survey Methodology to document all Biota on BNL

A full set of monitoring and survey protocols are still needed. Contracts for a research data base and forest health monitoring protocols were completed in 2005. Both are discussed below.

3.12.3.1 Reptiles and Amphibians

Work on reptiles and amphibians included radio telemetry tracking of eastern hognose snakes (*Heterodon platyrhinos*) and initiation of radio telemetry work with spotted turtles (*Clemmys guttata*).

The hognose snake project continued in 2005 with three remaining snakes and an additional five snakes being captured/recaptured and new transmitters implanted. The eight snakes were tracked throughout the summer or until they were lost to predation, transmitter auto-expelled from the snake, or a snake moved out of range and was lost. A poster and report were prepared on this project and a copy of the poster is attached to this report.

When snakes are found, their location and identification are recorded and added to a database. Larger snakes like eastern hognose and black racers are injected with a Passively Induced Transponder (PIT) tag. PITs provide a unique identifier and will allow long-term tracking of individuals. Using a specialized tag reader to access the identification number held in the PIT circuitry identifies an individual snake with a PIT. When a PIT carrying snake is identified the information on capture location is recorded. Repeated captures will allow analysis of age and movement over long periods of time.

The spotted turtle project also continued through the summer of 2005 in order to gain a better understanding of the habitat needs of this species. Six turtles of the original number released were followed throughout the summer. The results of this work are presented in the attached poster.

Interns began marking all eastern box turtles found by notching their carapace and releasing them. The practice started in 2003 and continued in 2005. A database of marked turtles was started. In the future if a turtle is captured it will be inspected for shell notches. If a notch pattern is identified, the turtle's location will be documented in a database. If there is no pattern, the shell will be notched and an initial entry will be made in the database for future tracking. Assistance from Lab employees could be developed to further the success of this program. A total of 165 turtles (51 new captures in 2005) have been captured since 2003 of which 146 have been marked and 11have been recaptured (6 in 2004 and 5 in 2005). As a result of this program at least 6 turtles were captured with ear infections, in 2004, and brought to the Bronx Zoo or a local wildlife rehabilitator for treatment. In 2005 and an additional 5-6 turtles were captured with infections with 3 being captured simultaneously in the TS-7 pond. Two of these individuals died and were sent to a disease specialist in Florida. An amphibian ranavirus (iridovirus) was isolated. The presence of turtles with this type of infection is of concern as there is potential for the illness to spread through the population and since the virus particularly affects amphibians the presence of the virus in turtles found in a key tiger salamander pond is of concern. Infected turtles that are successfully treated are returned to the location where they were found. A study of the box turtles is planned in 2006. This study will have two areas of focus. The first being a determination of the incidence of iridovirus in the turtles, and the second being a mark recapture study of the turtles.

3.12.3.2 Monitor Canada Goose & Wild Turkey Populations

The Canada goose population on site is currently estimated to be between 80 and 120 birds. A standardize protocol must still be developed to make a more accurate estimate. In June 2003 the NYSDEC requested permission to band Canada geese on site. Twenty-one geese were banded. A second attempt to band additional geese in 2003 was made but was unsuccessful. In June 2004 twenty-eight geese were banded onsite. No banding occurred in 2005. Banding allows researchers and waterfowl biologists opportunities for information gathering. During future efforts, banded geese will be recorded which allows estimates of age to be made. If a goose is shot by hunters or found dead the information from the band is sent to the FWS where information on banded birds is maintained. Through nationwide efforts the banding information leads to a better understanding of the larger population of geese in the Northeast.

3.12.3.3 Turkey Sighting Reports to NYSDEC

No reports were sent to NYSDEC in 2005. Drought conditions in 2005 forced the turkeys to disperse throughout the area. The number of poults produced was down compared to previous years. This along with the dispersal resulted in an estimate of between 300-350 birds in August 2005.

As the population continues to grow, there is potential for nuisance situations to arise. BNL will work with NYSDEC, as necessary, to address problems resulting from a large turkey population. The first incidences of nuisance situations were reported during the spring mating season in 2005. Several male turkeys were reported as “harassing” individuals that walked to close and numerous male turkeys took to pecking at their reflections seen on parked cars.

3.12.3.4 Song Bird Surveys

Songbird surveys have been carried out since May 2000. Monitoring involves acquisition of ambient weather information at the beginning and end of each of the six routes, and counting the number of individuals of each species heard or seen during a five minute period at each point on the route. Points are spaced approximately 300 meters (Fig. 4) apart to prevent overlap of counts from point to point. Monitoring is carried out monthly from April through September each year.

The current results of monitoring are provided in Table 5 below. In 2005, 67 species of birds were detected. Routes next to wetlands (Peconic River, Biology Fields, and Z-path routes) continue to have the highest number of species detected. This is likely due to higher biodiversity in these habitats that support a greater variety of nesting sites and foraging opportunities. Results along the Z-Path route are also beginning to indicate high number of species, likely due to the variability of habitats along this route. The Z-Path route goes through the most diverse habitats, ranging from pine forest, to wetlands, to mixed forest.

Over all, songbird surveys have resulted in the detection of 109 species of birds over the past six years. Most species detected have been breeding songbirds. However several species like herring gulls, double crested cormorants, and other sea birds were detected as they flew over the site.

Long-term surveys like the Breeding Bird Surveys (BBS), carried out since 1966, have indicated a decline in most songbird species. The intent of comparing BNL data to BBS data would be to document health of the local bird populations. The six-year trend in BNL data for each transect is presented in Figure 5. The overall trend shows declining numbers of species seen. However, when looking at data for the 55 most common birds detected (Table 6) there is variability by species. One species may be declining while another is increasing in numbers. It is important to utilize both a global perspective using all species as well as look at individual species and use a long-term analysis comparing to historic data rather than rely on a limited set of data. BNL will continue monitoring in 2006.

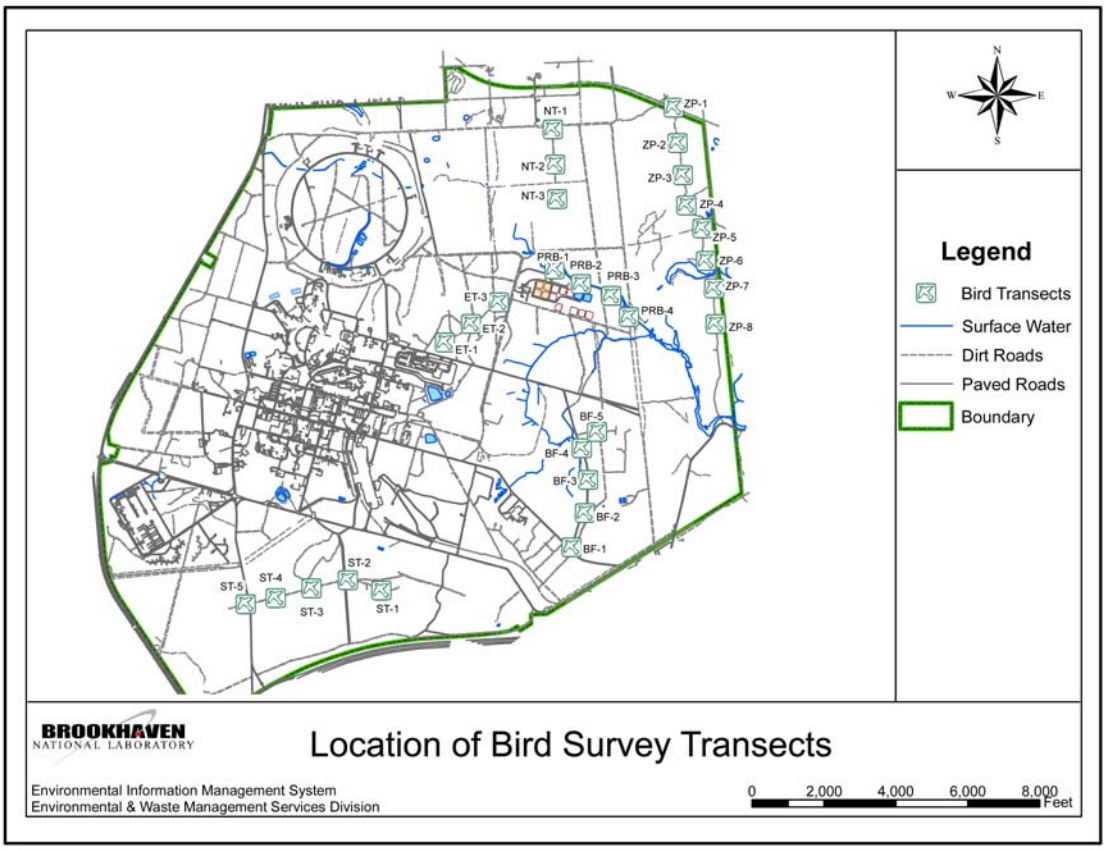

Figure 4. Songbird survey routes.

Table 5. Results of Bird Surveys

Bird Survey Results 2000 - 2005									
Year	# of Species Identified	# New Species Identified	Total # of Species	# of Species Biology Fields	# of Species East Trenches	# of Species North Transect	# of Species Peconic River	# of Species South Transect	# of Species Z-Path
2000	73		73	50	31	23	48	32	
2001	73	20	93	53	32	34	45	39	
2002	73	7	100	45	29	30	43	29	47
2003	79	6	106	49	27	31	47	33	44
2004	68	2	108	45	24	33	44	28	41
2005	67	3	109	50	27	31	42	27	43

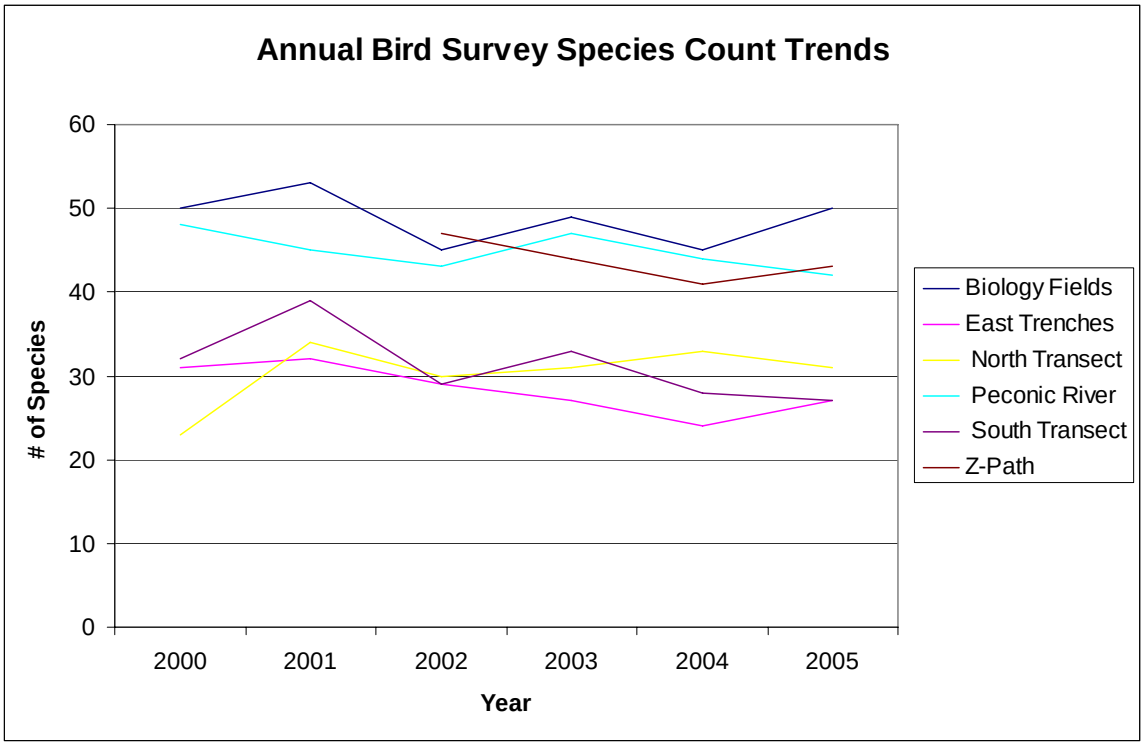

Figure 5. Trends in species counts of songbirds per transect from 2000 – 2005.

Table 6. Data concerning routinely documented bird species

		Year - Number					
Common Name	Scientific Name	2000	2001	2002	2003	2004	2005
American Crow	*Corvus brachyrhynchos*	71	74	87	121	49	29
American Robin	*Turdus migratorius*	207	120	492	231	176	178
Baltimore Oriole	*Icterus galbula*	6	41	39	53	53	35
Barn Swallow	*Hirundo rustica*		2	2	5	1	2
Black-and-White Warbler	*Mniotilta varia*	11	10	11	12	1	
Black-billed Cuckoo	*Coccyzus erythropthalmus*	10	14	9	3		3
Black-capped Chickadee	*Poecile atricapillus*	84	114	122	111	173	135
Blue Jay	*Cyannocitta cristata*	123	216	319	288	253	197
Blue-Grey Gnatcatcher	*Polioptila caerulea*		5	6	3	3	4
Blue-winged Warbler	*Vermivora pinus*	1		3	3	1	1
Brown Thrasher	*Toxostoma rufum*	9	6	1	7	1	
Brown-headed Cowbird	*Molothrus ater*	9	34	98	81	84	78
Canada Goose	*Branta canadensis*	28	82	46	216	103	93
Carolina Wren	*Thryothorus ludovicianus*	1	1	7	1	9	7
Cedar Waxwing	*Bombycilla cedrorum*	39	2	22	2	1	8
Chipping Sparrow	*Spizella passerina*	124	130	195	182	237	197
Common Grackle	*Quiscalus quiscula*	40	55	64	90	153	89
Common Yellowthroat	*Geothlypis trichas*	11	10	20	15	11	16
Cooper's Hawk	*Accipiter cooperii*		1	4	2	1	
Downy Woodpecker	*Picoides pubescens*	7	17	30	24	35	26
Eastern Bluebird	*Sialia sialis*	1	2	7	3	3	3
Eastern Kingbird	*Tyranus tyranus*	2	1	4	8	3	3
Eastern Phoebe	*Sayornis phoebe*	3	10	9	2	10	3
Eastern Towhee	*Pipilo erythrophthalmus*	151	216	252	211	219	220
Eastern Wood Peewee	*Contopus virens*	68	51	67	59	70	52
European Starlings	*Sturnus vulgaris*	32	21		18	7	
Fish Crow	*Corvus ossifragus*		3	1	2	2	
Goldfinch	*Carduelis tristis*	54	35	49	70	82	47
Grey Catbird	*Dumetella carolinensis*	57	65	68	62	49	47
Hairy Woodpecker	*Picoides villosus*		3	3	2	2	4
Hermit Thrush	*Catharus guttatus*		5	4	1	4	10
House Wren	*Troglodytes aedon*	14	4	7	11	3	3
Indigo Bunting	*Passerina cyanea*		5	11	15	21	8
Mallard Duck	*Anas platyrhyncos*	2	7	3	2	1	6
Mourning Dove	*Zenaida macroura*	55	41	78	39	46	27
Northern Cardinal	*Cardinalis cardinalis*	15	13	7	16	8	14
Northern Flicker	*Colaptes auratus*	31	21	38	20	27	21
Northern Mockingbird	*Mimus polyglottos*	6	13	13	9	6	7
Ovenbird	*Seiurus aurocapillus*	19	71	86	58	65	56
Pine Warbler	*Dendroica pinus*	5	23	54	25	81	57
Red-bellied Woodpecker	*Melanerpes carolinus*	12	8	4	7	15	3
Red-breasted Nuthatch	*Sitta canadensis*	5	19	13	11	25	43
Red-eyed Vireo	*Vireo olivaceus*	24	31	15	20	28	19
Red-tailed Hawk	*Buteo jamaicensis*	3	2	2	6	6	5
Red-winged Blackbird	*Agelaius phoeniceus*	8	12	45	16	34	25
Scarlet Tanager	*Piranga olivacea*	3	8	7	15	11	13
Sharp-shinned Hawk	*Accipiter striatus*	1		1	1	2	
Tree Swallow	*Tachycineta bicolor*	6	3	8	9	17	3
Tufted Titmouse	*Baeolophus bicolor*	34	19	29	32	25	26
Veery	*Catharus fuscescens*	3	1	6	3	3	
White-breasted Nuthatch	*Sitta carolinensis*	5	3	3	3	3	9
Wild Turkey	*Meleagris gallopavo*	15	3	7	8	9	36
Wood Thrush	*Hylocichla mustelina*	43	16	10	10	12	10
Yellow Warbler	*Dendroica petechia*	1		1	1	1	
Yellow-billed Cuckoo	*Coccyzus americanus*	13	8	20	26	5	

3.12.3.5 Odonate Surveys

Surveys of Odonata (dragonflies and damselflies) continued in 2005. A total of 32 species of dragonflies (4 new species for 2005) and 23 species of damselflies (5 new species for 2005) were identified from seventeen locations on site. Where possible both larval and adult forms were identified. One rare species of damselfly the NY State threatened Pine Barrens Bluet (*Enallagma recurvatum*) was identified from Zeke's Pond and a new New York record for the Double Ringed Pennant (*Celethemis verna*) were documented in 2005. The project was to initially look at only three ponds, but was expanded as the interns became more proficient at capture and identification. The project is to be continued in 2006 with an expansion to other ponds and locations at BNL. Table 8 presents a compiled list of all species found at BNL from 2003 through 2005. A copy of the poster produced as part of the 2005 intern work is attached to this document. Several species are ubiquitous, being found at most ponds, while some species are highly specific in their habitat needs.

Odonata being aquatic predatory insects and relatively easy to capture and identify, may be useful indicators of wetland health. Damselflies are highly specific egg layers, only laying eggs on or in the tissues of certain plants. In general the more diverse the damselfly population is, the higher the diversity of aquatic plants in a specific wetland. With appropriate training and familiarity with dragonflies and damselflies, a relatively quick assessment of a wetland's health may be made. For example the absence of a species with particular needs at a specific pond may provide indication that significant change is occurring at that location.

3.12.4 Population Management

There are currently four species on site whose populations either do or may require management in the near future. These are the white-tailed deer (discussed above), Canada geese, wild turkey, and feral cats.

3.12.4.1 Manage Canada Goose Population

As mentioned above, the Canada goose population is currently estimated at between 80 and 120 birds living year round on the BNL site. Should the nuisance situations caused by resident Canada geese increase to an unacceptable level, the appropriate permits to allow population reductions will be obtained from NYSDEC and FWS would be obtained. In addition appropriate public dialog would also take place prior to any actions. Occasionally nesting geese and geese with goslings cause concern for BNL employees because of their nesting behavior. A nesting pair of geese routinely causes problems at NSLS. In general workers at NSLS try to avoid the area near the nesting pair in order to not be attacked. Over wintering goose populations seem to have been reduced in 2005. This appears to indicate that a new early season goose hunt on Long Island to reduce resident Canada geese may be working.

Table 8. Dragonfly and damselfly species identified during surveys at BNL.

