EXPLORING EARTH'S MYSTERIES
...PROTECTING ITS FUTURE

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Formal Report

Natural Resource Management Plan for Brookhaven National Laboratory

October 2016

Environmental Protection Division
Brookhaven National Laboratory

Operated by
Brookhaven Science Associates
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DISCLAIMER

Preface

This comprehensive Natural Resource Management Plan (NRMP) for Brookhaven National Laboratory (BNL) was built on the successful foundation of the Wildlife Management Plan for BNL, which it replaces. This update to the 2003 plan continues to build on successes and efforts to better understand the ecosystems and natural resources found on the BNL site. The plan establishes the basis for managing the varied natural resources located on the 5,265-acre BNL site, setting goals and actions to achieve those goals. The planning of this document is based on the knowledge and expertise gained over the past 15 years by the Natural Resources management staff at BNL in concert with local natural resource agencies including the New York State Department of Environmental Conservation, Long Island Pine Barrens Joint Planning and Policy Commission, The Nature Conservancy, and others. The development of this plan works toward sound ecological management that not only benefits BNL's ecosystems but also benefits the greater Pine Barrens habitats in which BNL is situated. This plan applies equally to the Upton Ecological and Research Reserve (Upton Reserve). Any difference in management between the larger BNL area and the Upton Reserve are noted in the text.

Selected Acronyms

ATV	All-Terrain Vehicle
BMP	Best Management Practices
BNL	Brookhaven National Laboratory
CCC	Civilian Conservation Corps
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act or Superfund
CRMP	Cultural Resource Management Plan
CWPP	Community Wildfire Protection Plan
DOE	Department of Energy
EA	Environmental Assessment
EPD	Environmental Protection Division
FERN	Foundation for Ecological Research in the Northeast
FMP	Wildland Fire Management Plan for BNL
GIS	Geographic Information System
GPS	Global Positioning System
IPM	Integrated Pest Management
ISPZ	Invasive Species Prevention Zone
LIISMA	Long Island Invasive Species Management Area
LINPI	Long Island Native Plant Initiative
LISF	Long Island Solar Farm
LUIC	Land Use and Institutional Controls
MIST	Minimum Impact Suppression Tactics
NRCS	Natural Resource Conservation Service
NYSDEC	New York State Department of Environmental Conservation
NEPA	National Environmental Policy Act – Requires environmental review of major actions carried out, funded, or occurring on or by the federal government
NLEB	Northern long-eared bat
NPS	National Park Service
NRMP	Natural Resource Management Plan
OU	Operable Unit
PBC	Central Pine Barrens Joint Policy and Planning Commission
PBRF	Pine Barrens Research Forum
PLC	Protected Lands Council – one of the committees of the Central Pine Barrens
RHIC	Relativistic Heavy Ion Collider
SARA	Superfund Amendment and Reauthorization Act
SBMS	Standards Based Management System
SGCN	Species of Greatest Conservation Need
SPB	Southern pine beetle
SPDES	State Pollutant Discharge and Elimination System
STP	Sewage Treatment Plant
TNC	The Nature Conservancy
TS or ts	Tiger Salamander
Upton Reserve	Upton Ecological and Research
USDA	United States Department of Agriculture
USDA-APHIS-WS	United States Department of Agriculture, Animal Plant Health Inspection Service, Division of Wildlife Services
USFS	US Forest Service
USFWS	US Fish & Wildlife Service
WMP	Wildlife Management Plan –Plan that preceded the current Natural Resource Management Plan
WNS	White nose syndrome
WW I, WW II	World War I or II, as appropriate.

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Introduction

Purpose

The purpose of the Natural Resource Management Plan (NRMP) is to provide management guidance, promote stewardship of the natural resources found at BNL, and to sustainably integrate their protection with pursuit of the Laboratory's mission. The philosophy or guiding principles of the NRMP include stewardship, sustainability, adaptive ecosystem management, compliance, integration with other plans and requirements, and the incorporation of community involvement, where applicable.

The NRMP is periodically reviewed and updated, typically every five years. The last iteration of this plan included modifications resulting from the establishment of the Long Island Solar Farm. The body of this plan establishes the management goals and actions necessary for managing the natural resources at BNL in a sustainable manner. The appendices provide specific management requirements for threatened and endangered amphibians and fish (Appendices A and B, respectively).

Site Overview

BNL is a 5,265-acre federal facility located in the heart of the Central Pine Barrens on Long Island, New York, approximately 60 miles east of New York City and 60 miles west of Montauk Point. Long Island is approximately 120 miles long, east–west, and 20 miles wide at its widest point. The terrain on Long Island is relatively flat and low except along the north shore. Elevation ranges from sea level to 120 feet, with the highest points occurring on east–west moraines along the north shore and the midsection of Long Island. Topography south and east of the moraines is generally flat with a south-facing slope; this description characterizes the BNL site.

Roughly 1,820 acres of the BNL site are developed for Laboratory work, leaving about 3,445 acres as undeveloped woodland. The neighboring communities are predominantly residential developments scattered among wooded acreage. Many of the neighborhoods are virtually hidden by screens of overgrown, vine-covered woodland that lines most of the roads and highways. The majority of the woods is not maintained and contains significant amounts of surface litter (i.e. leaves and other partially decomposed organic matter).

Laboratory Mission

BNL is a multi-program national laboratory managed by Brookhaven Science Associates for the U.S. Department of Energy (DOE). BNL was founded in 1947, and is located on land formally operated as Camp Upton by the U.S. Army. BNL is in Suffolk County, New York, and is approximately 60 miles east of New York City.

The Lab's vision is to be the "provider of choice" for world-class science and facilities, in support of the DOE Office of Science and its mission to enable breakthroughs that ensure a successful future for our nation. To us, this means excellence in all aspects of our work – from science, to safety, to project management, and more.

From the Laboratory's perspective, the site mission is focusing on two broad areas of research. The first is advancing photon sciences and energy-related research and applying them to 21st-Century problems of critical importance to the nation. The second is advancing fundamental research in nuclear and particle physics to gain a deeper understanding of matter, energy, space, and time.

BNL makes its unique facilities, technical expertise, and the natural environment within its facility available to state and federal agencies, universities, and the private sector to conduct research in a manner that is consistent with these missions.

Background

The Wildlife Management Plan

In the mid-1990s BNL began developing a wildlife management program. This program was guided by the Wildlife Management Plan (WMP), which was reviewed and approved by various state and federal agencies in September 1999. The WMP primarily addressed concerns with the protection of New York State threatened and endangered species, or species of concern, as well as deer populations, invasive species management, and the revegetation of the area surrounding the Relativistic Heavy Ion Collider (RHIC). The WMP provided a strong and sound basis for wildlife management and established a basis for the development of the NRMP, which will guide the natural resource management program for BNL. All applicable actions found within the former WMP were incorporated within the first NRMP and these actions will continue to be updated and implemented under the new plan as necessary.

Upton Ecological and Research Reserve

The Upton Ecological and Research Reserve (Upton Reserve) is a 530-acre portion located on the eastern edge the BNL property and straddles the Peconic River. The Upton Reserve is made available for ecological research through the Natural Resource Program. Limited funding for research in the northeast, including the Upton Reserve, is provided by the Foundation for Ecological Research in the Northeast (FERN).

Integration with Other Documents

The NRMP must integrate with other requirements that govern BNL's operation. The Environmental Protection Division (EPD) is responsible for developing and implementing several management documents for BNL, including the Cultural Resource Management Plan (CRMP), Environmental Monitoring Plan, Environmental Management Systems, Wildland Fire Management Plan (FMP), and the Integrated Pest Management (IPM) Assessment and Plan. Other divisions are responsible for the Standards Based Management System (SBMS), environmental restoration, infrastructure management, emergency management, and sustainability. Where requirements from various other management systems affect this plan, those requirements will be integrated by direct reference. For example, the WW I trench systems and the white pine groves are both historic features of the BNL site, but their maintenance may be, in part, within the scope of natural resource management due to the proximity of natural resources to cultural resources (i.e. forest overlaid on top of WW I trenches).

Regulatory & Policy Framework

The development of a Natural Resource Management Plan is a contract requirement for BNL, according to DOE Order 436.1. There are also a number of federal, state, and local regulations and statutes relevant to wildlife, wetland, and natural resource management. It is BNL's policy to integrate environmental stewardship into all facets of the Laboratory's missions, to manage programs in a manner that protects the ecosystem. Some specific regulatory, secretarial, cooperative, and internal drivers are presented below.

Federal Regulations

Some Federal regulations directly or indirectly applicable to natural resource management or requiring coordination and integration include:

Endangered Species Act
Migratory Bird Treaty Act
Clean Water Act
Clean Air Act
National Historic Preservation Act
National Environmental Policy Act (NEPA)
Comprehensive Environmental Response, Compensation and Liability Act/Superfund Amendment and Reauthorization Act (CERCLA/SARA)
The Oil Pollution Act, Emergency Planning and Community Right to Know Act
Federal Insecticide, Fungicide and Rodenticide Act
10 CFR 1021 DOE's Rules Implementing the NEPA

10 CFR 1022 Compliance with Wetlands and Flood Plains Executive Orders
Executive Order 13423, Strengthening Greening the Government through Leadership in Federal Environmental, Energy and Transportation Management
Executive Order 13112 Invasive Species
Executive Order 13186 Responsibilities of Federal Agencies to Protect Migratory Birds

State Regulations

State regulations applicable to natural resource management include:

New York State Environmental Conservation Laws
NYS Endangered Species Act
NYS Wild, Scenic, Recreational, Rivers Act
NYS Wildlife Laws
NYS Wetlands Protections Laws
Pine Barrens Protection Act

Pine Barrens Protection Act

BNL occupies approximately five percent of the 102,500-acre Central Pine Barrens Region and works in cooperation with the Central Pine Barrens Joint Policy and Planning Commission (PBC) established by the Long Island Pine Barrens Protection Act of 1993. This Act requires preparation of a Central Pine Barrens Comprehensive Land Use Plan, which was completed by the PBC in 1995. Since the Act does not have its origin in a federal statute, federal facilities are not subject to it. However, BNL developed a Future Land Use Plan (BNL 1995) with considerable input from the PBC and other stakeholders. The Future Land Use Plan has largely been replaced by various requirements that are captured in the SBMS subject area titled Real Property Asset Management. None of BNL's planning documents preclude future development which may take place in pursuit of BNL's missions. However, history has shown a commitment to limited development whenever possible with new development occurring on previously disturbed areas and within the designated compatible growth area.

BNL participates as a member of several committees established under the Pine Barrens Protection Act, including the Central Pine Barrens Advisory Committee, Protected Lands Council (PLC), Law Enforcement Task Force, and the Wildfire Task Force. As a member of these committees BNL provides technical assistance and professional experience to the decision-making process of the PBC.

Land Use Planning

Since being placed on the CERCLA National Priorities List in 1989, BNL has been undergoing a comprehensive environmental cleanup. Thirty contaminated areas or facilities have been or will be remediated as part of this cleanup program (BNL 2009). As part of BNL's responsibility for cleanup and environmental protection, Land Use and Institutional Controls (LUICs) must be implemented to prevent the exposure of workers and the public to unnecessary levels of contaminants—both chemical and radiological. This is done through administrative and engineering controls that restrict or limit access, activities, and/or use of an area.

In the future, BNL may need space for new scientific machines requiring large areas of real estate for expansion. The LUICs are taken into consideration during the planning process. The environmental aspects of development anywhere on the site are always considered during planning.

Department of Energy Policies/Orders

DOE P 141.1 Department of Energy Management of Cultural Resources
DOE P 430.1 Land and Facility Use Planning
DOE O 430.1B Real Property and Asset Management
DOE P 450.4A Integrated Safety Management Policy
DOE O 450.2 Integrated Safety Management
DOE O 451.1B Chg 3 National Environmental Policy Act Compliance Program
DOE O 458.1 Admin Chg 3 Radiation Protection of the Public and Environment

Laboratory Policy

BNL has developed an Environmental Stewardship Policy that is integrated into all of the Laboratory's missions. BNL will manage its programs in a manner that protects the ecosystem and public health. In support of this policy, BNL has made the following commitments:

- We are committed to achieving compliance with applicable environmental requirements.
- In consideration of the potential impacts of our activities on the environment, we will integrate pollution prevention/waste minimization, resource conservation, and compliance into all of our planning and decision-making. We will adopt cost-effective practices that eliminate, minimize or mitigate environmental impacts.
- We will define, prioritize, and aggressively correct and clean up existing environmental problems.
- We will work to continually improve our Environmental Management System and performance.
- We will establish appropriate environmental objectives and performance indicators to guide these efforts and measure our progress.
- We will maintain a positive, proactive, and constructive relationship with our neighbors in the community, regulators, DOE, and our other stakeholders. We will openly communicate with stakeholders on our progress and performance.

All Staff have a role in achieving the policy commitments. In addition, the Laboratory Director conducts an annual review of BNL's progress on environmental and sustainability goals and adherence to this policy.

Partners

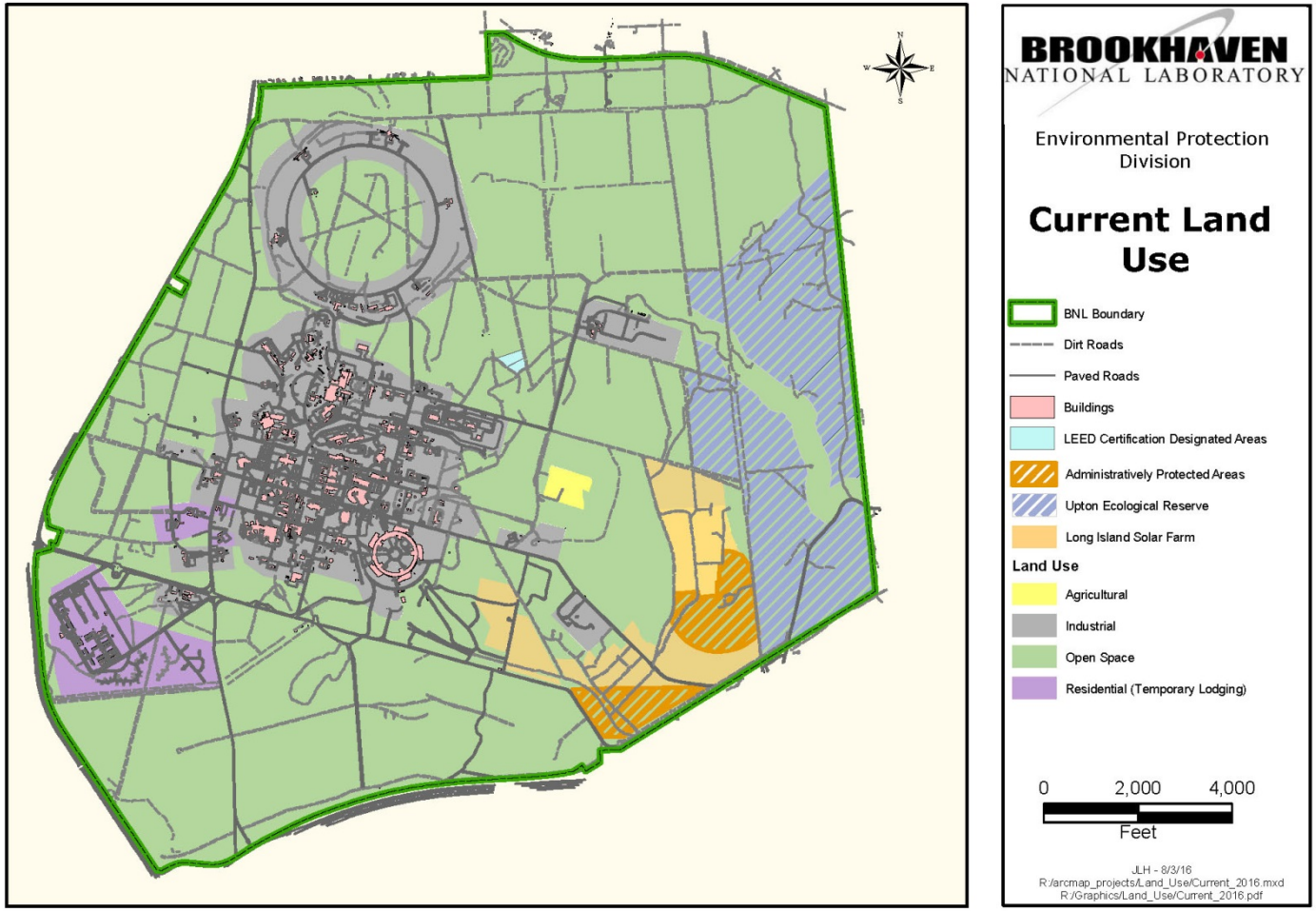
Several agencies and organizations provide technical expertise on either a cooperative or paid basis. Agencies providing cooperative and/or paid consultation support include the U.S. Department of Agriculture (USDA), U.S. Forest Service (USFS), USDA Animal Plant Health Inspection Service – Division of Wildlife Services (USDA APHIS-WS), USDA Natural Resources Conservation Service (NRCS), U.S. National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), Cornell Cooperative Extension, and New York State Department of Environmental Conservation (NYSDEC).

