6 Natural and Cultural Resources

The Brookhaven National Laboratory Natural Resource Management Program is designed to protect and manage flora and fauna and the ecosystems in which they exist. The Laboratory's natural resource management strategy is based on understanding the site's resources and on maintaining compliance with applicable regulations. The goals of the program include protecting and monitoring the ecosystem, conducting research, and communicating with on-site personnel and the public on ecological issues. BNL focuses on protecting both Federal and New York State threatened and endangered species on site, as well as continuing the Laboratory's leadership role within the greater Long Island Central Pine Barrens ecosystem. Monitoring to determine whether current or historical activities are affecting natural resources is also part of the program. In 2014, deer, fish, and vegetation sampling results were consistent with previous years.

The overriding goal of the Cultural Resource Management Program is to ensure that proper stewardship of BNL historic resources is established and maintained. Additional goals of the program include maintaining compliance with various historic preservation and archeological laws and regulations, and ensuring the availability of identified resources to on-site personnel and the public for research and interpretation.

6.1 NATURAL RESOURCE MANAGEMENT PROGRAM

The Natural Resource Management Program at BNL promotes stewardship of the natural resources found at the Laboratory, and integrates natural resource management and protection with the Laboratory's scientific mission. BNL's Natural Resource Management Plan (NRMP) describes the program strategy, elements, and planned activities for managing the various natural resources found on site. The NRMP is updated every five years (BNL 2011).

6.1.1 Identification and Mapping

An understanding of an environmental baseline is the foundation of natural resource management planning. BNL uses digital global positioning systems (GPS) and geographic information systems (GIS) to clearly relate various "layers" of geographic information (e.g., vegetation types, soil condition, habitat, forest health, etc.). This is done to gain insight into interrelationships between the biotic systems and physical conditions at the Laboratory.

In 2012, a forest fire was started on the northern part of the BNL site, burning approximately 300 acres and an additional 700 acres off site. Within two days of the fire, BNL natural resource personnel began recording the extent of the fire using GPS, established photo points, and began tracking both fire damage and post-fire recovery. Maps of the fire and photo locations were entered into the GIS for future reference and the burned areas are revisited periodically to track recovery. A deer exclosure area was established to track impacts of BNL's high deer population on the burn area as it continues to recover.

Work associated with tracking impacts from the construction of the Long Island Solar Farm (LISF) at BNL continue to be entered into the GIS as a tool to assist analysis of changes to wildlife populations and vegetation. In 2014, natural resource personnel and interns

continued to look at use of the LISF site by wildlife; use of fence openings by wildlife; changes in bird use; and changes in vegetation.

A wide variety of vegetation, birds, reptiles, amphibians, and mammals inhabit the site. Through implementation of the NRMP, endangered, threatened, and species of special concern have been identified as having been resident at BNL during the past 30 years or are expected to be present on site (see Table 6-1). The only New York State endangered species confirmed as currently inhabiting Laboratory property is the eastern tiger salamander (*Ambystoma t. tigrinum*). Six other New York State endangered species have been identified at BNL in the past or are possibly present including: the Persius duskywing butterfly (*Erynnis p. persius*), the crested fringed orchid (*Plantathera cristata*), Engelman spikerush (*Eleocharis engelmannii*), fireweed (*Erectites heiracifolia var. megalocarpa*), dwarf huckleberry (*Gaylussacia bigeloviana*), and whorled loosestrife (*Lysimachia quadrifoli*).

Seven New York State threatened species have been positively identified on site and three other species are considered likely to be present. Threatened species include two fish, the banded sunfish (*Enneacanthus obesus*) and swamp darter (*Etheostoma fusiforme*); and plants, including the stiff-leaved goldenrod (*Oligoneuron rigida*), stargrass (*Aletris farinose*), and eastern showy aster (*Eurybia spectabilis*). The northern harrier (*Circus cyaneus*) is periodically seen in the fall. Insects listed as threatened include the Pine Barrens bluet (*Enallagma recurvatum*), a damselfly, which was confirmed at one of the many coastal plain ponds located on site. Two other damselflies, the little bluet (*Enallagma minisculum*) and the scarlet bluet (*Enallagma pictum*), are likely to be present at one or more of the ponds on site. The frosted elfin (*Callophrys irus*), a butterfly, has been historically present on site due to its preferred habitat and host plant, wild lupine (*Lupinus perennis*).

A number of other species that are listed as rare, of special concern, or exploitably vulnerable by New York State either currently inhabit the site, visit during migration, or have been identified historically are listed in Table 6-1.

BNL historically has had no federally threatened or endangered species present on site. On October 2, 2013, the U.S. Fish & Wildlife Service (FWS) published a notice in the Federal Register that the northern long-eared bat (*Myotis septentrionalis*) be recommended for listing as an Endangered Species under the Federal Endangered Species Act. The comment period was extended two times with a final determination to be completed late in 2014 and listing to occur in early 2015. The northern long-eared bat is known to be present at BNL, having been identified as the first case of white-nosed syndrome found on Long Island in 2011. Work on identifying bats continued in 2014 and is discussed in Section 6.5.

6.1.2 Habitat Protection and Enhancement

BNL has administrative processes in place to protect on-site habitats and natural resources. Activities to eliminate or minimize negative effects on endangered, threatened, or sensitive species are either incorporated into Laboratory procedures or into specific program or project plans. Human access to critical habitats, when necessary, is limited, and habitats are enhanced to improve survival or increase populations. Routine activities, such as road maintenance, are not performed until the planned activities have been evaluated and determined to be unlikely to affect habitat.

6.1.2.1 Salamander Protection Efforts

Many safeguards are in place to protect eastern tiger salamander breeding areas. BNL staff must review any project planned near eastern tiger salamander habitats, and every effort is made to minimize impacts. A map of the breeding areas is reviewed when new projects are proposed. The map is updated as new information concerning the salamanders is generated through research and monitoring. The current map incorporates buffer areas around tiger salamander habitats of 1,000 feet based on guidance from the New York State Department of Environmental Conservation (NYSDEC). Other efforts to protect this state-endangered species include determining when

adult salamanders are migrating toward breeding locations, when metamorphosis has been completed, and when juveniles are migrating after metamorphosis. During these times, construction and maintenance activities near their habitats are postponed or closely monitored.

Water quality testing is conducted as part of the routine monitoring of recharge basins, as discussed in Chapter 5. In cooperation with NYSDEC, habitat surveys have been routinely conducted since 1999. Biologists conducting egg mass and larval surveys have confirmed 26 on-site ponds that are used by eastern tiger salamanders. In 2014, egg mass surveys confirmed the presence of salamanders in 5 of the 26 ponds. Whenever possible, ponds with documented egg masses from the spring surveys are revisited in June and July to check for the presence of larval salamanders.

Protection of the eastern tiger salamander was a key component of the Environmental Assessment (EA) conducted for the LISF project. The unique shape of the LISF facility is, in part, the result of a need to provide sufficient, viable habitat for the tiger salamander. In 2010, the LISF project completed habitat enhancements to improve one pond in the area, with the enhancements intended to allow the pond to retain water for longer periods of time to support larval development. The enhanced pond is currently being managed to remove invasive plants that moved into the pond from surrounding areas. Several areas of the LISF have maintained standing water since construction, and these areas have been monitored for use by amphibians but have not been identified as supporting tiger salamanders.

6.1.2.2 Banded Sunfish

Banded sunfish protection efforts include observing whether adequate water is present within areas currently identified as sunfish habitat, ensuring that existing vegetation in their habitat is not disturbed, and evaluating all activities taking place in ponds and the Peconic River on site for potential impacts on these habitats. Population estimates are periodically conducted within these waters to determine their current health. During the last population

Table 6-1. New York State Threatened, Endangered, Exploitably Vulnerable, and Species of Special Concern at BNL.

Common Name	Scientific Name	State Status	BNL Status
Insects			
Black-bordered lemon moth	*Marimatha nigrofimbria*	SGCN	Confirmed
Comet darner	*Anax longipes*	SGCN	Confirmed
Frosted elfin	*Callophrys iris*	T	Likely
Little bluet	*Enallagma minusculum*	T	Likely
Mottled duskywing	*Erynnis martialis*	SC	Likely
New England bluet	*Enallagma laterale*	SGCN	Likely
Persius duskywing	*Erynnis persius persius*	E	Likely
Pine Barrens bluet	*Enallagma recurvatum*	T	Confirmed
Pine barrens zanclognatha	*Zanclognatha martha*	SGCN	Confirmed
Scarlet bluet	*Enallagma pictum*	T	Likely
Fish			
Banded sunfish	*Enniacanthus obesus*	T	Confirmed
Swamp darter	*Etheostoma fusiforme*	T	Confirmed
Amphibians			
Eastern spadefoot toad	*Scaphiopus holbrookii*	SC	Confirmed
Eastern tiger salamander	*Ambystoma tigrinum tigrinum*	E	Confirmed
Four-toed salamander	*Hemidactylium scutatum*	SGCN	Confirmed
Fowler's toad	*Bufo fowleri*	SGCN	Confirmed
Marbled salamander	*Ambystoma opacum*	SC	Confirmed
Reptiles			
Eastern box turtle	*Terrapene carolina*	SC	Confirmed
Eastern hognose snake	*Heterodon platyrhinos*	SC	Confirmed
Eastern ribbon snake	*Thamnophis sauritus*	SGCN	Confirmed
Northern black racer	*Coluber constrictor*	SGCN	Confirmed
Snapping turtle	*Chelydra serpentina*	SGCN	Confirmed
Spotted turtle	*Clemmys guttata*	SC	Confirmed
Stinkpot turtle	*Sternotherus odoratus*	SGCN	Confirmed
Worm snake	*Carphophis amoenus*	SC	Confirmed
Birds (nesting, transient, or potentially present)			
Black-billed cuckoo	*Coccyzus erythropthalmus*	SGCN	Confirmed
Blue-winged warbler	*Vermivora pinus*	SGCN	Confirmed
Brown thrasher	*Toxostoma rufum*	SGCN	Confirmed
Cooper's hawk	*Accipiter cooperii*	SC	Confirmed
Glossy ibis	*Plegadis falcinellus*	SGCN	Confirmed
Grasshopper sparrow	*Ammodramus savannarum*	SC	Confirmed
Great egret	*Ardea alba*	SGCN	Confirmed
Horned lark	*Eremophila alpestris*	SC	Confirmed
Northern bobwhite	*Colinus virginianus*	SGCN	Confirmed
Northern harrier	*Circus cyaneus*	T	Confirmed
Osprey	*Pandion haliaetus*	SC	Confirmed
Prairie warbler	*Dendroica discolor*	SGCN	Confirmed
Red-headed woodpecker	*Melanerpes erythrocephalus*	SC	Confirmed
Scarlet tanager	*Piranga olivacea*	SGCN	Confirmed
Sharp-shinned hawk	*Accipiter striatus*	SC	Confirmed
Whip-poor-will	*Caprimulgus vociferus*	SC	Confirmed
Wood thrush	*Hylocichla mustelina*	SGCN	Confirmed
Plants			
Bayberry	*Myrica pensylvanica*	V	Confirmed
Bracken fern**	*Pteridium alquilinum var. pseudocaudatum*	E	Possible
Butterfly weed	*Asclepias tuberosa ssp. interior*	V	Confirmed
Cinnamon fern	*Osmunda cinnamomea*	V	Confirmed