Odonate Species found at BNL			
Dragonflies		**Family Libellulidae (cont.)**	**Scientific Name**
Family Aeshnidae	**Scientific Name**	Ruby Meadowhawk	*Sympetrum Rubicundulum*
Shadow Darner	*Aeshna umbrosa*	Band-winged Meadowhawk	*Sympetrum semicinctum*
Comet Darner	*Anax lonipes*	Carolina Saddlebags	*Tramea carolina*
Common Green Darner	*Anax junius*	Black Saddlebags	*Tramea lacerata*
Swamp Darner	*Epiaeschna heros*		
Harlequin Darner	*Gomphaeschna furcillata*	**Damselflies**	
Family Corduliidae		**Family Calopterygidae**	
Williamson's Emerald	*Somatochlora williamsoni*	Ebony Jewelwing	*Calopteryx maculata*
Family Gomphidae		**Family Coenagrionidae**	
Unicorn Clubtail	*Arigomphus villosipes*	Variable Dancer	*Argia fumipennis violacea*
Ashy Clubtail	*Gomphus lividus*	Azure Bluet	*Enallagma aspersum*
Family Libellulidae		Familiar Bluet	*Enallagma civile*
Calico Pennant	*Celithemis elisa*	Northern Bluet	*Enallagma cyathigerum*
Halloween Pennent	*Celithemis eponina*	Atlantic Bluet	*Enallagma doubledayi*
Double Ringed Pennant	*Celithemis verna*	Big Bluet	*Enallagma durum*
Setwing	*Dythemis*	Marsh Bluet	*Enallagma ebrium*
Eastern Pondhawk	*Erythemis symplicicollis*	Skimming Bluet	*Enallagma geminatum*
Bar-winged Skimmer	*Libellula axilena*	Pine Barrens Bluet	*Enallagma recurvatum*
Spangled Skimmer	*Libellula cyanea*	Citrine Forktail	*Ischnura hastata*
Blue Corporal	*Libellula deplanta*	Fragile Forktail	*Ischnura posita*
Slaty Skimmer	*Libellula incesta*	Rambur's Forktail	*Ischnura ramburii*
Widow Skimmer	*Libellula luctuosa*	Eastern Forktail	*Ischnura verticalis*
Common Whitetail	*Libellula lydia*	Sphagnum Sprite	*Nehalennia gracilis*
Twelve-Spotted Skimmer	*Libellula pulchella*	**Family Lestidae**	
Painted Skimmer	*Libellula semifasciata*	Spotted Spreadwing	*Lestes Congenen*
Great Blue Skimmer	*Libellula vibrans*	Common Spreadwing	*Lestes disjunctus disjunctus*
Blue Dasher	*Pachydiplax longipennis*	Amber-winged Spreadwing	*Lestes eurinus*
Wandering Glider	*Pantala flavescens*	Sweetflag Spreadwing	*Lestes forcipatus*
Spot-winged Glider	*Pantala hymenaea*	Elegant Spreadwing	*Lestes inaequalis*
Eastern Amberwing	*Perithemis tenera*	Slender Spreadwing	*Lestes rectangularis*
Cherry-Faced Meadowhawk	*Sympetrum internum*	Lyre-tipped Spreadwing	*Lestes unguiculatus*
White-faced Meadowhawk	*Sympetrum obtrusum*	Swamp Spreadwing	*Lestes vigilax*
New species found in 2005	**NY threatened species**	**New NY Record**	

3.12.4.2 Manage Wild Turkey Population

As the wild turkey population continues to grow, the likelihood of nuisance situations and over population may come about. The NYSDEC currently does not allow hunting of wild turkey on Long Island. Should the population reach levels requiring control, special permits and arrangements would need to be made with NYSDEC. As with any population management, appropriate public dialog would occur prior to actions. The first complaints concerning wild turkey came in 2004. 2 to 4 turkeys routinely caused problems at the firehouse early in 2004 and again in 2005. Arrangements were made to move the birds but removing them to another portion of the Lab was not necessary. Should complaints result in the future, BNL will work in cooperation with NYSDEC to

remove and transfer problem birds to other areas onsite. In 2005 numerous reports of individuals feeding turkeys at various locations were received. Several articles in the BNL Monday Memo and Bulletin encouraged employees not to feed the wildlife. Additionally, individual e-mails were sent to building managers where feeding occurred asking them to discourage feeding around buildings. Feeding contributes to familiarity and a dependence on the food source, which in turn may result in aggression if the food is not provided.

3.12.4.3 Feral Animals

Feral animals are considered to be domestic animals that have been released to the wild and have lost their basic domestication. Examples of typical feral animals are wild and free roaming dogs and cats. Currently, there is no indication of wild and free roaming dogs at BNL. However, there is an estimated 30 – 50 feral cats of which approximately 35 are managed in three cat colonies by an ad hoc group of Laboratory employees, who are working to humanely reduce the population onsite.

In 2004, a photographic survey of the cats being maintained in the colonies was initiated. Based on photographic comparisons the current population of cats is estimated at 40 in the colonies with a few other cats scattered throughout the Laboratory. A repeat survey of the colonies in 2005 provided indication that the colonies were neither growing nor shrinking.

3.12.4.3.1 Establish BNL Policy on feral animals

No additional work was done on this in 2005

3.12.4.3.2 Protocols for monitoring and managing feral cats

A monitoring protocol has been developed to identify individual cats in each colony in order to track the population. Digital photographs of cats have been taken and markings that will facilitate the identification of individuals continue to be sought. Monitoring indicated that no real change in the colony structure occurred in 2005.

Toward the end of 2005 plans were started to add additional monitoring requirements in 2006 that would allow the tracking of feeding of the cats. This will be done to start estimating the amount of food the various colonies are receiving, to keep a better track of the cat population, and to track general health of the population.

3.13 Vegetation Management

BNL continues to participate in the EPA Region 2 Performance Track program with one of the commitments being the restoration of 10 acres/year to either native vegetation or to a prescribed fire regime. BNL scheduled a prescribed fire for Oct. 2005, but was unable to complete the action due to rain.

3.13.1 Native Vegetation

Native vegetation is considered to be plant species (trees, shrubs, grasses, etc.) that are from the Long Island area and not introduced species. Management of native vegetation involves both forest management of the Pine Barrens and management of landscaping, which is carried out primarily by Plant Engineering Grounds Maintenance crews. In partial fulfillment of BNL's goal of 10 acres of vegetation restored, approximately 9 acres of mowed areas were designated "no-mow" areas to encourage reversion back to forest. In 2005 additional areas where warehouses and the former incinerator once stood were restored with native grasses.

3.13.1.1 Establish Protocol for Use of Native Vegetation

Over the past several years BNL has been using native vegetation for various projects. The most work has been carried out at the RHIC ring with lesser amount of work being conducted between restoration work and planting areas left bare after demolition of obsolete buildings. While the NRMP stresses use of native vegetation there is no procedure built into design work requiring use of native vegetation. Development of a protocol must still be developed. Most development projects now utilize the Natural Resource Manager as a reviewer to ensure use of native plants where applicable. BNL's Master Planning document for infrastructure changes now includes a list of acceptable native plants for trees, shrubs, and ornamentals. Lawn areas are still typically planted with non-native grasses as no suitable native "turf" grass has been identified.

New construction projects including the Research Support Building and the Center for Functional Nanomaterials both include landscaping plans that utilize native vegetation.

3.13.1.2 Use Native Vegetation on Restoration and new Construction Projects

Construction projects utilizing native vegetation included the former warehouse areas, which had native trees and native grasses planted in the spring of 2005. The former waste management area and glass holes area were also planted with native grasses to ensure protection of soil.

3.13.1.3 RHIC Revegetation

The RHIC Revegetation project was in its 4th year during 2005. The area between 2 and 4 O'clock continues to not allow grasses to establish. Few grasses or wildflowers that had been planted will germinate. The area has a layer of lichens and mosses in many spots that seem to eliminate grass seed germination. One last attempt to establish native plants in the area occurred 2005. Both pitch pines and hydro seeding of native grass seed took place in April and May of 2005. Unfortunately most of the pitch pines planted in 2005 died due to drought conditions. Should the grasses not take, naturally occurring pitch pines in the area are beginning to grow and will eventually spread and cover the area. The restoration will take longer but will appear to be more natural than planting.

3.13.1.4 Establish Policy and procedure for cutting trees

A policy and procedure for tree cutting still needs to be developed.

An informal process is used in which the Assistant Laboratory Director for Facilities and Operations makes a decision based on input from Plant Engineering and the Natural Resource Manager. This informal process appears to be efficient as it has become a routine procedure in 2005.

3.13.2 Invasive Species

BNL continued to participate in the Long Island Weed Management Area efforts in 2005.

3.13.2.1 Identify and Monitor Distribution of Invasive Species

An invasive species-mapping project was started in 2003. A summer high school intern mapped the presence of invasive plants in the pocket forests within the developed portions (Figure 6) of the Lab in 2005. A copy of this intern's poster is attached to this report.

3.13.2.2 Establish Volunteer "Weed Watchers" group

The volunteer "Weed Watchers" group did not function in 2005. The maintenance of a volunteer group requires significant input and coordination by either a volunteer coordinator or a permanent employee. Because all areas of the Laboratory are now mapped through efforts of various interns, the need of a coordinated volunteer "Weed Watcher" group is no longer necessary.

3.13.2.3 Removal or Control of Invasive Plants

This action must still be planned. Several areas containing small infestations of highly invasive plants were identified in 2003. The plants in these areas will hopefully be removed before they spread to undeveloped forested areas. An external source of funds must be obtained to support this effort.

3.13.2.4 Identify Funding Sources

One of the major issues for invasive species management is funding. In order to protect weed free areas, weeds that can be controlled need to be removed or controlled. Control often means removal and destruction of invasive plants using mechanical or chemical means. Both mechanisms can be expensive. The Natural Resource Management program is requesting budget increases and looking for other funding mechanisms.

No funding has been found to implement reduction of invasive species.

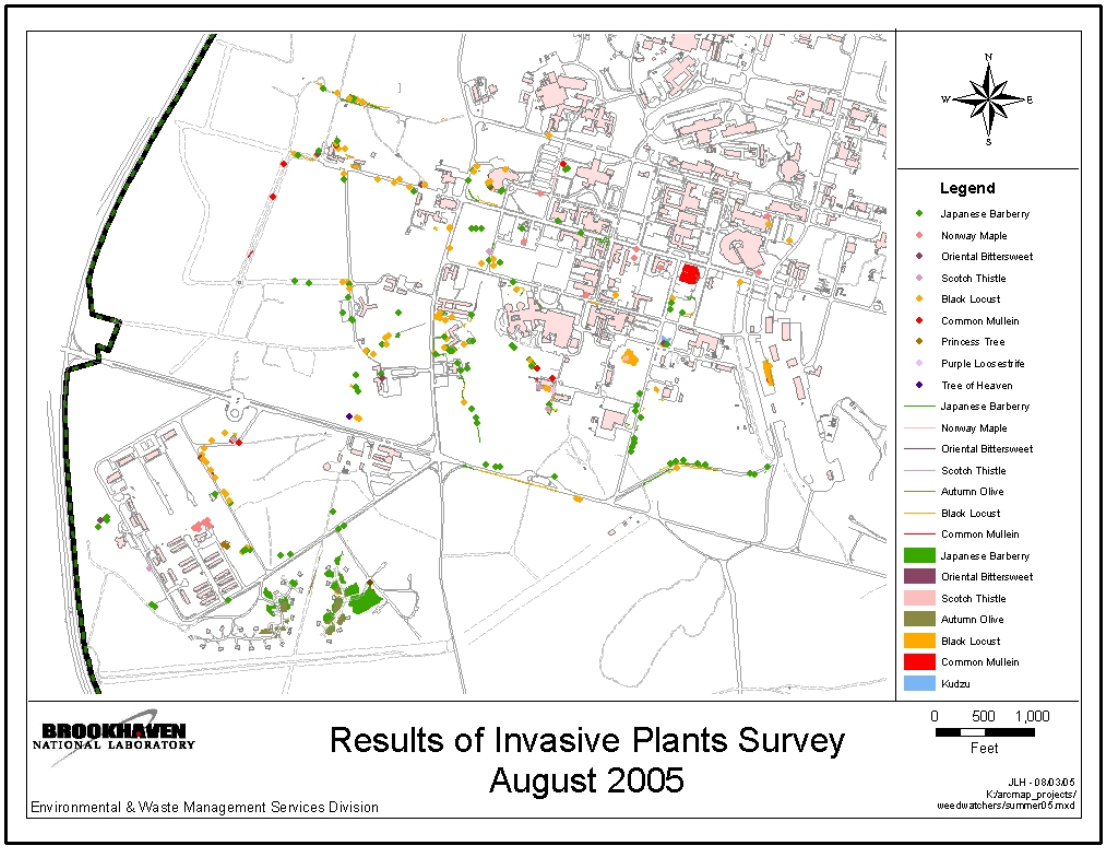

Figure 6. Invasive plant distributions in the constructed area of the Laboratory.

3.14 Ecosystem Monitoring & Management

The Natural Resource Management program must still develop many of the monitoring protocols necessary for gathering information concerning the various habitats at BNL. With proper monitoring protocols decisions for management can be made and evaluation of management actions will allow changes to be made. Many of these protocols will be developed in cooperation with the Foundation for Ecological Research in the Northeast.

In April 2005 the Upton Reserve and FERN to delivery of forest health monitoring protocols and monitoring began in June 2005. The Forest Health Monitoring of the Central Pine Barrens is discussed below and was carried out by FERN in cooperation with the Laboratory, The Nature Conservancy, and other Pine Barrens partnerships.

3.14.1 Wetland Health Monitoring

In 2005 work on wetland health monitoring involved gaining an understanding of the relationship between soil chemistry, water infiltration, and water chemistry of various ponds on BNL. The work was conducted by a Faculty and Student Team from North Carolina A&T. The team worked on four ponds along the north boundary of the Laboratory and gained significant information about the ponds and surrounding uplands. In the future this type of information will be linked to distributions of organisms like

dragonflies and damselflies as well as amphibians to begin developing monitoring protocols for freshwater wetlands. A copy of the poster produced by the FaST team is attached to this report. It is expected that two FaST teams will participate in the program in 2006 gaining significantly more knowledge about these types of interactions, refining protocols, and setting the stage for monitoring throughout the Central Pine Barrens in 2007.

3.14.1.1 Determine Functionality of BNL Central Wetlands

No activity on this item took place in 2005.

3.14.1.2 Maintain or improve wetland functions

This action cannot be undertaken until wetland health monitoring and a determination on functionality is completed. Once the previous two actions are completed then plans for management of the wetlands can be made.

3.14.2 Forest Health Monitoring

Forest health monitoring was initiated in 2002 with the establishment of several deer exclosures in the Upton Reserve. These were visited in 2003, 2004, and 2005 with photo points established in order to track vegetation growth. Additional locations outside of the Upton Reserve need to be established to have sufficient documentation of all forest types at BNL.

In addition to the deer exclosures, FERN initiated the first ever Forest Health Monitoring of the Central Pine Barrens. This activity was conducted using six interns lead by an experienced team leader and was based out of BNL. The two 3-intern teams established 50 permanent plots in coastal oak forest, oak-pine, and pine-oak forests throughout the Pine Barrens. These permanent plots will be periodically visited to track changes to the forest over time and provide a snapshot of the forest health. The six interns had to produce individual research papers. A copy of their posters is attached to this report.

3.14.2.1 Develop Criteria

As mentioned above the protocols were received and implemented across the entire Pine Barrens in 2005, including onsite at BNL.

3.14.2.2 Establish Forest Health Monitoring locations

Monitoring locations and the number of plots necessary was determined by the contractor who developed the various monitoring protocols for forest health. As mentioned above a total of 50 plots in three forest types were established. Additional random plots were identified and continued establishment of plots will take place in 2006 and 2007 if necessary.

3.15 Security

Several security issues were identified in the NRMP that need to be addressed. Most notably is the illegal use of ATVs and motorcycles on site, followed by other trespass issues regarding foot, bicycle, and horse traffic. While foot, bicycle, and horse traffic is illegal it generally does not result in significant damage to the ecosystem.

3.15.1 Illegal Use of ATVs

The northern and eastern most areas of the Laboratory including the Upton Reserve are subject to illegal trespass by individuals using ATVs and motorcycles. The historic use of these vehicles has resulted in areas of significant damage to both forest and wetlands.

In 2005 two accidents occurred at BNL a “dirt bike” motorcyclist riding illegally onsite ran into a tree while racing north of the north firebreak and had to be transported to a local hospital for care of injuries.

3.15.2 Other Trespass issues

In 2005 an individual riding a horse was thrown while riding onsite and had to be taken off site by helicopter. Additionally several fires along the northern portion of the Laboratory were set by trespassers.

To improve access by both offsite volunteer fire fighters and BNL’s own Emergency Services personnel several berms were removed along the north firebreak and new keyed swing gaits were installed at strategic locations on the north boundary of the Lab. These actions may also help in access by security and Police “sting” efforts.

Control of other trespass issues concerning foot, bicycle, and horse access must be addressed in the future.

3.16 Pesticide Use

Plant Engineering and Biology currently manage pesticide use on site using state requirements for application. The need for an SBMS Subject Area and discussions on appropriate use for natural resource management must still be completed.

3.16.1 SBMS Subject Area

This action, if deemed necessary, must still be initiated. Current practices follow all required regulations. If a subject area is needed, its development must be placed on the SBMS master schedule.

3.16.2 Use in Natural Resource Management

In the future the use of pesticides, primarily herbicides, will be necessary for control of invasive plants. Protocols for use and approvals must be developed.

3.17 Wildland Fire Management

BNL approved the Wildland Fire Management Plan for BNL in September 2003. This stand-alone plan is referenced in the NRMP since wildland fire and prescribed fire may have significant roles in natural resource management.

3.17.1 Implement Wildland Fire Management Plan

With the approval of the Wildland Fire Management Plan, its implementation is primarily through development of prescribed fire management plans. A prescribed fire management plan for CY2005 was completed and approved for implementation. However, poor weather during the week of the Annual Fire Academy prevented implementation. The same plan will be utilized for implementation in 2006

3.17.2 Implement Use of Prescribed Fire

The first prescribed fire took place in November 2004 when approximately 7 acres of forest and grassed firebreak were burned. The purpose of the fire was to open up the understory canopy to facilitate oak regeneration. Both pre- and post fire monitoring took place and a second round of post-fire monitoring was conducted in 2005. The results of the post-fire monitoring in the spring of 2005 indicated that the prescribed fire in 2004 was at least partially successful. The area burned had been divided into two parcels, the eastern most parcel appeared to have more oak seedlings than the western most parcel. Both areas did have fuel reduction that will decrease the carrying capacity for fire in these plots.

As mentioned above the prescribed fire plan for a 2005 was not implemented due to weather. The area planned for the fire is a 15 acre plot just east of the Gamma Forest. Since the prescription could not be met in 2005 the same area will be targeted for 2006. Additionally, this area is part of a 60 acre plot and the prescribed fire plan can be modified to burn other portions of this area as well.

3.18 Integration of Cultural Resources

Since BNL is on the site of WW I and WW II Camp Upton and the Depression Era Upton National Forest, several historic features are likely to exist. Work on the Cultural Resource Management Plan (CRMP) has identified some of the potential cultural resources that could be affected by natural resource management actions.

3.18.1 Identify Cultural Resources and Develop GIS layers

Cultural resource map layers in the GIS include locations of WWI trenches and 1850s homesteads. In 2005 one area of WWI trenches was identified as a set-aside as part of fulfilling a requirement under the Leadership in Energy Efficient Design (LEED) program for construction of new buildings. This set-aside is roughly equal to the area covered by both the Research Support Building and the Center for Functional

Nanomaterials both of which are seeking LEED certification upon completion. This area is now specified within the GIS as a reference requiring review prior to any significant actions taking place in the area.

3.19 GIS and GPS

The Natural Resource Management program has integrated GIS and GPS into much of its management. GPS is routinely used to obtain location information of species, habitats and most recently the movement of species including eastern hognose snakes, spotted turtles, and box turtles. GPS information is entered into the GIS and new layers developed as necessary.

3.19.1 Develop Natural Resource data layers for GIS

The GIS has been used to map home range information for all species that are being tracked with radio telemetry equipment. In 2005 the tiger salamander will be added to the list of species being tracked.

3.19.2 Plan Trails and paths that limit impact

No actions were taken on this in 2005.

3.19.3 Fill data gaps concerning flora and fauna

Filling data gaps is documented throughout this annual report in earlier sections concerning endangered, threatened, and species of special concern, reptile and amphibian studies, and Odonate studies as examples.

3.20 Education Programs

In 2005, the Natural Resource Management program and the Foundation for Ecological Research in the Northeast hosted eighteen individuals that included a Faculty and Student Team (Professor and 2 students), two Lab Science Teacher Professional Development interns, eleven undergraduate research interns, and two high school interns, all working on various projects. These interns completed work on salamanders, radio telemetry work on hognose snake, spotted turtles, inventory of Odonate species, population analysis of banded sunfish, soil and water chemistry interactions of coastal plain ponds, forest health monitoring, and invasive species mapping. Additionally, FERN hired a coordinator to manage six interns working on the Forest Health Monitoring.

Each intern was responsible for their own research as well as assisting each other in the collection of data. Results of the research were presented in a poster session sponsored by the Office of Education Programs, and the research was also presented at a poster session at the Pine Barrens Research Forum. Copies of all posters are attached to this report.

Many students and BNL staff participated in the BNL Science Museum's Summer Camp program. Each week, camp participants met on Thursday at the Weaver Rd. pond to learn about soils and water. Each intern also presented their research to the campers. These lessons introduced students in grades 4 –6 to the various research topics, and gave the student interns an opportunity to learn teaching skills.