Cooperative efforts between BNL and the PBC provide opportunities for achieving mutual natural resource management goals. BNL lies within the Central Pine Barrens Region, the third largest protected forest area in New York State. The Commission is charged with implementing a comprehensive land use plan for the Central Pine Barrens. Two primary goals of this plan are 1) to protect, preserve, and enhance the functional integrity of the Pine Barrens ecosystem and its significant natural resources, including plant and animal populations and communities, and 2) to protect the quality of surface water and groundwater.

BNL is a member of several of the councils created by the PBC to foster stewardship in the Pine Barrens including the Advisory Council, the PLC, the Wildfire Task Force, and the Law Enforcement Task Force. The structure of the PLC and the expertise of its member organizations are an especially valuable resource for enhancing BNL's Natural Resource Management Program. Through BNL's continued active participation on the PLC and its cooperative interagency natural resource protection and management efforts, BNL can reap the benefits fostered by the PLC's goal "to forge stronger working relationships and partnerships between all public land holders and conservation land managers in the Central Pine Barrens so as to allow for sharing of limited resources and to strengthen the capacity of individual land managers to accomplish regional pine barrens resource protection and management goals."

In collaboration with the Central Pine Barrens Commission, the Ridge and Manorville Fire Departments, and other state and local land management agencies a Community Wildfire Protection Plan (CWPP) has been developed for the Ridge-Manorville-Calverton areas and including portions of BNL. One of the goals of the CWPP is the implementation of prioritized fuel reduction through mechanical treatments of the forest and prescribed fire. BNL has been identified as a priority site for fuel reduction activities in part because of the fuel loading data that have been collected for the forested areas adjacent to the communities on the northern portion of the Lab and because prescribed fire activities have already been planned for these areas.

Figure 1. Map of current land use.



Implementation of a CWPP may make the Lab eligible for funding for these activities, which has been a limiting factor in the implementation of our fuel reduction program.

Since 1996, BNL has also been one of the four organizational sponsors—along with the PBC, FERN, and the Long Island Groundwater Research Institute of State University of New York at Stony Brook—of Pine Barrens Research Forum (PBRF). This two-day, October event draws scientists, researchers, managers, students at all levels, teachers, agency personnel, citizens, and interested individuals together to share research initiatives and results in diverse disciplines such as ecology, surface and groundwater hydrology, wildlife, botany, fire, historical land uses, land use planning, technology, and tools. The PBRF held its 20th event in 2015 with a decision to suspend the event until additional Pine Barrens related research was completed warranting future events. The future of the event may be dependent on the continued success of the larger Long Island Natural History Conference held annual each spring.

BNL resources have also been utilized for holding the annual New York Wildfire and Incident Management Academy, the Long Island Natural History Conference, and other public functions related to natural resource management.

Private organizations with expertise in wildlife and natural resource management are utilized when necessary. The Nature Conservancy (TNC) staffs a Long Island office with individuals trained and experienced in environmental conservation. This organization is utilized as a source for consultation and cooperation where applicable. Other organizations, such as the Long Island Invasive Species Management Area (LIISMA), the Long Island Native Plant Initiative (LINPI), Audubon Society, the Long Island Pine Barrens Society, the North Atlantic Fire Science Exchange, and others are used where appropriate for managing or obtaining information about natural resources at BNL.

Action item:

- Maintain and improve relationships between neighboring landowners, support agencies, and private environmental groups.
- Improve management decisions through the use of innovative tools.

Long Island Solar Farm (LISF)

As part of DOE's commitment to promoting and developing renewable energy sources, DOE entered into an agreement with BP Solar resulting in the construction of a 32-megawatt photovoltaic electric generation plant on a 200-acre portion of the BNL property (Figure 1). This land was released to BP Solar by DOE under an easement. The solar farm continues to be a non-polluting, renewable solar energy facility that is the largest photovoltaic project in the Northeast. The LISF is managed by an M&O operator on behalf of the owners. BNL interfaces with the LISF to ensure sound ecological management of the facility.

The significance of the LISF to Natural Resources Management lies in the fact that it presents us with an opportunity to conduct a great deal of research. This is discussed in more detail in the Research section later in this document.

Adaptive Management

The Natural Resource Management program will utilize "Adaptive Management" as a mechanism for continual improvement to the program. Adaptive Management follows a similar pattern that is utilized by Integrated Safety Management and Environmental and Safety Management systems (Figure 2). It is defined below.

> *Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Its most effective form–"active" adaptive management–employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed.* (Adaptive Management 2011).

In this plan the problems are defined through management needs; strategies are determined; actions are assigned and implemented; results are monitored, reported, and evaluated; and adjustments are made to the program.

Gaps in management are likely to be identified in the future and will need to be addressed. Significant gaps will result in the need to submit an addendum to this plan within a reasonable amount of time, while other gaps will be noted and added to the plan during major revisions.

Action items:

- Adapt natural resource management decisions based on up-to-date information gained collectively through cooperation with outside agencies and organizations.
- Write an annual summary report to chronicle the progress of current action items and add new action items as necessary.
- Update the Natural Resource Management Plan every 5 years.

Figure 2. The Adaptive Management Process Cycle.

Geographic Information System (GIS)

As a part of the Natural Resource Management program, any location-based information is stored in a SQL Server-Based SDE Enterprise Geo-database by ESRI. This includes layers such as vegetation, telemetry study information, roads, buildings, invasive plant locations, cultural resources, and more. Over 150 layers are available to assist in mapping and planning. As management is conducted, efforts are made to include a GIS component in all management and monitoring activities. Global Positioning System (GPS) units are available at a variety of accuracy levels to map and plot locations. Project locations and management activities are recorded for future use and analysis. Metadata (the "data about data") should also be recorded for future reference.

Action item:

- Continue to develop and maintain GIS layers documenting natural resources.
- Utilize these GIS layers to assist in mapping and planning.
- Establish metadata for all data layers and new data entries

Resource Assessment

Geology and Soils

Six major stratigraphic units that underlie most of Long Island have been identified in test drilling on site (BNL 1977). From the deepest level to the surface, these units include the Pre-Cretaceous bedrock, the Raritan formation (with two members), the Magothy formation, the Gardiners clay, and the upper Pleistocene deposits. The upper Pleistocene deposits consist primarily of glacial sand and gravel, plus associated local silt and clay. This unit represents the outwash and moraine deposits of the Wisconsin period. At BNL the thickness of the highly permeable upper Pleistocene deposits varies between 120 and 250 feet (BNL 2002). The sandiest soil is found on the eastern third of the island. On the south shore coastal plain, soils are typically moister. On the north shore the soil is typically finer than elsewhere on the island. In general, the soils at BNL are typical of pine barrens ecosystems. They are quick-draining, consisting of 80-96% sand, low in organic matter, acidic, and nutrient-poor.

Vegetation Types

BNL is located in the heart of the Central Pine Barrens. The Central Pine Barrens Region of Long Island represents one of only three known Atlantic coastal pine barrens ecosystems in the world. Approximately 3,445 acres of the BNL consists of pine barrens habitat. This acreage has been adjusted to reflect the clearing of approximately 165 acres of pine barrens for the placement of solar panels for the Long Island Solar Farm Project. The pine barrens consist primarily of communities of pitch pine (*Pinus rigida*) and oak species (*Quercus coccinea*, *Q. rubra*, *Q. alba*, *Q. velutina*) with an understory of scrub oak (*Q. ilicifolia*) and a variety of ericaceous (heath) shrubs like black huckleberry (*Gaylussacia baccata*), blueberry species (*Vaccinium* spp.), bearberry (*Arctostaphylos uva-ursi*), and wintergreen (*Gaultheria procumbens*) (USFWS 1997). Other common species include bracken fern (*Pteridium aquilinum*), little bluestem (*Schizachyrium scoparium*), and Pennsylvania sedge (*Carex pensylvanica*).

Based on data collected for the creation of a map of vegetation assemblages on site there are three main forest types at BNL (Figure 3). These are pitch pine/white oak (*Q. alba*) forest consisting of approximately 1,200 acres, scarlet oak (*Q, coccinea*)-heath forest consisting of approximately 1,000 acres, and pitch pine/mixed oak-heath forest consisting of a little over 900 acres. In 1934, the Civilian Conservation Corps (CCC) established the Upton National Forest and several CCC camps began planting trees on the former Army site. This is the origination of the white pine (*Pinus strobus*) forest on site that currently covers over 440 acres and is considered a cultural resource as well as a natural one that must be managed. These acreage values have also been adjusted to reflect the habitat lost to the Long Island Solar Farm project.

Other existing vegetation assemblages include red maple (*Acer rubrum*)/scarlet oak-mesic heath forest; red maple-mesic heath forest; red maple-black gum (*Nyssa sylvatica*) wet forest; and black cherry (*Prunus serotina*) forest. In addition, approximately 220 acres are classified as early successional consisting of an array of grasses that were either planted or colonized on their own. These include little bluestem and Indian grass (*Sorghastrum nutans*), big bluestem (*Andropogon gerardii*), broom sedge (*Andropogon virginicus*), panic grasses (*Panicum* spp.), and a variety of non-native pasture grasses. A number of heath species as well as species of moss and lichen can be found in these areas. Cryptobiotic soils may also be present.

Wetlands and the Peconic River

BNL has about 200 acres of wetlands on-site. These include six jurisdictional wetlands and numerous small basins and ponds that provide a variety of habitats (Figure 4). The Peconic River and Zeke's Pond are both Class I wetlands under NYSDEC regulations. The east central part of the Laboratory contains wetlands that have been historically ditched for mosquito control. This area is likely no longer a fully functional wetland.

The headwaters of the Peconic River begin near the Laboratory west of the William Floyd Parkway and flow through it from west to east. The river near the headwaters is very narrow, slow-moving and heavily vegetated with species like leatherleaf (*Chamaedaphne calyculata*), round-leaf sundew (*Drosera rotundifolia*), and several species of peat moss (*Sphagnum* spp.) (USFWS 1997). The marshes in this area also contain species such as blue manna-grass (*Glyceria obtusa*), tussock sedge (*Carex stricta*), bluejoint grass (*Calamagrostis canadensis*), as well as swamp loosestrife (*Decodon verticillatus*) and red maple.

Vernal pools and shallow coastal plain ponds are common in the area of the headwaters. Coastal plain ponds are globally significant habitats characterized by gently sloping shorelines and because they are groundwater-fed, water levels fluctuate seasonally and yearly based on the height of the water table (USFWS 1997). These fluctuating water levels are essential to the survival of the rare pondshore vegetation communities. Times of high water will kill the saplings of woody species that invade from the surrounding area and times of low water allow for the germination of seeds and growth of new plants. Coastal plain ponds are home to a variety of carnivorous plants like bladderworts (*Utricularia* spp.) and sundews (*Drosera* spp.) as well as numerous rush species (*Juncus* spp.) (New York Natural Heritage Program 2011).

Fire Ecology

Pine barrens have evolved over thousands of years in the presence of frequent fires. As a result, plant and animal species of the pine barrens have become adapted to conditions created by periodic fires. For example, pitch pine seeds germinate and grow best on mineral soil in full sunlight, conditions created when fire burns off surface litter and removes competing vegetation (BNL 2014).

As the pine barrens are found on acidic, well-drained sandy soils with low nutrients, many of the plants in the pine barrens produce waxes, resins, or volatile compounds in their leaves to help retain moisture. These substances tend to be highly flammable. Additional plant characteristics that favor fire include decay-resistant litter of low water-absorbing capacity that accumulates on the soil surface, and abundant dead branches and twigs. Pitch pines are able to survive most fires due to thick, insulating bark and to their unusual ability to rapidly sprout from buds in the trunk and root collar. Shrubs and herbs in the pine barrens also rapidly sprout from underground roots and rhizomes (BNL 2014).

Some research asserts that pine barrens species alter their environment to favor their own perpetuation (Noble and Slatyer 1977, Rowe 1983). Fire-tolerant species promote ignition with their volatile foliage. Fire then consumes the available litter that would otherwise decompose and enrich the soil making it more hospitable for less fire-tolerant species. Reduced nutrient levels favor species that tolerate fire and poor soil, and the presence of these species favors recurring fire. This feedback loop may be destabilized when fires are suppressed or prevented, when nutrients are added to the soil, or by prolonged wet weather. With prolonged fire exclusion (through active wildfire suppression and fire prevention efforts), plant succession ultimately could result in the replacement of pine barrens with oak forests.

In the pitch pine barrens of Long Island, both light and severe surface fires as well as stand-replacement crown fires occur at "short" (25- to 50-year) return intervals (Olsvig *et al.* 1979). In fact, both surface and stand-replacement fires may have occurred every 10 to 40 years. Most of the fires on Long Island prior to European settlement are believed to have been the result of Native American activities relating to land management and hunting. With the construction of the Long Island Railroad in the mid-19th century fire frequency and intensity increased (Kurczewski and Boyle 2000). Lightning-sparked fires are less frequent than in the western United States, because lightning strikes on Long Island usually occur in the rainy season and the combustible materials are usually also somewhat damp, given the normal annual rainfall. Historically, the warm season grasslands (Hempstead Plains), oak–brush plains, and dwarf pine plains had the highest fire frequencies. Fires also occurred frequently, but not to the same extent as the preceding group, in pitch pine, pine–oak, and oak–pine stands.

New York state has identified the Central Pine Barrens Region of Long Island as having not only the greatest amount of wildland/urban interface in the state, but also as being its most fire-prone area. At BNL, fire has been aggressively suppressed for at least 75 years and as a result there has been a buildup of fuels in the forest understory in the form of leaf litter and branches. This fuel buildup could ultimately lead to the ignition of a catastrophic wildfire which has the potential to not only endanger structures and human life, but have adverse ecological effects if it occurs at the wrong time of year. Further information can be found in the Fire Management Plan (BNL 2014) and the CWPP (Amato 2016).