(continued on next page)

Table 6-1. New York State Threatened, Endangered, Exploitably Vulnerable, and Species of Special Concern at BNL *(concluded).*

Common Name	Scientific Name	State Status	BNL Status
Clayton's fern	*Osmunda claytoniana*	V	Confirmed
Crested fringed orchid	*Plantathera cristata*	E	Likely
Dwarf huckleberry	*Gaylussacia bigeloviana*	E	Confirmed
Eastern showy aster**	*Eurybia spectabilis*	T	Confirmed
Engelman spikerush	*Eleocharis engelmannii*	E	Confirmed
Fireweed**	*Erectites heiracifolia var. megalocarpa*	E	Possible
Flowering dogwood	*Cornus florida*	V	Confirmed
Green fringed orchid	*Platanthera lacera*	V	Confirmed
Ground pine	*Dendrolycopodium obscurum*	V	Confirmed
Long-beaked bald-rush	*Rhynchospora scirpoides*	R	Confirmed
Marginal wood fern	*Dryopteris marginalis*	V	Confirmed
Marsh fern	*Thelypteris palustris var. pubescens*	V	Confirmed
Narrow-leafed bush clover	*Lespedeza augustifolia*	R	Confirmed
New York fern	*Thelypteris novaboracensis*	V	Confirmed
Pink lady's slipper	*Cypripedium acaule*	V	Confirmed
Possum haw**	*Viburnum nudum var. nudum*	E	Possible
Prostate knotweed**	*Polygonum aviculare ssp. buxiforme*	E	Possible
Round-leaved sundew	*Drosera rotundifolia var. rotundifolia*	V	Confirmed
Royal fern	*Osmunda regalis*	V	Confirmed
Sheep laurel	*Kalmia angustifolia*	V	Confirmed
Small-flowered false foxglove	*Agalinis paupercula*	R	Confirmed
Spotted wintergreen	*Chimaphila maculata*	V	Confirmed
Stargrass	*Aletris farinosa*	T	Confirmed
Stiff-leaved goldenrod	*Oligoneuron rigida*	T	Confirmed
Swamp azalea	*Rhododendron viscosum*	V	Confirmed
Virginia chain-fern	*Woodwardia virginica*	V	Confirmed
Whorled loosestrife	*Lysimachia quadrifolia*	E	Confirmed
Wild lupine	*Lupinus perennis*	R	Confirmed
Winterberry	*Ilex verticillata*	V	Confirmed

Notes:
* Table information based on 6 NYCRR Part 182, NYCRR Part 193, and BNL survey data.
** Species added in 2014
No federally listed threatened or endangered species are known to occur at BNL.

E = endangered
R = rare
T = threatened
SC = species of special concern
SGCN = species of greatest conservation need
V = exploitably vulnerable

survey in 2011, approximately 6,400 banded sunfish were counted. In 2014, in conjunction with NYSDEC, tissue samples from banded sunfish were obtained from several ponds within the Peconic River drainage to further investigate the genetic relationships of the various isolated populations of this fish. Work was conducted by student researchers under the direction of a research teacher in Sayville, New York.

6.1.2.3 Migratory Birds

A total of 216 species of birds have been identified at BNL since 1948; at least 85 species are known to nest on site. Some of these nesting birds have shown declines in their populations nationwide over the past 30 years. The Laboratory conducts routine monitoring of songbirds along seven permanent bird survey routes in various habitats on site. A new route was established in 2010 in the vicinity of the LISF.

In 2014, monthly surveys were conducted starting at the end of April and extending through the end of August. Two routes associated with the LISF were monitored twice monthly from the end of April through mid-September. These surveys identified 70 songbird species, compared to the 74 species identified in 2013 and 69 species in 2012. A total of 132 bird species have been identified in surveys in the past 14 years; 59 of these species were present in each of the past 15 years. Variations in the number and species identified during each survey may reflect the time of observation, variations in weather patterns between years, and possible changes in the environment. The three most diverse transects pass near on-site wetlands near the LISF and the Peconic River. The four transects passing through the various forest types on site (white pine, moist pine barrens, and dry pine barrens) showed a less diverse bird community. Bird survey data are stored in an electronic database for future reference and study.

In 2013, BNL worked with a statistician to analyze 13 years of collected data. This effort found that 20 percent of the bird species accounted for 80 percent of the number of birds detected on bird surveys. This is known as the Pareto Principle, or the 80-20 rule: approximately 80 percent of the effects come from 20 percent of the causes (Rispoli, et al. 2014). Statistical analysis of the bird survey data continued in 2014.

No known data on the effects of a large, utility-scale solar array such as the LISF are known within scientific literature. To assess the effects of the solar farm on local bird populations, the collection of migratory bird data in both the Biology Field transect and the LISF transect

is important. It is currently predicted that the LISF will improve habitat for some migratory birds over time, as understory vegetation grows below the arrays and deer are kept out of the area. One species, the indigo bunting (*Passerina cyanea*), was absent along the Biology Field transect in 2011, but was heard along the solar farm transect in 2012, returned to the Biology Field transect in 2013, and was present on both transects in 2014. This temporary absence is thought to be due to disturbance from construction activities while building the LISF.

The eastern bluebird (*Sialia sialis*) has been identified as a declining species of migratory birds in North America. This is due to loss of habitat and nest site competition from European starlings (*Sturnus vulgaris*) and house sparrows (*Passer domesticus*). BNL's NRMP includes habitat enhancement for the eastern bluebird. Since 2000, the Laboratory has installed more than 56 nest boxes around open grassland areas on site to enhance their population. Although many of these boxes were removed from service in 2010 in preparation for the construction of the LISF, the LISF created nearly 200 acres of suitable habitat for the eastern blue bird. Forty new boxes were installed around the northern most portions of the solar farm in 2012.

Migratory birds occasionally cause safety and health concerns, particularly Canada geese (*Branta canadensis*) and several species of migratory birds that occasionally nest on buildings or in construction areas on site. Over the past several years, the resident Canada goose population at BNL began increasing, with the potential to reach large enough numbers that could result in health and safety issues. In 2007, under a permit from FWS, the Laboratory began managing the resident goose population by limiting the number of eggs that could hatch. In 2014, 25 nests were treated and approximately 24 goslings were produced. By the end of 2014, the goose population was estimated at just over 100 birds.

6.1.3 Population Management

In addition to controlling resident Canada goose populations described above, the Laboratory also monitors and manages other populations, including species of interest, to ensure that they are sustained and to control invasive species.

6.1.3.1 Wild Turkey

The forested areas of BNL provide good nesting and foraging habitat for wild turkey (*Meleagris gallapavo*). In 2014, the on-site population was approximately 300 birds. In 2009, the wild turkey population across Suffolk County, Long Island, was determined to be of sufficient size to support hunting. Each year, NYSDEC manages a five-day hunting period for several areas across Long Island, which typically results in over 100 birds taken.

6.1.3.2 White-Tailed Deer

BNL consistently updates information on the resident population of white-tailed deer (*Odocoileus virginianus*). As there are no natural predators on site, and hunting is currently not permitted at the Laboratory, there are no significant pressures on the population to migrate beyond their typical home range of approximately 1 square mile. Normally, a population density of 10 to 30 deer per square mile is considered an optimum sustainable level for a given area. This would equate to approximately 80 to 250 deer inhabiting the Laboratory property under optimal circumstances. This was the approximate density in 1966, when BNL reported an estimate of 267 deer on site (Dwyer 1966). The Laboratory has been conducting routine population surveys of the white-tailed deer since 2000. The fall 2014 survey estimated the population at approximately 830 animals.

Deer overpopulation can affect animal and human health (e.g., animal starvation, Lyme disease from deer ticks, collision injuries to both humans and animals), species diversity (songbird species reduction due to selective grazing and destruction of habitat by deer), and property damage (collision damage to autos and browsing damage to ornamental plantings). Deer related collisions on site are less common than in the past, presumably due to improved vehicular speed controls and employee training.

High deer populations are a regional problem,

and the Laboratory is just one area on Long Island with such an issue. In 2012, several governmental entities on eastern Long Island began working to manage deer populations and the USDA-Wildlife Services, in cooperation with NYSDEC and the Suffolk County Farm Bureau, planned a limited culling operation. Culling was to start in several of Long Island's east end towns in late 2013, but was delayed to early 2014 due to public concerns about the program. The program eventually resulted in 192 deer taken in just one east end town.

In 2008, BNL began developing a deer management plan which included an option to reduce the population through culling. The planning effort included engagement of Laboratory employees and guests in discussions concerning the need and methods for deer management. In 2012, an EA under the National Environmental Policy Act (NEPA) was completed and sent to NY State for comment. The Final EA was completed in the spring of 2013. Additionally, under BNL's permit for deployment of the 4-Poster tick management system issued by NYSDEC, the Laboratory is required to implement a deer management program. Planning for implementing the deer cull continued through 2014 with a contract to reduce the deer population by 300 animals being in place at year's end.

6.1.4 Compliance Assurance and Potential Impact Assessment

The NEPA review process at BNL ensures that environmental impacts of a proposed action or activity are adequately evaluated and addressed. The Laboratory uses NEPA reviews when identifying potential environmental impacts associated with site activities, especially projects that may result in physical alterations to the landscape and structures. As appropriate, stakeholders such as EPA, NYSDEC, Suffolk County Department of Health Services (SCDHS), BNL's Community Advisory Council, and the Brookhaven Executive Roundtable are involved in reviewing major projects that have the potential for significant environmental impacts. Formal NEPA reviews are coordinated with the State of New York. No Environmental Assessments were conducted in 2014.

6.2 UPTON ECOLOGICAL AND RESEARCH RESERVE

The Upton Ecological and Research Reserve (Upton Reserve) consists of 530 acres located on the eastern boundary of the BNL site. The reserve has been designated as an area for the protection of sensitive habitats and a place where researchers can study local ecosystems. The Upton Reserve is home to a wide variety of flora and fauna. It contains wetlands and is largely within the core preservation area of the Long Island Central Pine Barrens. Based on information from a 1994–1995 biological survey of the Laboratory, experts believe the reserve is home to more than 200 plant species and at least 162 species of mammals, birds, fish, reptiles, and amphibians (LMS 1995).