3.21 Research

Research carried out in 2005 through funding from FERN included the Forest Health Monitoring mentioned above and an evaluation of more than forty rare wetland plant communities within the Pine Barrens. FERN and BNL also took delivery of the forest health monitoring protocols and the Pine Barrens research database funded by the U.S. Fish & Wildlife Service through the Upton Reserve.

3.21.1 Identify, attract, and support ecological research to BNL

Researchers from SUNY Binghamton continued working on a tiger salamander research in 2005. A Ph.D. candidate is working on movements of salamanders, breeding biology and genetics of this state endangered species. Research is expected to last through mid-year 2007.

The Foundation for Ecological Research in the Northeast continues to work on identifying outside sources for funding research in the Pine Barrens.

3.22 NRMP Plan Update

Since the NRMP was completed in December 2003 it will not require a complete update until 2008 (five years). However, in the preparation of the first annual report, Appendix C of the NRMP was rearranged to facilitate reporting requirements. The modified version of Appendix C is attached. In addition, if new actions are identified they will be appended to the Appendix C Actions Table in the future.

This report once completed will be provided to the TAG for review and any suggestions or new actions arising from that review will be incorporated into the Actions table.

APPENDIX C

NATURAL RESOURCE MANAGEMENT PLAN – ACTION ITEMS

Action Item	Site ID	Action	Planned Date	Action Taken
1	*Site-wide	Transition WMP Action into NRMP	December 2003	Complete
2	Site-wide	Annual Summary Report	Annual by March 31	Ongoing
3	Site-wide*	TAG Review of Annual Report	Annual by May	
4	Site-wide*	Adapt Management based on new information	As Required	2nd annual report 3/31/05, ongoing
5	Site-wide*	Improve decision making through use of innovative tools	As Necessary	Implemented 2003, ongoing
6	Site-wide*	Maintain and Improve relationships with stakeholders	Continual	Ongoing
Peconic River/Basins				
7	Peconic River Station HMn	Monitoring for flow: water quality	Monthly sampling SPDES Program	Ongoing
8	Fish Sampling Peconic River	Fish sampling with NYSDEC/Cold Spring Harbor: population assessment of banded sunfish and swamp darter	Annual Spring/Summer	Ongoing
9	TS-7	Monitoring for water quality	Monthly sampling SPDES Program	Ongoing
Deer Management				
10	*Site-wide	Issue and Discussion Paper on deer management by Natural Resource Manager	Fall 2003	On hold, indefinitely
11	*Site-wide	Environmental Assessment under NEPA for deer management		On hold, indefinitely
12	*Site-wide	Implement Deer Management		On hold, indefinitely
13	Site-wide	Deer population estimation	Nov-Jan May-June	Ongoing. Routine estimates made twice a year, new protocol developed in 2004
Special Status Species				
14	*Site-wide	Maintain Special-status species list	Annual Review	Ongoing
15	*Site-wide	Identify habitats of special-status species	Continual	Ongoing
Tiger Salamander				
16	Site-wide	TS annual egg mass surveys at breeding ponds	Feb-April 2003	Ongoing
17	Site-wide	TS Larval Survey	Annual June-July	Ongoing
18	Education	Provide educational material or opportunities to BNL staff and public on environmental issues	Continual	Ongoing
19	*RHIC	New pond being added at RHIC	Summer 2004	native vegetation established
20	Tiger salamander	Set up cover boards around one breeding site (as a test case)	Summer	Summer 2001 & 2002, completed, drift fences installed

APPENDIX C

NATURAL RESOURCE MANAGEMENT PLAN - ACTION ITEMS

(continued)

Action Item	Site ID	Action	Planned Date	Action Taken
21	TS-A7	Lining of pool ER program	Aug 2003	Completed
22	TS-W6b	Pond Remediation ER program	2004-2005	Completed
Banded Sunfish				
23	OU V	Peconic River Remediation Program	Spring 2004	Completed, tracking success of restoration
Frosted Elfin				
24	*Habitat Specific	Confirm presence/absence of Frosted Elfin	May-June Annually	Ongoing
25	*Habitat Specific	Establish standard monitoring protocols for the Frosted Elfin		
26	*Species Specific	Maintain and Enhance habitat for the Frosted Elfin	Continual	Ongoing
27	*Site-wide	Habitat assessment for lupine	Spring 2004	Ongoing
Habitat Enhancement/ other species				
28	Site-wide	Bird nests/boxes	Ongoing	Routine monitoring and maintenance of bluebird, kestrel, wood duck nest boxes
29	*Site-wide	Develop survey methodology to document all biota on BNL	2004	Contract through Upton Reserve
30	Site-wide	Monitor Canada Goose and Wild Turkey populations	Ongoing	
31	Site-wide	Turkey sighting reports to NYSDEC	Ongoing	Reports sent annually in September or upon request
32	Site-wide	Song bird surveys	April – Sept.	Continuing
33	*Site-wide	Odonata Surveys	Summers	Initiated 2003, ongoing
34	*Site-wide	Reptiles and amphibian Surveys	Ongoing	Reptiles & Amphibians started 2003
Population Management				
35	*Site-wide	Manage Canada Goose population	As necessary	Not needed, yet
36	*Site-wide	Manage Wild Turkey population	As necessary	Not needed, yet
37	*Site-wide	Establish BNL policy on feral animals		
38	*Site-wide	Establish monitoring and management protocols for feral animals	Fall 2003	Initiated
Vegetation Management				
39	*Site-wide	Establish protocol for use of native vegetation		Routinely done w/out protocol
40	*Site-wide	Use native vegetation on restorations and new construction landscaping	As necessary and applicable	Initiated 2003, ongoing
41	RHIC Revegetation	Implement Revegetation	Ongoing	Grasses planted 2002 and 2003, Completed 2005

APPENDIX C

NATURAL RESOURCE MANAGEMENT PLAN - ACTION ITEMS

(continued)

Action Item	Site ID	Action	Planned Date	Action Taken
42	*Site-wide	Establish policy and procedure for cutting trees		Informal Procedure appears adequate.
Invasive Species				
43	*Site-wide	Identify and monitor distribution of invasive species.	Ongoing	Mapping started Summer 2003, completed 2005
44	*Site-wide	Establish volunteer "Weed Watchers" group	Ongoing	Group formed May 2003, disbanded 2005
45	*Site-wide	Removal or control of invasive plants where possible.	As necessary	
46	*Site-wide	Identify funding for removal or control of invasive plants where possible.	As necessary	
Ecosystem Monitoring and Management				
47	*Site-wide	Develop criteria to monitor wetland health		
48	*Site-wide	Determine functionality of BNL Central wetlands		
49	*Site-wide	Maintain or improve wetland functions		
50	*Site-wide	Develop criteria to monitor forest health	Fall 2004	Completed 2005
51	*Site-wide	Establish forest health monitoring locations	Summer 2005	Initiated 2005
Security				
52	*Site-wide	Coordinate with Security to reduce illegal use of ATVs	Continual	Ongoing
53	*Site-wide	Other trespass Issues		
Pesticide Use				
54	*Site-wide	Determine need for a SBMS subject area on pesticides	As necessary	
55	*Site-wide	Pesticide use for natural resource management		
Wildland Fire Management				
56	*Site-wide	Implement Fire Management Plan	Sept. 2003	Plan Approved September 2003
57	*Site-wide	Implement use of prescribed fire and mechanical fuel reduction	March 2003	1st Fire November 2004 CY2005 Approved
Cultural Resource Management				
58	*Site-wide	Identify cultural resources and develop into GIS layers	Ongoing	LEED Area Identified 2005
GIS and GPS				
59	*Site-wide	Develop natural resource data layers of GIS	Ongoing	
60	*Site-wide	Plan trails and paths that limit impact on the environment while introducing employees to forest diversity.		

APPENDIX C

NATURAL RESOURCE MANAGEMENT PLAN - ACTION ITEMS

(continued)

Action Item	Site ID	Action	Planned Date	Action Taken
61	*Site-wide	Fill data gaps concerning all flora and fauna, including the following: terrestrial and aquatic invertebrates, Lepidoptera, wild flowers, and grasses.	Ongoing	
62	Site-wide	Education Programs	Ongoing	Utilize Office of Education Programs Interns, etc. 18 interns 2005
Research				
63	Site-wide	Cooperate with Upton Reserve, support and conduct research as needed	Ongoing	Assisting Upton Reserve in coordinating research programs, Transitioned to FERN
64	*Site-wide	Identify, attract, and support ecological research at BNL	Ongoing	Coordinating with FERN
65	Site-wide	NRMP Plan Update	Every 5 years Next update 2008	---

Notes: * New initiative

ER – Environmental Restoration
GIS – Geographical Information System
NEPA – National Environmental Policy Act
NYSDEC - New York State Department of Environmental Conservation
NRMP – Natural Resource Management Plan
OU V – Operable Unit V
RHIC - Relativistic Heavy Ion Collider
TS – Tiger Salamander

ATTACHEMENTS

STUDENT INTERN POSTERS

Survey of Banded Sunfish Population in Zeke's Pond

Katie Heiser(Lafayette College Easton, PA 18042) Dr. Timothy Green (Brookhaven National Laboratory Upton, NY 11973)

Introduction

In New York State the range of the Banded Sunfish (*Enneacanthus obesus)* is constrained to small areas of Long Island. Because of this, it has been listed as a threatened species by the State. The headwaters of the Peconic River provided suitable habitat with thick vegetation lining the shores. However, during the Peconic River restoration project at Brookhaven National Laboratory, much of this habitat was destroyed. In 2003 and 2004, an attempt to save the population was made and 195 banded sunfish were rescued ahead of the Peconic River cleanup. Many of the Banded Sunfish living in the Peconic River were relocated to Zeke's pond.

Zeke's pond is a large coastal plain pond located in the east central portion of BNL. In 2002 drought conditions resulted in the pond nearly drying up. A small population of banded sunfish were rescued and reintroduced to the pond in 2003. Those fish plus the 195 rescued from the Peconic River in 2003 made up the breeding stock for the present population study.

Adult Banded Sunfish(*Enneacanthus obesus*)

Results

The number of fish per square foot was determined for each seine run. Then a density was determined for the area seined. The average for all seine runs was 0.35 Banded Sunfish per square foot. Assuming a 98% confidence rate there was a range of 0.33-0.37 fish per square foot. The total area covered by the pond is approximately 290,800 square feet (6.68 acres). Based on the average number of fish per square foot the population was estimated at approximately 101,800 fish in the pond. However, based on the range of 0.33 - .037 per square foot, there could be anywhere from 95,900 fish to 107,600 fish in the Zeke's pond. The efficiency of the seining was not evaluated, so there could be a significantly larger population than predicted.

The effectiveness of the seining based on visual observations was as low as 50%. The exact efficiency is uncertain, however that would place the estimate significantly higher at approximately 202,000 banded sunfish. Since this study did not evaluate the efficiency of the sampling technique, the total estimate for this study will remain at approximately 101,000 fish.

Zeke's Pond

Materials and Methods

Seine nets proved to be the most effective way to capture the Banded Sunfish. Originally it was thought that the fish would prefer the more vegetated portions of the pond. This would mean differences in the density of fish in the pond. Therefore, both open water and vegetated areas were seined in an attempt to find the densities of the different habitats. All of the runs were logged individually and described. After the fish were captured, they were counted, measured and then immediately released back into the pond. The standard length was measured from the snout to the end of the body or just prior to the start of the tail fin.

A seine net is a large net with two poles at either end that is pulled through the water by two people. Ideally the net will end up covering everything from the bottom to the surface of the pond.

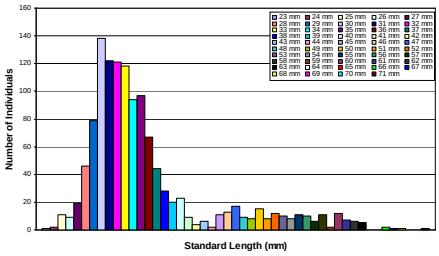

Figure 1 shows all of the individuals surveyed by length. The population is comprised of mostly juvenile fish.

Juvenile Banded Sunfish

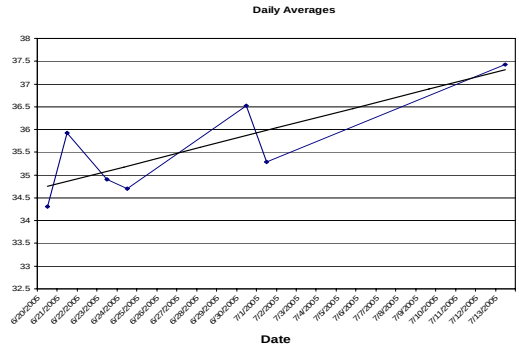

Figure 2 shows the average growth rate from the first day of seining to the last. The fish grew so rapidly that there were few fish under 30mm by the final week of seining.

This study clearly includes this year's hatchlings, for which the mortality rate is unknown. At a different point in the year the number of fish surviving in the pond could be very different. However, the life cycle of the Banded Sunfish has not been closely studied and their population patterns are unknown. The abundance of hatchlings and rapid growth rate could be indicative of a future overpopulation problem and the population could plummet in a few years. It is hoped that the number of breeding individuals will be increased next year and the population will begin to stabilize.

Although the Banded Sunfish appear to be doing well, there are a number of other species living in Zeke's Pond. The effect of these species on the Banded Sunfish is unknown. While seining, Green Frog and Bullfrog tadpoles were commonly captured. Tadpoles were not counted or measured, and were immediately released. The next most common animal found in the net was the Pumpkinseed Sunfish. While they were not part of the study, they were still measured. By the end of the study there had been approximately 20 Pumpkinseeds ranging in length from 18mm to 65mm. Larger adult Pumpkinseeds were also observed, but none were captured. Although this information may not serve to estimate the size of the population it does show an established population of Pumpkinseed Sunfish in Zeke's pond.

Banded Sunfish being released into Zeke's Pond

While fish were being collected for this study, many Banded Sunfish were observed in the wild. Individuals were seen guarding small six to eight inch depressions in the mud. It is assumed that the fish were guarding nests, much like other sunfish. Behavior like this is also indicative of a healthy and growing population.

Despite the variable range of possible population estimates presented in this study, the rescue project appears to have been successful. Based on the study, the initial population has grown approximately 500 times its original size. It is hopeful that this phenomenal growth rate has allowed the sunfish to become permanently established in Zeke's Pond and will allow their reintroduction to the Peconic River and possibly re-establish populations in other suitable ponds in the Peconic River system.

Acknowledgments

I thank the U.S. Department of Energy, Office of Science and the National Science Foundation (NSF) for this unique opportunity to conduct research at Brookhaven National Laboratory through the SULI program. I especially thank my mentor, Tim Green for his wealth of knowledge, excellent mentoring and help collecting fish. I also thank Jennifer Higbie for her help with the GIS. I would also like to offer my gratitude to all the people who came out to see the project and help seine for fish.

Home Range Size and Spatial Ecology of Eastern Hognose Snakes (*Heterodon platirhinos*) on Brookhaven National Laboratory

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Abstract

Once considered an abundant species on Long Island the eastern hognose snake, *Heterodon platirhinos*, is now found only in small fragmented portions of the species former range. After 1996, *H. platirhinos* was incorrectly believed to be extirpated from Long Island as there were no sightings of the species until 2001 when the species was rediscovered again at Brookhaven National Laboratory (BNL). Since the spring of 2003, radio telemetry studies have been conducted at BNL on *H. platirhinos* to learn more about the factors triggering this species decline. In this study, radio telemetry was utilized to discover more information about the snakes' habitat preferences, mortality rates, and home range sizes. The study consisted of eight snakes that were tracked and monitored daily with the use of GPS/GIS. Aside from tracking, snout vent length, total length measurements and weights were recorded opportunistically to obtain data on growth rates and possible nesting behavior in the snakes. Snakes were active on 67% of days tracked during a portion of the activity season for the species. Preliminary data collected for home ranges displays a maximum home range of 10.7ha for SN30 with the a minimum size of 0.4ha for SN41. The data collected from this study will be used to further enhance the conservation of this Special Concern status species.

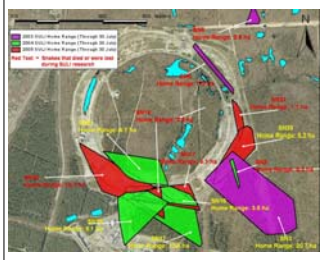
Introduction

The site of Brookhaven National Laboratory (BNL) located in the core of the Central Pine Barrens (CPB) of Long Island provides an ideal habitat for many declining species of herpetofauna native to the area. Due impart to the fact that BNLs property is protected from the spreading development occurring throughout the area, many rare and special concern species are found on the site with viable populations among the CPBs sandy soils, pitch pine/ shrub forests and wetlands. A variety of herpetofauna such as spotted turtles (*Clemmys guttata*), eastern tiger salamanders (*Ambystoma tigrinum tigrinum*) and eastern Hognose snakes (*Heterodon platirhinos*) exist at BNL in moderate numbers.

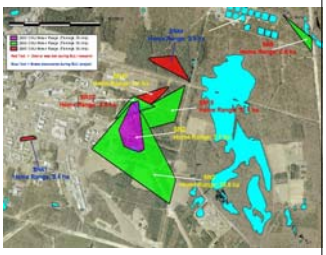
This study focused on a total of eight Eastern Hognose Snakes and their movements during a portion of the activity season for the species, which generally falls between the months of April through November. Historically an abundant species on Long Island, *H. platirhinos* was commonly found in habitats such as coastal dune communities and the sandy soiled Pine Barrens [5]. ,Due to a general lack of biological information on this species After loosing much of its preferred habitat to development on Long Island this understudied species was brought to biologists' attention after it was deemed extirpated in the area after 1996. Since its rediscovery in 2001 at BNL, *H. platirhinos* has become the focus of a three year (including current study) radio-telemetry project that has helped biologists gain a greater view into what factors are causing this species' decline. Since 2003 radio-telemetry studies have been implemented at BNL on a total of # snakes, overseen by biologists from the US Fish and Wildlife Service and BNL. The goals of this study have helped these biologists gain a better understanding of this species home range size, habitat preferences, and local distributions.

The range of *H. platirhinos* extends from central Minnesota to s. New Hampshire to Florida west to Texas and Kansas [2].The hognose snake is a robust snake that varies in size from 500mm to 1156mm with an average length of 500 to 650mm for males and 650 to 850mm for females [1]. *H. platirhinos'* color is extremely variable with specimens ranging from yellow with dark bands to olive black with the normal coloring being tan with 20-30 darker bands placed laterally across the body [2]. *H. platirhinos'* sharply upturned rostrum and wide neck aid the snake in its usual activities of foraging for its main prey the fowlers toad *(Bufo Woodhousei fowleri)*, burrowing for shelter, and bluffing conceived predators with its elaborate "cobra" display [3]. The snake generally uses a progressive behavioral defense technique that begins with its famous cobra imitation followed by its characteristic death feigning act. Once disturbed, the snake will try to deter predators by fanning the hood of its neck, raising its head, mock striking while loudly hissing. If that act fails to dissuade the perceived threat the snake immediately resorts to playing dead by rolling over on its dorsal side writhing about with mouth agape, tongue lolling out. Even when manually placed back on its ventral side the snake will instinctively revert back to its belly up position.

Results



Represents home ranges for individual snakes studied near the RHIC ring with differentiation between 2003, 2004, and 2005 studies.



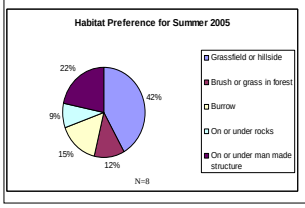
Representation of snakes home ranges near the center of BNLs site with differentiation between 2003, 2004 and 2005 studies.

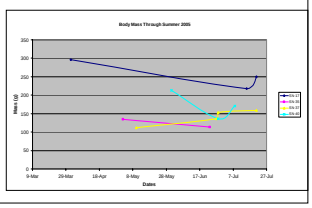
Direction of movements with total distanced moved per snake for 2005 study.