Figure 3. Map of vegetation assemblages at BNL.

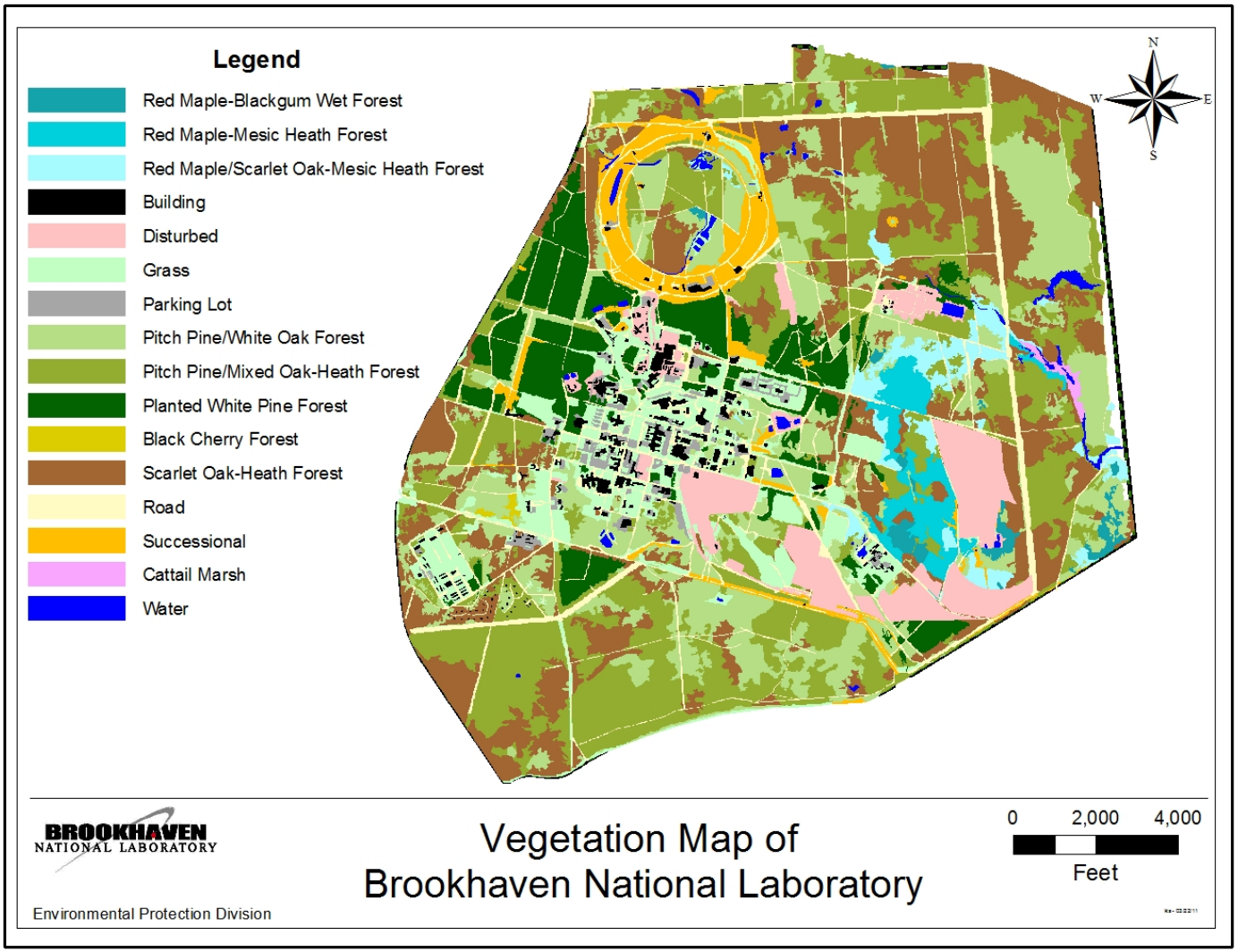
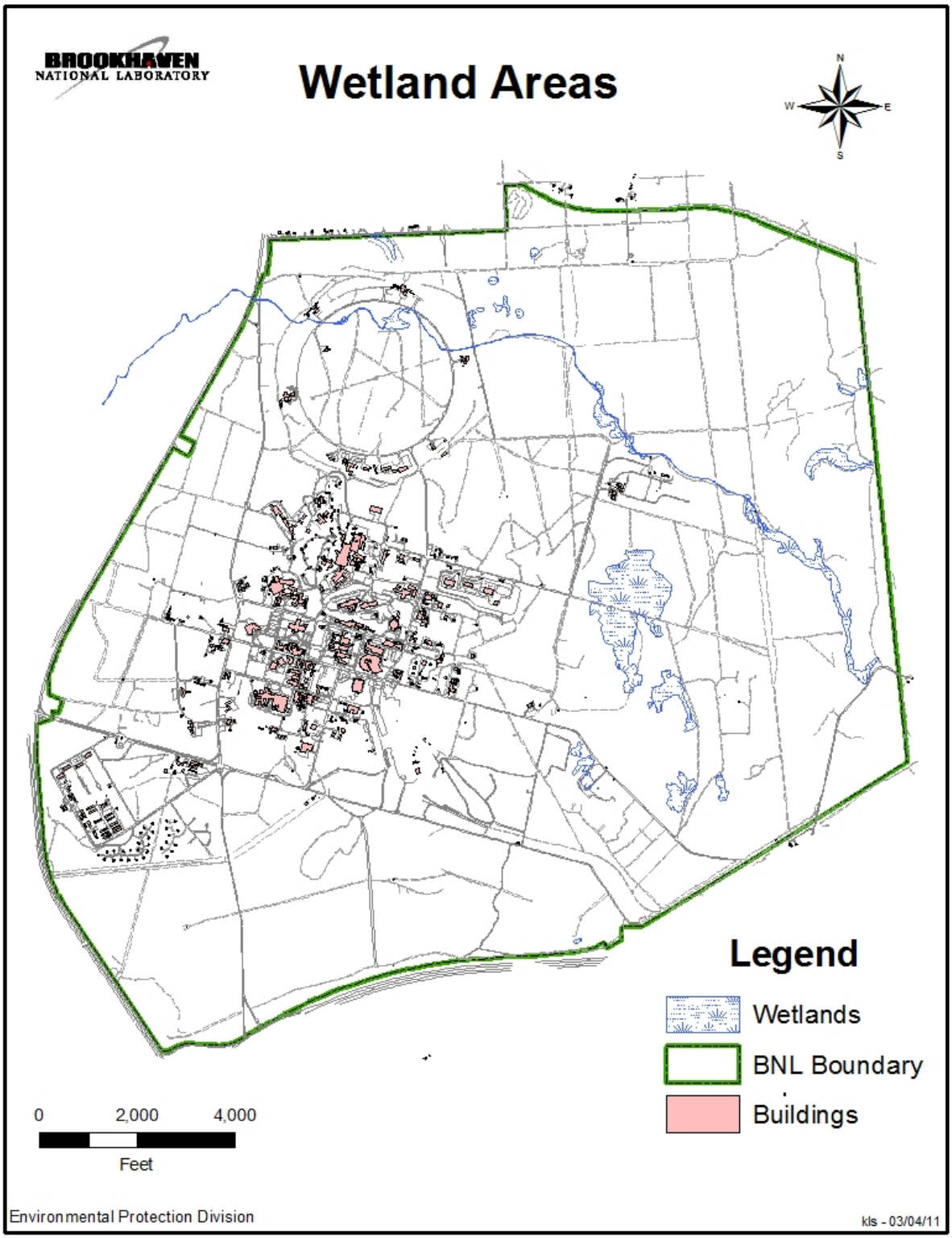


Figure 4. Locations of wetlands at BNL.



Special Status Species

BNL is home to a number of plants and animals that are considered special status species including the Federally threatened northern long-eared bat (*Myotis septentrionalis*), the New York State endangered tiger salamander (*Ambystoma tigrinum tigrinum*) and Persius duskywing (*Erynnis persius persius)*, and the state threatened banded sunfish (*Enniacanthus obesus*), swamp darter (*Etheostoma fusiforme*), frosted elfin butterfly (*Callophrys iris*) little bluet (*Enallagma minisculumI),* pine barrens bluet *(Enallagma recurvatum*), and northern harrier (*Circus cyaneus*). Endangered and threatened plants include the crested fringed orchid (*Plantathera cristata*), stargrass (*Aletris farinosa*), and stiff goldenrod (*Solidago rigida*). In addition, there are a number of species considered as part of NYSDEC's New York Comprehensive Wildlife Conservation Strategy to be "species of greatest conservation need" (SGCN). This designation has no legislative mandate. It is intended to create an awareness of species which are declining, but may not yet have a special status in the hopes that management of those species now will prevent the need that they be listed in the future.

Table 1 contains a list of all special status species either confirmed to be present on site or likely to be present on site.

Action item:

- Maintain and update the list of special status species.
- Identify habitats of special status species as necessary.
- Continue surveys of Odonates, reptiles, amphibians, SGCNs.

Migratory Birds

Songbird surveys have been conducted annually from April – August at BNL since the year 2000. Monitoring involves recording ambient weather conditions at the beginning and end of each of the seven 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 apart to prevent overlap of counts from point to point. To date, 131 species of birds have been detected at BNL. See Table 2 for a list of species documented on site.

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.

Table 1. Special status species at BNL.

Threatened & Endangered Species, Species of Special Concern, & Species of Greatest Conservation Need			
Common Name	***Scientific Name***	**State Status**	**BNL Status**
Insects			
Comet darner	*Anax longipes*	SGCN	Confirmed
Rusty-patched bumble bee	*Bombus affinis*	SGCN	Likely
Ashton's cuckoo bumble bee	*Bombus astoni*	SGCN	Likely
Yellow bumble bee	*Bombus fervidus*	SGCN	Likely
Yellow-banded bumble bee	*Bombus terricola*	SGCN	Likely
American bumble bee	*Bombus pensylvanicus*	SGCN	Likely
Frosted elfin	*Callophrys iris*	T	Likely
Double-ringed pennant	*Celithemis verna*	SGCN	Confirmed
Atlantic bluet	*Enallagma doubledayi*	SGCN	Likely
New England bluet	*Enallagma laterale*	SGCN	Likely
Little bluet	*Enallagma minusculum*	T	Confirmed
Scarlet bluet	*Enallagma pictum*	T	Likely
Pine Barrens bluet	*Enallagma recurvatum*	T	Confirmed
Mottled duskywing	*Erynnis martialis*	SC	Likely
Persius duskywing	*Erynnis persius persius*	E	Likely
Seaside dragonlet	*Erythrodiplax berenice*	SGCN	Confirmed
Rambur's forktail	*Ischnura ramburii*	SGCN	Confirmed
Lyre-tipped spreadwing	*Lestes unguiculatus*	SGCN	Confirmed
Black-bordered lemon moth	*Marimatha nigrofimbria*	SGCN	Confirmed
Southern sprite	*Nehalennia integricollis*	SGCN	Likely
Fish			
Banded sunfish	*Enniacanthus obesus*	T	Confirmed
Swamp darter	*Etheostoma fusiforme*	T	Confirmed
Amphibians			
Marbled salamander	*Ambystoma opacum*	SC	Confirmed
Eastern tiger salamander	*Ambystoma tigrinum tigrinum*	E	Confirmed
Fowler's toad	*Bufo fowleri*	SGCN	Confirmed
Four-toed salamander	*Hemidactylium scutatum*	SGCN	Confirmed
Eastern spadefoot toad	*Scaphiopus holbrookii*	SC	Confirmed
Reptiles			
Worm snake	*Carphophis amoenus*	SC	Confirmed
Snapping turtle	*Chelydra serpentina*	SGCN	Confirmed
Spotted turtle	*Clemmys guttata*	SC	Confirmed
Northern black racer	*Coluber constrictor*	SGCN	Confirmed
Eastern hognose snake	*Heterodon platyrhinos*	SC	Confirmed
Southeastern mud turtle	*Kinosternon subrubrum subrubrum*	SGCN	Confirmed
Smooth greensnake	*Opheodrys vernalis*	SGCN	Confirmed
Stinkpot turtle	*Sternotherus odoratus*	SGCN	Confirmed
Eastern box turtle	*Terrapene carolina*	SC	Confirmed
Eastern ribbon snake	*Thamnophis sauritus*	SGCN	Confirmed
Birds (nesting, transient, or potentially present)			
Grasshopper sparrow	*Ammodramus savannarum*	SC	Confirmed
Golden eagle	*Aquila chrysaetos*	SGCN	Confirmed
Great egret	*Ardea alba*	SGCN	Confirmed
Whip-poor-will	*Caprimulgus vociferus*	SC	Confirmed

Common nighthawk	*Chordeiles minor*	SGCN	Confirmed
Northern harrier	*Circus cyaneus*	T	Confirmed
Black-billed cuckoo	*Coccyzus erythropthalmus*	SGCN	Confirmed
Northern bobwhite	*Colinus virginianus*	SGCN	Confirmed
Prairie warbler	*Dendroica discolor*	SGCN	Confirmed
Horned lark	*Eremophila alpestris*	SC	Confirmed
American Kestrel	*Falco sparverius*	SGCN	Confirmed
Common loon	*Gavia immer*	SGCN	Confirmed
Bald Eagle	*Haliaeetus leucocephalus*	SGCN	Confirmed
Wood thrush	*Hylocichla mustelina*	SGCN	Confirmed
Red-headed woodpecker	*Melanerpes erythrocephalus*	SC	Confirmed
Yellow-crowned night heron	*Nyctanassa violacea*	SGCN	Confirmed
Black-crowned night heron	*Nycticorax nycticorax*	SGCN	Confirmed
Scarlet tanager	*Piranga olivacea*	SGCN	Confirmed
Glossy ibis	*Plegadis falcinellus*	SGCN	Confirmed
American woodcock	*Scolopax minor*	SGCN	Confirmed
Black-throated blue warbler	*Setophaga caerulescens*	SGCN	Confirmed
Brown thrasher	*Toxostoma rufum*	SGCN	Confirmed
Greater yellowlegs	*Tringa melanoleuca*	SGCN	Confirmed
Blue-winged warbler	*Vermivora pinus*	SGCN	Confirmed
Mammals			
Silver-haired bat	*Lasionycteris noctivagans*	SGCN	Confirmed
Eastern red bat	*Lasiurus borealis*	SGCN	Confirmed
Hoary bat	*Lasiurus cinereus*	SGCN	Confirmed
Eastern small-footed bat	*Myotis leibii*	SGCN	Confirmed
Little brown bat	*Myotis lucifugus*	SGCN	Confirmed
Northern long-eared bat	*Myotis septentrionalis*	FT	Confirmed
Plants			
Small-flowered false foxglove	*Agalinis paupercula*	R	Confirmed
Stargrass	*Aletris farinosa*	T	Confirmed
Butterfly weed	*Asclepias tuberosa ssp. interior*	V	Confirmed
Spotted wintergreen	*Chimaphila maculata*	V	Confirmed
Flowering dogwood	*Cornus florida*	V	Confirmed
Pink lady's slipper	*Cypripedium acaule*	V	Confirmed
Ground pine	*Dendrolycopodium obscurum*	V	Confirmed
Round-leaved sundew	*Drosera rotundifolia var. rotundifolia*	V	Likely
Marginal wood fern	*Dryopteris marginalis*	V	Confirmed
Engelman spikerush	*Eleocharis engelmannii*	E	Confirmed
Fireweed	*Erectites hieracifolia var. megalocarpa*	E	Possible
Eastern showy aster	*Eurybia spectabilis*	T	Confirmed
Dwarf huckleberry	*Gaylussacia bigeloviana*	E	Confirmed
Winterberry	*Ilex verticillata*	V	Confirmed
Sheep laurel	*Kalmia angustifolia*	V	Confirmed
Narrow-leafed bush clover	*Lespedeza augustifolia*	T	Confirmed
Wild lupine	*Lupinus perennis*	R	Confirmed
Whorled loosestrife	*Lysimachia quadrifolia*	E	Confirmed
Bayberry	*Myrica pensylvanica*	V	Confirmed
Stiff-leaved goldenrod	*Oligoneuron rigida var. rigidum*	T	Possible
Cinnamon fern	*Osmunda cinnamomea*	V	Confirmed
Clayton's fern	*Osmunda claytoniana*	V	Confirmed
Royal fern	*Osmunda regalis ssp. spectabilis*	V	Confirmed
Crested fringed orchid	*Plantathera cristata*	E	Likely

Green fringed orchis	*Platanthera lacera*	V	Confirmed
Prostrate knotweed	*Polygonum aviculare ssp. buxiforme*	E	Possible
Bracken fern	*Pteridium alquilinum var. pseudocaudatum*	E	Possible
Swamp azalea	*Rhododendron viscosum*	V	Confirmed
Long-beaked bald-rush	*Rhynchospora scirpoides*	R	Confirmed
New York fern	*Thelypteris novaboracensis*	V	Confirmed
Marsh fern	*Thelypteris palustris var. pubescens*	V	Confirmed
Possum haw	*Viburnum nudum var. nudum*	E	Possible
Virginia chain-fern	*Woodwardia virginica*	V	Confirmed

Notes: * Information based on 6 NYCRR Part 182, 6 NYCRR Part 193, and BNL survey data.
E = endangered, T = threatened, SC = species of special concern, R = rare, V = exploitably vulnerable, SGCN = species of greatest conservation need, FT = Federally threatened

Table 2. Bird species documented on site.