The Upton Reserve is managed by BNL and the Foundation for Ecological Research in the Northeast (FERN). Funding is coordinated for research projects that occur within the reserve and the larger pine barrens area of Long Island. Research supported by FERN in 2014 includes: formal results of the work on leopard frogs was published in which a new species, *Rana (Lithobates) kauffeldi*, was described from locations on Staten Island (Feinberg, et. al 2014). Other research supported by FERN included continued investigation into bat populations on Long Island that were impacted by white-nosed syndrome and the funding of a leopard frog identification guide to help differentiate the newly discovered species of leopard frog in the northeast. Information on these projects and others is provided in Section 6.5.

6.3 MONITORING FLORA AND FAUNA

The Laboratory routinely conducts surveillance monitoring of flora and fauna to determine the effects of past and present activities on site. In addition to surveillance monitoring, routine CERCLA-required monitoring results associated with post-cleanup monitoring of the Peconic River is also conducted. Because soil contaminated with a radioactive isotope of cesium (Cs-137) was used in some BNL landscaping projects in the past, traces of Cs-137 can be found in deer and in other animals and plants on site. At the cellular level, Cs-137 takes the place

of potassium (K), an essential nutrient. Most radionuclide tables in this chapter also list analytical results for potassium-40 (K-40), a naturally occurring radioisotope of potassium that is commonly found in flora and fauna. Studies indicate that Cs-137 out-competes potassium when potassium salts are limited in the environment, which is typical on Long Island. Including K-40 in tables allow for a comparison with Cs-137 levels and is used, in part, to determine the accuracy of analytical results. The results of the annual sampling conducted under the flora and fauna monitoring program follow.

6.3.1 Deer Sampling

White-tailed deer in New York State are typically large, with males weighing, on average, approximately 150 pounds; females typically weigh approximately 100 pounds. However, white-tailed deer on Long Island tend to be much smaller, weighing an average of 80 pounds. The meat available for consumption from local deer ranges from 20 to 40 pounds per animal. This fact has implications for calculating the potential radiation dose to consumers of deer meat containing Cs-137, because smaller deer do not provide sufficient amounts of meat (flesh) to support the necessary calculations. Samples of meat and liver are taken from each deer, when possible, and are analyzed for Cs-137. Data are reported on a wet-weight basis, as that is the form most likely used for consumption.

Since 1996, BNL has routinely collected deer samples from on- and off-site areas. While most off-site samples are the result of car/deer accidents near the Laboratory, in most years, samples from deer taken by hunters beyond BNL boundaries or samples from car/deer accidents greater than 1 mile from BNL are used. Based on more than a decade of sampling, deer taken from more than 1 mile from BNL are used for comparison with populations on and near the Laboratory that could acquire Cs-137 from a BNL source. In 2014, five deer were obtained on site, five from off-site locations within 1 mile of the Laboratory, and six from areas greater than 1 mile from the BNL boundary. The results of deer sampling are shown in Table 6-2.

6.3.1.1 Cesium-137 in White-Tailed Deer

Based on historic and current data, white-tailed deer sampled at or near the Laboratory contain higher concentrations of Cs-137 than deer from greater than 1 mile off site (BNL 2000), most likely because they graze on vegetation growing in soil where elevated Cs-137 levels are known to exist. Cs-137 in soil can be transferred to aboveground plant matter via root uptake, where it then becomes available to browsing/grazing animals or is consumed directly while the animal is grazing.

Removal of contaminated soil areas on site has occurred under the Laboratory's cleanup program, with all major areas of contaminated soil being remediated by September 2005. The number of deer obtained for sampling steadily increased between 1996 and 2004. However, the number of deer obtained from 2005 to 2014 was significantly lower. In 1998, a statistical analysis suggested that 40 deer from off site and 25 deer from on site are needed to achieve a statistically sound data set. The number obtained each year has not met this preferred level because sample availability depends on accidents between vehicles and deer and people reporting dead deer. Figure 6-1 shows the location of all deer samples taken within a 5-mile radius of the Laboratory since 2010. Most of the off-site samples are concentrated along the William Floyd Parkway on the west boundary of BNL, whereas most on-site samples are collected near the Laboratory's main entrance gate and the developed portions of the site. This distribution is most likely due to the fact that people on their way to work see and report dead deer. Vehicle collisions with deer on site occur primarily early or late in the day, when deer are more active and traffic to and from the front gate is greatest.

In 2014, Cs-137 concentrations in deer meat samples were obtained from five deer on site with a range of values from 0.02 pCi/g, wet weight, to 1.46 pCi/g, wet weight, and an arithmetic average of 0.60 pCi/g, wet weight, as shown in Table 6-2. The wet weight concentration is before a sample is dried for analysis and is the form most likely to be consumed. Dry weight concentrations are typically higher than

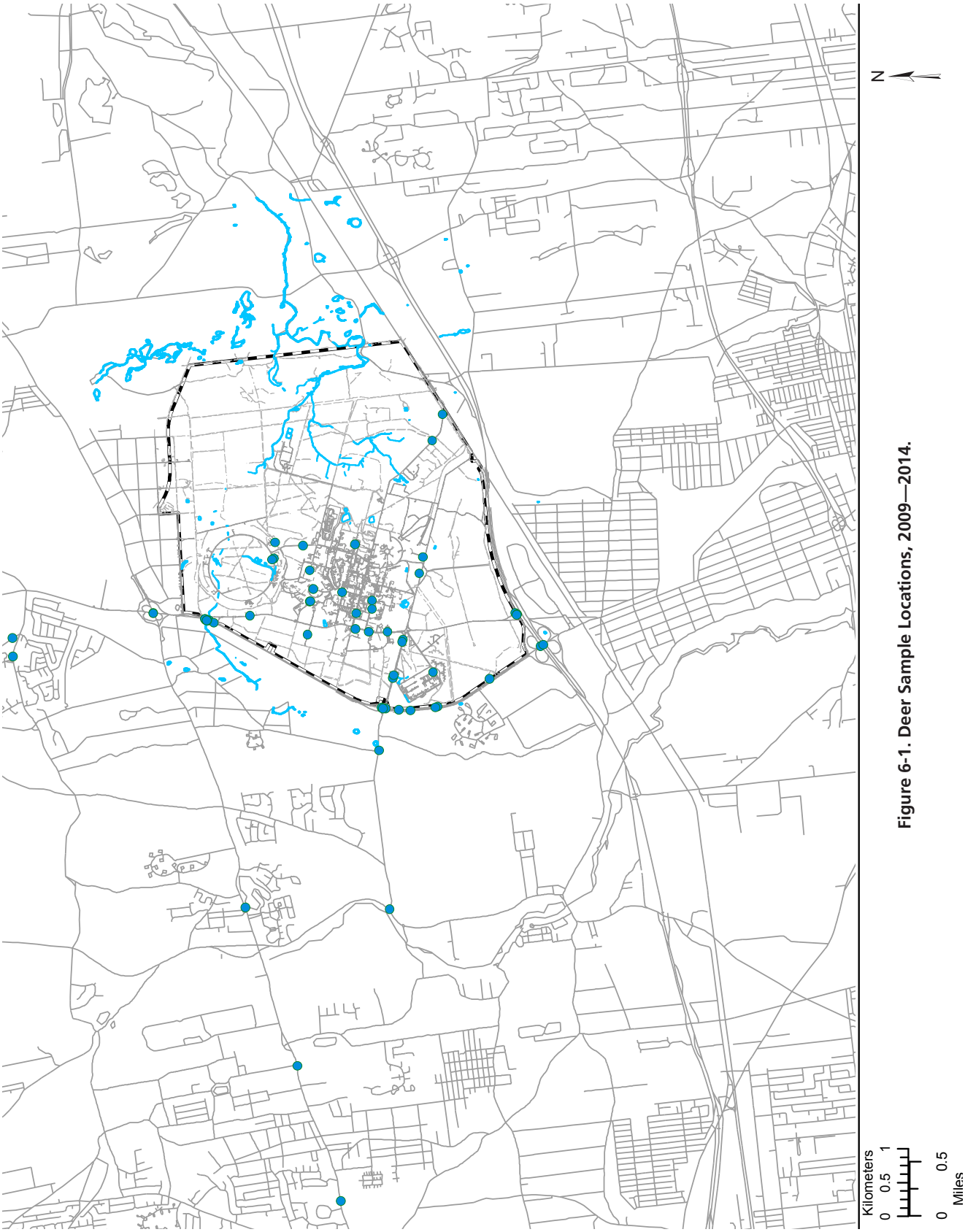


Figure 6-1. Deer Sample Locations, 2009—2014.

wet weight values. The highest on-site sample in 2014 (1.46pCi/g, wet weight) was about 2 times higher than the highest on-site sample reported in 2013 (0.85 pCi/g, wet weight) and 8 times lower than the highest level ever reported in 1996 (11.74 pCi/g, wet weight).

Cs-137 concentrations in off-site deer meat samples are typically separated into two groups: samples taken within 1 mile of BNL (five samples) and samples taken farther away (six samples), as shown in Table 6-2. Concentrations in meat samples taken within 1 mile ranged from non-detect to 1.93 pCi/g, wet weight, with an arithmetic average of 0.56 pCi/g, wet weight. Because deer on site may routinely travel up to 1 mile off site, the arithmetic average for deer taken on site and within 1 mile of the Laboratory is also calculated; for 2014, this was 0.58 pCi/g, wet weight. Deer samples from greater than 1 mile from BNL ranged from 0.10 pCi/g, wet weight, to 0.35 pCi/g, wet weight, with the arithmetic average being 0.32 pCi/g, wet weight.

Figure 6-2 compares the average values of Cs-137 concentrations in meat samples collected in 2014 from four different location groupings; 2013 was the first year in which the average Cs-137 content from deer taken within 1 mile of the Laboratory was lower than the on-site average, and this result was repeated again in 2014. While no definitive explanation can be given to the difference from past results, it could simply be an artifact of low sample numbers and randomness in sample acquisition. Although not shown on the figure, 88 percent of all meat samples taken both on and off site are below 1 pCi/g, wet weight.

Figure 6-3 presents the 10-year trend of on-site and near off-site Cs-137 averages in deer meat. While similar in number to the samples taken in 2008, samples from 2014 indicate a narrower range of error and a significantly lower average. The 2014 average is approximately 3 times lower than the 2008 average and is 60 percent higher than the 2012 average, which had been the lowest average seen since trending began in 2000. These sample results continue to indicate the effectiveness of cleanup actions across the Laboratory, with the trend being downward from 2005 to 2014.