Snake I.D.	Sex	SVL (cm)	Total Lg. (cm)	Weight (g)	Dates monitored	Average distance per movement(m)	Home range (ha)	Days tracked (d)	Fate
1	F	51	61	129	6/9/2003 - 10/7/2003	210	10.5	121	hibernated
5	F	66	79	282	6/9/2003 - 6/30/2003	285	1.3	22	lost, transmitter failure
6	F	56	66	227	6/18/2003 - 7/14/2003	136	0.8	27	lost, transmitter failure
2	F	67	80	338	5/19/2004 - 8/30/2004 and 2/23/2005 - 7/30/2005	438 / 457	8.2 / 33.8	324	active
3	M	61	75	241	5/19/2004 - 8/30/2004 and 2/23/2005 - 6/22/2005	300/224	23.3 / 0.4	286	transmitter found w ithout snake
15	M	44	59	135	4/27/2004 - 6/1/2004	933	10.1	36	transmitter found w ithout snake
18	M	43.5	56	82	5/7/2004 - 7/30/2004	101.7	8.2	85	active
21	F	43	51	101	5/7/2004 - 7/30/2004	100.5	6.1	85	active
22	F	65	72	213	5/19/2004 - 6/29/2004	83.4	3.1	38	eaten by mammal(s)
24	F	56.8	67.4	243	5/25/2004 - 6/21/2004	80.5	1.8	28	run over by large truck
16	F	62.5	72	252	5/4/04 - 8/30/04 and 4/18/05-7/22/05	254 / 154	3.5 / 2.9	126	avian predation
17	F	68	83	250	5/4/04 - 8/30/04 and 4/23/05- 6/27/05	351 / 146	12.6 / 5.1	105	avian predation
30	M	49	63	164	9/14/04-6/17/05	288	10.7	25	transmitter found w ithout snake
35	M	50	62	114	5/12/05-7/29/05	154	5.2	43	active
37	F	51	61	159	5/19/05-7/29/05	107	1.1	37	avian predation
40	F	55.5	66.8	171	6/6/05-7/29/05	117	3	36	active
41	F	56.5	67	137	7/6/05-7/29/05	62	0.4	19	active
44	F	74	89	376	7/21/05-7/29/05	345	3.9	8	active

Snakes tracked in 2003
Snakes tracked in 2003 and 2004
Snakes tracked in 2004
Snakes tracked in 2004 and 2005
Snakes tracked in 2005

Compilation of general data for all snakes tracked to present.





Materials and Methods

A total of eight snakes were tracked on a daily basis excluding weekends to determine home range size, overlaps if any and survivorship among the specimens. Five of the eight snakes (including SN16 and SN17 who were in the 2004 study) were originally captured at the site of BNL's Relativistic Heavy Ion Collider (RHIC), a heavily disturbed open area surrounded by a 4 km circumference 10m high man made berm. Since its construction, the RHIC ring has been the capture site of a majority of the snakes used in the previous two years of the study due to its sandy and open, high grass habitat. The three remaining snakes were captured in varying habitats such as SN40 who preferred high grass fields bordered by white pine groves, SN41 who was found at the residential heart of BNLs site, and SN44 who resided in the large portion of white pine forest on the site.

After the initial capture, surgery for transmitter implantation was performed and snakes were released to their respective sites within fourteen days after the procedure. After the location of a snake was confirmed, weather data was collected with the use of a sky master weather station for the relative humidity, air temperature and average wind speed. A GPS point for each days location was logged with Garmin rino 110 unit. The snakes location, macro and micro habitat and activity were also recorded. The area was then flagged with information such as the snakes' identification number, air temp, date and time. Arc View 3.3 GIS was used to analyze the area of each snakes home range. Snout vent length, total length and weights were obtained when allowable but did not exceed once per week per snake. Measurements and weights were only obtained when the snake was active so as not to disturb the snake into false movements. Weights were taken in the hopes of discovering a gravid female, which has yet to be documented at BNL.

Discussion and Conclusion

A Student *t*-test was performed with the data from the 2003, 2004, and current study to determine if there was a correlation between mass and home range size for *H. platirhinos*. The results showed no significant difference between the two variables for each comparison: 2003 vs. 2004, 2004 vs. 2005, and 2003 vs. 2005.

Due to the high mortality rate among this species, comparisons for two full seasons of research have been unsuccessful. Many factors contribute to the disruption of this study such as the discovery of transmitters with no apparent signs of predation. A possible solution to this puzzling phenomenon may have been found this season when SN37 was captured for the purpose of collecting morphological data on June 27, 2005. It was discovered that the transmitter of SN37 was in the process of expulsion from the snake. The snake was collected and held in observation until it was transported to the Bronx Zoo for a new surgical technique to be applied to the transmitter placement surgery. Shortly after SN40 was noted to be undergoing this same condition and was also collected on July 7, 2005 for the new transmitter replacement procedure to be performed. A different suture technique was applied to both snakes to ensure the placement of the transmitters and has proven to be very effective to date.

More research needs to be extrapolated about *H. platirhinos'* habitat preferences and life history characteristics to further enhance the conservation of this species. The preservation of habitats preferred by *H. platirhinos* will likely play a key role in ensuring viable populations of this species for the future.

References

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BROOKHAVEN NATIONAL LABORATORY

U.S. FISH & WILDLIFE SERVICE

UNIVERSITY OF Rhode Island

Use of the Program DISTANCE to Assess Population Size of the Eastern Hognose Snake (*Heterodon platirhinos*) at the Brookhaven National Laboratory

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INTRODUCTION

The eastern hognose snake (*Heterodon platirhinos*) is a species of particular interest on Long Island and throughout the northeast, where habitat loss and declines in reported sightings have become a cause for concern. In the early 20th century, *H. platirhinos* was described as being found by "the bucket full" in several areas on Long Island, such as the Rockaways (Engelhardt et al., 1915) and Fire Island (Yeaton, 1972), where the species now appears to be extirpated. There are currently few viable populations remaining on Long Island. The combined effects of several anthropogenic factors, including habitat destruction and habitat fragmentation appear to be the most likely contributors to the snake's decline.

The eastern hognose snake displays unique defensive behaviors that can be described as bluffing and "feigning death." When threatened, *H. platirhinos* will spread its head and neck like a cobra. The snake then hisses and makes forward thrusts but does not bite. If the snake is continually harassed, it will rub its mouth against the ground and turn belly up, writhe for a short while, and then lie still with its mouth open and tongue sticking out (Edgren, 1955). If the snake is turned over, it will immediately roll onto its back again. Once the threat or disturbance has passed, there is a short recovery period that typically lasts for several minutes. After this recovery period has passed, the snake will resume its normal activities.

Despite this snake's fascinating behavior and the growing concern about the status of *H. platirhinos*, little research has been conducted on this species. Few previous efforts have been made to assess the abundance or population size of hognose snakes. The software package DISTANCE was used as a survey technique in an attempt to determine the population size of *H. platirhinos* at Brookhaven National Laboratory (BNL).

METHODS AND MATERIALS

The program DISTANCE is computer software that allows the user to design and analyze sampling surveys of wildlife populations. It generates transects through a designated area and produces a population estimate upon the input of all sightings. Before using DISTANCE, preliminary information regarding the snake's general ecology and life history characteristics needed to be reviewed and considered. Hognose snakes prefer open, sandy areas that can be found in the Pitch pine/Oak forest, grassland, and successional habitats of BNL. A GIS vegetation map of the BNL property was carefully looked over and these three habitats were selected as possible *H. platirhinos* habitat. Since *H. platirhinos* sometimes tends to move from these habitats to more forested areas (J. Feinberg, unpublished data), a 122 m buffer was added to this to insure the inclusion of all hognose snake habitat. The final transect survey area, including the 122 m buffer, encompassed over 99% of the positions of located hognose snakes from previous capture locations, sightings, and positions of snakes involved in a radio telemetry study (J. Feinberg, unpublished data). A survey was then created using DISTANCE, which included 91 line transects that totaled 243 km. These transects were walked from mid-May to early July, the period of greatest activity for hognose snakes at BNL. The transects were walked between 0700h and 1500h, which was previously described as peak hognose activity hours (Plummer, 2000).

Figure 1: Map of BNL and DISTANCE survey area.

Figure 2: A grassland habitat: an example of habitat that is preferred by *H. platirhinos*.

DISCUSSION AND CONCLUSIONS

The total number of eastern hognose snakes observed while walking transects was one ($N = 1$). A sample size of 60-80 is suggested as a minimum for a reliable estimate of population size and density (Buckland et al., 2001), so analysis would not produce an accurate population estimate and was futile. The program DISTANCE, and predetermined, linear walking transects in general, do not appear to be efficient in the estimation of hognose snake population size.

Several explanations can be proposed for the failure to accumulate enough hognose snake sightings. One is that there are too many variables involved in the snake's activity. An example of this is the snake's shed cycle. Most of the transects were located in areas where hognose snakes had been seen most often in the past and were walked while the snakes were in their shed cycle. During the shed cycle, the snakes become inactive and are often not visible. They may be in a rock pile, burrowed in sandy soil, or hidden at the base of a grass tussock. It was not possible to know the snakes were in this inactive cycle until shed skins were found after the fact. Another possible explanation for the inability to accumulate hognose snake sightings is that the buffer created may have been too large and too much marginal hognose snake habitat may have been included. The buffer habitat was actually greater in area than the preferred habitat that was surveyed. It was necessary to include this habitat though, as some individual hognose snakes utilize marginal habitat, on occasion.

Due to the cryptic nature of *H. platirhinos* and its complex activity cycles, an intricate formula that accounts for the snake's activity throughout the year is necessary to conduct an accurate population estimate. Data collected by Jeremy Feinberg appears to indicate that random pedestrian surveys may be more efficient than systematic transects in the accumulation of snake sightings. For example, during the brief period of this study, six hognose snakes were found in 29 hours of random surveys, whereas only one snake was found in approximately 114 hours of walking transects.

Thus, the incompatibility between the required sampling protocols of DISTANCE and actually finding snakes in areas where they are definitely known to occur appears to indicate that the DISTANCE software package is not an effective means of estimating *H. platirhinos* population size at BNL. Whether or not this conclusion can be applied to other populations of this species in different habitats (e.g., beach dunes, prairies, etc.) or to other species cannot be determined at this time, but may be the case, especially among other cryptic species.

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Home Range Estimates and Habitat Preferences of Spotted Turtles (*Clemmys guttata*) Assessed Through the Utilization of Radio Telemetry, GPS, and GIS Technology

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Abstract

Beginning in the fall of 2003, a behavioral ecology study of the spotted turtle, *Clemmys guttata*, implementing radio telemetry was initiated at Brookhaven National Laboratory (BNL). Both hatchery-raised (headstarted) and native spotted turtles were radio tracked in order to discern anomalous behavior in hatchery-raised turtles and the applicability of the raise-and-release method in reestablishing viable spotted turtle populations in native habitats. Individuals from the study group were monitored regularly, habitat data gathered and positional data logged utilizing GPS technology. The GPS points gathered were used to map hypothetical home ranges for each turtle using GIS technology. No significant difference was found between the summer 2004 headstarted turtle home range sizes and the summer 2005 headstarted turtle home range sizes (Student *t*-test, $\alpha = 0.05$, $p = 0.3073$). Also, no significant difference was found between the combined 2004 and 2005 headstarted turtle home range sizes and the combined 2004 and 2005 native turtle home range sizes (Student *t*-test, $\alpha = 0.05$, $p = 0.6088$). Because the spotted turtle is considered a species of special concern in New York State, the results of this study are relevant to conservation policy.

Introduction

The spotted turtle, *Clemmys guttata*, is a relatively small North American semi-aquatic turtle found from Ontario to Florida along the East Coast, and west through New York, Pennsylvania, Ohio, Michigan, Indiana, and Illinois. This species has carapace length of up to 12.5 cm. and is easily distinguished from other turtles sharing the same range by conspicuous yellow markings on the carapace, legs and head. The presence of a yellow or tan throat is another unique characteristic of the spotted turtle differentiating it from similar species [1].

Spotted turtles typically reside in shallow vernal pools, marshes, bogs, swamps, or permanent bodies of water, however *C. guttata may* leave their aquatic habitats throughout the year and move upland to hibernate, aestivate, nest, and to migrate to more productive aquatic environments [1]. These seasonal activities are all reflected in the home range size of individual turtles. Therefore, turtles in marginal environments should exhibit larger home ranges than turtles in more pristine habitats [2].

Although once abundant in New York State, the spotted turtle is currently recognized as a Species of Special Concern. Presently, biologists are observing an alarming trend toward population decline across the entire range of this species [3]. Many suspected anthropogenic catalysts have been cited as primary antagonists provoking this trend; including: habitat loss, alteration, and fragmentation, road mortalities, and pet trade collection. Also, habitat succession has been proposed to be a natural agent playing an integral role in this species-encompassing trend [3].

The focus of this project was to evaluate the efficacy of the raise-and-release method (headstarting) in augmenting senescent turtle populations. Although headstarting is not a novel conservation technique, little is known about the long-term effectiveness of this practice as it pertains to *C. guttata*.

Thirty spotted turtles were donated from the Cold Spring Harbor Fish Hatchery and Aquarium to Brookhaven National Laboratory for this study. Of the thirty-headstarted turtles released, nine were fitted with radio transmitters. In conjunction with this sample population, two native spotted turtles were also fitted with radio transmitters. Home range size, macro and microhabitat preference, and aestivation, hibernation, and migratory behavior were all criteria analyzed to elucidate the extent to which the headstarted turtles have acclimated to their new home at BNL. Because of the status of the spotted turtle in New York and the state of the species in general, the potential ramifications of this project in regards to conservation policy are extensive.

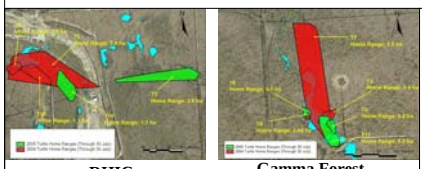
Materials and Methods

Eleven turtles (nine headstarted and two natives) were fitted with radio transmitters for this study. L.L. Electronics 4g LF series transmitters were adhered to the caudal section of the carapace using either epoxy or black electrical tape. Morphological measurements were taken prior to release. These measurements included weight, plastron length, plastron width, and carapace length.

Weather permitting, turtles were tracked daily, Monday through Friday, with occasional weekend data collection. Daily locations of turtles were determined utilizing a Communications Specialists Model R1000 telemetry receiver and an AF Antronics Model F150-3FB antenna. Once discovered, the precise location of a turtle was marked with florescent flagging tape. Turtle ID#, date of discovery, time of discovery, and temperature were logged on the flagging tape with black permanent marker. Turtle ID#, date of observation, time of observation, location, macrohabitat, microhabitat, and percent cloud cover were logged in a field journal. Wind speed, temperature, and relative humidity measurements were taken with a Forestry Suppliers *Kestrel 4000* personal weather station. Water temperature was taken when applicable using a standard thermometer.

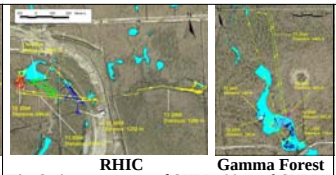
A GPS point was taken to mark the precise daily locations of each turtle, using a Garmin *rino* 110 personal navigator. Arcview v. 3.3 was used to analyze spatial data and estimate the minimum convex polygon (MCP) and line distance for each turtle. This GIS program was also used to overlay the MCP home range maps onto aerial photos.

Results



RHIC Gamma Forest

Fig. 1 A comparison of SULI 2004 and SULI 2005 home range estimates.



RHIC Gamma Forest

Fig. 2 A comparison of SULI 2004 and SULI 2005 line distances.

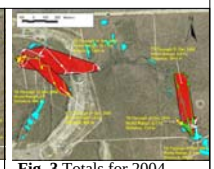


Fig. 3 Totals for 2004.

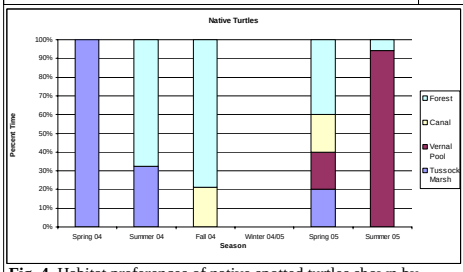


Fig. 4 Habitat preferences of native spotted turtles shown by percent time spent in each habitat (N = 2).

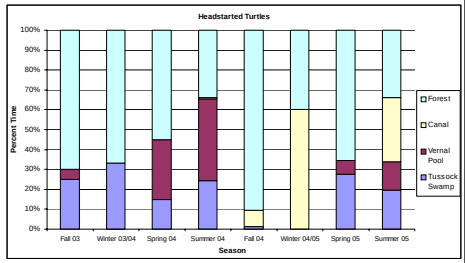


Fig. 5 Habitat preferences of headstarted spotted turtles shown by percent time spent in each habitat (N = 9).

ID#	Native (N)/ Headstarted (H)	Weight (g)	Carapace (mm)	Plastron Length (mm)	Plastron Width (mm)	Dates Monitored	Days Tracked (d)	Average Distance Per Movement Summer 04 (m)	Average Distance Per Movement Summer 05 (m)	Home Range Summer 04 (Hectares)	Home Range Summer 05 (Hectares)	Fate
1	H	57	73.8	66.5	44.5	10/14/03-12/22/03	6	-	-	-	-	Unknown-Transmitter Failure
2	H	58	71.1	61.6	40.3	10/14/03-07/29/05	123	85	44	0.4	0.2	Active
3	H	83	81.7	69.2	44.9	10/14/03-07/29/05	110	372	114	7.4	2.5	Active
4	H	64	74	64	43.4	10/14/03-04/27/05	10	-	-	-	-	Unknown-Transmitter Failure
5	H	56	67.7	58.1	39.5	10/14/03-04/19/04	9	-	-	-	-	Unknown-Transmitter Failure
6	H	63	72.5	64.1	41.4	10/14/03-04/07/04	9	-	-	-	-	Unknown-Transmitter Failure
7	N	195	103.6	93	64.2	05/05/04-10/31/04	56	426	-	5.5	-	Unknown-Transmitter Failure
8	H	74	77.0	67.4	43.3	06/10/04-07/06/05	63	27	34	0.04	0.1	Lost to Predation
9	H	56	71	60.6	39.2	06/10/04-04/07/05	58	146	-	0.5	-	Lost to Predation
10	H	62	74	63.9	41.7	06/10/04-07/29/05	104	292	86	1.1	1.3	Active
11	N	75	78	73	45	05/13/05-07/29/05	40	-	77	-	0.8	Active

Table 1. A compilation of data for all spotted turtles tracked during the duration of this study.

*Morphological data was taken prior to release of the animal after first being fitted with a transmitter.

Discussion and Conclusion

On initial inspection, it appeared that the home range sizes of the headstarted turtles had dropped significantly when comparing the summer 2004 home range sizes to the summer 2005 home range sizes, yet statistical analysis suggests that there is no significant difference between the two years (Student *t*-test, $\alpha = 0.05$, $p = 0.3073$). Also, no significant difference was found between the home range sizes of native turtles and headstarted turtles (Student *t*-test, $\alpha = 0.05$, $p = 0.6088$). Although useful, due to the small sample size this information may not be reflective of the actual degree of acclimation currently maintained by the headstarted turtle population. The documentation of mating behavior or nesting would be the ultimate indication that headstarted turtles are able to adjust to a natural environment. More research is required to definitively elucidate the value of headstarting programs in augmenting senescent or extirpated turtle populations.

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BROOKHAVEN NATIONAL LABORATORY

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UNIVERSITY OF Rhode Island

Odonate Species Survey in Correlation with Air Temperature and Precipitation at Brookhaven National Laboratory

Saneddy Quezada Community College Institute of Science and Technology

Dr. Timothy M. Green Brookhaven National Laboratory, Environmental and Waste Management Services Division

Introduction

Odonates are large predacious winged insects, which include *Anistopera* (dragonflies) and *Zygoptera* (damselflies). Odonates are physically characterized by long, bright colored bodies, two pairs of membranous wings, and large compound eyes. Earliest fossil records of Odonates indicate their existence approximately 300 to 325 million years ago. According to fossil records, their wingspan reached 70 to 75 centimeters long, making them one of the largest and oldest invertebrate groups ever to exist. Meteorological conditions may be a factor in the distribution of these insects. The project attempted to compare meteorological data from the summers of 2003, 2004, and 2005 and its correlation with the distribution and richness of Odonates at Brookhaven National Laboratory. The purpose of the project is to obtain accurate data that will assist in the understanding of Odonate emergence and behavior in correspondence with humidity, precipitation, and air temperature. The project utilizes weather records of the last two summers, courtesy of the Atmospheric Science Division at Brookhaven National Laboratory. Data from the past two summers of the Environmental & Waste Management Services Division at BNL are also being applied to fulfill the goal of this project, as well as current sampling and assessment of the many wetlands on the BNL site. While sampling the ponds, a new species was added to the New York State list of Odonates *Celithemis verna* or Double-Ring Pennant. Also, one of the three threatened damselflies (*Enallagma recurvatum)* was recorded for the first time at BNL this summer.