Common Name	***Scientific Name***	**Common Name**	***Scientific Name***
Acadian Flycatcher	*Empidonax virescens*	Hermit Thrush	*Catharus guttatus*
American Crow	*Corvus brachyrhynchos*	Herring Gull	*Larus argentatus*
American Kestrel	*Falco sparverius*	Horned Lark	*Eremophila alpestris*
American Redstart	*Setophaga ruticilla*	House Finch	*Carpodacus mexicanus*
American Robin	*Turdus migratorius*	House Wren	*Troglodytes aedon*
Baltimore Oriole	*Icterus galbula*	Indigo Bunting	*Passerina cyanea*
Bald Eagle	*Haliaeetus leucocephalus*	Killdeer	*Charadrius vociferus*
Bewick's Wren	*Thryomanes bewickii*	Magnolia Warbler	*Dendroica magnolia*
Black-and-White Warbler	*Mniotilta varia*	Mallard Duck	*Anas platyrhyncos*
Black-billed Cuckoo	*Coccyzus erythropthalmus*	Merlin	*Falco columbarius*
Black-capped Chickadee	*Poecile atricapillus*	Mourning Dove	*Zenaida macroura*
Black-crowned Night-heron	*Nycticorax nycticorax*	Nashville Warbler	*Vermivora ruficapilla*
Blackpole	*Dendroica striata*	Northern Bobwhite	*Colinus virginianus*
Black-throated Blue Warbler	*Setophaga caerulescens*	Northern Cardinal	*Cardinalis cardinalis*
Blue-Grey Gnatcatcher	*Polioptila caerulea*	Northern Flicker	*Colaptes auratus*
Blue-headed Vireo	*Vireo solitarius*	Northern Harrier	*Circus cyaneus*
Blue-winged Warbler	*Vermivora pinus*	Northern Mockingbird	*Mimus polyglottos*
Broad-winged Hawk	*Buteo platyteris*	Northern Parula	*Parula americana*
Brown Creeper	*Certhia americana*	Northern Rough-winged Swallow	*Steligdopteryx serripennis*
Brown Thrasher	*Toxostoma rufum*	Orchard Oriole	*Icterus spurius*
Brown-headed Cowbird	*Molothrus ater*	Osprey	*Pandion haliaetus*
Canada Goose	*Branta canadensis*	Ovenbird	*Seiurus aurocapillus*
Carolina Wren	*Thryothorus ludovicianus*	Palm Warbler	*Dendroica palmarum*
Cedar Waxwing	*Bombycilla cedrorum*	Pine Warbler	*Dendroica pinus*
Chestnut-sided Warbler	*Dendroica pensylvanica*	Plain Pigeon	*Columbus livia*
Chimney Swift	*Chaetura pelagica*	Prairie Warbler	*Dendroica discolor*

Common Name	***Scientific Name***	**Common Name**	***Scientific Name***
Chipping Sparrow	*Spizella passerina*	Purple Martin	*Progne subis*
Common Grackle	*Quiscalus quiscula*	Red-bellied Woodpecker	*Melanerpes carolinus*
Common Loon	*Gavia immer*	Red-breasted Nuthatch	*Sitta canadensis*
Common Nighthawk	*Chordeiles minor*	Red-eyed Vireo	*Vireo olivaceus*
Common Peafowl	*Pavo cristatus*	Red-headed Woodpecker	*Melanerpes erythrocephalas*
Common Yellowthroat	*Geothlypis trichas*	Red-tailed Hawk	*Buteo jamaicensis*
Cooper's Hawk	*Accipiter cooperii*	Red-throated Loon	*Gavia stellata*
Dark-eyed Junco	*Junco hyemalis*	Red-winged Blackbird	*Agelaius phoeniceus*
Double-crested Cormorant	*Phalacrocorax auritus*	Ring-billed Gull	*Larus delawarensis*
Downy Woodpecker	*Picoides pubescens*	Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Eastern Bluebird	*Sialia sialis*	Ruby-crowned Kinglet	*Regulus calendula*
Eastern Kingbird	*Tyranus tyranus*	Ruby-throated Hummingbird	*Archilochus colubris*
Eastern Phoebe	*Sayornis phoebe*	Savannah Sparrow	*Passerculus sandwichensis*
Eastern Screech Owl	*Otus asio*	Scarlet Tanager	*Piranga olivacea*
Eastern Towhee	*Pipilo erythrophthalmus*	Sharp-shinned Hawk	*Accipiter striatus*
Eastern Wood Peewee	*Contopus virens*	Song Sparrow	*Melospiza melodia*
European Starlings	*Sturnus vulgaris*	Summer Tanager	*Piranga rubra*
Field Sparrow	*Spizella pusilla*	Tree Swallow	*Tachycineta bicolor*
Fox Sparrow	*Passerella iliaca*	Tufted Titmouse	*Baeolophus bicolor*
Fish Crow	*Corvus ossifragus*	Veery	*Catharus fuscescens*
Glossy Ibis	*Plegadis falcinellus*	Whip-poor-will	*Caprimulgus vociferus*
Golden Eagle	*Aquila chrysaetos*	White-breasted Nuthatch	*Sitta carolinensis*
Golden-crowned Kinglet	*Regulus satrapa*	White-eyed Vireo	*Vireo griseus*
Goldfinch	*Carduelis tristis*	White-throated Sparrow	*Zonotrichia albicollis*
Grasshopper Sparrow	*Ammodramus savannarum*	Wild Turkey	*Meleagris gallopavo*
Great Black-backed Gull	*Larus marinus*	Wood Duck	*Aix sponsa*
Great Blue Heron	*Ardea herodias*	Wood Thrush	*Hylocichla mustelina*
Great Crested Flycatcher	*Myiarchus crinitus*	Worm-eating Warbler	*Helmitheros vermivorus*
Great Egret	*Ardea alba*	Yellow Warbler	*Dendroica petechia*
Great Horned Owl	*Bubo virginianus*	Yellow-bellied Sapsucker	*Sphyrapicus varius*
Greater Yellowlegs	*Tringa melanoleuca*	Yellow-billed Cuckoo	*Coccyzus americanus*
Green Heron	*Butorides virescens*	Yellow-crowned night-heron	*Nyctanassa violacea*
Grey Catbird	*Dumetella carolinensis*	Yellow-rumped Warbler	*Dendroica coronata*
Hairy Woodpecker	*Picoides villosus*	Yellow-throated Warbler	*Dendroica dominica*

Other Species

Wild Turkey

The eastern wild turkey (*Meleagris gallapavo*) was re-introduced to Long Island in 1992 by the NYSDEC. The original introduction occurred in two locations, the Montauk Peninsula, and at Southaven County Park southwest of BNL. The Southaven population quickly migrated down the Carmans River to Wertheim National Wildlife Refuge and up the Carmans River and across William Floyd Parkway to BNL. The population of wild turkey was first estimated at 175 birds in 1999, with steady growth occurring through 2005. Habitat at BNL supports the continued existence of the wild turkey. The primarily oak-dominated woodlands provide adequate food source in both summer (insects) and winter (acorns and other seeds) in most years, while stands of white pines provide insulating shelter in colder months. The population appears to have stabilized at around 350 birds, but fluctuates around this number dependent upon mast crops.

Canada Geese

Canada geese (*Branta canadensis*) have established non-migratory populations throughout the Midwest and northeastern United States. Currently, a relatively small population (approximately85-100 birds) is established at BNL. Resident Canada geese at BNL typically feed on lawn grasses and nest in areas next to buildings, along drainage swales, recharge basins, and the Sewage Treatment Plant (STP). The population is maintained through egg oiling authorized under a permit established under USFWS programs.

White-tailed Deer

White-tailed deer (*Odocoileus virginianus*) are the most prevalent large mammal species on Long Island and at BNL. In 1966, the population was estimated at approximately 267 animals. A study in 1992 determined that BNL had a population of approximately 700 animals (85/sq. mi). Follow-up surveys in December 2000 estimated 1,200 animals (145/ sq. mi). Deer surveys have been conducted semi-annually since then using a modified distance sampling technique with transects and aerial fly-overs. Transects are driven throughout the property and a modified distance-based approach is applied. A GIS-based population model has been created to produce an estimate based on vegetation types.

Population levels are considered to be above the ecosystems carrying capacity and the effects of overpopulation on the ecosystem are still evident. Most scientific literature suggests a population of deer should be between 10 and 30 animals per square mile. This would be equivalent to the population levels seen in 1966.

High deer populations have resulted in virtually every ornamental shrub being grazed within 4 to 5 feet of the ground. Browse lines on trees and in the forest are evident, and the forest has a lack of seedlings and, in most areas, saplings that are needed for continued forest regeneration. Decreased food supplies together with overpopulation have resulted in most deer at BNL being malnourished; this has led to an increased death rate in deer.

A deer cull was implemented in February 2015. A total of 300 deer were taken and over 7,000 pounds of meat was donated to a venison donation program. Ideally, culling would continue annually until the population has been sufficiently reduced, however, this is dependent upon funding. Another cull is scheduled for November 2016 when an additional 250-275 will be removed. Once population levels supportive of ecosystem sustainability are reached, other methods of control will be investigated and pursued, as appropriate.

Invasive Species

Executive Order 13112, entitled Invasive Species, states that governmental agencies will have in-place mechanisms for identifying invasive species and for the early detection, control, and removal of invasive species when it is practical to do so. During the summers of 2003 and 2005 interns surveyed and mapped invasive plant species at BNL. Table 3 contains a list of the species found and the number of infestations found of each species. From these data an Invasive Species Prevention Zone (ISPZ) was delineated that includes approximately 2,400 acres (Figure 5). The ISPZ has been broken into two units and spans the southern, eastern, and northern portions of the Laboratory. Unit I is approximately 810 acres and

encompasses the southern section of the Laboratory from Princeton Ave. to the Long Island Expressway with the exception of the apartment and cottage area. Unit II is 1,586 acres and includes the Upton Reserve, the area north of Fifth Ave and east of the Stump Dump, and the area east of the RHIC to the East Firebreak. These areas were chosen due to the large expanses of undeveloped land and minimal invasive species already present. The ISPZ also contains many environmentally sensitive wetlands and ponds. Unit II also buffers the Robert Cushman County Park. An ISPZ plan was written and should be referenced for information on the locations of infestations and plans for management (BNL 2008).

In addition, BNL has been an active member of LIISMA since its inception in 2001 and participated on the Scientific Review Committee—a LIISMA subcommittee tasked with the scientific assessment of the invasiveness of plant species on both Long Island and New York State as a whole. This committee, in turn, informs the respective Invasive Species Advisory Councils for Nassau and Suffolk Counties and recommends new species to be added to the existing "Do Not Sell" lists.

Few non-native pest and pathogen species currently threaten the natural resources of BNL. European gypsy moth (*Lymantria dispar*) has been present on Long Island for many decades and though infestations periodically impact the oak species in the Pine Barrens (often in combination with native defoliators), their populations have been reduced by the presence of a fungus (*Entomophaga maimaiga*) that has been released on more than one occasion as a biological control agent.

Sirex woodwasp (*Sirex noctilio*) is not currently present on Long Island, but has been documented in 15 counties in upstate New York. This species is a potentially serious threat to both the pitch pine and eastern white pine trees at BNL. It has decimated pine plantations in many parts of the southern hemisphere and has no known native controls. While the female wasp is laying her eggs in the bark of a susceptible tree, she injects a toxic mucous and a fungus into the tree. The mucous kills the wood from the egg-laying site on upward and the fungus then feeds on the dead wood. The larvae, in turn, feed on the fungus and bore deep into and through the wood. This makes the wasp extremely difficult to detect and control. While it prefers non-native pine species like Scots pine, it will attack any native softwood species.

Table 3. List of invasive species found within the ISPZ.

Scientific Name	Common Name	Number of Infestations
Acer platanoides	Norway maple	1
Artemisia vulgaris	Mugwort	3
Berberis thunbergii	Japanese barberry	widespread
Carduus nutans	Musk thistle or nodding thistle	1
Celastrus orbiculatus	Oriental bittersweet	6
Centaurea maculosa	Spotted knapweed	1
Eleagnus umbellata	Autumn olive	1
Lonicera japonica	Japanese honeysuckle	2
Microstegium vimineum	Japanese stiltgrass	widespread
Phragmites australis	Common reed	widespread
Robinia pseudoacacia	Black locust	20
Rosa multiflora	Multiflora rose	2
Solanum dulcamara	Climbing nightshade	1
Cynanchum louiseae	Black swallow-wort	2

Pollinators

Recognizing the importance of honey bees and native pollinators, President Obama issued a Presidential Memorandum in 2014 entitled Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators. This served to establish an interagency task force (which included a DOE representative) that

directs Federal agencies to evaluate and use their resources, facilities, and land management responsibilities to expand knowledge of pollinator health and to increase habitat quality. The Task Force developed Best Management Practices (BMPs) to create or enhance pollinator habitat on Federal lands which were adopted by DOE. These include limiting pesticide use, habitat management in the form of prescribed fire and/or mowing, managing lawns for pollinators, and proper use of mulch in landscaping.

BNL already implements many of these practices. Per the Lab's IPM Plan the use of pesticides has been minimized to prevent harm to non-target species. For example, herbicide application is limited to specific areas to prevent application to nectar-producing plants, insecticides/acaricides are seldom utilized for broadcast spraying, tick management areas have targeted application of pesticides through use of tools like the 4-Poster tick management devices and Damminix tubes, and careful consideration is given to requests for broadcast application of broad spectrum pesticides. In addition, pesticides and fertilizers are not applied to lawns to allow species that are attractive to pollinators, such as clovers, to grow.