The effectiveness of the clean-up on Cs-137 in deer meat was evaluated and published in the scientific literature (Rispoli, et. al 2014). The average Cs-137 content was shown to be statistically lower than before clean-up. Samples taken at distances greater than 1 mile from the BNL site were shown to remain consistent before and after clean-up, while the on-site and near off-site values were shown to decline. In preparing for monitoring associated with the planned reduction of the deer population, the ten-year average for on-site deer samples was calculated to be at 1.0 pCi/g, wet weight.

When possible, liver samples are taken concurrently with meat samples. The liver generally accumulates Cs-137 at a lower rate than muscle tissue. The typically lower values in liver allow the results to be used as a validity check for meat values (i.e., if liver values are higher than meat values, results can be considered questionable and should be confirmed). In liver samples collected on site in 2014, Cs-137 concentrations ranged from non-detect to 0.52pCi/g, wet weight, with an average of 0.27 pCi/g, wet weight. The off-site Cs-137 concentration in liver ranged from non-detect to 1.07 pCi/g, wet weight, with an arithmetic average for off-site liver samples within 1 mile of 0.31 pCi/g, wet weight, and a combined on-site and within 1 mile average of 0.58 pCi/g, wet weight. Liver samples from deer taken greater than one mile from BNL ranged from 0.05 to 0.31 pCi/g, wet weight, with an average of 0.12 pCi/g, wet weight.

The potential radiological dose resulting from deer meat consumption is discussed in Chapter 8. The New York State Department of Health (NYSDOH) has formally considered the potential public health risk associated with elevated Cs-137 levels in on-site deer, and determined that neither hunting restrictions nor formal health advisories are warranted (NYSDOH 1999).

With respect to the health of on-site deer based on their exposure to radionuclides, the International Atomic Energy Agency (IAEA) has concluded that chronic dose rates of 100 millirad per day to even the most

Table 6-2. Radiological Analyses of Deer Tissue.

Sample Location	Collection Date	Tissue	K-40 pCi/g (Wet Weight)	Cs-137 pCi/g (Wet Weight)
BNL, On Site				
Building 913, south	06/11/14	Flesh	2.9±0.27	0.02±0.01
		Liver	1.71±0.24	ND
South of Building 650	10/06/14	Flesh	3.18±0.33	0.02±0.01
		Liver	1.96±0.34	ND
Upton Road, 50 feet south of Bell Avenue	10/23/14	Flesh	3.57±0.26	0.59±0.03
		Liver	2.45±0.29	0.46±0.03
Brookhaven Avenue near LISF gate	10/31/14	Flesh	2.99±0.30	1.46±0.05
		Liver	1.62±0.40	0.52±0.05
West Princeton Avenue at motorpool	12/02/14	Flesh	2.84±0.35	0.92±0.05
		Liver	2.6±0.32	0.35±0.03
< 1 Mile from BNL				
William Floyd Parkway, south of north gate	03/24/14	Flesh	2.56±0.21	ND
		Liver	2.44±0.20	ND
William Floyd Parkway at north gate	05/21/14	Flesh	2.83±0.28	0.16±0.02
		Liver	2.55±0.38	0.05±0.02
Long Island Expressway at south gate	08/12/14	Flesh	3.34±0.44	0.39±0.04
		Liver	2.76±0.27	0.19±0.02
William Floyd Parkway at north gate	09/24/14	Flesh	3.22±0.22	1.93±0.04
		Liver	2.68±0.22	1.07±0.03
William Floyd Parkway, 1/4 mile south of main gate	10/27/14	Flesh	2.81±0.34	0.30±0.03
		Liver	2.39±0.30	0.22±0.03
> 1 Mile from BNL				
Route 21 at Cathedral Pines	03/19/14	Flesh	2.91±0.24	0.18±0.02
		Liver	2.26±0.24	0.05±0.01
Route 25 and Artist Drive	03/27/14	Flesh	2.35±0.34	0.10±0.02
		Liver	2.84±0.41	0.07±0.02
William Floyd Parkway, 1/2 mile south of Route 25A	06/19/14	Flesh	3.6±0.36	0.29±0.03
		Liver	2.75±0.31	0.10±0.02
Route 25 at Union Cemetery	10/16/14	Flesh	3.44±0.44	0.35±0.04
		Liver	2.62±0.53	0.31± 0.05
Mastic Beach Biltmore Drive at Wavecrest Drive	11/01/14	Flesh	2.87±0.29	0.13±0.02
		Liver	3.19±0.52	0.06±0.02
Route 25 at St. Francis Cabrini Church, Coram	11/13/14	Flesh	2.94±0.38	0.33±0.04
		Liver	2.25±0.31	0.06±0.02
Averages by Tissue				
Flesh Averages				
All Samples (18)			3.03±1.37	0.46±0.13
BNL Average (5)			3.10±0.68	0.60±0.08
< 1 Mile Average (5)			2.95±0.69	0.56±0.07
BNL + < 1 Mile Average (10)			3.02±0.97	0.58±0.10
> 1 Mile Average (8)			3.04±0.96	0.32±0.08
Liver Averages				
All Samples (18)			2.37±1.44	0.21±0.11
BNL Average (5)			2.07±0.72	0.27±0.07
< 1 Mile Average (5)			2.56±0.63	0.31±0.05
BNL + < 1 Mile Average (10)			2.32±0.96	0.29±0.09
> 1 Mile Average (8)			2.44±1.07	0.12±0.07

Notes:
All averages are the arithmetic average with confidence limits using a 2 sigma (95%) propogated error.
All values are shown with a 95% confidence interval.
K-40 occurs naturally in the environment and is presented as a comparison to Cs-137.
ND = not detected

radiosensitive species in terrestrial ecosystems are unlikely to cause detrimental effects in animal populations (IAEA 1992). A deer containing a uniform distribution of Cs-137 within muscle tissue at the highest levels observed to date (11.74 pCi/g, wet weight, reported in 1996) would carry a total amount of approximately 0.2 μCi. That animal would receive an absorbed dose of approximately 3 millirad per day, which is only 3 percent of the IAEA threshold. The deer observed and sampled on site appear to have no health effects from the level of Cs-137 found in their tissues.

6.3.2 Other Animals Sampled

When other animals, such as wild turkey or Canada geese, are found dead along the roads of BNL and the immediate vicinity due to road mortality, they are tested for Cs-137. In 2014, two geese were sampled. A sample of the breast meat from each goose was sent for analysis, with values of non-detect for Cs-137 received for both samples.

6.3.3 Fish Sampling

BNL maintains an ongoing program for collecting and analyzing fish from the Peconic River and surrounding freshwater bodies. Monitoring of the river is conducted under the environmental surveillance program and the CERCLA post-cleanup program. Surveillance monitoring occurs during even-numbered years and post-cleanup monitoring occurs in odd-numbered years. Therefore, data presented for 2014 consists of surveillance monitoring of fish from the Peconic River locations, as well as background monitoring of fish from Lower Lake on the Carmans River.

Samples collected on site were from Area A of the Peconic River just downstream of the Sewage Treatment Plant (STP) outfall and Area D near the east boundary of the Laboratory. Various species of fish were also collected off site from Shultz Road, Donahue's Pond, and Lower Lake on the Carmans River (see Figure 5-7 for sampling stations). Lower Lake on the Carmans River is the non-Peconic control site. Sampling is carried out under a permit from NYSDEC.

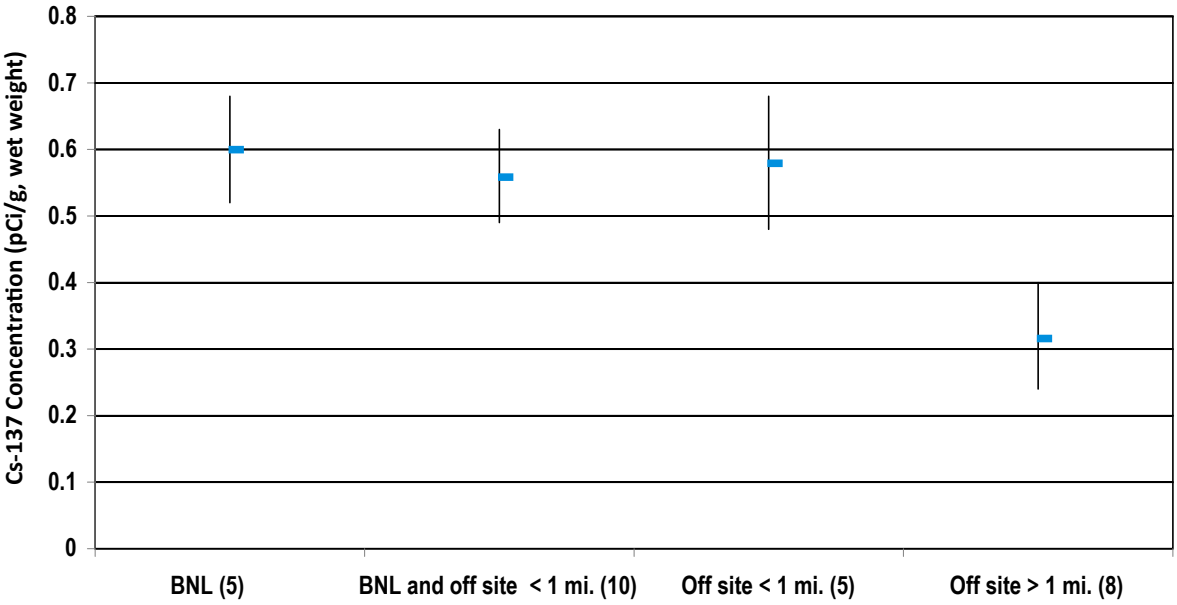
6.3.3.1 Radiological Analysis of Fish

The species collected for radiological analysis in 2014 included brown bullhead (*Ictalurus nebulosus*), chain pickerel (*Esox niger*), largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*). The edible (fillet) content of each fish were collected for analysis. Gamma spectroscopy analysis was performed on all samples. When fish samples were not of sufficient volume to conduct all non-radiological and radiological analyses, samples of the same species were composited. Table 6-3 presents specific information on the sampling location, species collected, and analytical results. All sample results are presented as wet weight concentrations, and information on the naturally occurring radioisotope K-40 is included as a comparison.

Cs-137 was measured at levels ranging from non-detected to 0.18 pCi/g, wet weight, from the Peconic River system, and all samples from the Carmans River had non-detectable levels. Detectable Cs-137 levels in fish ranged from an estimated 0.08 pCi/g to 0.11 pCi/g, wet weight, in both largemouth bass and brown bullhead taken from Donahue's Pond to an estimated 0.18 pCi/g, wet weight, in a composite sample of largemouth bass taken from Area A. For comparison, the highest recent value of Cs-137 was 0.78 pCi/g, wet weight, in a composite sample of bluegill (*Lepomis macrochirus*) taken from Forge Pond in 2011.