Results

During the summer of 2005, a total of 12 wetlands were assessed on site at BNL. The Ponds surveyed were P-1, P-2, P-3, P-6, P-7, P-8, P-10, P-13, P-16, P-17, Zeke's pond, and the Peconic River. Over the three years of odonate research at BNL, 53 species have been found out of 91 recorded in Suffolk County, including *Celithemis verna,* commonly known as the Double-ringed pennant, which was found for the first time at BNL this summer and is a new species record for the New York State list of Odonates. After three years of search one out of the three endangered damselfly was found in Zeke's Pond *Enallagma recurvatum* commonly known as the Pine-barrens bluet. After analysis of the weather conditions in comparison with odonate emergence, it was found that air temperature has no noticeable association with odonate emergence. Precipitation on the other hand was found to have a visible correlation with odonate emergence.

Table 4 **Air Temperature 2005**

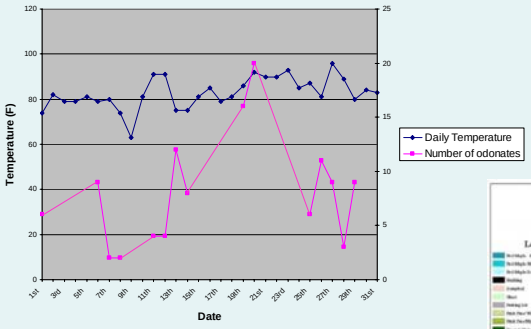


Table 1 Species Distribution Table	
Dragonflies	
Family Aeshnidae	**Scientific Name**
Shadow Darner	*Aeshna umbrosa*
Comet Darner	*Anax longipes*
Common Green Darner	*Anax junius*
Swamp Darner	*Epiaeschna heros*
Harlequin Darner	*Gomphaeschna furcillata*
Family Corduliidae	
Williamson's Emerald	*Somatochlora williamsoni*
Family Gomphidae	
Unicorn Clubtail	*Arigomphus villosipes*
Ashy Clubtail	*Gomphus lividus*
Family Libellulidae	
Calico Pennant	*Celithemis elisa*
Halloween Pennent	*Celithemis eponina*
Double Ringed Pennant	*Celithemis verna*
Setwing	*Dythemis*
Eastern Pondhawk	*Erythemis symplicicollis*
Bar-winged Skimmer	*Libellula axilena*
Spangled Skimmer	*Libellula cyanea*
Blue Corporal	*Libellula deplanta*
Slaty Skimmer	*Libellula incesta*
Widow Skimmer	*Libellula luctuosa*
Common Whitetail	*Libellula lydia*
Twelve-Spotted Skimmer	*Libellula pulchella*
Painted Skimmer	*Libellula semifasciata*
Great Blue Skimmer	*Libellula vibrans*
Blue Dasher	*Pachydiplax longipennis*
Wandering Glider	*Pantala flavescens*
Spot-winged Glider	*Pantala hymenaea*
Eastern Amberwing	*Perithemis tenera*
Cherry-Faced Meadowhawk	*Sympetrum internum*
White-faced Meadowhawk	*Sympetrum obtrusum*
Ruby Meadowhawk	*Sympetrum Rubicundulum*
Band-winged Meadowhawk	*Sympetrum semicinctum*
Carolina Saddlebags	*Tramea carolina*
Black Saddlebags	*Tramea lacerata*
Damselflies	
Family Calopterygidae	
Ebony Jewelwing	*Calopteryx maculata*
Family Coenagrionidae	
Variable Dancer	*Argia fumipennis violacea*
Azure Bluet	*Enallagma aspersum*
Familiar Bluet	*Enallagma civile*
Northern Bluet	*Enallagma cyathigerum*
Atlantic Bluet	*Enallagma doubledayi*
Big Bluet	*Enallagma durum*
Marsh Bluet	*Enallagma ebrium*
Skimming Bluet	*Enallagma geminatum*
Pine Barrens Bluet	*Enallagma recurvatum*
Citrine Forktail	*Ischnura hastata*
Fragile Forktail	*Ischnura posita*
Rambur's Forktail	*Ischnura ramburii*
Eastern Forktail	*Ischnura verticalis*
Sphagnum Sprite	*Nehalennia gracilis*
Family Lestidae	
Spotted Spreadwing	*Lestes Congenen*
Common Spreadwing	*Lestes disjunctus disjunctus*
Amber-winged Spreadwing	*Lestes eurinus*
Sweetflag Spreadwing	*Lestes forcipatus*
Elegant Spreadwing	*Lestes inaequalis*
Slender Spreadwing	*Lestes rectangularis*
Lyre-tipped Spreadwing	*Lestes unguiculatus*
Swamp Spreadwing	*Lestes vigilax*
New species found in 2005	**NY threatened species**
	New NY Record

Table 3

Materials and Methods

In order to collect adult Odonatas a 15" net was used to catch insects while they were in flight or perched on vegetation. Chest waders were worn while wading in or around the ponds where odonates could be found. A pair of 10 x 50 Burris signature series binoculars was used to observe odonate behavior. Once the specimens were caught they were placed in glassine envelopes and then placed in a Tupperware jar where they were kept alive to preserve they vibrant coloration. A digital camera was used to take pictures of the insects in their natural environment.

Lab work was conducted with the aid of a variety of tools and materials, including a 7 - 25x Bausch & Lomb dissecting microscope to magnify the sections and features of the insect, dissecting tweezers and a gel filled Petri dish, to examine the sample. Each insect was first cooled to slow down its metabolism and prevent color fading prior to examination. Once the specimen was identified and its information recorded the insect was immediately immersed in acetone for 24 hours to dehydrate and to dissolve its body fat. After the 24 hour process they were removed from the acetone, dried for an hour and stored in a file box.

Air temperature, humidity, and precipitation were recorded daily and analyzed with odonate emergence. Correlating data from the summers 2003, 2004 and 2005 to compare results.

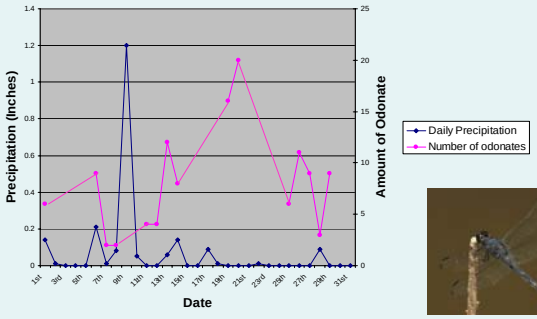
DISCUSSION

The purpose of the Odonate research of the summer of 2005 was to obtain accurate data that would assist in the understanding of the insects' emergence and behavior in correspondence with precipitation, and air temperature. Also, to continue with the identification and survey of the species found at Brookhaven National Laboratory, and to continue the search for the three threatened damselflies in the New York State list of threatened and endangered species.

A total of twelve wetlands were surveyed during the summer of 2005 (as shown in Table 3). To date a total of 53 odonate species have been recorded at BNL, nine of those species were found in the summer of 2005, including one of the three threatened damselflies *Enallagma recurvatum,* and *Celithemis verna* or the Double-ringed pennant which was found during the summer of 2005 at BNL and is a first time record for New York State.

After analizing the weather data obtained from the National Weather Service, located at BNL, it was found that between air temperature and odonate emergence there is no visible correlation (as shown in Table 4), although there was a relationship between the number of odonate individuals found when the air temperature rose from about 80º F and the humidity reached above 75%. In contrast, the precipitation charts indicate a correspondence between precipitation and emergence (as shown in table 2). Days after either a high or low point in precipitation, the level of odonate emergence increased significantly. Showing that the presence/abscence of rain affects the emergence and mating of the insects, although future research is needed to obtain precise answers for this apparent connection.

Table 2 **2005 Precipitation**



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Hostos Community College

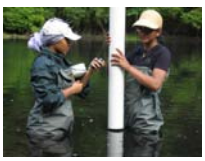
BROOKHAVEN NATIONAL LABORATORY

The Relationship of Soil and Water Chemistry to the Preservation of Salamander Habitats in the Long Island Pine Barrens

Cassandra Gill, Sonya Lamb, Dr. Rita Hagevik

Abstract

The Eastern Tiger Salamander has been listed as an endangered species on Long Island in New York since 1983. Many salamanders are threatened by habitat loss and water pollution. The purpose of this study was to develop an understanding of the chemical and biological factors that affect salamander population and distribution, identify possible threats to viability, and contribute to the development of a management plan to protect this species. Field studies and analysis activities included soil and water measurements important to the ecological functioning of coastal ponds in the Long Island Pine Barrens—Peconic River Complex. Soil and water samples were collected and analyzed in four natural ponds using colorimetric and spectroscopic methods. Metals in the samples were further analyzed using an inductively coupled plasma–atomic emission spectrometer (ICP). Tiger salamanders appeared to thrive in areas with low concentrations of pollutants and moderate levels of natural factors such as dissolved oxygen. The presence of tannin—lignin and the amount of suspended solids had an affect on salamander populations. This showed that salamanders prefer oxygen-rich environments that contain relatively low amounts of decaying matter. According to our research, longer hydroperiods are preferred by the species. This work was completed as a small portion of the implemented Wildlife Management Plan being conducted by the Environmental and Waste Management Services Division at Brookhaven National Laboratory. The soil and water chemistry of ponds with and without tiger salamanders were analyzed in order to further investigate the decline of the species and to better understand ways in which to preserve their habitats.



Taking core sample at Pond 1

Assessing Pond 2

Using YSI Water Quality Meter at Pond 13a

Vegetation surrounding Pond 3

Assessing Pond 17b

Background

The size of the woodlands and wetlands required for terrestrial salamander habitats are becoming reduced and the chemistry of the soils and water are being altered due to the effects of water level fluctuations, pollution, the introduction of predatory fish and combinations of other related factors. Though tiger salamanders spend much of their time on land, most begin migrating to breeding ponds as early as January or as late as April. During this time of year, the females will begin to submerge their egg masses approximately one foot below the surface of the pond. Around June and July, larval salamanders will emerge and begin transformation in the drying ponds. High larval mortality will occur if the ponds dry up too quickly. This study was done during the larval period of the salamanders. Egg masses were observed in Ponds 1 and 2.

Tiger salamanders spend a large portion of their life cycle out of the water, beneath the surface in burrows. As a result, the chemical makeup and porosity of the soil are crucial to the salamander's existence. The soils of the Long Island Pine Barrens are mostly sandy and well drained making it desirable for the largest of the six mole salamanders found in New York State.

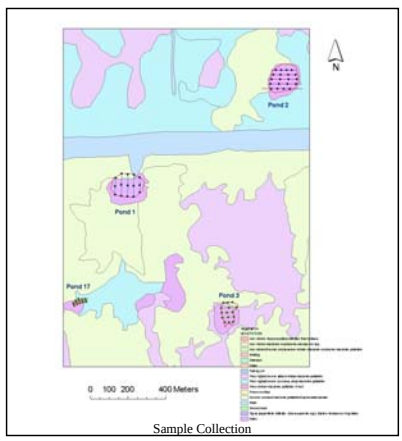
As more research is conducted, it is crucial to build a management plan that encompasses all aspects of the tiger salamander's life cycle. After having conducted this research, we realize that biological factors associated with salamanders are only a part of the solution. Water and soil interactions in and around the vernal ponds are equally critical to salamander habitat preservation and deserve equal concern.

Methods

Site selection
Four ponds were selected on the north end of Brookhaven National Laboratory, 1, 2, 3, and 17b. Ponds 1 and 2, known tiger salamander ponds, were compared to ponds 3 and 17b, non-salamander ponds. In addition, pond 13a was used as a comparison because of recorded tiger salamander abundance.

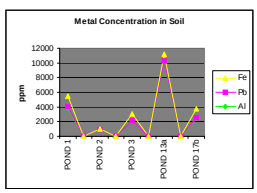
Water Testing
After the ponds were marked and mapped, 15 equidistant points within the ponds were located using a GPS unit for sampling. Twenty points were selected for pond 2. Water depth was measured at each point where approximately 250ml of water was collected. Then, using a calibrated YSI water quality meter, the temperature (°C), pH, dissolved oxygen (mg/L), turbidity (NTU) and conductivity (μs/cm²) were measured and digitally recorded. A Hach CEL/890 Advanced Portable Laboratory kit and colorimeter was used to test for nitrate, chlorine, sulfate, phosphorous, tannin-lignin, suspended solids and molybdenum. An Inductively Coupled Plasma—Atomic Emission Spectrometer (ICP—AES) tested for copper, iron, zinc, aluminum and lead. Calcium and magnesium were also tested in order to later determine water hardness.

Soil Testing
Eight sites were marked using GPS at equal distances around the perimeter of each pond, in addition to one point from the middle (n=9 from each pond). The soil temperature, a general description of the vegetation surrounding each point, and litter depth were recorded. A Guelph permeameter was used to measure soil porosity at each point. A core sample was taken at the northeast corner of each pond using a soil auger. Once dry, the soil moisture was calculated and soil color was determined using a Munsell color chart. The soil was then tested for pH, nitrate, phosphorous, potassium, aluminum, chloride, ferric iron, sulfate and magnesium using a LaMotte Combination Soil and a LaMotte Soil Micronutrients Kit. The percentage of organic matter in the soil was measured using a wet oxidation method with hydrogen peroxide. Soil samples were digested using EPA method 3050B for acid digestion of sediments, sludge, and soils, and tested using the ICP—AES for copper, iron, zinc, magnesium, cadmium, aluminum and lead. Vegetation samples were taken from inside each pond and identified.

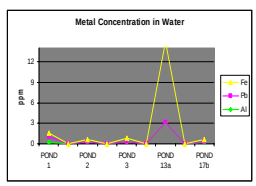


Sample Collection

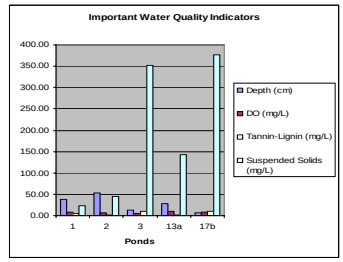
Results



Of all the metals tested in the water and soil, only Al, Pb and Fe were found in high concentrations. Concentrations were higher in the soil than the water.



Concentrations of lead in the soil and water were higher than expected.



Testing and analyzing water samples

Collecting water samples

Locating points using GPS units

Preparing samples for the ICP-AES

Conclusions

Pond 1 was most like pond 13a, the comparison pond, because it contained similar amounts of dissolved oxygen, temperature, conductivity, phosphorous, iron and a higher pH than pond 2 or the non-salamander ponds 3 and 17a. Ponds with salamanders had greater hydroperiods, dissolved oxygen levels, and molybdenum levels. Higher molybdenum levels could be a result of ponds 1 and 2 closer location to the dirt road. Ponds without salamanders had significantly higher turbidity, tannin/lignin, suspended solids, calcium, and total hardness.

Salamanders can tolerate a wide range of environmental conditions as long as a combination of desirable levels of pH, dissolved oxygen, and hydroperiod are present. Even though pond 17b had several variables in common with pond 13a, it is possible that salamanders were not found in ponds 17b or 3 because the combination of desirable conditions was not present.

In this study, natural pollution was more significant than man-induced pollution. There were high levels of iron in the soil of salamander ponds. Iron could help increase the amount of vegetation, such as rice cutgrass, which seems to be preferred by tiger salamander for egg attachment. The higher levels of lead found in soil could be due to the past addition of tetraethyl lead to gasoline over a period of time.

Our team agrees with the management plan set forth by Brookhaven National Laboratory. Ponds should be monitored on a regular basis and maintenance during migration times should be kept to a minimum. A buffer zone of at least 850 feet should be maintained and one well marked path to each pond should be established to reduce the amount of human disturbance to the ponds.

Inductively Coupled Plasma—Atomic Emission Spectrometer

Acknowledgements
Supported by the LS-AMP program and Brookhaven National Laboratory. Special thanks to our mentors: Tim Green, Mark Fuhrmann, John Heiser, Jennifer Higbie, Noel Blackburn and all of the Office of Education staff for offering us their guidance, support and inspiration. Thank you to the many others who assisted us, especially Laura Opitz and Saneddy Quezada.

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Survey of Invasive Species Surrounding Brookhaven National Laboratory

Non-native plants were first introduced to North America around 1850. Appearing in nursery catalogs, early non-native plants began as simple ornamental plants. While some of these plants have turned out to be harmless and non-invasive many others have turned out to be harmful to the surrounding flora. Invasive plants compete with native plants for space and often displace the native plants they are competing with. As the invasive species dislodge the native plants, the environment loses the wide diversity of plants it once had. In addition, the invasive plants ruin the environment's biodiversity by decreasing the amount of food the animals have to eat. Many of the invasive species cannot be consumed by animals and because the native plants have been supplanted, the animals have nothing else to eat.

Invasive plants can cause extreme damage to native plants, however, luckily there are only a few invasive plants that are able to cause this kind of damage. Furthermore Only a small sub-set of the 1,100 non-native species known are invasive. Taking this into consideration, Brookhaven is now trying to estimate the extent of the damage done by these invasive species and is also attempting to figure out the area these invasive species take up.

It is often hard to estimate the size or density of an invasive species when looking at a picture. Instead, we use a global positioning system in order to plot the coordinates of the location of the plants. In addition to the coordinates, the GPS is able to store information about the species such as the specific species found, the size of the area it occupies, and the shape of its area upon taking the coordinates of the locations of these plants.

The GPS unit, called a MobileMapper, works in coordination with a program called ArcGIS. ArcGIS is a program used for computerized mapping. After I record the information with the GPS system, the results are exported as a layer. This layer can be combined with existing layers in the ArcGIS program to form a map. The resulting map can be used for visualization and analysis such as the map in figure 1.

There are multiple problems affecting this process. Weather may affect the consistency and reliability of the GPS. For example, fog can greatly affect the number of satellites the GPS can read and it increases the error value. The error value is read by the PDOP which stands for positional dilution of precision. PDOP is able to accurately perceive the accuracy of the GPS unit by reading the interferences affecting the GPS. In addition to GPS errors, there are also human errors. Many of the areas I encountered were extremely dense, hindering my ability to plot every plant I could see or find.

Japanese Barberry is among the most common shrubbery found in Brookhaven. Barberry tends to excessively grow, taking up all of the surrounding land. This plant was introduced to the U.S. in 1875 from Russia to Boston.

Brookhaven National Laboratory covers 5,265 acres within the Pine Barrens. The Laboratory is trying to estimate the amount of land taken up by invasive species. By doing this, Brookhaven will be able to help maintain Long Island's biodiversity as well as protect Long Island's native plants from these invasive species. Due to the behavior of invasive species, it is important to try to eradicate these plants before they do too much harm to the native plants. If left unchecked many of these invasive species will out-compete the native plants. The invasive plants out-shade these plants as well as take up essential nutrients and thus prevent native plants from growing

Finding how much land the invasive plants take up is essential in helping managers make decisions about keeping a healthy environment. In collecting this base-line data, it will be easier for employees at Brookhaven to come up with a plan to control these invasive species. Once Brookhaven has come up with a plan to control these plants, it will be easier to assist the preservation of our biodiversity and keep our environment free from the threat of invasive species.

Scotch Thistle was not commonly found during my search however, there are multiple types of thistle – this is simply one of them..