Prescribed fire is implemented not only for fuel reduction purposed, but to promote the health of ecosystems and a prescribed mowing regime has begun on some area of the Lab which includes seeding with grasses and wildflowers known to promote pollinators. An additional 275 acres have been identified for further habitat enhancement.

Action items:

- Work with Site Services to continue to identify low-frequency mowing areas and seed with pollinator-promoting wildflowers and grasses.
- Work with Site Services to better implement mulching BMPs in landscaped areas.
- Conduct pollinator research to better understand and monitor pollinator populations and develop new monitoring techniques.

Feral and Nuisance Animals

Feral and nuisance animals have the potential to cause problems that could impact worker health, cause property damage, or affect biodiversity. Feral and free-ranging animals (domestic cats and dogs) have the potential to carry diseases (rabies, distemper, toxoplasmosis, etc.) that are transmissible to humans and native fauna, to cause unpleasant odors from urine and feces, and to affect biodiversity by altering predation patterns for birds, reptiles, amphibians, and small mammals. Nuisance situations are defined as being unwanted human–animal interactions and include such situations as rodents chewing cables, animals in food preparation areas and garbage collection areas, animals under portable buildings (e.g. groundhogs, skunks, raccoons, etc.), and deer destroying vegetation. Migratory birds can also pose a problem. For example, killdeer have made their nests on construction sites and barn swallows have built nests in buildings slated for demolition. BNL has been successful at reducing feral cat populations from numbers estimated around 50 cats in the early 2000s to periodic observations in out areas. This reduction was done primarily through efforts of several dedicated individuals managing three colonies, without addition of animals, through to the end of life for all cats in the colonies. Feral cats now observed on the BNL site are likely to be truly feral and in need of management.

Cultural Resources

In 2003 the Laboratory developed a Cultural Resource Management Plan to better manage cultural resources identified on site. To date, the Cultural Resource Program has identified several culturally significant areas that may be affected by natural resource activities. There is a potential that prehistoric features and artifacts may exist in some habitats. Prior to BNL, the property was part of Camp Upton during World War I and II. As a result, a number of historic elements still exist on the site. WW I trenches and foundations can be found in some of the forested areas as well as unexploded ordnance and military artifacts. An archeological survey has also revealed the remains of two homes from the 1800's. Actions such as prescribed fire, fire suppression, and forest thinning (the white pines) may significantly impact historic features and artifacts if care is not taken during the planning phase, therefore, it is important that knowledge of cultural resources be fully integrated into natural resource planning. Cultural Resource Management issues are now routinely incorporated in natural resource planning.

Action item:

- Continue to develop and maintain GIS layers documenting the location of cultural resources. The Natural Resource Manager will identify cultural resources that could be affected by natural resource activities. Pre- and post-fire surveys for cultural resources will be performed in prescribed fire areas.

Monitoring & Management Recommendations

Habitat Monitoring & Management

Freshwater Wetland Monitoring

In order to understand the status of the freshwater wetlands of the Long Island Pine Barrens, FERN developed a monitoring protocol to collect data to measure indicators associated with several primary ecological attributes of wetlands. By collecting and analyzing the data on the current conditions of the freshwater wetlands of the Pine Barrens, the monitoring program would provide baseline wetland health data to enable detecting future change due to threats or management and conservation efforts. It will also help to identify research needs within the Long Island Pine Barrens. This protocol uses a combination of bio-assemblage monitoring methods. Physical features are described, including the presence or absence of buffer zones and effects of human impacts. Water and sediment quality is characterized and lists of plant species are compiled. Measures of soil compaction may document effects of all-terrain vehicles (ATVs) and other recreational activities. Odonates inhabiting the wetlands are identified and documented. New York designated SGCN and invasive species are recorded as well (FERN 2008). Little information currently exists about the state of wetlands in the Pine Barrens region which is unfortunate as wetlands provide many essential functions and support a great deal of wildlife.

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 storm water 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 for the previous year is made available in October and may be viewed via the internet at https://www.bnl.gov/esh/env/ser/. Routine sampling has not indicated any concerns for threatened or endangered species within basins or the Peconic River.

With changes in regulatory limits for metals in BNL's discharge to surface water, BNL has discontinued STP discharge to the Peconic River in favor of discharging directly to groundwater. Work on the Sewage Treatment Plant upgrades for the conversion to a groundwater discharge system began in 2013 with the preparation of 4 recharge basins located in the former WW I sand filter beds south and southeast of the existing sand filter beds. The conversion of the STP discharge from a surface water discharge (Peconic River) to groundwater discharge was completed by October 2014.

Action items:

- Continue monitoring water quality of storm water basins as appropriate

Peconic River Flow Monitoring

Though effluent from the STP no long discharges to the Peconic River, flow continues to be measured at several locations including above the STP effluent discharge (Outfall HE estimated), 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). The need to continue flow monitoring and the potential for removing monitoring stations will also be evaluated. Removal or modification of the monitoring stations would improve fish migratory access during high flows.

Operable Unit (OU) V Peconic River Remediation Program

The Peconic River cleanup began in April 2004 and concluded in May 2005. Flows from the upstream portion of the river were diverted downstream past the east boundary of the Laboratory. This was done to facilitate the cleanup. 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 downstream out of the way of the project. Upon conclusion of cleanup 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. Monitoring of the cleanup success resulted in three additional areas being cleaned up in the 2010-2011 timeframe with subsequent restoration and monitoring taking place since then. Monitoring results since 2011 have identified an additional area (roughly 2,000 sq. ft.) that requires remediation.

With the overall success of cleanup efforts in the Peconic River and removal of discharges to the river there exists an opportunity to include wildlife viewing areas. This would provide an additional opportunity to educate employees and visitors alike of the natural resources that exist on site.

Action items:

- Continue monitoring flow of Peconic River.
- Explore the possibility of creating wildlife viewing areas.
- Evaluate removal of weirs and any other barriers to fish migration in the on-site portions of the Peconic River.

Fish Sampling in the Peconic River

Population assessments of the onsite portion of the Peconic River have been completed annually because of the remediation efforts. Fish sampling on the Peconic River has typically been initiated in April and continues through early June. The early season sampling allows for more and larger fish to be obtained. Sampling, when limited, does not appear to affect the population within the onsite portions of the river as numerous smaller fish are seen during sampling events.

Since BNL no longer discharges to the Peconic River and the river is often dry, the need for continued fish monitoring has been evaluated and the Data Quality Objectives for monitoring fish have been modified to reflect the changing situation, lack of water, lack of suitable fish populations, and sufficiently large enough fish that would support continued monitoring events. The next scheduled round of fish sampling associated with the Peconic River cleanup would normally occur in 2017. The Laboratory is preparing its third 5-year Review of clean-up effectiveness and the need for continued monitoring of fish will be addressed taking into consideration recent changes in the conditions of the river.

Law Enforcement

BNL currently participates in the Law Enforcement Taskforce under the Pine Barrens Commission. This group serves cooperatively to share law enforcement resources throughout the Pine Barrens region of Long Island. BNL can request additional law enforcement support from surrounding law enforcement agencies, including Suffolk County Police, Suffolk County Parks Police, Suffolk County Sheriff's Office, NYSDEC game wardens, NYSDEC Forest Rangers, and U.S. Fish & Wildlife Service officers. Typically, BNL detains violators and transfers them to the Suffolk County Police for disposition.

Law enforcement for natural resource protection is provided, as needed, by the BNL Laboratory Protection Division. Increased law enforcement is typically needed when trespass situations such as off-road vehicles (ATVs and dirt bikes) and poaching occur. ATV traffic has been an ongoing problem at BNL. Because the site is not completely fenced, there are ample ways for people to gain access to the Lab illegally and may use existing trails or create new trails and tracks for ATVs. ATVs disturb the soil, impact special status species habitat, increase erosion, destroy vegetation, and further fragment natural areas. This is particularly true of the sensitive areas around coastal plain ponds and vernal pools. BNL works with the Pine Barrens Law Enforcement Task Force and on-site security in an effort to deter ATV riders, but more needs to be done to prevent further destruction of important habitat.

Action items:

- Continue to monitor ATV use and damage.

- Continue to work with security and the Law Enforcement Task force to reduce ATV use at BNL and investigate deterrents such as felling trees across trails.
- Work with security on other trespass issues.

Forest Health Monitoring

In 2005, a consulting ecologist developed forest health monitoring protocols for the Upton Ecological and Research Reserve at BNL. The purpose of these protocols is to identify and measure both quantitative and qualitative indicators of the status of key ecological attributes of the forest, woodland and shrubland conservation targets in order to:

- Provide a baseline of the ecological integrity of conservation target condition;
- Detect and document long-term direction, rate and types of changes in attributes of the conservation targets;
- Provide baseline data to assist in setting management goals and developing adaptive management programs; and
- Identify research needs and priorities.

These protocols are designed to detect a 10% change in health over a ten-year period. When the data is collected again in 2015-2016, the data will be able to detect and document the degree and direction of change in forest health, and to assist in identifying priorities for management and research within the Long Island Pine Barrens. These protocols were implemented in 2005-6 and baseline data was collected at 13 plots on the BNL site and a total of 92 plots across the pine barrens.

Action item:

- Analyze all forest health data to assess changes over the previous 10 years.
- Revisit forest health monitoring plots in 2020-21 to collect monitoring data and analyze to determine changes.
- Monitor deer exclosures associated with 4 BNL forest health plots to determine effects of deer on forest health.

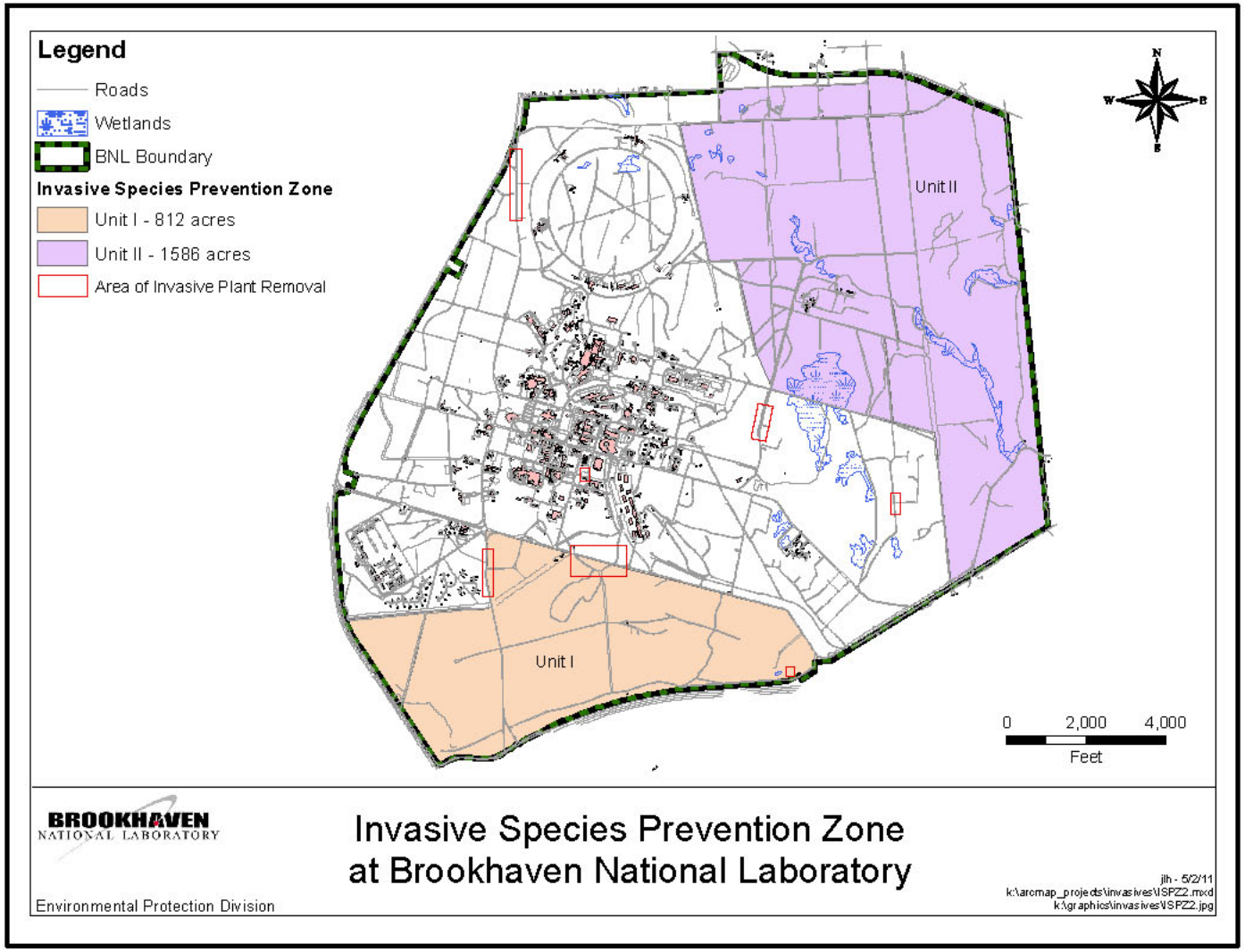
Southern Pine Beetle

The southern pine beetle (SPB; *Dendroctonus frontalis*) is a rice-sized native bark beetle ranging from Texas to Pennsylvania and from Arizona to Honduras in Central America. Over the last 10-15 years it has been increasing its range northward due in part to higher winter temperatures. It was detected on Long Island for the first time in September 2014. Considered one of the most destructive insect pests in the country, it has the potential to kill thousands of acres of pines during an outbreak.

Pitch pine, the predominant tree species of the pine barrens ecosystem, is a preferred host species for SPB. It kills trees in two ways: a) adult female beetles and larvae construct a network of S-shaped tunnels through the cambial layer which prevents the transport of carbohydrates to the roots, and b) SPB introduces blue-stain fungus (*Ceratocystis polonica*) which impedes the circulation of water throughout the tree, further stressing it. In the New Jersey Pinelands SPB can have up to seven generations in a year and tree mortality can occur in just a few short months.

SPB is now widespread throughout the forests on Long Island and has the potential to seriously impact the Long Island Pine Barrens. Long Island's forests have never been actively managed. Unlike many other areas of the country where forests are managed for timber, our forests do not experience regular thinning, and fire which is nature's way of regulating itself, has been removed from the ecosystem.

Figure 5. Location of ISPZs at BNL.



This lack of management has created forests that are too dense and full of over-mature trees, resulting in unhealthy, stressed forests. Stressed trees produce less oleoresin—their primary defense against insect attacks, and so they have lowered resistance to pests like SPB. In addition, without fire to consume leaf litter and other surface fuels to expose mineral soil, once the existing pitch pine trees die new pitch pines cannot germinate which could result in the complete loss of our pine barrens ecosystem.

Aerial and ground surveys conducted at BNL have shown that SPB can be found throughout the Lab, both in the central campus area around buildings as well as in forested areas on site. Populations are being monitored and management options are being explored. BNL has been consulting with the NYSDEC, the USFS, and others to determine possible long term solutions for dealing with this pest including suppression and preventative thinning. Suppression involves the cutting of infested trees plus an additional buffer of uninfested trees which disrupts the pheromone trail and slows the spread of infestations. This is only feasible for very small infestations, however.

Preventative thinning is the selective removal of trees from the forest. When used in conjunction with prescribed fire the benefits are twofold: a) in the short term, more open stands disrupt pheromone communication, and b) in the long term, a reduction in tree density results in healthier trees that are more resilient to SBP attacks.