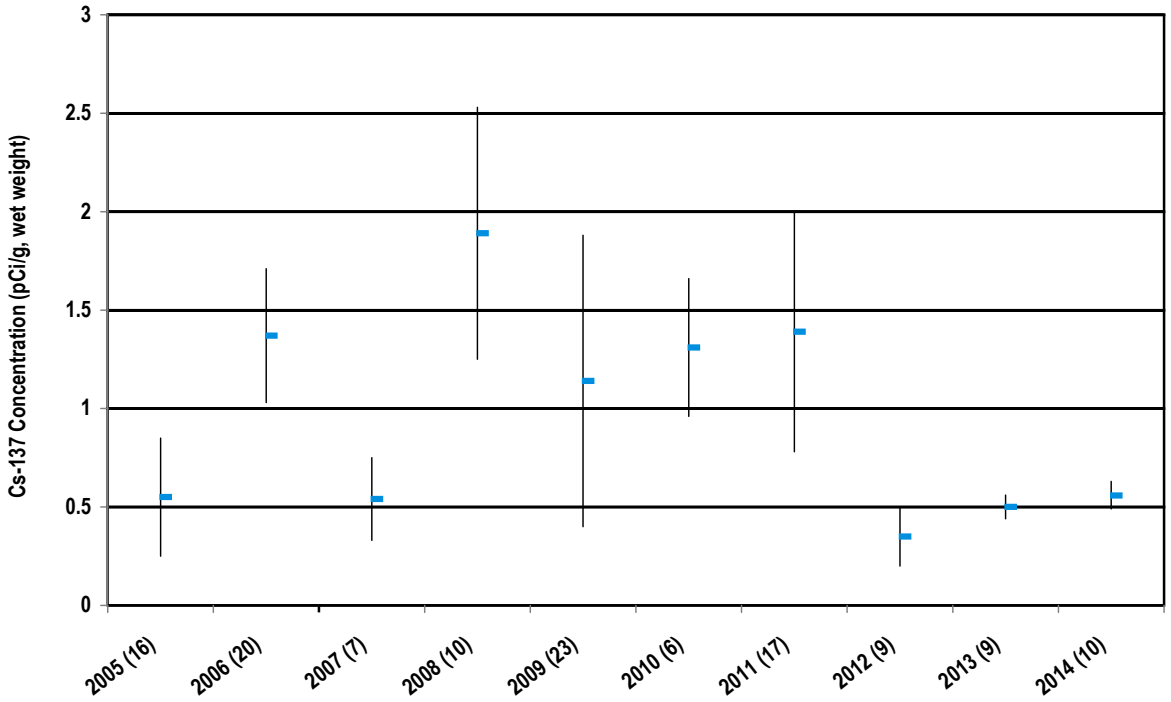
To account for the different feeding habits and weights of various species, it is important to compare Cs-137 concentrations and other contaminants in species with similar feeding habits (i.e., bottom feeders such as brown bullhead should be compared to other bottom feeders). Cs-137 concentrations in brown bullhead collected at all locations along the Peconic River had values less than 0.16 pCi/g, wet weight. Largemouth bass, the top predator from the Peconic River, showed Cs-137 levels of 0.18 pCi/g, wet weight, or less. Levels of Cs-137 in all fish species appear to be declining, compared to historic values.

Though it is clear from discharge records and sediment sampling that past BNL operations



Notes: Averages are shown for samples collected at BNL, on site and off site within 1 mile, off site within 1 mile of BNL, and off site greater than 1 mile from BNL.
Numbers in parentheses indicate the number of samples in that data set.
All values are presented with a 95% confidence interval.
Cs-137 = cesium-137

Figure 6-2. Comparison of Cs-137 Average Concentrations in Deer Meat, 2014.



Notes: Averages are shown for samples collected at BNL and within 1 mile.
Numbers in parentheses indicate the number of samples in that data set.
All values are presented with a 95% confidence interval.
Cs-137 = cesium-137

Figure 6-3. Ten-Year Trend of Cs-137 Concentrations in Deer Meat.

Table 6-3. Radiological Analysis of Fish from the Peconic River System and Carmans River, Lower Lake.

Location/Species	K-40	Cs-137
	pCi/g Wet Weight	
BNL, Area A		
Brown bullhead (composite)*	3.79 ± 0.46	0.11 ± 0.03
Brown bullhead (composite)*	3.15 ± 0.32	0.13 ± 0.02
Brown bullhead (composite)*	2.58 ± 0.57	0.12 ± 0.04
Brown bullhead (composite)*	3.16 ± 0.78	0.16 ± 0.05
Chain pickerel (composite)	No Data	No Data
Largemouth bass (composite)*	3.65 ± 0.40	0.18 ± 0.03
Pumpkinseed (composite)*	3.06 ± 0.55	0.12 ± 0.03
Pumpkinseed (composite)*	2.70 ± 0.90	0.12 ± 0.05
Pumpkinseed (composite)*	2.94 ± 0.89	0.15 ± 0.08
Donahue's Pond		
Brown bullhead*	2.41 ± 0.66	0.08 ± 0.04
Brown bullhead	2.62 ± 1.43	ND
Largemouth bass*	3.64 ± 0.87	0.08 ± 0.06
Largemouth bass*	3.19 ± 1.04	0.08 ± 0.06
Largemouth bass*	3.09 ± 0.739	0.11 ± 0.06
Lower Lake		
Bluegill	3.53 ± 0.86	ND
Bluegill (composite)	3.28 ± 0.81	ND
Bluegill (composite)	2.56 ± 0.56	ND
Brown bullhead	2.94 ± 0.60	ND
Brown bullhead	3.38 ± 0.71	ND
Brown bullhead	3.08 ± 0.75	ND
Brown bullhead	2.84 ± 0.66	ND
Brown bullhead (composite)	2.78 ± 0.69	ND
Largemouth bass	2.44 ± 0.97	ND
Largemouth bass	No Data	No Data
Pumpkinseed	No Data	No Data

Notes:
All samples analyzed as edible portions (fillets), including composite samples.
All values shown with a 95% confidence interval.
K-40 occurs naturally in the environment and is presented as a comparison to Cs-137.
* = estimated value for Cs-137 based on lab qualifiers
Cs-137 = cesium-137
K-40 = potassium-40
No Data = insufficient sample size to complete analysis
ND = not detected based on lab qualifiers

have contributed to anthropogenic (human-caused) radionuclide levels in the Peconic River system, most of these radionuclides were released between the late 1950s and early 1970s. Concentrations continue to decline over time by natural radioactive decay. Cs-137 has a half-life of 30 years. Discharge monitoring has demonstrated that no Cs-137 was released from the STP to the Peconic River during 2003 through 2014. Discharges from the STP to the Peconic River stopped in October 2014. Additionally, the cleanup of both on- and off-site portions of the Peconic River is estimated to have removed approximately 88 percent of the identified Cs-137 in the sediment that was co-located with mercury. Removal of this contamination is expected to result in continued decreases in Cs-137 levels in fish.

6.3.3.2 Fish Population Assessment

The relative sizes of fish caught during annual sampling events are tracked and modifications to future sampling events are made, as necessary, to ensure long-term health of the on-site fish populations. Successful sampling of sufficiently large fish for analysis from 2008 through 2014, even with low water levels in the on-site portion of the Peconic River, indicated that populations are maintaining themselves and can continue to support annual sampling efforts. With the termination of discharges to the Peconic River, on-site fish populations may decline and the need for monitoring will be evaluated.

6.3.3.3 Non-Radiological Analysis of Fish

Beginning in 2005, all fish of sufficient size have been analyzed as edible portions (fillets). Due to its known health effects, mercury is the metal of highest concern. Monitoring results for 2014 surveillance monitoring of the Peconic River and comparison to Lower Lake on the Carmans River is shown in Table 6-4. All samples were obtained between April and mid-June. During 2014, mercury ranged from 0.18 mg/kg in a composite of brown bullhead to 0.73 mg/kg in a composite sample of largemouth bass in Area A, and from less than the

minimum detection level (MDL) in a brown bullhead to 0.62 mg/kg in a largemouth bass at Donahue's Pond. Mercury in control fish taken from Lower Lake on the Carmans River ranged from less than the MDL in bluegill, pumpkinseed, brown bullhead, and largemouth bass to 0.15 mg/kg in a brown bullhead.

Monitoring data for mercury analysis in fish is presented as a range of results by species and location in Table 6-5 and utilizes the data regardless of whether or not it fell below MDLs in order to facilitate comparisons. The data are presented graphically in Figure 6-4. Data are typically compared to the EPA mercury water criterion of 0.3 mg/kg. Mercury values in on-site fish taken from Area A during 2014 are similar those seen in 2013 but higher than those seen in 2011 and 2012. This increase is most likely due to low water flow conditions in the river since late summer 2011, with limited open water areas and little or no flow off site. Consequently, fish have been isolated to the BNL site and any methylated mercury was not diluted by flow. Mercury content in fish between on site locations and off site locations indicate that concentrations decrease significantly once off site, and values at Donahue's Pond are similar to those from Lower Lake on the Carmans River.

Fish are also monitored for a variety of other metals during surveillance monitoring years. The analytical results for metals of concern are also presented in Table 6-4. None of the metals were above levels of concern, and are similar to values seen historically. On site fish are monitored for PCBs due to their historical use at BNL. Table 6-6 shows the results for PCBs from fish taken from Area A on site. Fillets are analyzed for PCBs after metals and radionuclides. Due to lack of sufficient sample volume, some samples had no PCB analysis. Only two PCB congeners were detected; Aroclor-1254 and Aroclor-1260; most values were below the MDL. Both Aroclor-1254 and Aroclor-1260 were detected in brown bullhead and largemouth bass above the MDL, and Aroclor-1254 was also detected in a sample from pumpkinseed. The highest concentration of Aroclor-1254 was 55.1 µg/kg in brown bullhead, and the highest concentration of Aroclor-1260 was 35.7 µg/kg found in the same sample. These levels are compared to the Food and Drug Administration tolerance levels of 2 ppm in edible portions of fish in the commercial food supply.

6.3.4 Aquatic Sampling

6.3.4.1 Radiological Analysis

Annual sampling of sediment and vegetation in the Peconic River was conducted in 2014. (See Chapter 5 for a discussion on water quality and monitoring and Figure 5-7 for the locations of sampling stations.) During 2014, Cs-137 was detected in a single aquatic vegetation sample at an estimated concentration of 0.03 pCi/g, wet weight, as shown in Table 6-7.

6.3.5 Peconic River Post-Cleanup Monitoring

Approximately 20 acres of the Peconic River were remediated in 2004 and 2005 to remove sediments contaminated with mercury and associated contaminants. To ensure that the cleanup provided adequate protection of human health and the environment, BNL conducted five years (2006-2010) of post-cleanup monitoring of the sediment, surface water, and fish. This monitoring effort identified approximately 0.39 acres in three small areas (PR-WC-06, PR-SS-15, and sediment trap areas) with mercury concentrations greater than the cleanup goal of 2.0 mg/kg. The three areas were remediated between November 2010 and February 2011 (see Section 6.3.5.1).