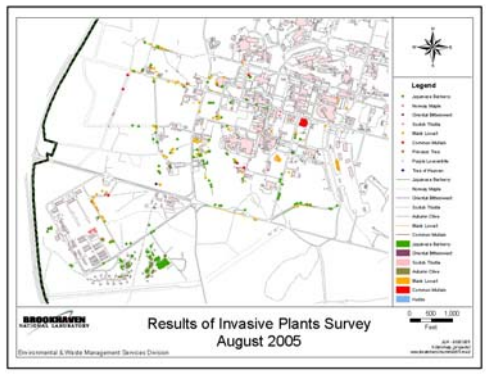

Figure 1

Both the map (fig. 1) and the graph (fig. 2) represent the different invasive species I found as well as the number of times they appeared. The map shows where the invasive species were found in reference to the buildings and roads around Brookhaven National Laboratory. In total, I covered 272 acres around Brookhaven in search of invasive plants. Fortunately, I did not find invasive plants in all 272 acres of land I went through. This shows that there are actually invasive free areas and that there are no invasive species around those areas

The most common invasive plants I found were Japanese Barberry and Black Locust. Japanese Barberry was the most common of all of the invasive species I found. However, there were also invasive plants that were rarely found, but when they were found, they appeared to have taken over the area they surrounded. Kudzu, for example, was only found in a little area by the Upton Gas Station. But within this area, Kudzu was the dominant plant.

After going through the locations I encountered, I noticed that the plants I found seemed to have been planted ornamentally. After these species were planted, many of them spread and they eventually may become like the clusters of invasive plants I found such as Japanese Barberry.

The Black Locust is a common invasive species in Brookhaven. It is among the two most common invasive species I found during my search. Black Locust is normally found along the edges of roads forming a straight line.

After surveying the main campus area of Brookhaven, I have found that invasive species do not merely exist in these areas but are extremely widespread. The Black Locust and Japanese Barberry fill the areas around the streets and are also found within the forests. These invasive plants take the place of our native alternatives thus out-competing many of the native plants.

It is essential that all of us try to help stop the spread of invasive plants to help save our environment's biodiversity. These plants will continue to grow unless we do something to stop that. From the mapping already done around Brookhaven, it is clear we already have an abundance of invasive plants. Now we need to focus on controlling these plants. Your role in all of this would be to try to prevent any further planting of invasive species as ornamental plants.

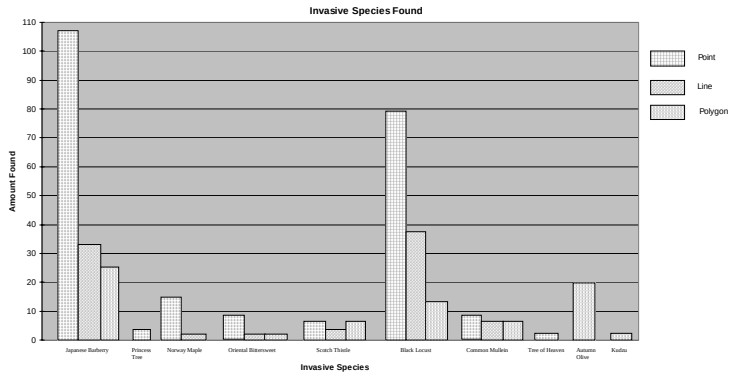

Figure 2

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The Norway Maple Tree grows in 13 states in the eastern United States and displaces many native trees, shrubs, and herbs. It is not a very common invasive species. One way to differentiate it from native maple trees is the sap that forms in the veins of the leaves and in the stems. This species is normally planted as an ornamental plant not just around Brookhaven, but around the rest of Long Island.

Oriental Bittersweet was originally introduced to the United States in 1860 from Asia as an ornamental plant and is still sold despite its affects on the environment. This versatile plant is able to grow in many types of areas and overwhelms both native and non-native trees by growing all over them.

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Understory composition of the Long Island Pine Barrens.

Miranda Davis, Dr. Tim Green, and Robert Anderson
(Brookhaven National Laboratory)

Abstract

The Pine Barrens of Long Island is a unique community that must be properly managed in order to preserve the diverse array of flora and fauna it supports. Without management involving prescribed burnings it is likely that the Pine Barrens will disappear through natural succession leading to an oak-based climax community. In general the Pine Barrens are dominated by *Pinus rigida* and other shrub species that are believed to be facilitated by regular burning; however, very few studies have been conducted in this area. In order to better understand this sequence of succession and the importance of this community, we have studied the vegetational composition of the under-story in both pine and oak-based communities on Long Island. By examining random plots within both forest types we calculated the percent composition of different plant species for the under-story of both oak and pine-based forests. While both communities have a shrub layer dominated by the same species (*Gaylussacia baccata*, *Vaccinium palidum*, and *Quercus ilicifolia*), we found that the relative proportions of these species differ between the forest types. Results illustrated the vegetational differences between these two distinct communities, which may be critical to the survival of the diverse fauna the Pine Barrens are known for.

Introduction

The Central Pine Barrens of Long Island is currently of great ecological concern. This primarily pitch pine (*Pinus rigida*) and scrub oak (*Quercus ilicifolia*) based community type has been documented to host a diverse array of rare flora and fauna including quite a few state-rare Lepidoptera species (Wagner et al. 2003; Grand & Mello 2004; Forman & Boerner 1981). These Lepidoptera are often dependent on specific under-story shrub species, which are common in the Pine Barrens (Wagner et al. 2003). Much of the bird diversity is also dependent on the characteristic open canopy and extensive shrub layer provided by this habitat (Forman & Boerner 1981). Unfortunately, the fire-dependent Pine Barrens communities are under threat by the increased human development and over-zealous fire suppression, which has already resulted in the loss of 50 percent of the Pine Barrens historical range (Jordan 2003). Without frequent burning the typical pitch pine-based community of the Pine Barrens gives way to a more shade-tolerant hardwood community dominated primarily by various oaks (Quercus spp.) (Jordan 2003; Forman & Boerner 1981; Seischab 1991).

As part of a larger study being done by FERN (The Foundation for Ecological Research in the Northeast) I have set out to examine the variation in under-story vegetation between the near-exclusive pitch-pine forest and other community types with in the Pine Barrens. Previous studies have found that under-story vegetation varies greatly across successional stages in other Pine Barrens communities (Matlack et al. 1992; Plocher 1999). It is likely that pine and oak-based communities may vary in under-story composition and the overall height and coverage of their shrub and herbaceous layers. To my knowledge this has yet to be documented in the Long Island Pine Barrens. I will estimate the species composition of the under-story and compare the extent and diversity of this layer in pitch-pine forest as opposed to the later successional stages which incorporate a higher amount of hardwood (primarily oak) trees and which may take over if a proactive fire management plan is not implemented.

Methods and Materials

Vegetation maps of the Long Island Pine Barrens region were commissioned by the Nature Conservancy and used to distinguish pine-based areas (characterized by >90 percent pitch pine canopy cover) from other community types with a relatively higher amount of oak species in the canopy (</= 90 percent pitch pine canopy cover). Random points were then chosen for sampling using the Global Information System (GIS). Seven plots were completed within pitch pine communities and forty plots within relatively oak-based communities.

Line transects were then used to measure the composition of the shrub/herb layers. Random numbers were chosen to determine the location of the transects (ten per plot) and the points along it to be sampled. Points were sampled by dropping a rod (less than 1 cm in diameter) to the ground and recording the species "hit" by the rod. Plants were only recorded as a "hit" if they were less than two meters in height (comprising part of the under-story). For the purposes of this study "hits" of mosses and lichens were not included. This method led to a total of 200 sample points per plot. The number of hits of each species of plant was added up with in each plot.

Ocular estimations of the total percent cover and height of the shrub and herbaceous layers were conducted. This was essentially subjective and was done by examining the entire plot, after having sampled the line transects, and making an educated guess as to the parameters.

Results

Pie charts illustrating the total percent composition of the two communities are displayed in Figures I and II. The predominant species in both pine and oak communities are *Carex pensylvanica*, *Gaylussacia baccata*, *Quercus ilicifolia*, *Vaccinium pallidum*, *Vaccinium angustifolium*, and *Pteridium aquilinum*. These six species comprise 97 and 96 percent of the total under-story vegetation in pine and oak communities respectively. Of these species *Q. ilicifolia* is more commonly hit in pine plots while the other five species are more predominant in communities with relatively more oak canopy. In particular, the variation in the prevalence of *Q. ilicifolia*, and *G. baccata* is striking. *Q. ilicifolia* comprised roughly 38 percent of the under-story in pine communities while only eight percent of the shrub layer in other communities (a difference of eight percent). *G. baccata* comprised roughly 39 percent of the under-story layer in oak communities and only 27 percent in pine communities (a difference of 11 percent) (Figures I & II). All other under-story species showed a less than ten percent change in dominance between the two community types.

A photograph of a fellow student researcher (Matt Kull) in a pitch pine plot.

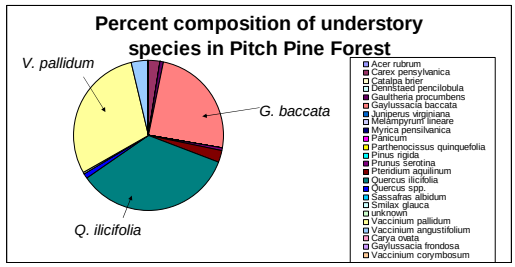

Figure I: The relative percent of the under-story vegetation within pitch pine communities comprised by each encountered species is shown.

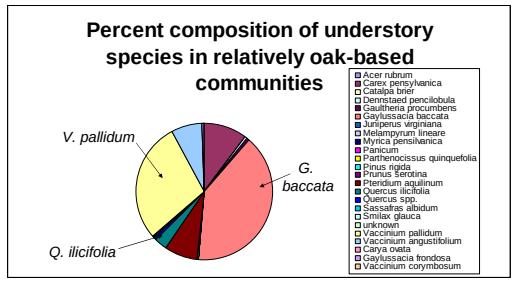

Figure II: The relative percent of the under-story vegetation within oak (non-exclusively pitch pine) communities comprised by each encountered species is shown.

A photograph of a fellow student researcher (Chauncey Leahy) in a oak plot.

Results (cont.)

When analyzing the average number of hits per plot according to community type there appears to be significantly more *Q. ilicifolia* (116 hits per plot on average) in pine communities than in oak communities (with only 24 hits per plot on average) (two-tailed t-test, p=0.0001, α=0.05, assuming unequal variance). While no other species show significant variation it is necessary to note that there appears to be less *C. pensylvanica*, *G. baccata*, *P. aquilinum*, *V. pallidum*, and *V. angustifolium* on average in pine communities.

When comparing the ocular estimations of the cover and height of the shrub and herb layer between the two communities, some more interesting results are found. The estimated average height of the shrub and herbaceous layer does not vary significantly between pine and oak communities; however, the estimated cover does. While there is an estimated 86.7 percent of shrub cover in exclusively pitch pine communities, there is only an estimated 70.9 percent of shrub cover in oak communities (two-tailed t-test, p=0.002, α=0.05, assuming unequal variance). On the other hand, for the herbaceous layer there is an estimated 10.6 percent cover in oak plots and only 2.7 percent of cover in pine plots (two-tailed t-test, p=0.007, α=0.05, assuming unequal variance).

Discussion

These results show that the extent and composition of the under-story vegetation varies a great deal between these pine and oak-based communities within the Pine Barrens. While both communities were dominated by primarily the same under-story species the relative proportions of those species varied a lot. The pitch pine communities observed in this study showed a much more extensive shrub layer (represented by overall cover) than the oak communities. This difference is most likely due to the higher amount of *Quercus ilicifolia* in the pitch pine plots sampled. The fact that the oak communities were estimated to have a higher degree of herbaceous cover coincides with the higher proportions of *Pteridium aquilinum* and *Carex pensylvanica* found in those plots and makes sense as high amounts of shrub cover most likely shade out many herbaceous plants. As pitch pine communities mature and succumb to primarily oak-dominated communities through succession due to a lack of regular burning it is likely that the under-story will be increasingly dominated by *Gaylussacia baccata, Vaccinium pallidum*, *Vaccinium angustifolium* and herb species, while *Q. ilicifolia* is lost. These results coincide with other studies, which found significant variation in under-story composition (Matlack et al. 1992; Plocher 1999) and which found that *Q. ilicifolia* was more common in communities undergoing regular disturbance due to severe burning (Jordan et. al 2003; Plocher 1999).

These findings have important implications for the fauna of the Pine Barrens. The Pine Barrens are know for supporting a diverse array of bird and arthropod species, particularly Lepidoptera. Wagner et al. (2003) found that of 56 Lepidoptera species, which are of conservation concern and are known to utilize shrubland habitats in the Northeast, at least 29 percent are dependent on *Q. ilicifolia* for survival and/or reproduction. Without the extensive shrub layer of these species provided by pitch pine communities, many rare Lepidoptera may be doomed to local extinction. The same fate may apply to many of the bird species inhabiting the Pine Barrens which are known to prefer these areas due to the open canopy (Forman & Boerner 1981).

The extreme variation in under-story composition and the extent of cover in the herb and shrub layers in combination with the ecological importance of these factors suggest that future study in this area would be wise. In the future FERN should continue monitoring under-story species and take their results into account when developing comprehensive management plans for the Pine Barrens. Results of this study illustrate that if the pitch pine communities are not managed properly with prescribed burns and are allowed to give way to oak forests then there will be drastic changes in the under-story composition leading to a reduced shrub layer and dire consequences for the fauna endemic to this area.

Acknowledgements

I would like to thank my mentors Dr. Timothy Green and Robert Anderson for their guidance and support. I am grateful to Valorie Titus for her invaluable advice and patience. I would like to thank Jennifer Higbie for her guidance and assistance. I am appreciative of my colleagues Matthew Kull, Chauncey Leahy, Kathryn Gutleber, Andrew Siefert, and Dana Tievsky. Finally, I would like to thank all those at Brookhaven National Laboratory and FERN for giving me this wonderful opportunity.

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A Study of the Age Class Structure of Quercus alba, Quercus coccinea and Quercus velutina: A Comparative Analysis of Quercus Species Reproduction as an Indicator of Forest Succession within the Long Island Pine Barrens Core Area

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TIMOTHY GREEEN, Ph.D. (Brookhaven National Lab, Upton, NY 11973-5000)

Investigation of the age class structure of Quercus species within the Long Island Pine Barrens Core Area is an important aspect of monitoring the health of the Pine Barrens. The reproduction of Quercus alba, Quercus coccinea and Quercus velutina is a primary indicator of the possibility of the successional change from a pine to an oak dominated forest. The rates of reproduction for Quercus alba, Quercus coccinea and Quercus velutina can also be used to foresee the possible dominance of one particular Quercus species in forest succession. By comparing the numbers of seedlings, saplings and mature trees, the success of reproduction for these three different Quercus species was analyzed. The numbers of seedlings and saplings were recorded through the use of four two-meter wide belt transects within sixteen by twenty-five meter plots. These plots were located within the Pine Barrens subtargets of Pitch Pine, Pine-Oak, Oak-Pine and Coastal Oak forests. The number of mature trees was recorded within these same plots. This study found the success of reproduction of Quercus alba, Quercus coccinea and Quercus velutina within Pitch Pine, Pine-Oak, Oak-Pine and Coastal Oak forests to be relatively low. Within the four different forest communities surveyed, Quercus alba, Quercus coccinea and Quercus velutina all displayed a low number of saplings, indicating that current reproduction of these Quercus species is not very successful. No one Quercus species was repeatedly more successful in reproduction than any other. There are several factors which may influence this trend, including exposure to light, levels of litter and duff, and deer browse. Although the current levels of reproduction of Quercus species are relatively low, they are still important indicators of forest succession from pine to oak dominated forests within the Long Island Pine Barrens Core Area.

INTRODUCTION

The Long Island Pine Barrens, an area comprising 102,500 acres of central and eastern Long Island, is a region of ecological importance [1: 1]. In order to further understand the importance of the Long Island Pine Barrens, the Foundation for Ecological Research in the Northeast (FERN), in cooperation with the Nature Conservancy, the Upton Ecological Research Reserve and Brookhaven National Lab, has developed a monitoring program in order to collect data to measure indicators of primary ecological attributes of the Pine Barrens region. By collecting data on the current conditions of the Pine Barrens, the monitoring program will be able to provide a baseline of forest health in order to determine the actions of further conservation efforts. The monitoring program will also serve to detect and document the degree and direction of change in forest health, and to identify the priorities of research within the Long Island Pine Barrens [2: 3].

In this paper, the age class structure of Quercus alba, Quercus coccinea and Quercus velutina were compared in order to investigate success of reproduction for each of these species. The reproduction of Quercus species is indicative of the possibility of forest succession from pine dominated forest to an oak dominated forest [3: 14]. The numbers of seedlings, saplings and mature trees were collected within various randomly generated plots within the target of the Central Pine Barrens of Long Island. These plots within the different subtargets of the Central Pine Barrens target were generated using Geographic Information System (GIS) software. The subtargets studied were the communities of Pitch Pine, Pine-Oak, Oak-Pine and Coastal Oak forests.

The purpose of this research is to 1) study the reproductive patterns of Quercus alba, Quercus coccinea and Quercus velutina so that they may be used as primary indicators of the successional change from a pine to an oak dominated forest and 2) use the rates of reproduction of Quercus alba, Quercus coccinea and Quercus velutina to foresee the possible dominance of one particular Quercus species in the stages of forest succession. These findings will help to determine both the current and future ecological integrity of the Long Island Pine Barrens.

A map of the Central Pine Barrens. Courtesy of http://www.ph.state.ny.us.

METHODS

The data for this research was collected by following Monitoring Protocols for Central Pine Barrens Field Plots. The randomly generated plots were established in different areas within each of the four subtargets. These plots had dimensions of sixteen by twenty-five meters, and were located at least fifty meters from any human disturbances, and at least twenty meters from any ecological boundaries or differing community types. Within these plots, the numbers of seedlings, saplings and mature trees were measured.

In order to measure the estimated number of seedlings and saplings within each of the plots, four two by twenty-five meter transects were used. The entire area that was sampled for seedlings and saplings of different pine and hardwood species was eight by twenty-five meters, or half of the surveyed plot. Species that were found within these transects were identified and recorded according to genus and species. At times, due to defoliation or indistinguishable characteristics, oak species were classified only according to genus (*Quercus*). Seedlings and saplings that had multiple stems were counted only as one seedling.

In order to measure the number of mature trees within each of the plots, hardwood and pine species that had a dbh (diameter at breast height) greater than 2.5 cm and less than or equal to 10 cm, and those that had a dbh greater than 10 cm were recorded. The diameter of the trees was measured at 1.37 meters from the ground using either calipers or a dbh tape. Trees that fell in these categories were measured by dbh to the nearest millimeter and then tallied. As was the case with seedlings and saplings, if tree split below the diameter at breast height into two or more stems, the tree was still counted as being singular. If the leaves of a tree were defoliated, or if the tree had indistinguishable characteristics, the oak species were classified only according to genus (*Quercus)* and the abbreviation for species (*spp*.).

The data used for this study was taken from forty plots, which were comprised of five Pitch Pine forest plots, five Pine-Oak forest plots, fourteen Oak-Pine forest plots and sixteen Coastal Oak forest plots. The numbers of seedlings, saplings and trees collected throughout the surveying of these plots were compiled in a database in Microsoft Access. After the completion of forty plots, the averages of the numbers of seedlings, saplings and mature trees were calculated. These averages were then used to generate graphs displaying the relationships between Quercus species reproduction and the stages of forest succession.

RESULTS

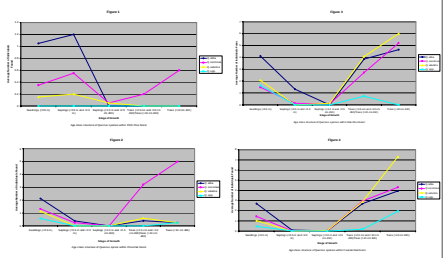

Figure 1 shows the age class structure of Quercus species within Pitch Pine forest. Within this forest, Quercus coccinea, Quercus alba and Quercus velutina displayed low average numbers of saplings greater than 2.0 meters and trees, after showing an increase from seedlings to saplings between 0.5 meters and 2.0 meters. Quercus coccinea, however, appears to be the most successful in reproduction within this forest, as it exhibited mature individuals following the sapling stage.

Figure 2 shows the age class structure of Quercus species within Pine-Oak forest. Quercus alba, Quercus coccinea, and Quercus velutina all displayed a decrease in average number of individuals found from seedlings to saplings, followed by an increase in trees between 2.5 and 10 centimeters dbh. Quercus coccinea was the only species of oak to have an increased average number of trees greater than 10 centimeters dbh.

Figure 3 shows the age class structure of Quercus species within Oak-Pine forest. Quercus alba, Quercus coccinea and Quercus velutina showed a decrease in the average number of individuals found from seedlings to saplings, and an increase in the average number of individuals found from saplings to trees.