Action item:

- Continue to monitor SPB populations.
- Explore management options including spot suppression, timber sales or no-cost contracts for thinning in conjunction with prescribed fire.

Prescribed Fire

The forested areas of BNL have had no active fire management for over 75 years. Presumably, throughout the entire history of the site, fire management has been limited to suppression tactics. The accumulation of excessive fuel loads in the forests at BNL supports this assertion. A specific management initiative for suppression, prescribed fire, and fuel reduction is needed to manage the forest assets at BNL and ensure ecological integrity, biodiversity, and the protection of natural, cultural, and economic resources.

A Wildland Fire Management Plan (FMP) was developed to cover these issues (BNL 2003). It addresses the suppression of wildfire, use of Minimum Impact Suppression Tactics (MIST), prescribed fire, and fuel reduction. The Wildland Fire Management Plan was updated and approved in 2014. An updated prescribed fire plan was developed for a 170-acre area of oak forest located in the northeast portion of the Laboratory. This plan is approved for a 5-year period with an annual review conducted prior to implementation.

An inventory of fuels in other areas of the Lab needs to be conducted and additional burn plans should be written. Fuels monitoring should be conducted regularly, particularly post-fire to determine the rate at which fuel loads recover. The impacts of southern pine beetle on the fuels complex must be evaluated as well.

Action item:

- Implement the Fire Management Plan.
- Monitor wildland fire fuels.
- Implement growing and dormant season prescribed fire (as appropriate) and mechanical treatments for ecological and fuel reduction purposes.

White Pine Stands

In addition to being considered a cultural resource the stands of white pine planted by the CCC over 70 years ago are a natural resource that is in need of management. Approximately 440 acres of white pine forest exists at BNL. These stands are in need of thinning in order to remain healthy, but in order to determine the most effective way to do this the Natural Resource Division must consult with the Forest Service and NYSDEC Foresters.

It would be cost prohibitive to hire an outside contractor to come in and selectively cut trees and have them transported off-site. Unfortunately, there are no longer any local lumber mills on Long Island interested in white pine and buying an old mill to process the lumber would likely be impractical. Another option would be to reach out to the Forest Service and/or private timber companies to determine if they would agree to remove the trees for the value of the timber.

Action Item:

- Enlist the help of the Forest Service and/or NYSDEC Foresters to explore the possibility of entering into a no-cost contract with a private timber company to cut and remove the trees for the value of the wood.

Invasive Species

It is important that an Adaptive Management approach be used in dealing with invasive species. The approach should always be comprehensive, examining all options and using IPM practices. IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques; such as manual and mechanical removal, grazing, biological control; modification of cultural practices, chemical application, and the use of prescribed fire. Pest control methods are selected and applied in a manner that minimizes risks to human health, to beneficial and non-target organisms, and to the environment. IPM methods seek to exploit a pest's innate biological weaknesses by timing efforts to coincide with specific parts of a species' life cycle. It is important to consider each available option, because it is often through a well-timed combination of different actions that the best control is achieved.

There are currently plans to re-survey the current ISPZ and expand the acreage to include additional wetlands that are documented tiger salamander habitat. Part of the relatively un-invaded white pine plantation may also be included. The ISPZ plan will be rewritten to reflect the changes.

As new funding sources become available, more active management of the invasive plants on-site will be considered. In the meantime, BNL will continue to participate in LIISMA and the Scientific Review Committee. In addition, the site should be monitored for spread of the existing infestations as well as the early detection of new species. This includes pests and pathogens as new species are being discovered and moved around the landscape. New species that are detected should be immediately mapped via GPS and management should be implemented as soon as possible to prevent further spread and keep control costs low.

As part of a prevention strategy, planting lists containing native and non-native species have been distributed to BNL's Facilities & Operations Division as a tool to aid in planning for new construction landscaping. Only native species and, if possible, local genotypes are being recommended for use in restoration projects.

Action Items:

- Re-survey the current ISPZ, explore addition of new areas to ISPZ and rewrite the ISPZ plan.
- Continue monitoring of existing infestations and surveys for new infestations of invasive plants as well as pests and pathogens.
- Manage invasive species infestations when possible with priority given to new species found on site.
- Utilize annual funding levels to implement invasive species management.
- Use native species and local genotypes where possible for restoration projects and new construction landscaping.

Population Monitoring & Management

Several species are of special interest for natural resource management. Some are highly noticeable (like deer and turkey), while others (songbirds and salamanders) are of interest to select groups of people or are of regulatory concern. Management of these populations may be primarily passive unless they are

determined to need active management to enhance, maintain, or reduce the population. Population management often includes managing and/or increasing suitable habitat so there may be some overlap with the previous section.

Special Status Species

Northern long-eared bat

The northern long-eared bat (NLEB) is a medium sized bat that, in the summer, tends to roost singly or in small colonies under bark and within the cavities and crevices of live and dead trees. They emerge at dusk to fly through the understory of mature forest feeding on moths, flies, leafhoppers, caddisflies, and beetles, which they catch while in flight using echolocation. This bat also feeds by gleaning motionless insects from vegetation and water surfaces (USFWS 2015).

Breeding occurs in late summer or early fall. After copulation, females store sperm during hibernation until spring when they emerge from their hibernacula, ovulate and the stored sperm fertilizes an egg in a strategy called delayed fertilization (USFWS 2015). After fertilization, pregnant females migrate to summer areas where they roost in small colonies of 30-60 individuals and give birth to a single pup in late May to late July. Young bats start flying by 18 to 21 days after birth (USFWS 2015).

NLEB was federally listed as threatened in April 2015. Its numbers have declined approximately 99% since white-nose syndrome (WNS; *Pseudogymnoascus destructans*) emerged in New York in 2006 through 2015. Similar declines have occurred in the northeastern part of their range (Turner *et al.* 2011; USFWS 2013). WNS is the single greatest threat to this species. The fungus may invade hair follicles and cause lesions under the skin causing bats to wake frequently from hibernation and consequently burn fat reserves that are needed to survive the winter resulting in emaciation (Blehert *et al.* 2009). Extensive damage to their wing membranes and dehydration may also be contributing factors to mortality (USFWS 2013).

At BNL, static and mobile acoustic surveys as well as mist-netting have been conducted during the growing season to determine the presence and extent of NLEB and other bat species since 2011. Though the presence of NLEB has been confirmed during the summer months, little data exist concerning winter habitat requirements in this area. Winter habitat for this species needs to be identified and management actions implemented, if necessary.

Despite the listing, the USFWS ruled that most forest management activities are unlikely to have a significant impact on populations of NLEB and its ability to recover so they have declined to regulate such activities. Currently, buildings scheduled for demolition have been inspected for the presence of bats prior to demolition and acoustic surveys are performed in forested areas prior to prescribed burns. These activities will continue in order to be proactive and with the intention to continue to collect information on this species.

Action items:

- Continue to monitor for the presence of NLEB in forested areas scheduled for management that may impact the bats (e.g. prescribed fire, thinning) and inspect buildings for bats prior to demolition.
- Track research findings on winter habitat needs during the dormant season on Long Island.

Frosted elfin

The frosted elfin is a small butterfly that lives at the edges of fields near woods or scrubs of Long Island. The frosted elfin, which is an obligate species and is limited to the use of wild lupine for egg laying and larval development, has been added to the special-status species list. Historically, NYSDEC and the New York Natural Heritage Program have documented frosted elfin within a single 30'X100' patch of lupine on BNL. This area of lupine will be maintained. In 2003, lupine seed was scattered in the RHIC Ring as part of the RHIC revegetation, and seeds were also scattered along the East Firebreak. Unfortunately, these

attempts were unsuccessful. Attempts to expand lupine populations will continue as more information is obtained about seed collection and preparation.

Action items:

- Continue to monitor the existing lupine patch for presence/absence of frosted elfin.
- Assess habitat needs for lupine.
- Increase the population of lupine on site by including it on planting lists and in management activities to promote pollinators (see section on pollinators).

Banded sunfish & swamp darter

The banded sunfish is a small sunfish that typically lives in heavily vegetated backwaters and deeper pools of the Peconic River system on Long Island. At BNL the banded sunfish is currently found only in Zeke's Pond. It has been managed passively by ensuring that water flow is maintained in the Peconic River. Historically, this has been accomplished, in part, by discharges to the river from the STP. Annual surveys conducted on the river between the STP and the East Firebreak documented the population and sizes of the banded sunfish within this stretch of the river. With the change of the STP discharge going from surface water to groundwater recharge, the Peconic River flow will result in the river functioning solely on groundwater fluctuation as it relates to precipitation patterns. The banded sunfish is currently not known to be found within onsite portions of the Peconic River but may colonize this stretch of the river when water is present. Occasionally, periods of high flow allow predatory fish such as brown bullhead to access to Zeke's pond and these fish can impact the banded sunfish population. Alternatively, extreme drought can also impact populations when both water and dissolved oxygen levels become exceptionally low. In these cases, it may be necessary to work with the NYSDEC to re-introduce banded sunfish to Zeke's Pond and perhaps to other suitable on-site areas of the Peconic River.

The swamp darter is a small fish that lives in still, dark waters of Long Island and often occurs with the banded sunfish. A single healthy population of this fish was identified during summer 2000 in Zeke's Pond. The drought of 2003 seems to have wiped out this population, however, surveys for this species will be conducted to confirm (or refute) its presence.

Action items:

- Continue monitoring banded sunfish populations biennially and survey for the existence of swamp darter on-site.
- Explore re-introduction of both species to on-site portion of the Peconic River as necessary.

Eastern 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 27 ponds or pond systems on site. In 2003, the addition of drift fence arrays around two ponds provided substantial information concerning the emergence of tiger salamanders from ponds. The tiger salamander population is apparently doing well at BNL. However, because the eastern tiger salamander is listed as a New York State endangered species, BNL will continue to protect and monitor its populations and habitat, and will conduct research, when possible, to better understand the biology and ecology of this species. BNL currently has a mechanism in place (a required digging permit) to ensure that BNL activities near tiger salamander habitat are reviewed prior to initiation and any activity that could be harmful is minimized; more significant actions require consultation with NYSDEC. In addition, all new construction projects are required to implement storm water controls such as silt fencing to mitigate the runoff of silt into the storm water system and, ultimately, into nearby ponds used by tiger salamanders.

Several of the known tiger salamander habitats are drainage or recharge basins. Periodic maintenance of these basins is necessary to ensure proper recharge capabilities. However, the timing of maintenance must be coordinated to ensure function of the basin as well as protection of tiger salamanders that may be present there. One known requirement for managing the tiger salamander population is a protocol for basin maintenance that will ensure adequate tiger salamander habitat.

Action items:

- Continue annual egg mass and larval surveys at breeding ponds.

Migratory Birds

As discussed previously, songbird surveys are conducted annually from April through August and will continue to be conducted in this manner. Some songbird species are also considered special status species within New York State (see Table 1) and BNL will manage habitat for these species when possible.

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 (*Sialia sialis*) is one of the better known birds for which nest boxes are important. The bluebird was once a species of special concern in New York State. The loss of natural cavities along with competition for available cavities from other cavity nesters like house wren, European starlings, house sparrows, and tree swallows resulted in declining populations. This species has recovered significantly due to massive efforts to provide artificial nest boxes in appropriate habitat, which exists at BNL as in other locations on Long Island.

BNL had 48 nest boxes distributed across the site in appropriate habitat (open fields near forested areas) in 2009. Several boxes were removed from around a recharge basin that was being enlarged to accommodate increased storm water flows. Additional boxes will be placed along the fence lines around the LISF site. House wrens, tree swallows, chickadees, and tufted titmouse also use the bluebird boxes.

All nest boxes including bluebird, wood duck, and kestrel boxes continue to be monitored by volunteers each year. Monitoring suggests limited use of wood duck boxes, and apparently no use of kestrel boxes is occurring.

Action items:

- Continue annual songbird surveys.
- Continue to maintain nest boxes where appropriate and monitor populations.
- Add nest box locations and other data to GIS library.
- Work with LISF to install nest boxes.

Other Species

Wild turkey

The wild turkey population at BNL appears to be flourishing and it is likely that it will continue to grow. It should be monitored for population health and watched to identify any potential nuisance situations that could require action.

Canada goose

Numerous requests for management of the geese were received in 2007 mainly dealing with presence of goose droppings on sidewalks and walkways. The population at the time was estimated at 157 individuals. In several instances geese were causing safety issues due to their defensive posturing to protect their nests. Due to the location of the nesting geese, some of the nests were destroyed, under permit, forcing the geese to move to another location. Because of the continued nuisance situations, the Natural Resource Program obtained a permit under new USFWS regulations established late in 2006 to manage nesting geese. Nest management continues annually and the population has been maintained at around 100 birds. This fluctuates dependent on success in locating and accessing goose nests. Approximately 20 nests are typically found each year.

Action items:

- Continue to monitor goose populations.
- Continue management and control of population by oiling eggs as necessary.

White-tailed deer

Without management the white-tailed deer population will continue to fluctuate and cause ecological damage to the forests and ornamental plantings at BNL. Both the USFWS and USDA-APHIS-WS have written environmental assessments for the management of deer populations at various locations across NY State. In the past, BNL has looked at the impacts of deer, conducted surveys to determine population size, as well as surveys to assess the attitude of BNL employees towards deer management. In 2008, BNL's Policy Council recommended establishing a deer management program.

An EA for deer management at the Lab was completed and adopted in 2013 and an initial cull of 300 deer was conducted in early 2015. Further reduction of the deer population is necessary and additional management activities will be implemented to establish and maintain a healthy and sustainable population.

Action items:

- Implement a deer management program.
- Continue estimation of the deer population.

Feral and nuisance animals

The existing feral cat colonies continue to be managed by an ad-hoc group of employees. There has been a minor decrease in the number of cats due to presence of several wild dogs that roamed through the BNL site in 2007. These dogs killed several of the feral cats before they were successfully captured and transferred to the Brookhaven Town animal shelter. One of the wild dogs gave birth to a litter of puppies. The Town allowed the mother to care for the puppies until they could be weaned and all of the puppies were adopted by local residents.

A general agreement on feral cats was established with the ad hoc cat managers. This agreement basically provides for the continued care of existing cats and does not allow any cats to be added to the colonies regardless of whether they are introduced or wander into a colony. This policy ensures that the colony size will be reduced over time. Data collected by simple ad hoc monitoring of cat colonies by care givers is routinely submitted to the Natural Resource Manager for review.

In general, Facilities and Operations staff resolves most feral and nuisance animal problems at BNL, however, problem identification, coordination, and resolution should, in part, be coordinated through the NRMP and the Natural Resource Manager in association with volunteer groups at the Laboratory. In the future many of these nuisance animals (raccoons, opossum, skunks and woodchucks) will be euthanized rather than be released in another part of the lab as the animals often return to the original site. Beneficial animals such as foxes should not be euthanized, but should be released elsewhere whenever possible. In instances when migratory birds become a problem Natural Resource Management will consult with USFWS and USDA-APHIS-WS in order to properly deal with the situation.

Action item:

- Continue implementation of BNL policy on feral animals.

Climate Change

As climate predictions become increasingly dire, natural resource managers continue to evaluate adaptation options for climate-sensitive ecosystems and seek actual on-the-ground implementation mechanisms. Resiliency is defined as the amount of change or disturbance that a system can absorb before it undergoes a fundamental shift to a different set of processes or structures. Helping to ensure the resilience of an ecosystem is predicated on maintaining the genetic diversity, biologic diversity, and heterogeneity of landscape mosaics within the system. To keep this diversity, ecosystem processes (*i.e.*, water cycle, mineral cycle, energy flow, and community dynamics) need to remain as intact as possible. Much of the natural resources management currently being done at BNL serves this very purpose, however, little is known about the impacts climate change will have on our ecosystems.