During the required CERCLA Five-Year review process in 2011, all data and accomplishments related to the Peconic River cleanup and subsequent monitoring were summarized and reviewed (BNL 2011). The Five-Year Review recommended that reduced monitoring should take place beginning in 2012. The reductions included decreasing sediment sampling to just the three areas associated with the supplemental cleanup; water monitoring was reduced from 30 locations to the current 14, and fish monitoring was to alternate years with the surveillance monitoring. The 2014 sediment and surface water results follow.

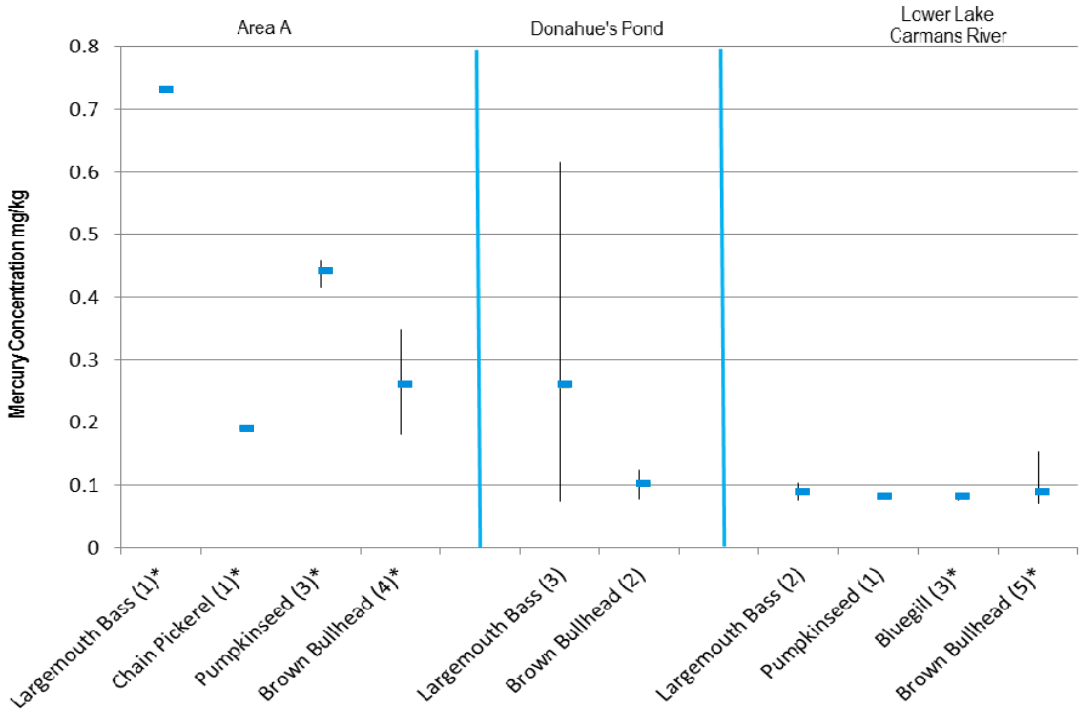
Table 6-4. Metals Analysis of Fish from the Peconic River and Lower Lake, Carmans River.

Location/Species	Barium	Chromium	Copper	Manganese	Mercury	Nickel	Zinc
BNL, Area A	---------- mg/kg ----------						
Brown bullhead (composite)	0.11	< MDL	< MDL	< MDL	0.181	< MDL	6.11
Brown bullhead (composite)	0.254	< MDL	0.851	< MDL	0.222	< MDL	11.2
Brown bullhead (composite)	0.234	< MDL	< MDL	0.208	0.348	< MDL	8.5
Brown bullhead (composite)	0.312	< MDL	0.691	0.196	0.28	< MDL	13.4
Chain pickerel (composite)	0.3	< MDL	0.558	0.385	0.189	< MDL	10.6
Largemouth bass (composite)	< MDL	< MDL	< MDL	< MDL	0.732	< MDL	6.55
Pumpkinseed (composite)	< MDL	< MDL	< MDL	< MDL	0.458	< MDL	8.74
Pumpkinseed (composite)	0.256	< MDL	< MDL	< MDL	0.446	< MDL	9.66
Pumpkinseed (composite)	0.266	< MDL	< MDL	< MDL	0.415	< MDL	8.54
Donahue's Pond							
Brown bullhead	1.16	< MDL	0.475	1.66	< MDL	< MDL	6.67
Brown bullhead	0.468	0.349	0.797	< MDL	0.123	< MDL	12.2
Largemouth bass	0.643	0.44	< MDL	1.03	< MDL	< MDL	26.9
Largemouth bass	0.775	0.245	< MDL	2.42	< MDL	< MDL	11
Largemouth bass	1.06	0.147	< MDL	0.721	0.616	< MDL	7.74
Lower Lake							
Bluegill	2.21	< MDL	< MDL	5.24	< MDL	< MDL	13.4
Bluegill (composite)	< MDL	< MDL	< MDL	0.211	< MDL	0.135	5.31
Bluegill (composite)	2.57	0.18	< MDL	3.97	< MDL	< MDL	13.6
Brown bullhead	0.26	0.152	0.291	0.509	< MDL	< MDL	6.53
Brown bullhead	0.225	< MDL	0.328	0.187	< MDL	0.19	9.97
Brown bullhead	0.166	< MDL	0.307	< MDL	0.152	< MDL	6.9
Brown bullhead	0.242	< MDL	< MDL	< MDL	< MDL	0.341	5.91
Brown bullhead (composite)	0.237	< MDL	0.281	< MDL	< MDL	0.184	6.6
Largemouth bass	0.153	< MDL	< MDL	0.188	< MDL	0.156	8.65
Largemouth bass	0.614	< MDL	< MDL	0.51	0.103	< MDL	17.3
Pumpkinseed	1.11	< MDL	< MDL	2.73	< MDL	< MDL	14.8

Notes:
See Figure 5-4 for sampling locations.
All samples were analyzed as edible portions (fillets), including composite samples.
Area letter designation refers to Peconic River cleanup areas on site.
MDL = minimum detection limit

6.3.5.1 Sediment Sampling

Sediment was sampled in June 2014 at three Peconic River locations associated with the supplemental cleanup areas remediated during 2010 and 2011 (see Table 6-7). Radiological analysis of sediments at all three locations indicate that low levels of Cs-137 are present, ranging from 0.32 pCi/g to 5.49 pCi/g, which are consistent with previous analyses of the river sediments. Analysis of sediment for mercury identified values ranging from 0.33 mg/kg to 7.40 mg/kg. The 7.40 mg/kg value was from a sample taken at the PR-WC-06 area, and was above the 2.0 mg/kg clean-up goal. This result, along with the fact that concentrations above 2.0 mg/kg were seen at this location in the past, resulted in an effort to determine the extent of mercury in sediment around this point. Additional samples were taken late in 2014 within two locations,



Notes: Number in parentheses indicate the number of samples included.
* = some samples were composite

Figure 6-4. Peconic River and Lower Lake, Carmans River Mercury Distribution in Fish Species (Minimum, Maximum, and Average Values).

one upstream and one downstream, with values above 2.0 mg/kg. Additional sampling is planned for 2015.

6.3.5.2 Water Column Sampling

Surface water was analyzed in June and July 2014 for total mercury and methyl mercury at 6 of the 14 Peconic River sampling stations (see Table 6-8). Water column sampling locations are shown on Figure 6.5. A sample of the treated STP effluent was also collected during each round of sampling. Eight stations could not be sampled in both June and July due to either being too shallow or dry. Total Suspended Solids (TSS) are reported in Table 6-8 because TSS values can provide an indication of the quality of the sample collection effort. Low TSS indicates a sample was taken without disturbing bottom sediments, whereas samples with high TSS values might explain, in part, unusually high mercury values due to increased particles that may contain mercury.

The maximum total mercury concentration in the June (30 ng/L) and July (32 ng/L) STP effluent samples were typical of what has been seen since efforts at mercury minimization have been implemented. The total mercury concentrations generally trended downwards, with minor fluctuations at increasing distance downstream from the STP, until reaching concentrations of 19 ng/L (June 2014) and 17 ng/L (July 2014) at sampling stations near Shultz Road, approximately 2.1 miles downstream of the STP outfall. One sample taken in July from PR-WC-06 had a mercury value of 140 ng/L, which was likely due to high amounts of sediment entrained in the sample as evidenced by the high TSS value of 41 mg/L.

Methyl mercury is the form of mercury that is bio-available to aquatic organisms. Methyl mercury was not detected in STP effluent samples in June and at a concentration of 0.11 ng/L in the July sample. Methyl mercury was measured at 5 monitoring stations in both June and July. In

Table 6-5. Mercury Analysis of Fish from the Peconic River System and Lower Lake, Carmans River.

Location/Species (number of samples)	Mercury mg/kg Min.	Max.	Avg.
BNL, Area A			
Brown bullhead (4)*	0.181	0.348	0.258
Chain bickerel (1)*	0.189	0.189	0.189
Largemouth bass (1)*	0.732	0.732	0.732
Pumpkinseed (3)*	0.415	0.458	0.44
Donahue's Pond			
Brown bullhead (2)	0.0773	0.123	0.1
Largemouth bass (3)	0.074	0.616	0.256
Lower Lake, Carmans River			
Bluegill (3)*	0.075	0.08	0.078
Brown bullhead (5)*	0.071	0.152	0.089
Largemouth bass (2)	0.075	0.103	0.089
Pumpkinseed (1)	0.078	0.078	0.078

Notes:
See Figure 5-4 for sampling locations.
All samples were analyzed as edible portions (fillets), including composite samples.
Area letter designation refers to Peconic River cleanup areas on site.
* = one or more samples in the average were composite samples.

Table 6-6. PCB Analysis of Fish from BNL Portions of the Peconic River System.

Location/Species	Aroclor-1254 µg/kg	Aroclor-1260 µg/kg
BNL, Area A		
Brown bullhead (composite)	< MDL	< MDL
Brown bullhead (composite)	55.1	35.7
Brown bullhead (composite)	53.4	31.2
Brown bullhead (composite)	No Data	No Data
Chain pickerel (composite)	No Data	No Data
Largemouth bass (composite)*	13.9	9.93
Pumpkinseed (composite)*	10.5	< MDL
Pumpkinseed (composite)	No Data	No Data
Pumpkinseed (composite)	No Data	No Data

Notes:
All samples were analyzed as edible portions (fillets), including composite samples.
* = estimated value for reported analyte based on lab qualifiers
MDL = minimum detection limit
No Data = insufficient sample size to complete analysis

June, methyl mercury ranged from 5.1 ng/L at the station immediately upstream of the STP effluent outfall to 0.66 ng/L at the station approximately 0.3 miles below the outfall. Values then increased on site to Area D, and then declined to 0.77 ng/L at a distance of 2.1 miles from the outfall. A similar pattern was seen in methyl mercury concentrations in July samples with the farthest downstream detection being roughly twice the value of the June sample.