Figure 4 shows the age class structure and tree recruitment of Quercus species within Coastal Oak forest. The average number of individuals found decreased from seedlings to saplings, displaying very low numbers of saplings. The average number of individuals found then increased from saplings to trees for Quercus alba, Quercus coccinea and Quercus velutina.

Quercus coccinea. Photo Courtesy of www.ces.ncsu.edu

Pictured above is a Quercus alba seedling. At right is a Quercus velutina leaf. Photos courtesy of www.pinebarrens.org

DISCUSSION

The age class structure of Quercus alba, Quercus coccinea and Quercus velutina normally shows a high number of seedlings, followed by a decrease in numbers as seedlings mature to saplings, and a slight increase as saplings mature to trees. Therefore, graphs representing the age class structure of Quercus alba, Quercus coccinea and Quercus velutina are supposed to resemble a "reverse J". Although the numbers of an oak species are supposed to decline with maturity, the scarcity of seedlings or saplings is an indicator of the possibility of failure of tree reproduction. If the numbers of seedlings and/or saplings are very low, reproduction can be seen to be struggling [2: 33]

As is indicated by the graphs of the age class structure of the different Quercus species, the reproduction of these three Quercus species displays minimal success. Across the four subtargets, the number of saplings greater than two meters was consistently low. The age class structure shows that seedlings are not surviving to maturity, which indicates that reproduction is failing [2:33]. What has been shown through the data collected by the monitoring program is that the number of species found decreases as the species mature from seedlings to saplings, with very few, if any, saplings greater than two meters. After this stage, however, the number of trees found for each species within the four subtargets increased, displaying stages of maturity beyond the sapling stage of growth.

There are several factors which may inhibit the reproduction and growth of Quercus alba, Quercus coccinea, and Quercus velutina within the Long Island Pine Barrens. These factors include exposure to light, litter and duff depth, and the extent of deer browse [2: 34]. In order for Quercus species to grow, they need an adequate amount of light and fairly deep levels of litter and duff [3: 15]. If these conditions are not met, and there is deer overbrowse due to the increasing deer population in the area, the reproduction of Quercus alba, Quercus coccinea and Quercus velutina will be unsuccessful [2: 34].

Although the data collected within these forty plots does appear to represent the failure of reproduction of Quercus alba, Quercus coccinea and Quercus velutina, there are other possible explanations for the appearance of the age class structure for these species. One such explanation is that the stages of forest succession within the Long Island Pine Barrens could allow for the uneven aging of Quercus species within the surveyed plots. The reason why there are few saplings may not just be the fault of inadequate exposure to light, unsuitable levels of litter and duff, or extent of deer browse, but also may be due to different periods of growth exhibited within a surveyed community [3:14].

Quercus alba, Quercus coccinea and Quercus velutina all displayed similar trends in age class structure, and therefore, no one Quercus species was more successful in reproduction than any other within the four different subtargets. There does not appear to be any one species that is dominant in reproduction at any point in forest succession from a Pitch Pine to a Coastal Oak community. Quercus alba, Quercus coccinea, and Quercus velutina all displayed low numbers of saplings, which may be indicative of the failure of reproduction for these Quercus species. Although the current levels of reproduction for Quercus species are relatively low, they still remain an important indicator of forest succession from pine to oak dominated forests, and need to be continually monitored within the Long Island Pine Barrens Core Area.

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Evaluation of canopy estimation techniques and repeatability of the Monitoring Protocols for Central Pine Barrens Field Plots

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Abstract The Central Pine Barrens of Long Island is an important and unique region of an ecosystem of which little is known. Due to anthropogenic disturbance, however, there is an ever-decreasing amount of this important community type. The Central Pine Barrens of Long Island is instrumental for maintaining a proper functioning aquifer essential for Long Island and thus merits study. A baseline index for the Pine Barrens is currently underway, but the effectiveness and accuracy of one of the protocols used is unknown. One of the most important parts of scientific endeavors is maintaining repeatability. I evaluated the densitometer measurements to check for accuracy and repeatability, using repeated plots to highlight both. The repeated plots demonstrated possible problems in terms of repeatability and accuracy, having large differences between the first and second data sets. The data also showed large discrepancies between the measured densitometer readings and visual estimation, indicative of inaccuracies most likely from observer bias. The purpose of using the densitometer is to have a more accurate measurement than estimation, but if the densitometer is not accurate this can cause problems with naming the community type and may merit amending the Protocols.

Introduction The Central Pine Barrens of Long Island encompasses roughly 100,000 acres, 52,000 belonging to a core preservation area, never to be developed. Due to a lack of management the Pine Barrens community type has drifted towards an unnatural state of climax. It has been estimated that over half of the naturally occurring Pine Barrens has either been developed or reverted to unnatural climax community (Noss et al., 1995). The fire suppression in the Pine Barrens causes the forest to revert to a closed canopy system where tree oaks dominate (Jordan et al., 2003). There are currently fire management projects underway in the Pine Barrens to attempt to restore what is thought to be the more natural community type.

However what is the natural species composition compared to the unnatural? This baseline index of species composition is requisite for proper management of the Pine Barrens. Fortunately a project started this summer is taking on this task. The data being collect is critical for the future of the Pine Barrens, which is a unique and necessary ecosystem. Besides being a taxonomic treasure trove of coarse droughty soil loving organisms, the Pine Barrens are essential for maintaining a proper functioning aquifer for Long Island. The Pine Barrens is also critical for a number of rare Lepidoptera (Wagner et al. 2003; Grand & Mello 2004).

This examination will focus on the canopy estimation of the baseline species index, concerning the repeatability and accuracy of a vertical densitometer. Canopy estimation techniques are numerous but necessary; estimating fuel amounts (Andersen 2005) to judge future fire potential, to estimating Leaf Area Index (LAI) for canopy productivity (Eriksson 2005). The measure of the canopy can have a great impact on the understory vegetation. The openness of the canopy can lead to more or less species and affect great aspects of their ecology (Brosofke et al. 2001). Canopy cover is also important for fauna as well, habitat for squirrels and other arboreal animals is greatly affected by the amount of canopy cover, and measuring the canopy can be indicative of potential habitat (Nelson et al. 2005).

Our method of using the vertical densitometer saves money over some other options, but how accurate it is should be evaluated and compared to other methods of estimation. In this scenario optical estimates are also being taken along with the densitometer readings, these will be compared. Also, different persons, to check for observer bias, with repeat of a select number of plots. The two data sets will then be examined for congruence, because maintaining repeatability in science is quintessential.

Methods and Materials For a more thorough account of the sampling methods see *Monitoring Protocols for Central Pine Barrens*, Michael S. Batcher 2005.

The canopy cover data was recorded using a vertical densitometer. A densitometer is a "t" shaped tube with two levels and a mirror allowing you to see the point just above you, and identify the canopy cover. For our purposes the canopy cover was recorded as pine, hardwood or sky. Percentage cover of emergent, canopy and sub-canopy categories also estimated canopy cover. Those three categories, however, were estimated without aid of instrumentation. The canopy data was also collected twice in select plots by a different team of researchers to provide a means for checking observer bias and repeatability.

The data was examined using percentages and comparison; the repeated plots were analyzed using a T-test.

What is it like to look through a densitometer (above). You can see the two level bubbles, and what is just above where you are standing to determine canopy cover.

A side profile view of a densitometer (above). It is a T shaped PVC tube with two levels and a mirror.

Results The data for the densitometer readings were changed into percentages to ease comparison between those measured and those estimated (from now on "estimated" will be those data gleaned without instrumentation and "measured" will be those gleaned with the densitometer). As visible in the Canopy cover table, there are large amounts of disparity between the estimated and the measured.

As a whole, the estimated numbers appear to be low of the measured values, though no statistical significance could be attained due to lack of fields. Some of the differences are very large, as in plots 1 and 31 being a factor of two apart.

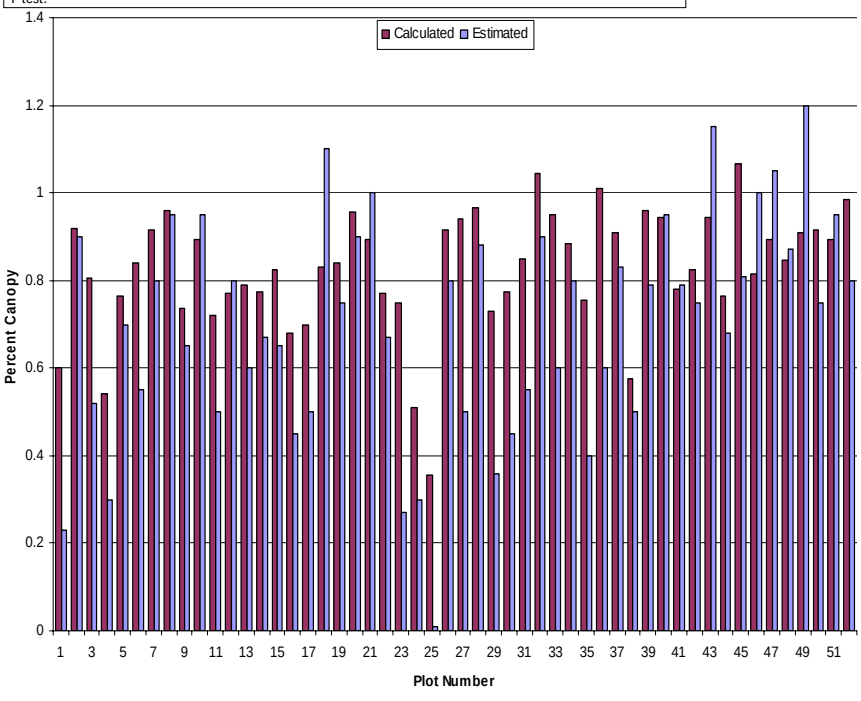
The repeated plots are impressive as well; plots 25 and 31 demonstrated statistically significant results using a T-test of $P < 0.01$. Though the other plots were not statistically significant the differences are worthy of note and consideration.

Discussion The difference between the measured and the estimated data within plots could be explained in several ways. Either the densitometer or the estimation data collection could have been incorrect due to a flaw in the protocol or in the recorder. Another concern could simply be that the technique isn't very accurate. Lastly, it could be that one is biased in its outcome. When examined, the estimation technique would naturally be the choice as being biased, its methodology as flawed, and susceptible to incorrect recording. With the densitometer the sampler could easily not be holding the instrument level or using the sighting mechanism correctly. One would assume, however, that the estimation is the flawed collection method here as it is up to complete observer bias to decide the figures. The data demonstrate no visible preference, with both estimation and measuring differing on average 13.5% on the repeats.

The repeated plots do show significance. Two of the plots showed a significant difference between the measured and the estimated via t-test. The estimated values can be explained in terms of observer bias, since it is simply estimation. The densitometer readings, however, are collected data using an instrument and would hopefully be more accurate.

An explanation of flawed densitometer outcomes involving random points questions the accuracy and precision of the Protocol. Twenty points along each line transect may not be enough for an accurate representation of the canopy. A possible thought would be that because of the reselection of random numbers, the exact points sampled would be different. The difference in the measured canopy cover because of different random points could demonstrate non repeatability aspect of the protocol. Observer bias can always be demonstrated, however, through incorrect use of the instrument or blatant erroneous recording; the latter hopefully could be discarded as a genuine explanation, but it is possible.

With the preliminary data showing a possible flaw in the densitometer measurements the accuracy of the plot community type may also be erroneous. The end community type is determined by the percentage of canopy cover. If we examine plots 25 and 25b, with a gap of 25% cover, we see the possibility of a misidentified plot community type. If those numbers were 49% and 73%, in a Pitch Pine community, the original data would have given it an open woodland designation, while the latter would be designated as a forest community.



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BROOKHAVEN NATIONAL LABORATORY

FERN Foundation for Ecological Research in the Northeast

Comparison of Snag Dynamics in Four Forest Community Types of the Central Pine Barrens

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ABSTRACT

The Long Island Central Pine Barrens (CPB) contains a variety of threatened forest communities that require active management. To determine future management practices the Foundation for Ecological Research in the Northeast (FERN) has initiated a forest health-monitoring project to evaluate potential forest health indicators (e.g. amount of available habitat) in the CPB. Snags (standing dead trees) provide suitable habitat for a variety of forest wildlife. The goal of this research was to quantify the abundance of snags in four of the forest community types in the CPB, to determine which contains a greater amount of available habitat. Field data was collected at forty random plots (16 x 25meters (m) 400m²), using the Monitoring Protocols for Central Pine Barrens Field Plots prepared by Michael S. Batcher. The field data collected at the forty plots was analyzed to estimate the abundance of snags in the targeted community types and establish the average diameter at breast height (dbh) of snags in each community type. Data analysis shows that the community type with the greatest incidence of snags/acre is coastal oak forest followed by oak-pine, pine-oak, and pitch pine, respectively. However more data is needed to increase the accuracy of the findings. The greatest average dbh exists in oak-pine forest, but when a standard deviation is applied to the data it shows there is no difference in the range of dbh's in each community type. This research is ongoing and when the data presented here are linked with future data, they can be used to determine the health of the forest.

INTRODUCTION

The Central Pine Barrens (CPB) make up approximately 41,683 hectares (ha) of Long Island, New York, and comprise a mosaic of threatened ecological communities (e.g. Forests, Woodlands, Shrublands, and globally rare Dwarf Pine Plains) [1]. These different community types are home to a variety of rare damselflies, butterflies, and moths as well as other invertebrates, birds, small mammals, bats, and herpetofauna [2]. FERN began a forest health-monitoring program in the CPB, in collaboration with the Pine Barrens Commission, the Upton Ecological and Research Reserve, The Nature Conservancy, the New York State Department of Environmental Conservation, and Brookhaven National Laboratory, to determine future conservation management goals and practices. To accomplish this, the initial research began assessing forest health indicators to establish their thresholds (e.g. the optimal amount of available habitat/ha) [3].

Snags are an important component of forest ecosystems; they play an essential role in forests' food web and wildlife habitat. As a snag begins to decompose it is colonized by invertebrates that convert the snag into a food source for many wildlife species such as woodpeckers who have the unique ability to drill for food and excavate cavities. Cavities made, used, and eventually abandoned by woodpeckers become available habitat for secondary cavity nesters (e.g. birds, herpetofauna, small mammals, invertebrates), incorporating snags into the life cycles of a large diversity of wildlife (see Figure 1).

The goals of this research were to 1) Quantify the abundance of snags in four of the forest community types, coastal oak, oak-pine, pitch pine, and pine-oak, in the CPB then 2) Determine which community type contains a greater amount of available habitat, and 3) Establish the average diameter at breast height (4.5 feet above ground) of snags in each community type.

METHODS

All methods used to collect data came from the CPB forest health monitoring protocols by M. Batcher [3].

Field data was collected at forty random 16 x 25m plots, shown in figure 2, generated in Geographic Information System (GIS) by The Nature Conservancy (TNC), in the targeted forest community types in the core preservation area of the Long Island Central Pine Barrens. Each plot was then located using Global Positioning System (GPS) units to navigate to the Universal Transverse Mercator (UTM) coordinates generated in GIS.

Once the plot was located the boundaries of the 16 x 25m plot were laid out using two 50-m tapes and chain pins. Then, using dbh tape all snags inside the plot were measured and their dbh was measured and recorded if it was >10cm at breast height. The reason data was only recorded for snags >10cm dbh is because they provide habitat for a more diverse amount of wildlife.

The field data collected at the fifty plots was entered into a Microsoft Access database created by M. Batcher. The data was then transferred to a Microsoft Excel spreadsheet for analysis.

RESULTS

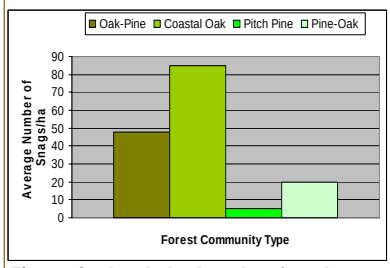

Figure 3: The calculated number of snag/ha extrapolated from the average number of snags per plot.

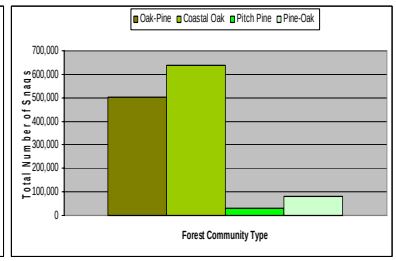

Figure 4: Estimated abundance of available wildlife habitat in each of the communities sampled.

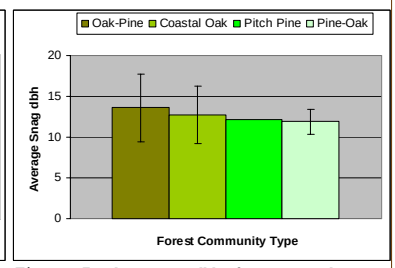

Figure 5: The average dbh of snags in each community type with their relative standard deviation.

CONCLUSION AND DISCUSSION

The community types examined in this research follow a pattern of succession that generally starts with pitch pine forest, which is then succeeded by pine-oak forest, oak-pine forest, and finally reaches coastal oak, the climax community. In their natural state, the CPB communities are dependent on wildfires to convert them from a later stage, such as coastal oak forest, to an earlier stage, such as pine-oak forest [2]. Based on the fact that pitch pine forest exists as a result of disturbance by wildfires, and coastal oak forest exists as the result of a lack of disturbance by wildfires, we would expect to see the greatest abundance of snags in coastal oak forest. Consequently, we would expect that amount to decline in oak-pine forest, pine-oak forest and pitch pine forest, respectively.

The data clearly show that the coastal oak forest community in the CPB contains the greatest abundance of available habitat in the form of snags. As expected that amount declines in oak-pine forest, pine-oak forest, and pitch pine forest. However, statistical analysis should be conducted to determine if we have sampled enough plots in each community type for the data to be statistically significant, and if we haven't, further analysis is needed to determine the number of additional plots that need to be sampled in each community type to make the data statistically significant. Average dbh's show that the oak-pine forest community contains the largest average dbh, although, as seen in Figure 3, when the standard deviation is applied to the data it shows there is no difference in the range of dbh's in the different community types. Pitch pine forest and pine-oak forest, again, lack a sufficient number of plots to represent them in this research; there was only one snag in the five pitch pine forest plots, so a standard deviation could not be applied.

This research is the first step in an ongoing project to monitor the health of the CPB. The baseline data presented in this paper gives a general idea of the abundance and average densities of snags in the CPB, and when it is linked with data from future sampling it can be used as an indicator to help establish the health of the forest. When the data is complete research needs to be conducted on the cavity dependent species of the CPB to determine how snag/ha is optimal for each of those species to sustain a healthy population. Then, by overlapping the optimal amount snag/ha each species needs and comparing that to what's available to them in the different community types the diversity of wildlife populations in those community types can be estimated and that information can be used to aid in the development of future environmental management plans for the CPB. To enhance future data it is suggested that modifications be made to future sampling protocols to include the condition of the snags as in [4,5,6], the number of foraging/nesting cavities as in [6], what species of animal, if any, is using the snag and for what purpose as in [6].

Figure 1: A flying squirrel using a cavity in a 12.2dbh hardwood snag for habitat.

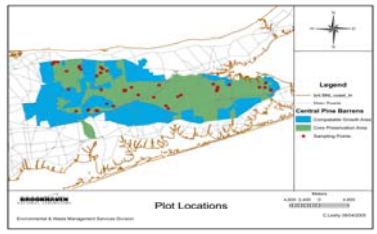

Figure 2: A map of the locations of the forty randomly located plots within the CPB.

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FERN
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Effects of Changes in Canopy Cover on Understory Vegetation in the Long Island Pine Barrens

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Introduction

The Central Pine Barrens (CPB) is a protected 41,480 ha ecosystem on Long Island, New York (Figure 1). Pine barrens are rare and threatened ecosystems found on coarse, droughty soils in the northeastern United States [1].

The Central Pine Barrens Monitoring Program was begun in summer 2005 to provide a baseline of the ecological health of the CPB [2].

Pine barrens ecosystems are mosaics of shrubland, woodland, and forest communities. Open-canopy pitch pine and scrub oak shrubland becomes closed-canopy pitch pine forest and ultimately coastal oak forest as succession occurs.

Canopy structure is an important factor in determining the composition of understory plant communities [3].

Figure 2. A pitch pine-scrub oak community.