Action items:

- Track and monitor current research findings and management recommendations.
- Explore possibility of performing research on local effects of climate change on site.

Research

Long Island Solar Farm

As mentioned previously, the creation of the LISF presents us with a unique opportunity to conduct research not only on the impacts directly associated with the facility, but also on the comparative impacts white-tailed deer have on many aspects of an ecosystem. Below is a list of potential research areas which is by no means complete.

1) Comparative impacts from deer. This is a large facility that will exclude deer, but allow other wildlife to enter/exit via wildlife friendly fencing. Questions needing answers:
   a) Does LISF provide improved habitat for small mammals?
   b) Does LISF provide improved habitat for migratory songbirds including nesting habitat?
   c) Does LISF allow adequate growth and diversity of understory vegetation?
   d) Does the LISF improve habitat for eastern tiger salamanders beyond state mandated protection areas?
   e) Does LISF vegetation management provide adequate habitat for native insect pollinators?
   f) Can the LISF benefit threatened and endangered insect species through provision of critical host plants?

2) Wildlife Use of LISF & effectiveness of wildlife friendly fencing. Questions needing answers:
   a) Does wildlife utilize wildlife openings in fences? Is spacing adequate? Are openings appropriately sized? Are openings appropriately located?
   b) Do birds utilize LISF arrays for perching, hunting, and/or foraging?
   c) Are reptiles and amphibians impacted by fencing? Specifically, does fencing impact movements of the eastern box turtle, a NY State species of special concern?
   d) Do meso-carnivores (e.g. red foxes) differentially utilize habitats in and out of the LISF due to openings and variations in prey base?

3) LISF arrays are expected to concentrate acid rain and mercury deposition along a "drip line" on each array. Does this impact wildlife?
   a) Do localized acid conditions impact soil chemistry causing aluminum toxicity to the local plant community?
   b) Does localized deposition of mercury differentially increase mercury in insects, increasing bioaccumulation in insectivorous birds and bats?

4) LISF Heat Island Effects
   a) Does the heat island impact nearby wetlands and wetland dependent species (i.e. marbled salamanders, spring peepers, wood frogs)?
   b) Does the heat island impact waterfowl?
   c) Does the heat island impact success of nesting birds?
   d) Does the heat island impact surrounding wetland insects (mosquitoes, midges, Odonates)?

Action items:

- Support and conduct research as needed.
- Identify, attract, and support ecological research at BNL.

Education and Outreach

Natural resource management has historically been of high interest to educators and the general public. Because of the interest as well as the often-controversial nature of natural resource management

activities, a public outreach and education program is a necessity. A variety of educational activities have been developed and coordinated through the Office of Educational Programs and Stakeholder and Community Relations. Coordination through Stakeholder and Community Relations is needed to involve the public through participation in nature-oriented activities, outreach opportunities, and education.

Every year, interns are hosted to conduct ecological and wildlife research to assist in understanding how the natural environment works. The information gained from these projects is used to make management decisions at the Laboratory. Interns are high school or undergraduate students participating in the BNL's Office of Education summer programs. During 10 weeks, the students conduct experiments, population surveys, ecological monitoring, and other natural resource investigations. Students are required to complete a paper and/or poster as part of their internship.

Action items:

- Continue to provide educational materials to staff and the public on environmental issues. Materials will be updated and redistributed as necessary. The Natural Resources pages on the BNL website should be updated for continued use as public education.
- Continue to host interns to assist with and conduct research on-site as part of BNL's Office of Educational programs.

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APPENDICES

Appendix A - Tiger Salamander Habitat Management Plan

Protection of the Eastern Tiger Salamander

The eastern tiger salamander (*Ambystoma tigrinum tigrinum*) was officially listed as a state-endangered species in 1983 (NYS ECL, Article 11, Section 11-0535; NYSCRR Title 6, part 182.6). Populations have declined as a result of loss of habitat through development, road mortality during breeding migration, introduction of predatory fish to breeding sites, collection by the bait and pet trade, water level fluctuations, pollution, and general disturbance of breeding sites.

The eastern tiger salamander is afforded "protection from habitat destruction, harm or harassment" by NYSDEC. All State-recognized breeding sites and the 1000-foot radius buffer zone surrounding each site are considered critical habitat for breeding, and are accorded the highest priority for protection. An additional 350 feet beyond this area is also considered as critical to the resident adult population (Madison and Farrand 1998). Use of land around the breeding pond buffer zone is subject to State Environmental Quality Review Act proceedings (Naidu 1994, pers. comm.; NYSDEC 1994), and therefore this 850-foot buffer zone is monitored by BNL, in collaboration with NYSDEC as needed.

Biology of the Eastern Tiger Salamander

The eastern tiger salamander, an amphibian, is the largest of six mole salamanders (genus *Ambystoma*) found in New York. These salamanders seem to prefer the sandy, friable soils that are typical of pine-oak communities (*Pinus rigida*/*Quercus spp*.) on Long Island. However, tiger salamanders are also found in fields, lawns, gardens, and pastures. Tiger salamanders have been historically recorded from Central Nassau County and Jamaica, Queens County, far outside the limits of the Pine Barrens. Both adults and sub-adults lead a fossorial (underground) existence, foraging for invertebrates, insects, worms, and slugs through their own burrows or existing small-mammal burrows and root-ways (passages created when roots rot away). Occasionally, salamanders may move under leaf litter, through hollow logs, or beneath debris. Other mole salamanders potentially occurring in the same habitat include marbled (*A. opacum*), spotted (*A. maculatum)*, and blue-spotted (*A. laterale*) salamanders (Lawler *et al.* 1995). All mole salamanders have similar body configurations: broad, flat heads with protruding eyes, large mouths, thick bodies, and strong legs with thick blunt toes (four front and five rear). Adults are easily distinguished from juveniles by their color patterns and size. Larval salamanders are similar to adult salamanders in body shape, but body size, development, and coloration can usually be used to distinguish between the species (Figure A-1). Adult tiger salamanders may live 10 to 15 years in the wild and grow to total lengths of 9 to 10 inches. Natural predators include short-tailed shrews, fish, snakes, turtles, herons, and shorebirds. Insect larvae may also prey on the early larval stages of tiger salamanders.

Distribution

In the northeastern United States, tiger salamanders do not occur north of Long Island or in Pennsylvania. South of Long Island, tiger salamanders are found in southern New Jersey, Delaware, and Maryland. Tiger salamander populations on Long Island center around the towns of Brookhaven and Southampton. Since 1984, NYSDEC has confirmed over ninety active tiger salamander breeding sites on Long Island (Blais 1993), however, since then it has been observed that a number of such sites have been eliminated as breeding sites, except at the Laboratory site, where the largest number of sites were observed. Lawler, Matusky & Skelly (LMS) confirmed 13on-site locations as tiger salamander breeding habitat during 1994 surveys (Lawler *et al.* 1995), whereas NYSDEC previously listed only one area. The on-site number of breeding ponds has now been confirmed at 27 locations.

Figure A-1. Tiger salamander.

Breeding Patterns

In New York, tiger salamanders migrate to breeding ponds as early as late November (Titus 2007, pers. comm.) or as late as mid-April. The timing depends on winter weather conditions, when the possibility of hard rains or snow occurs. Migration usually takes place at night. As with most mole salamanders, rain or melting snow stimulates the adults to emerge from underground retreats and migrate to breeding ponds. Males usually outnumber females and reach the ponds first. Courtship begins when a female encounters one or more males. Males nudge the female and set spermatophores (sperm packets) in the sediment or on sticks and leaves. The female maneuvers herself to insert spermatophores into her cloaca, where sperm from the spermatophore fertilize her eggs. Within a few days after fertilization, females lay 200 to 400 eggs in several batches. The eggs are attached underwater to sticks and emergent/submerged vegetation about one foot below the surface of shallow (approximately 3-ft) ponds. Depending on water temperature, eggs hatch in 14 to 30 days (Blais 1993).

Newly hatched larvae are 0.50 to 0.68 inches long. They metamorphose from mid-June to early August (Blais 1993), with occasional emergence as late as mid-September (Feinberg 2003, pers. comm.). The aquatic larvae have fan-like gills, but gradually develop lungs in preparation for a terrestrial adult life. Larval salamanders feed on aquatic invertebrates (insect larvae, copepods), and are known to feed on the larvae of other amphibians. Larvae may undergo early metamorphosis in drying ponds. Mortality is high if the ponds dry up too rapidly. Adults leave the ponds soon after breeding, triggered by favorable weather conditions such as rain or high humidity; sub-adults migrate following metamorphosis.

Based on the above observations, the critical times for the salamander species are as follows:

- December to April for spotted and tiger salamander adults when they are most active, most often above ground and moving to and from breeding ponds (within the 1000-ft buffer zone radius).

- May to the end of July for metamorphosis as they leave the ponds and travel to upland shelters (within the 1000-ft buffer zone).

Survey Methodology

Tiger salamander surveys were first conducted in 1994. Twenty-three locations on the BNL site were checked at least once for adults or egg masses; 17 locations were checked for both adults and egg masses. During May and June, 11 sites were checked for larval tiger salamanders, primarily to verify species identification, which had tentatively been determined, based on size and configuration of egg masses. Survey locations included sites identified by NYSDEC as historical/confirmed or potential tiger salamander breeding habitats. Evaluations of potential habitat were first made on the basis of field and aerial photograph investigations. Figure A-2 (not included in public copies of this report) is a scaled depiction of the breeding locations. Superimposed on the map, at each confirmed or potential location, is a 1000-ft buffer zone. In order to minimize negative impacts to salamanders the NYSDEC requires that any project occurring within 1000 feet of tiger salamander breeding ponds include provisions to preserve 100% of the existing upland forest habitat within 535 feet of the breeding pond and preserve "a minimum of 50% of the adjacent upland area within 1,000 feet of breeding ponds in contiguous blocks of suitable habitat, while allowing for the preservation of wooded corridors which provide connections to adjacent tiger salamander upland habitats" (NYSDEC 2010). As previously mentioned, information on tiger salamander pond locations is not public information; hence, the map showing the confirmed breeding ponds does not appear in distributed copies of this report.

Survey timing is coordinated with NYSDEC, the agency responsible for conducting concurrent tiger salamander studies on Long Island. Surveys at BNL are organized and carried out, under permit, by the Natural Resource Manager. Egg mass surveys are carried out between the end of January and mid-April, and larval surveys are conducted annually during the month of June. Emergence studies occur annually around two or more ponds to evaluate the use of cover boards and drift fences, and factors influencing their use.

All known and potential tiger salamander habitat is surveyed annually for egg masses. However, ponds that were completely dry and documented as not having egg masses by mid-April are not surveyed for larvae in June. All ponds documented with egg masses are resurveyed for larvae, if just to document the pond's having dried between the time of egg mass production and expected larval development.

The sampling methodology follows the basic protocols provided by NYSDEC (1994) and survey results are recorded and reported on log sheets. Results of activities under a NYSDEC Threatened and Endangered Species Permit are submitted to the agency yearly with a request for permit renewal.

Habitat Protection Protocols

As part of the ongoing process to maintain and improve the suitability of the tiger salamander habitat and the tiger salamander breeding sites, each site (confirmed or potential) has been reviewed with NYSDEC staff. Improvements described below began to be implemented in 1999 as funding allowed, and all management actions established in 1999 have been implemented. The schedule for implementation of new and existing actions is given in Appendix C of the Natural Resource Management Plan. Figure A-2 shows the location of the sites. (Note: This map is confidential, and is not included in copies for general distribution.) Protection of this species consists of the following actions:

- Identify and map tiger salamander habitat.
- Improve existing knowledge of the annual timing of migration, breeding, and emergence. During these times, construction or maintenance activities by the Laboratory engineering staff will be minimized. An example would be to restrict recharge basin maintenance activities to occur between August and December, to avoid the tiger salamander breeding and larval developmental periods.
- Test water quality as part of the routine monitoring of the basins. The data will be used to assess water quality, as it may affect tiger salamander breeding and larval development. Water quality parameters are routinely taken at recharge basins receiving discharge waters permitted under BNL's

SPDES permit and include a broad suite of analytes. All ponds surveyed for egg masses and/or larvae have standard water quality parameters measured at the time of the egg mass or larval surveys. Water quality parameters routinely sampled during these events include temperature, salinity, conductivity, turbidity, and pH. No chemical analysis of natural ponds is conducted.

- Consult with NYSDEC on any action that could possibly impact known or suspected tiger salamander habitats. Consultations will be coordinated through the Natural Resource Management Program staff. To ensure this action, EPD, Facilities and Operations Division, and Environmental Management Directorate program managers have received a map of known tiger salamander breeding areas, with the understanding that this information will remain confidential. When certain activities are planned within the 1000-ft buffer zone, BNL staff will consult with the EPD, and NYSDEC as needed, in particular if the proposed action has the potential to significantly impact a confirmed breeding location (i.e., land clearing activities, well drilling near known or suspected habitat). All major activities involving soil penetration, clearing, scraping, and so forth require the completion of a digging permit, which contains a sign-off line for threatened and endangered species. Any significant activities within designated tiger salamander habitat areas would automatically trigger the requirement for consultation with NYSDEC prior to initiating the action. The purpose of this review is to ensure that the planned activity does not interfere with breeding or migration activity.
- Continue routine maintenance of roadways (including salting, snow plowing and mowing road shoulders) and periodic clearing of firebreaks, as these activities pose no direct impact to the breeding pools. However, whenever possible, conduct these activities before or after the breeding cycle, and consider potential impacts in surrounding areas during other sensitive stages of the tiger salamander's life cycle.
- Control and monitor the use of pesticides and salt. Pesticide application is tailored to minimize use. Agricultural fields are usually cultivated after the salamanders have completed their migration; however, the use of pesticides may require that a monitoring program be initiated to determine if pesticide residues in the water could impact the development of larvae and juveniles. Salting the road during winter and the potential of runoff entering the breeding areas will require monitoring of the runoff to evaluate the impact on larvae and juveniles. Currently, the following water quality parameters are monitored for natural bodies of water: temperature, pH, dissolved oxygen, conductivity, and salinity. In addition, water from recharge basins is monitored for those attributes plus chlorides, nitrates, sulfates, and metals.
- Beginning in 2000, the Natural Resource Management program has coordinated an annual survey of existing and potential tiger salamander habitats. The results of such surveys provide information for determining the length of the breeding period and provide an active window for construction activities in and around the breeding areas, and identify changes in site use and possible activities that could affect this species. Based on these surveys, re-evaluate the NRMP every five years or as appropriate and update it with the additional threatened or endangered species found on BNL property.

Confirmed Breeding Sites

The following describes known or suspected tiger salamander habitat protection plans for confirmed and unconfirmed breeding sites. Note that NYSDEC has records confirming approximately 107 breeding localities in New York State since 1983 – 1984. It is not known how many of these sites are still active. Some of these populations have been extirpated, and some were apparently never used by large numbers of breeding salamanders. NYSDEC personnel believe that a relatively small number of sites have confirmed breeding activity every year they are surveyed. Differences in observations may be due to biological phenomena or search/observer bias (McDougal 1998, pers. comm.). A "TS" designation indicates that the site is confirmed; "ts" means unconfirmed; "TS-W" means a wetland complex; and, "TS-A" means a man-made pond.