6.3.6 Vegetation Sampling

6.3.6.1 Grassy Plants and Soil

Grassy vegetation sampling around the Laboratory was conducted in 2014. Vegetation was sampled from 12 random locations, as shown in Figure 6-6. All samples were analyzed for Cs-137 (Table 6-9). All but one of the grassy vegetation samples had non-detectable levels of Cs-137. The single sample with a detectable level had a concentration of 0.03 pCi/g, wet weight, which is consistent with past sampling efforts. Monitoring results for grassy vegetation is utilized for the annual dose to biota analysis reported in Chapter 8.

Soil sampling was conducted at the same 12 locations where the grassy vegetation was collected. Soil samples were analyzed for Cs-137(Table 6-9). Cs-137 concentrations in soils ranged from non-detect to 0.44 pCi/g, dry weight. These values were consistent with past soil monitoring results.

6.4 OTHER MONITORING

6.4.1 Basin Sediments

A five-year cycle for the collection of recharge basin sediment samples was established in 2003. There are 11 recharge basins that receive water discharges that are permitted under the Laboratory's State Pollutant Discharge Elimination System (SPDES) permit (see Figure 5-5 for outfall locations). Basin sediments were last sampled in 2012 and results were summarized in the 2012 Site Environmental Report (BNL, 2013b). The next round of routine basin sampling will be conducted in 2017.

6.4.2 Chronic Toxicity Tests

Under BNL's SPDES discharge permit, the Laboratory conducted chronic toxicity testing

Table 6-7. Survellience and Post Cleanup Montioring Data for Aquatic Vegetation and Sediment from the Peconic River.

Location	Matrix	K-40 pCi/g (Wet Weight)	Cs-137 pCi/g (Wet Weight)	Mercury mg/kg
Surveillance Samples				
BNL	Vegetation	3.70 ± 0.41	ND	NT
BNL	Vegetation	2.66 ± 0.35	ND	NT
BNL*	Vegetation	5.78 ± 0.49	0.03 ± 0.02	NT
BNL	Vegetation	3.91 ± 0.44	ND	NT
Post-Cleanup Samples				
PR-WC-06-D1-L50	Sediment	NT	5.49 ± 0.68	7.40
PR-WC-06-D1-L50-01	Sediment	NT	NT	3.30
PR-WC-06-D1-L50-02	Sediment	NT	NT	0.38
PR-WC-06-D1-L50-03	Sediment	NT	NT	0.97
PR-WC-06-D1-L50-04	Sediment	NT	NT	5.60
ST1-80-U20	Sediment	NT	1.56 ± 0.22	0.50
PR-SS-15-U1-L65-O	Sediment	NT	0.32 ± 0.07	0.33

Notes:
All values are shown with a 95% confidence interval.
Radiological values for sediment are reported as dry weight.
K-40 Occurs naturally in the environment and is presented as a comparison to Cs-137.
* = values for Cs-137 are estimated based on analytical lab qualifiers
Cs-137 = cesium-137
K-40 = potassium-40
ND = not detected
NT = not tested

of the STP effluent. The results of the chronic toxicity tests are discussed in Chapter 3, Section 3.6.1.1. Because the Laboratory discontinued discharging STP effluent to the Peconic River in October 2014, chronic toxicity testing will no longer be required under the new SPDES discharge permit.

6.4.3 Radiological and Mercury Monitoring of Precipitation

During 2014, precipitation samples were collected quarterly at air monitoring Stations P4 and S5 (see Figure 4-3 for station locations). The samples were analyzed for radiological content and total mercury. Gross alpha activity measurements were above the MDL at P4 in the first three quarters and in the first and third quarters at S5 (Table 6-10).

Gross beta activity was measured in samples collected during all four quarters, at monitoring stations P4 and S5. Location P4 had a maximum gross beta activity level of 3.13 pCi/L in the fourth quarter of 2014. Location S5 had a maximum gross beta activity level of 6.30 pCi/L in the first quarter. Gross beta, gamma, and Sr-90 activity values were within the range of historically observed values at these two locations.

Mercury concentrations in precipitation have been measured at BNL since 2007. Analysis of mercury in precipitation is conducted to document mercury deposition that is attributable to off-site sources. This information is compared to Peconic River monitoring data and aids in understanding the sources of mercury within the Peconic River watershed. Mercury was detected in all of the precipitation samples collected at both sampling stations. During 2014, mercury ranged from 2.24 ng/L at station P4 in October to 7.32 ng/L at station P4 in July. This range is one twelfth to one third of the highest value measured in precipitation, 24.6 ng/L, detected in 2013.

Table 6-8. Post Cleanup Peconic River Water Column Monitoring.

Location	Station Description	Dist from STP (miles)	June 2014			July 2014		
			Mercury	Methyl Mercury	TSS	Mercury	Methyl Mercury	TSS
			ng/L		mg/L	ng/L		mg/L
PR-WC-15	Upstream of Forest Path	-0.17	SW	SW	SW	SW	SW	SW
PR-WC-14	Upstream of STP	-0.13	SW	SW	SW	SW	SW	SW
PR-WC-13	Upstream of STP	-0.07	SW	SW	SW	SW	SW	SW
PR-WC-12-D7	Downstream of Sump	-0.04	7.2	5.1	6	2	1.4	ND
STP-EFF-UVG	Grab Sample	0	30	ND	ND	32	0.11	ND
PR-WC-11DS	50 feet downstream of outfall	0.01	SW	SW	SW	SW	SW	SW
PR-WC-10	West of HMN	0.3	27	0.66	2	48	.41	ND
PR-WC-09	Downstream of HMN	0.56	SW	SW	SW	SW	SW	SW
PR-WC-08	South of Area B	0.78	24	1.6	10	35	1.3	3
PR-WC-07	South of Area C	0.96	SW	SW	SW	SW	SW	SW
PR-WC-06	South of Area D*	1.1	17	3.2	50	140	1.8	41
PR-WC-05	Downstream of HQ	1.46	SW	SW	SW	SW	SW	SW
PR-WC-04	2nd downstream of HQ	1.7	SW	SW	SW	SW	SW	SW
PR-WC-03	3rd west of Schultz Road	2.1	19	0.77	9	17	1.4	16
PR-WC-02	2nd west of Schultz Road	2.52	SW	SW	SW	SW	SW	SW

Notes:
See Figure 6-5 for Peconic River sampling locations.
ND = not detected based on lab qualifiers
STP = Sewage Treatment Plant
SW = water too shallow to sample
* = estimated value based on lab qualifiers

6.5 WILDLIFE PROGRAMS

BNL sponsors a variety of educational and outreach activities involving natural resources. These programs are designed to help participants understand the ecosystem and to foster an interest in science. Wildlife programs are conducted at the Laboratory in collaboration with DOE, local agencies, colleges, and high schools. Ecological research is also conducted on site to update the current natural resource inventory, gain a better understanding of the ecosystem, and guide management planning.

In 2014, BNL hosted 15 student interns and one faculty member. Two of the interns worked with a faculty member from Dowling College as part of the BNL Visiting Faculty Program (VFP), and 13 interns participated in research associated with various projects including several related to the LISF. The Natural Resource program typically supports two interns in the spring, three in the fall, and the remainder participating in the summer internship program.

The VFP team continued ongoing work on statistical analysis of migratory bird data and data associated with Cs-137 in deer. The Cs-137 in deer work was published in October 2014 and discussed the effectiveness of environmental cleanup with regard to the uptake of Cs-137 by deer (Rispoli, et. al., 2014).

Work associated with the LISF involved tracking 24 eastern box turtles outfitted with transmitters to determine home range sizes. Many of the turtles were captured in or near the LISF in order to determine if they utilize habitats found in the facility. Since 2011, student interns have followed a total of 40 different turtles; as a result, BNL is building a very good understanding of their habits. Turtles are also permanently marked to facilitate identification of individual turtles as part of a mark

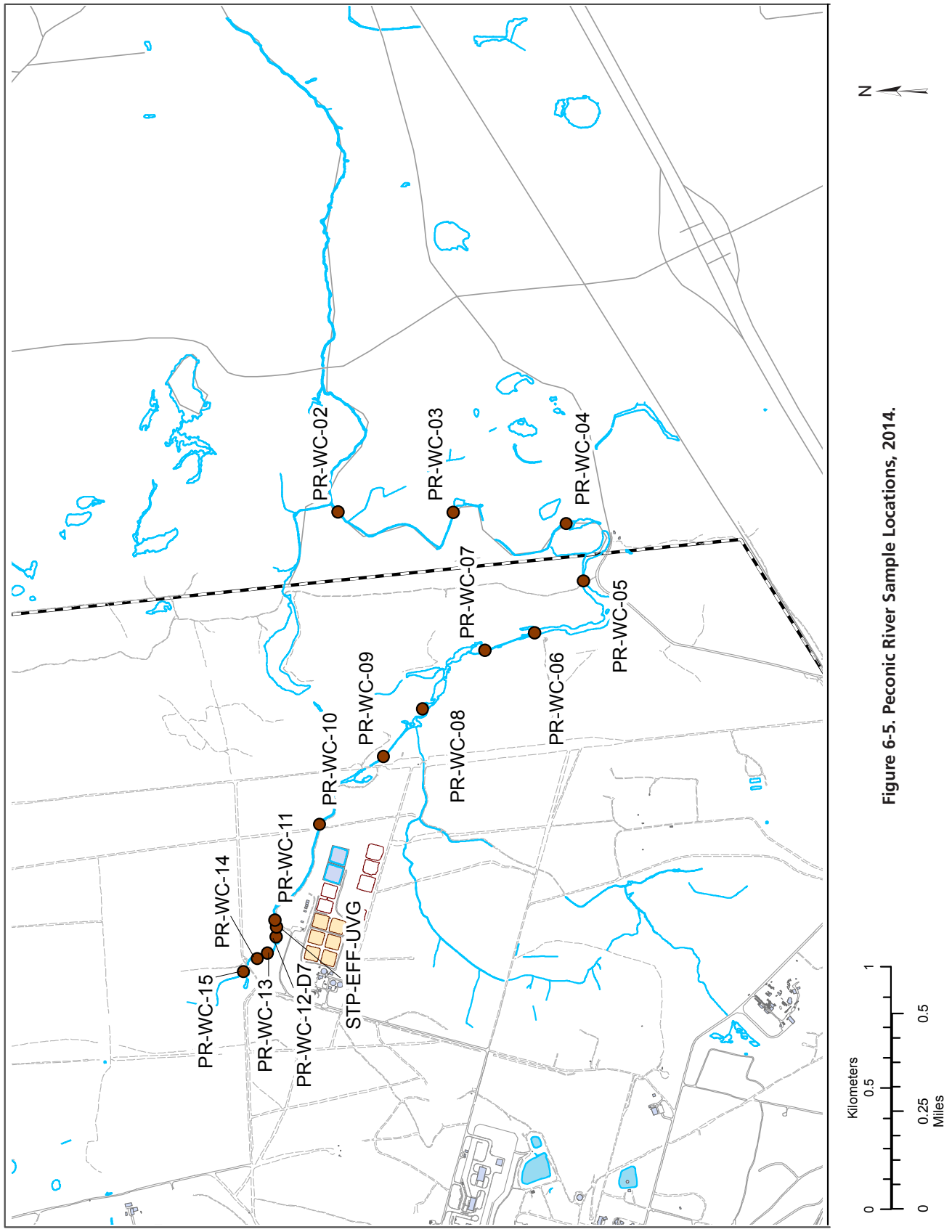


Figure 6-5. Peconic River Sample Locations, 2014.