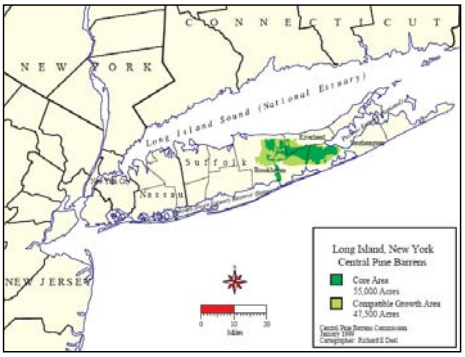

Figure 1. Long Island's Central Pine Barrens [4].

Objectives

- Determine whether and how differences in tree canopy cover affect the composition and species richness of understory plant communities in the Long Island pine barrens.
- As part of the CPB Monitoring Program, contribute to providing a baseline of the ecological health of the Central Pine Barrens.

We expected to find:
1) negative relationship between total canopy cover and understory species richness and percent cover
2) greatest understory species richness in areas with a mixed pine-oak canopy.

Methods

Study Area. Research was conducted in the 22,275 ha Core Preservation Area of the CPB (Figure 1). Data collection for the first year of the study focused on closed-canopy pine barrens communities

Field Methods. Field data collection methods were developed by Batcher [2] for the CPB Monitoring Program. Study plots (400 m^2) were randomly selected within the study area.

Canopy and understory cover were sampled systematically in each plot along line transects.

Understory plant (<2m) cover was sampled by vertically dropping a 2-meter pole at each sampling point and recording each species touching the pole.

Tree canopy (≥2m) cover was sampled by taking densitometer readings at each sampling point. Total percent canopy cover and percent of canopy cover made up of hardwood (proportion hardwood cover) were calculated.

Quantitative Methods. Understory characteristics were analyzed as a function of total percent canopy cover and proportion of hardwood cover. Linear regression was used to model relationships unless a nonlinear model explained at least an additional 10% of variance in the dependent variable [3]. Correlation was used to measure the strength of the relationships.

Results

Overstory and understory cover data were sampled from 43 plots.

Total percent canopy cover did not explain differences in species richness. Species richness was greatest where there was mixed pine-hardwood cover (Figure 3).

Percent total understory cover was negatively related to percent canopy cover and proportion of canopy cover made up of hardwood (Figure 4).

Understory shrub cover and *Quercus ilicifolia* (scrub oak) cover decreased as hardwood cover in the canopy increased (Figure 5).

Herbaceous plant cover was not explained by overstory characteristics.

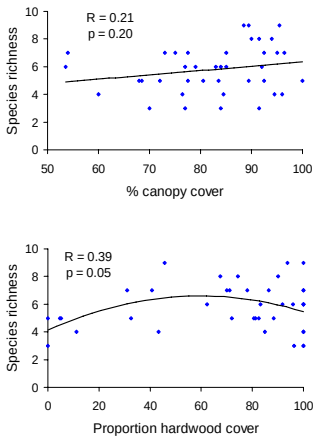

Figure 3. Overstory influences on understory species richness.

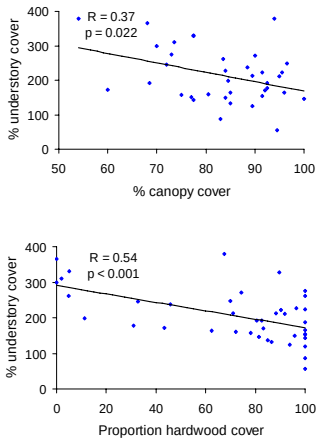

Figure 4. Overstory influences on understory percent cover.

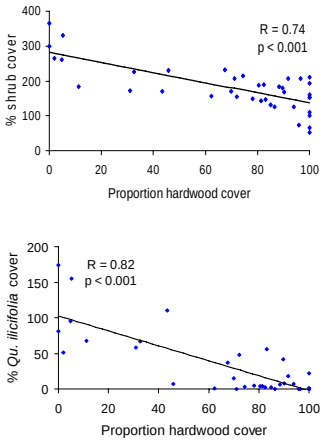

Figure 5. Overstory composition influences on shrub communities.

Conclusions

Overstory characteristics explained differences in understory composition, as predicted. Total understory and shrub cover were highest in communities with more open canopy and therefore more light availability, a pattern observed in many previous studies [5,6].

Shrub cover decreased as hardwood cover increased. In particular, scrub oak, a host species for rare Lepidoptera [7], was most abundant in pitch pine communities.

Understory species richness was greatest in mixed pine-oak forest, an intermediate successional community. This finding supports the intermediate-disturbance hypothesis.

Understanding the interactions between overstory and understory will allow us to predict changes in understory diversity and composition as a result of successional change and forest management. The Central Pine Barrens Monitoring Program's ongoing research will document these changes and provide information to help preserve the health of the pine barrens.

Acknowledgements: Thanks to Tim Green and FERN for making this project possible; Bob Anderson for his leadership and help in all aspects of this research; Miranda Davis, Kathryn Gutleber, Matt Kull, Chauncey Leahy, and Dana Tievsky for data collection and everything else; Mike Batcher and Marilyn Jordan for getting us started; Lindsay Goodale for her input and support.

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A Comparison of Litter Densities in Four Community Types of the Long Island Central Pine Barrens

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Timothy Green, PhD, program mentor, Department of Environmental Sciences, Brookhaven National Laboratory, Upton, NY 11973

ABSTRACT

The condition of the Long Island Central Pine Barrens has been an area of ecological concern for the past three decades. In 2003, the Foundation for Ecological Research in the Northeast (FERN) was founded to support scientific research in the Pine Barrens. FERN's groundbreaking project is the Central Pine Barrens Monitoring Program, for which field research began during the summer of 2005 at Brookhaven National Laboratory. The purpose of this research is to determine the current status of forest health in order to promote longevity and conservation in the Pine Barrens, as well as to learn what research should be done in the future. Specifically, litter densities from Pitch Pine, Pine-Oak, Oak-Pine, and Coastal Oak habitats were compared in order to justify the succession of the Pine Barrens and prepare for future prescribed forest fires. Using Geographic Information System (GIS) and Global Positioning System (GPS) technology, random plots of land were selected throughout eastern Long Island. These twenty-five by sixteen meter plots of land were then thoroughly surveyed. As part of the protocol, litter and duff depth data were collected at twenty points along each of the ten line transects in the plot. Pitch Pine forests were found to have the most litter, with an average depth of 8.5844 centimeters. Pine-Oak forests have an average litter depth of 4.4079 cm. Oak-Pine and Coastal Oak forests have comparable litter depths. Oak-Pine forests have an average litter depth of 4.8086 cm while Coastal Oak forests have an average litter depth of 4.4057 cm. A comparison of the vastly different litter densities of the four community types yields results that are consistent with the previously determined succession of the Pine Barrens and shows that litter density plays a key role in aiding forest succession. In the future, data collected under the Central Pine Barrens Monitoring Program can be used to determine a threshold for litter density in order to prescribe forest fires at appropriate times and preserve the Pine Barrens in the most effective manner.

Figure 1. A map of the Central Long Island Pine Barrens indicating the core preservation area [5]

INTRODUCTION

The Long Island Pine Barrens Society was founded in 1977 in order to bring attention to the depleting natural resources of the Pine Barrens. Initial preservation attempts to provide core or "greenbelt" areas, shown in Figure 1, during the late 1970's and early 1980's did not alleviate threats to the Pine Barrens ecosystem [1].

In 2003 the Foundation for Ecological Research in the Northeast (FERN) was founded to fund ecological and environmental research at Brookhaven National Laboratory [1]. The primary project of FERN is the Central Pine Barrens Monitoring Program. The goal of this project is to track the current and future health of the Pine Barrens so that future research needs and priorities can be identified [2].

It is anticipated that the results of this research will provide data relevant to the determination of appropriate timing for prescribed forest fires. Properly timed wildfires benefit the Pine Barrens. Reduction of litter (which is composed of leaves, twigs, pine needles, and other dead vegetation) and canopy cover in the forest provides for direct sunlight on the soil and triggers new tree growth. Melting of the pine cones' resin coating enables the cone to burst open and scatter seeds directly on bare soil [3].

Baseline data for this longitudinal study were collected during the summer of 2005 at Brookhaven National Laboratory. Pitch Pine, Pine-Oak, Oak-Pine, and Coastal Oak forests were targeted at this time. Pitch Pine forests commonly have a canopy cover of nearly 100 percent pitch pine trees while Pine-Oak and Oak-Pine forests have a canopy of mixed pitch pine and oak trees. All these community types include a shrub layer consisting of huckleberry, blueberry, and scrub oak. Coastal Oak forests typically contain a canopy of various tree oaks and little to no pitch pines in addition to "a nearly continuous shrub layer of huckleberry and blueberry" [2].

In order to validate the succession of the Pine Barrens, litter was measured in each of the four community types.

MATERIALS AND METHODS

Plots in the Central Pine Barrens throughout eastern Long Island were randomly selected using Geographic Information System (GIS). Each plot was first located using Global Positioning System (GPS) to insure that it was in the targeted community type. Next, shrub, tree, and herbaceous cover was recorded at twenty points, each one meter apart, along each of twenty transects. A densitometer was used at each point to determine an exact reading of the canopy cover. Litter and duff depths were measured to the nearest millimeter at points 3, 8,13, and 18 along each transect.

Belt transects were completed following the line transects. Tapes were placed at two, four, six, and eight meters along the sixteen-meter edge of the plot so that seedling and sapling data could be collected for four belt transects. Next, data on trees, snags, and downed logs were collected. .

Before leaving the plot, we estimated the percent cover and average height of each stratum including trees, shrubs, vegetation, and epiphytes. The edges and center of the plot as well as a witness tree were marked so that the plot can be located in the future.

A total of 40 plots were measured, however 10 were excluded from the study due to the vagueness of the actual community type. The breakdown of the 30 plots included for data analysis is noted in Table 1. Litter depth data for each plot (the forty points sampled) was averaged to create a mean litter depth for each plot. This data was then sorted by community type and graphically analyzed [2].

Plant Community	Number of plots
Pitch Pine	4
Pine-Oak	4
Oak-Pine	11
Coastal Oak	11

Table 1. The community type breakdown of the 30 plots used in this research.

Dana Tievsky measuring the litter depth of an Oak-Pine Forest.

RESULTS

	Pitch Pine	Pine-Oak	Oak-Pine	Coastal Oak
Litter Depth (cm)	8.5844	7.48	4.8086	4.4057
Standard Deviation	1.9448	1.0448	0.8151	0.8181
Variance	3.7822	1.0915	0.6644	0.6692

Table 2. The average litter depth of each community type (the mean of the average litter depth for each plot by community type). Standard deviation and variance of each mean is also displayed

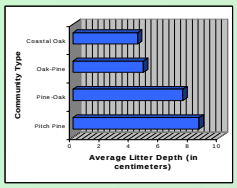


Figure 2. A comparison of average litter depth by community type.

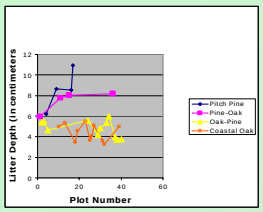
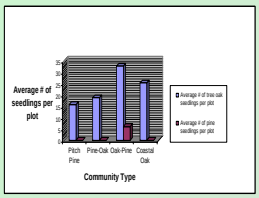


Figure 3. The average litter depth of each plot graphed to show variation in results for each community type.



Community Type	Average Number of Tree Oaks seedlings per plot	Average # of Pine seedlings per plot
Pitch Pine	15.75	<1
Pine-Oak	18.75	<1
Oak-Pine	32.82	6.1
Coastal Oak	25.36	<1

Figure 4. A comparison of the average number of tree oak seedlings to pine seedlings for each community type (in table and graph form).

To the left is a picture of a road along an Oak-Pine Forest in Rocky Point.

Kathryn Gutleber and Andrew Siefert measure the dbh of hardwood trees in a Pine-Oak Forest

DISCUSSION AND CONCLUSION

By comparing the data in Figure 1 to the forest succession diagram in Figure 4, it is evident that litter depth plays an important role in the transitions of forest succession. The early stages of succession, Pitch Pine and Pine-Oak, have a high average litter depth per plot whereas the later stages of succession, Coastal Oak and Oak-Pine forests have lower litter depths. This data can be considered statistically significant since the data for each community type is within two standard deviations of its' corresponding mean.

Furthermore, this research demonstrates better regeneration in the later stages of succession. The likely explanation is that relatively shallow litter depth permits sunlight to directly reach the soil for better tree regeneration [4]. In fact, the tree oaks most common to the Pine Barrens (Quercus alba, Quercus velutina, and Quercus coccinea) require light litter cover and full to partial sun for seedling establishment.

Similarly, pine (Pinus rigida) requires exposed mineral soil i.e., absence of litter, and partial to full sun for seedling growth. However, it should also be noted that pitch pine cones can require exposure to fire in order to spread the pine seeds for growth. After a period of 10 to 20 years without occurrence of fire, the oak canopies close, restricting the soils' access to sunlight. The pine trees in the canopy can persist, but pine seedlings cannot germinate with the excessive litter and lack of sunlight [4].

Therefore, it is sometimes necessary to prescribe forest fires and establish and maintain them safely and correctly[4]. In the near future, researchers should use the data findings of the Central Pine Barrens Monitoring Program to determine a litter depth threshold. This would enable prescribed fires to be properly timed for maximum conservation efforts.

ACKNOWLEDGMENTS

This research was conducted at Brookhaven National Laboratory. I would like to thank my mentor Timothy Green and my advisor Robert Anderson for their direction and guidance during the course of the summer. Additionally, I thank the U.S. Department of Energy, Office of Science, and the SULI program for allowing me the opportunity to participate in such an exceptional and fulfilling internship program. Special thanks also goes to the other members of the program crew: Kathryn Gutleber, Andrew Siefert, Matthew Kull, Miranda Davis and Chauncey Leahy.

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Inquiry Based Learning at Brookhaven National Laboratory Freshwater Ponds

An introduction of technology and scientific field research in the science curriculum.

Focus: How can scientific research technology and environmental monitoring techniques be used to determine and maintain environmental quality?

Amy Meyer & Ivan Suarez

July 2005—Laboratory Science Teacher Professional Development Program (LSTPD)

Eastern Tiger Salamander Tracking and Monitoring Techniques

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Abstract

Various methods are used for the tracking and monitoring of the New York State Endangered Species, the Eastern Tiger Salamander (*Ambystoma tigrinum*) in ponds and vernal pools surrounding Brookhaven National Lab (BNL). Such techniques as radio tracking, drift fencing, seining, and the use of an artificial egg-laying substrate, serve to monitor the tiger salamander, allowing for information to be gathered concerning habitat use during and after breeding, movement patterns, emigration distance, and seasonal habits.

Introduction

Once traced to Albany, tiger salamander populations are now found in New York State solely in Nassau and Suffolk counties on Long Island (figure 1). This decrease in tiger salamander habitat is widely attributed to development and human impact on the land. Through the tracking and monitoring of this New York State endangered species, one can survey the impact of development on an area, and what can be done to preserve the natural habitat of the animals which reside there.

Due to the fragile breeding habitat which tiger salamanders employ, this species serves as an indicator to the condition of the surrounding environment. Although tiger salamanders spend the majority of their time upland in a fossorial environment, the condition of the habitat in which they breed is of great importance to their survival as a species.

Methods and Materials

1.) Drift Fence Surveys

Drift fences serve as a means of monitoring salamanders in their natural habitat. Fences are constructed around the pond in an effort to sample the salamander as they move to and from aquatic breeding sites. Traps are checked daily for salamanders that have been captured. Animals found are then processed at the site, as weight, length, air and water temperature, pond water depth, and time are all taken into account.

Drift fences are made preferably of aluminum flashing held up by stakes on either side, encircling the pond (figure 2). Plastic buckets are used as traps, known as pitfalls.

2.) Egg Mass Grids

Egg mass grids are used to detect the presence of tiger salamanders, by serving as artificial oviposition sites at ponds and vernal pools.

Grids are assembled from polyvinyl chloride (PVC) tubing and nylon cord. PVC is connected in a rectangular shape and holes are drilled at intervals, which the nylon cord is then draw through, and woven in 10 cm squares. Foam pipe insulation is attached to one end to allow one end of the grid to float, and the opposite end to sink. (Alvarez, 2004) Grids are frequently checked for eggs which are subsequently identified and counted (figure 3).

3.) Seining

Seining is used to assess the species richness of animals in a pond, also allowing for detection of tiger salamanders. In addition, seining allows for the removal of salamander larvae and metamorphs from the water in order to count and identify (figure 4). Seining is best performed at night, when larvae rises up in the water column to feed. For small ponds, it is most effective to seine directly across the entire pond from shore to shore. In larger ponds, it is most effective to seine in towards shore in one continuous sweep. The bottom of the seine should be held to the pond floor by lead weights, to ensure an accurate survey of species richness and pond diversity. Each side of the net is attached to a seine pole, allowing the user to drag the net through the water, while keeping the bottom edge on the pond floor. If seining is being used to estimate density of animals in a pond, each seine haul should be independent of past ones so that each haul gives an independent estimate of the density of animals. (Heyer et. Al, 1994)

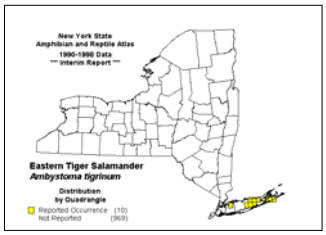

Fig.1 Current range of the Eastern Tiger Salamander in NYS.
http://www.dec.state.ny.us/website/dfwmr/wildlife/herp/eatisala.gif

Fig. 2 Drift fencing at breeding pond.

Fig. 3 Tiger salamander egg mass.

Fig. 4 Tiger salamander larvae.

Fig.5 Post-surgery adult tiger salamander.

Fig. 6 Metamorph found by seining in pond.

Fig. 7 Size of transmitter implanted in salamander when compared to a nickel.

4.) Radio Tracking

After being found in vernal pools and ponds, by way of previously mentioned methods the salamanders are marked by a transmitter during a short surgery. During the approximately twenty minute operation, the salamander is anesthetized by an anesthetic known as MS-222 (tricane methanosulfonate). A small incision is made on the abdomen, and the transmitter is inserted into the coelomic cavity (figure 7). If an individual already carries a transmitter, it must be removed in order to accommodate a new transmitter. At the end of the survey, animals with remaining transmitters should be found in order to remove transmitters. The incision made on the animal is closed with a non-dissolvable polyviolene suture (figure 5). The animal is rinsed with water so that any remaining anesthetic is removed, and revives about 15 to 30 min after the surgery. The animal is placed in a plastic container, kept moist by a wet paper towel, and recovers within hours, ready to return to its natural habitat.

Tracking the animal when back in its natural habitat is performed using handheld radio receivers attached to the 3-element yagi antenna. This system detects radio signals which become progressively stronger as the animal becomes closer. When a signal is tracked to a specific point, it is marked by flagging in the field to facilitate relocation. Additionally, GPS coordinates are taken, as well as date, time, air temperature, wind speed, and humidity.

Results

1.) Drift Fence Surveys

As a year round survey, drift fences provide information as to when tiger salamanders move to and from breeding sites as well as when movements due to weather occur. Metamorphs began emergence in late June and have continued through August.

2.) Egg Mass Grids

Egg mass grids were constructed or repaired, and placed at ponds in preparation for the tiger salamander breeding season, which begins around January, ending in April, with most activity generally taking place in March.

3.) Seining

Seining attempts produced confirmation of the presence of tiger salamanders in various ponds at BNL (figure 6). Seining in mid to late July indicated that metamorph emergence was nearing completion, as seining attempts provided less animals.

4.) Radio Tracking

Approximately 46 tiger salamanders are currently being tracked at 4 different ponds on lab property. Thus far, there have been no known mortalities due to transmitter implants. When dug up to change transmitters, one transmitter was found showing evident signs of predation, potentially by a short tailed shrew. It was also confirmed that tiger salamanders are more prone to movement during and soon after precipitation. (Faccio, 2003) The premature loss of some signals was suspected to be due to predation, transmitter failure, or length of migration.

Discussion/Conclusion

By tracking and monitoring the tiger salamander, one can determine during which periods migration to and from breeding ponds occur, at what point metamorphosis of tiger salamander larvae is complete, and the distance of migration after breeding or emergence. Knowledge of movements and habitat preferences is essential to the preservation of this endangered amphibian.

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