TS-1 is a vernal pool. This is a suitable habitat for breeding tiger salamanders, with appropriate submerged vegetation for attachment of egg masses. A number of potential predators are present, including bullfrogs, green frogs, painted turtles, and solitary sandpipers. This site has had egg masses

documented most years since 2000. The habitat is relatively undisturbed, but has occasional trespass visitation along pond margins.

TS-2 is a vernal pool. This is a suitable habitat for breeding tiger salamanders and develops appropriate attachment sites for egg masses most years (egg masses have been documented annually). The public uses this pond illegally as an ATV racetrack. The use of this pond by ATV users will continue to be monitored. BNL participates with the Law Enforcement Task Force of the Central Pine Barrens to patrol the area in an attempt to eliminate or at least limit the incidence of ATV use in the area. Should continued action be necessary, NYSDEC will be consulted to develop potential solutions to the problem.

TS-4a & b, also known as Zeke's Pond, is a large pond that once fed the Peconic River. It is known habitat for two state threatened fish, the banded sunfish and swamp darter. Water is generally persistent enough to maintain a predatory fish population, largemouth bass and brown bullhead catfish that likely would limit successful tiger salamander use. The drought of 2002 resulted in this pond drying up. Prior to the reintroduction of banded sunfish, this pond was surveyed for other fish. During that survey several larval tiger salamanders were identified, confirming this pond as a viable tiger salamander habitat. The pond will continue to be surveyed on an annual basis.

TS-5, a coastal plain pond, has been surveyed for egg masses and they are occasionally present. Dead adult tiger salamanders were documented in 2000 along the banks of the pond and larval tiger salamanders were documented in May 1994. The presence of fish has been routinely documented. It is likely that the pond is being stocked by individuals in the nearby neighborhood. No fish are currently in the pond.

TS-6, also known as the "water tank pond" was the only area on the BNL property identified as a significant habitat by NYSDEC (so designated because of its function as tiger salamander breeding habitat). The observation of several adult males and females, egg masses, and larvae attest to this. This pond is also known as habitat for marbled salamanders, red-spotted newts*, and four-toed salamanders. The pond will continue to be surveyed annually for egg masses and larvae.*

TS-7 is a modified wetland area used as a retention basin. It is also known as "Weaver Road Pond" or "Blue's Pond" and receives surface runoff from a man-made channel. The presence of adult salamander, egg masses, and larvae confirm that this retention basin provides breeding habitat for tiger salamanders. There is limited egg mass attachment, which does not seem to affect the use of this pond for production. There is some potential for road mortality during periods of salamander migration, and the basin receives runoff from a drainage ditch. Routine analyses of storm water runoff done during the year can be used to determine whether water quality in this pond is affected. The road adjacent to this pond has been blocked off to vehicular traffic because of occasional flooding. Blocking this road has prevented road kills, especially during the breeding season. This pond is routinely used for tiger salamander research to determine the timing and directional variation of emergence. Annual surveys will continue.

TS-8 is a coastal plain pond. The presence of males, females, and egg masses indicates that this pond provides a suitable habitat for tiger salamanders. This pond will continue to be surveyed for egg masses, larvae, and adults.

TS-9 is a sedge depression that becomes an elongated vernal pool by seasonal flooding. Presence of egg masses and larvae indicates that this pond may periodically (in wet years) provide a suitable habitat for tiger salamanders. This pond will continue to be surveyed for egg masses, larvae, and adults.

Figure A-2. Distribution of known and suspected tiger salamander habitat.

Note: This is a confidential map with restricted distribution. For more information call Dr. Timothy Green at 631-344-3091.

TS-10 is a man-made retention basin. The basin receives run-off and once-through non-contact cooling water from a large drainage ditch. This basin, until recently, had the potential of drying up and as such would not allow larvae to metamorphose to adult salamanders. However, diversion of once-through non-contact cooling water to this basin has resulted in a continuous water source. As a result, limited emergent and submerged vegetation has begun to establish within the basin. This basin was modified in 2009 to increase the retention volume to accept increased storm water flows associated with the NSLS-II. In 2010, heavy flows from the NSLS-II construction site carried significant amounts of silt to the basin, sealing the bottom preventing infiltration. The basin bottom will need to be scraped to allow infiltration and management of water levels at the correct depth for tiger salamanders.

TS-13 is a retention basin composed of two ponds. While the western most, larger basin allows rapid recharge with little potential for standing water, the eastern, smaller basin tends to retain water when used. Adult tiger salamanders were found in this basin; however, there was no evidence of egg masses or juveniles. In 2001 this basin contained water during the breeding season. While no egg masses were found, larvae were recovered in May 2001 as the basin began to dry down and were subsequently collected and transferred to a more permanent habitat. Because this basin may periodically be used for recharge of discharge waters, it will be managed as follows. If the basin is receiving, and retaining sufficient water for breeding from January through April, the water flow will be maintained through August of the year. If there is no water in the basin during breeding, then water may be diverted from this basin and flow terminated at any time for management purposes. This basin will continue to be included in annual surveys.

TS-13a (650 Sump) was created as part of the clean-up effort for the discharge lines and sump area. After cleanup the area was restored with native vegetation. The restoration was supposed to result in a recharge basin that would not hold water. The result, however, was a ponded area that immediately attracted tiger salamanders. Therefore, this pond is now managed as tiger salamander habitat.

TS-15 is a small depression located within a larger surrounding wetland area. Egg masses have been noted both within the depression and throughout the surrounding wetland. Both the depression and the wetland contain suitable attachment sites for egg masses. This pond will continue to be monitored annually during field surveys.

TS-15a has historically acted as a population sink for tiger salamanders because the berms prevented infiltration of water from the surrounding wetlands as the pond dried down. In dry years the pond dried prior to metamorphosis. As part of the environmental benefits work related to the Long Island Solar Farm, BP Solar modified TS-15a based on plans approved by the NYSDEC.

TS-18a &b are lined basins designed to capture sewage waters suspected of containing radiological or chemical contaminants above BNL's SPDES Permit limits. These two ponds, located at the east end of the Sewage Treatment Plant (STP), are lined with double plastic liners to prevent groundwater intrusion of potentially contaminated waters. Because the liners may tear or otherwise be damaged if not kept in place, several inches of water are maintained within the basins. This water is known to be a site of successful breeding by tiger salamanders, but the function of these ponds is protection of the Peconic River and groundwater from potentially harmful effluents. Therefore, these ponds are not specifically managed for tiger salamanders, but every effort is made, in coordination with NYSDEC, to ensure the protection of larval tiger salamanders should transfer actions need to occur.

TS-19 & TS-135 are small vernal pools that contain water only during years of high rainfall. When they do contain water they provide suitable habitat for tiger salamanders and egg masses have been detected in these ponds during wet years. These ponds will continue to be monitored annually.

TS-W3 is a vernal pool complex located in a large herbaceous wetland along the Peconic River within the RHIC ring. Presence of adult salamanders, egg masses, and larvae confirm this pool is a suitable habitat for tiger salamander breeding. However, this pond may receive road runoff from the William Floyd Parkway in wet years, as well as from the RHIC ring road. Much of the area contains sufficient egg mass sites on any given year. In most years this pond dries out prior to larval development. Annual surveys will continue to be conducted at this location.

TS-W4 is a series of small vernal pools. Presence of egg masses and larvae confirm this site as a breeding site for tiger salamanders. However, the pools are extremely small, often less than 20 square ft. of surface area and they tend to have high water temperatures and drying conditions prior to larval development. These small pools will likely be filled in as part of the Environmental Restoration program, but the adjacent TS-A7 pools will be upgraded to improve the habitat for tiger salamanders.

TS-A6a, TS-A6b, TS-A6c, TS-A6d and associated canal are all part of a recharge basin system receiving coolant water from facilities. Tiger salamander egg masses have been identified in the canal and at least one larval salamander has been documented in one of the ponds in 2000 and 2001. Historically, large numbers of fish were present in these ponds. Currently the ponds contain golden shiners that periodically die off due to drying conditions, high water temperatures, or low dissolved oxygen. The ponds are periodically maintained for recharge purposes. This maintenance activity will be coordinated to occur between August and December. TS-A6d is a large basin added to the complex in 2002. The northern end of this basin is to be planted with native vegetation to encourage use by the tiger salamander. The sides and outer surfaces of this basin are to be planted with native grasses to reduce erosion. Annual surveys will continue to occur to document the use of these ponds and the associated canal by tiger salamanders.

TS-A7 contains two man-made retention basins lined with plastic. The presence of adult salamanders, egg masses, and larvae during surveys confirm this as a breeding pond for salamanders. These basins have consistently provided suitable habitat for reproduction. However, no larvae have been documented since 2000. This is probably due to high water temperatures, low dissolved oxygen, and drying conditions. The Environmental Restoration Program will be removing known contamination from these ponds, forming one pond in the area, and constructing the single pond specifically to enhance tiger salamander habitat.

TS-W6a is in a wetland area shaded by a dense tree canopy. The area contains a man-made channel as well as four naturally occurring vernal pools. Egg masses indicate that tiger salamanders use this wetland. This site will continue to be surveyed annually.

TS-W6b is a vernal pool located across from TS-W6a. The presence of adult salamanders, egg masses, and larvae confirms that this pool is a breeding site for tiger salamanders. However, the pond typically dries up before the larvae transform to sub-adults. This pool also contains contaminants and is scheduled for environmental cleanup in the near future, to improve water retention capabilities. The pool will continue to be surveyed annually for egg masses, larvae, and adults as appropriate.

Unconfirmed Breeding Sites

ts-3 and **ts-17** are vernal pools located near confirmed tiger salamander habitats. Although the ponds appear to be undisturbed and have suitable habitat and ample egg attachment sites, no evidence of salamander use has been found. Because these ponds tend to be shallow and dry down, they are not likely to be suitable habitat except during the wettest years. These ponds will be surveyed when water is present during the breeding season. Ts-17a has been documented as containing tiger salamander egg masses in 2011. Verification of survival needs to occur in summer 2011.

ts-16 is composed of three recharge basins. Two smaller basins have been historically used for the discharge of cooling water associated with operations at Building 490. Those operations no longer occur and it is likely that these two basins will never receive sufficient water in the future to benefit tiger salamander breeding. The larger basin is currently being used for the discharge of water generated by a groundwater treatment system. The volume of water generated is sufficient to support tiger salamander breeding. However, the flow rates generated result in sufficient current to limit tiger salamander

breeding. This basin is also maintained specifically to enhance groundwater recharge, thus the basin has few, if any, suitable spots for egg mass attachment. This basin will continue to be surveyed for use by tiger salamanders, and maintenance of the basin will be coordinated to occur between August and December.

ts-11 was found to be suitable as a breeding site. However, this pond is outside the jurisdiction of BNL and will not be managed under the NRMP, with the exception of complying with legal requirements should any actions be proposed in the area on BNL property.

ts-12 is composed of two ponds within a flooded forest depression resulting from the discharge of once-through, noncontact cooling water. The amount of discharge water has decreased over the years and typical water levels are only 1-2 inches in the cooler months. The majority of the ponds are dry during warmer months. It is not likely that this area is suitable for breeding, but it will continue to be surveyed for evidence of use by the salamanders.

ts-W2 is located within the fence of the Gamma Forest and is composed of several small ponds associated with the Peconic River. Persistent water and egg mass attachment sites make this site suitable for tiger salamanders. However, the persistent water and connection to the river also provides habitat suitable to support fish. This site will continue to be monitored to document the presence or absence of tiger salamanders.

ts-W5 is composed of two small ponds located north of Brookhaven Avenue near TS-W6b (a confirmed site). These pools hold water for extended periods only in wet years. The pool will be visited annually and surveyed only if it contains water during the breeding season.

ts-14 (Note: this pool was mistakenly included as a confirmed location under the Wildlife Management Plan. The designation has been changed from TS-14 to ts-14). This pool is located at the northeast corner of the sludge drying beds that were once part of the STP. The pond was likely used as a final settling basin for the WW I facility. The Peconic River flows into the pond on the west and exits the pond on the east. The depth of the pond is unknown but exceeds 6 ft. The depth of the pond has prevented the accurate survey for egg masses, larvae, and adults. It is not likely that this is suitable breeding habitat due to the presence of fish (brown bullhead, chain pickerel, etc.).

Appendix B - Protection of Threatened Fish

Introduction

As indicated earlier, the banded sunfish (*Enneacanthus obesus*) and swamp darter (*Etheostoma fusiforme*), Figure B-1 and B-2, are listed as threatened within New York State. They are not, however, in any protection category with the federal government. The reason for state threatened status is that the only remaining populations of the banded sunfish and swamp darter in New York are in eastern Long Island and these sites are considered vulnerable to adverse environmental impacts. The habitat of these fish is primarily in slow water areas within lakes, ponds, and backwaters of streams and rivers (Breeder, 1936). Their preferred substrate is sand or mud, and other preferred areas are often shallow with vegetation over detritus-laden bottoms. Vegetation in these areas is dense enough to maintain a viable habitat for both fish.

Protection or Enhancement of Threatened Fish Habitat

The current water and vegetation conditions in the Peconic River and large ponds associated with the river on site support the requirements for successful habitation by banded sunfish and swamp darters, as observed during the exploratory and routine sampling of fauna by BNL and NYSDEC. The primary impacts on such habitats have been predominantly natural. For example, lower than normal rainfall followed by extended drought conditions has contributed to lowering of the water table, leading to decreased water-flow in the river and drying of ponds.

Given the above characteristics of the habitat of the banded sunfish, protection of threatened fish is based on the following actions:

- Eliminating, reducing, or controlling pollutant discharges. Discharges to the Peconic River are evaluated for pollution control at the *source*, as opposed to pollution control at the discharge point into the Sewage Treatment Plant (STP) or the recharge basins. BNL has a pollution prevention/process evaluation program that evaluates sources and develops and implements pollution prevention measures. Periodic reports are prepared on the pollution prevention program and progress.

- Ensuring that existing vegetation in the sunfish habitat area is not disturbed. This is accomplished by reviewing all activities that are proposed in the Peconic River on site. If the selected environmental-restoration remedy for the contaminated sediment in the Peconic River is excavation and removal, the extent and duration of any disturbance will be minimized as much as possible and the habitat should be restored when the project is completed.

- Continuing to monitor the banded sunfish population by routine sampling of the river in cooperation with NYSDEC's Fisheries Branch and Cold Springs Harbor Fish Hatchery and Museum. Population counts and size measurements are made during the sampling surveys.

- Reducing potential predator species in Zeke's Pond. For example, pickerel and largemouth bass are removed during the fish-sampling program. A record of the number of pickerel and largemouth bass taken is logged at each sampling event to determine the success of controlling predators.

- Ensuring that on-going remediation efforts do not have an unacceptable impact on habitats. It is anticipated that the Peconic River may undergo a significant cleanup. A remedial system design is in progress involving proposals to dredge the sediment on site to remove contaminants. The final decision has not been made. However, it is understood that any remedial action must consider the impact on the flora and fauna of the Peconic River, and that the habitat of the banded sunfish will be factored into the final assessment of the cleanup operation.

- Restoration after natural disaster occurs. The swamp darter is known to exist at only one BNL location, Zeke's Pond. The population and water levels of this site are periodically evaluated to determine continued suitability for this fish. Unfortunately, the drought of 2002 resulted in the complete drying of this pond, with the subsequent loss of the swamp darter population inhabiting the area. Consultation

with NYSDEC Freshwater Fisheries should discuss the implementation of a restoration project.

Figure B-1. Banded sunfish.

Figure B-2. Swamp darter.