Figure 6-6. Vegetation Sample Locations, 2014.

Table 6-9. Radiological Analysis of Grassy Vegetation and Associated Soils (2014).

Location/Matrix	K-40	Cs-137
	pCi/g (Wet Weight)	
Meteorology Field		
Vegetation	3.79 ± 0.47	ND
Soil	9.54 ± 0.56	0.13 ± 0.39
West End of Brookhaven Avenue		
Vegetation	2.77 ± 0.40	0.03 ± 0.02
Soil	6.00 ± 0.71	0.44 ± 0.06
Field south of HT-E		
Vegetation	6.16 ± 0.63	ND
Soil	5.73 ± 0.70	0.11 ± 0.04
RHIC Berm at 6 o'clock		
Vegetation	ND	ND
Soil	4.76 ± 0.51	0.08 ± 0.03
RHIC Berm at 8 o'clock		
Vegetation	3.53 ± 0.61	ND
Soil	4.76 ± 0.51	0.08 ± 0.03
RHIC Berm at 10 o'clock		
Vegetation	2.27 ± 0.58	ND
Soil	3.95 ± 0.50	0.07 ± 0.04
Sothwest Corner HWMF, outside fence		
Vegetation	3.37 ± 0.62	ND
Soil	5.97 ± 0.68	0.23 ± 0.05
Booster Berm NSLS-II		
Vegetation	3.39 ± 0.61	0.04 ± 0.02
Soil	6.36 ± 0.52	0.19 ± 0.03
NSLS-II BERM		
Vegetation	3.58 ± 0.52	ND
Soil	5.54 ± 0.52	0.16 ± 0.04
Former Landfill		
Vegetation	4.31 ± 0.58	ND
Soil	5.76 ± 0.55	0.14 ± 0.04
HM-N		
Vegetation	4.16 ± 0.52	ND
Soil	4.64 ± 0.45	0.04 ± 0.02
P7 Air Station		
Vegetation	5.15 ± 0.69	ND
Soil	8.47 ± 0.65	ND

Notes:
All values are shown with a 95% confidence interval.
Radiological values for soils are reported on a "dry weight" basis.
K-40 occurs naturally in the environment and is presented as a comparison to Cs-137.
Cs-137 = cesium-137
HWMF = Hazardous Waste Management Facility
k-40 = potassium-40
ND = not detected
NSLS-II = National Synchrotron Light Source II
RHIC = Relativistic Heavy Ion Collider

Table 6-10. Precipitation Monitoring (Radiological and Mercury).

Location/ Matrix	Gross Alpha	Gross Beta	Mercury
	pCi/g		ng/L
P4			
01/15/04	-	-	6.11
01/31/14	3.35 ± 1.19	2.61 ± 0.89	-
04/09/14	-	-	5
04/30/14	2.17 ± 1.18	2.26 ± 0.80	-
07/16/14	-	-	7.32
07/31/14	3.35 ± 1.29	2.52 ± 0.86	-
10/06/14	-	-	2.24
11/26/14	ND	3.1 3 ± 0.87	-
S5			
01/15/04	-	-	6.28
01/31/14	4.81 ± 1.48	6.30 ± 1.22	-
04/09/14	-	-	6.22
04/30/14	ND	2.36 ± 0.77	-
07/16/14	-	-	4.98
07/31/14	1.95 ± 1.13	1.82 ± 0.75	-
10/06/14	-	-	2.66
11/26/14	ND	3.46 ± 0.88	-

Notes:
All values are shown with a 95% confidence interval.
K-40 occurs naturally in the environment and is presented as a comparison to Cs-137.
AGS = Alternate Gradient Synchrotron
Cs-137 = cesium-137
K-40 = potassium-40
ND = not detected
* = value for Cs-137 is estimated

recapture effort. Several turtles marked in early 2000 have been recaptured 10 years later, providing a snapshot into longevity and movement in turtles.

Interns also conducted surveys in and around the LISF to study the relationship and impacts of this facility on the local ecosystems. Vegetation data were gathered on paired transects during the summer and fall, and paired small mammal trapping grids and moveable cameras were used to look at how animals used the fence openings. Paired trapping grids were established to compare small mammal population in the core of the facility to core habitats outside of the facility, and to compare recruitment of small mammals from the forest to the immediate interior of the solar farm (one grid on either side of the LISF fence). The camera

surveillance data verified that all species that were expected to use the openings are doing so (e.g., raccoons, skunks, foxes, etc.). Paired transects for vegetation allow comparison of vegetation growth and establishment inside and outside of the LISF. In addition, interior transects were established based on the vegetative assemblage that existed prior to construction.

To facilitate the analysis of the wildlife surveillance data and to develop plans for the placement of transects, trapping grids, and placement of cameras, all surveillance data are entered into databases, and a GIS is used to visualize the data.

In March 2011, a northern long-eared bat (*Myotis septentrionalis*) was found on the ground outside a building on site. The bat appeared to have discoloration on the fur around its muzzle and was reported to NYSDEC as a possible incidence of white-nose syndrome. White-nose syndrome is a recently identified fungal infection impacting bats throughout the Northeast and Midwest. The bat was the first recorded incidence of white-nose syndrome on Long Island. As a result, BNL and NYSDEC established permanent acoustical survey routes on Long Island for monitoring. In 2014, a bat specialist captured bats on site using mist-netting. These results were compared to 2012 and 2013 efforts, and confirmed that white-nosed syndrome has had a major impact on certain bat species, particularly the northern long-eared bat which showed a dramatic reduction in population at BNL based upon 15 captures in 2012 to only one capture in 2013. However, captured 'young of the year' in 2014 suggest that there is potential for the population to survive, even if at low population densities. Additional work on the northern long-eared bat needs to be completed to facilitate recovery plans for this soon to be listed species.

In 2014, BNL continued to participate in several events in support of ecological education programs including: providing on-site ecology tours; hosting the Nineteenth Annual Pine Barrens Research Forum for ecosystems researchers to share and discuss their results; participated in the Fifth Annual Pine Barrens Discovery Day held in association with the Tri-Hamlet Celebration at the Wertheim National Wildlife Refuge; and assisting the Central Pine Barrens Commission on "A Day in the Life of the Rivers," which allowed students from multiple school districts to acquire environmental and biological data about the Carmans, Peconic, and Nissequogue Rivers.

The Laboratory also hosted the annual New York Wildfire & Incident Management Academy, offered by NYSDEC and the Central Pine Barrens Commission. Using the Incident Command System of wildfire management, this academy trains firefighters in the methods of wildland fire suppression, prescribed fire, and fire analysis. BNL has developed and is implementing a Wildland Fire Management Plan. The Laboratory continues the use of prescribed fire for fuel and forest management and is working with NYSDEC to conduct growing season fires in northern and eastern sections of the BNL property. A growing season prescribed fire was planned to take place in June 2014; however, due to last minute changes in meteorological conditions, the planned fire was suspended. Because the team was already assembled for the prescribe fire, the action was changed to a training exercise to improve fire line hose lays and use of new techniques in wildland fire and prescribed fire management.

6.6 CULTURAL RESOURCE ACTIVITIES

The BNL Cultural Resource Management (CRM) Program ensures that the Laboratory fully complies with numerous cultural resource regulations. The Cultural Resource Management Plan for Brookhaven National Laboratory (BNL 2013a) guides the management of all of the Laboratory's historical resources. BNL's cultural resources include buildings and structures, World War I (WWI) earthwork features, the Camp Upton Historical Collection, scientific equipment, photo/audio/video archives, and institutional records. As various cultural resources are identified, plans for their long-term stewardship are developed and implemented. Achieving these goals will ensure that the contributions BNL and the site have made to our history and culture are documented and available for interpretation.

The Laboratory has three structures or sites that have been determined to be eligible for listing on the National Register of Historic Places: the Brookhaven Graphite Research Reactor (BGRR) complex, the High Flux Beam Reactor (HFBR) complex, and the WWI training trenches associated with Camp Upton. The trenches are examples of the few surviving WWI earthworks in the United States.

In 2014, BNL submitted a Section 106 review concerning the planned demolition of four structures on site to the New York State Historic Preservation Office (NYSHPO) for review as required under the National Historic Preservation Act. Although the four buildings were auxiliary support structures associated with the early history of BNL, they were determined not to have played a significant contribution. The NYSHPO requested additional analysis in order to provide concurrence with the finding.

The Laboratory loaned the Long Island History Museum materials from the Camp Upton Collection covering both World War I and WW II for their display on "Long Island at War." The loan of materials and display were described in a BNL website in an article titled 'Long Island at War: Camp Upton Artifacts on Display at Long Island Museum.' A small display on Camp Upton is continually maintained at the Laboratory's cafeteria and conference center, Berkner Hall. The display is reviewed each year for changes before the Summer Sundays program starts in July. During 2014, the display was updated with new material, including a graphic map of WWI Camp Upton showing where major buildings were located, along with photos of those structures. As part of the outreach effort of the Cultural Resource Management program, a presentation on the 'History of the BNL Site' was developed and presented to BNL's Community Advisory Council and a modified version focusing on the history of the site from a natural history perspective was presented at a meeting of the South Shore Audubon Society.

The Laboratory undergoes an annual external assessment as part of its ISO 14001 certification. During the 2014 assessment, the Cultural Resource Management program was evaluated. The Cultural Resource Management Plan contains a Standard Operating Procedure (SOP) for the tagging of cultural resource items. This SOP had not been implemented due to staffing issues. The assessment listed the finding as a non-conformance and corrective actions were required to ensure that the tagging program was implemented. An intern project was posted at C.W. Post Library Sciences department, and an intern was selected and scheduled to start on the project by year's end.

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