Flora and Fauna

CHAPTER 7

Brookhaven National Laboratory (BNL) has a wildlife management program to protect flora and fauna and their habitats. BNL's wildlife management strategy is based on an understanding of the resources onsite, assuring compliance with applicable requirements, protecting and monitoring the ecosystem, research, and communication. Monitoring to determine whether current or historical activities have endangered wildlife is part of this program. No BNL-related radionuclides were detected in local farm-grown vegetation in 1998. Deer and fish sampling results are consistent with previous years. Deer residing on the BNL site were found to contain elevated concentrations of cesium-137. Fish from the Peconic River collected at the BNL boundary appear to show a slightly elevated radionuclide content, though at levels which continue to decrease over time.

7.1 WILDLIFE MANAGEMENT PROGRAM

The purpose of the Wildlife Management Program is to promote stewardship of the natural resources found at Brookhaven National Laboratory (BNL), and to integrate their protection with the Laboratory's mission. In 1998, BNL developed a Wildlife Management Plan that describes the program strategy, elements and planned actions (Naidu, 1998). The program elements and some of the associated actions are summarized below.

7.1.1 IDENTIFICATION AND MAPPING OF NATURAL RESOURCES

An understanding of the environmental baseline is the starting point for wildlife management planning. The Pine Barrens Commission conducted a natural resources inventory of the BNL site based on data collected from 1970 to 1990. This mapping process has identified environmentally sensitive areas, and significant wildlife communities. BNL is in the process of updating this inventory.

As noted in Chapter 1, a wide variety of vegetation, birds, reptiles, amphibians, and mammals have been found onsite at BNL. There is only one New York State (NYS) endangered species that is a regular inhabitant of BNL property—the tiger salamander *(Ambystoma tigrinum)* (see Figure 7-1). One NYS "Species of Special Concern" has also been identified, namely, the banded sunfish (Enneacanthus obesus) (see Figure 7-2).

7.1.2 HABITAT PROTECTION OR ENHANCEMENT

Actions to eliminate or minimize negative impacts on sensitive or critical species are either incorporated into BNL procedures or incorporated into specific project plans. Environmental restoration efforts remove sources that could pollute habitats. Access to critical habitats is restricted. A map of tiger salamander breeding locations is maintained and reviewed when projects are proposed to ensure that those projects do not negatively affect the breeding areas. In some cases, habitats are enhanced to improve survival or increase populations. Routine activities (e.g., road maintenance) that are not expected to impact habitats are allowed to proceed.

Efforts to protect the tiger salamander include determining when adult salamanders are migrating toward breeding locations, when juveniles and adults are migrating after breeding, and when metamorphosis has been completed. During these times, construction and/or maintenance activities by BNL are minimized. Water quality testing is conducted as part of the routine monitoring of water basins. These data are used to assess the quality of water prior to the breeding cycle. Beginning in 1999, a biennial survey of tiger salamander habitats will be conducted. The results of such surveys will pinpoint how long the breeding period lasts here and provide a window for construction activities in and around the breeding areas. The information may also identify changes in site use that are needed and possible activities that could be affecting this species.

Banded sunfish protection efforts include ensuring that adequate flow of the river is maintained within areas currently identified as sunfish habitats, ensuring that existing vegetation in the sunfish habitat is not disturbed, and evaluating all river remediation efforts for potential impacts on these habitats. The banded sunfish is shown in Figure 7-2.

During 1998, BNL participated in the American Forestry Global ReLeaf program as part of the Long Island re-vegetation program. This program was instituted in the wake of the extensive forest fires of 1995. Students, volunteers and BNL staff and their families planted over 15,000 pine seedlings in the vicinity of BNL's northern firebreaks (see Figure 7-3). Over 50 percent of the seedlings survived. The program will be repeated in 1999.

7.1.3 POPULATION MANAGEMENT

BNL also manages other populations as necessary to ensure that they are sustainable, and to control undesirable species. For example, BNL monitors populations of species of interest, such as the wild turkey. BNL is also in the process of updating information on the deer populations onsite. Since there are no natural predators onsite and hunting has never been permitted at BNL, there are no significant pressures on the population to migrate beyond their typical geographical range of approximately 1.6 kilometers (one mile). A 1992 study indicated that the population of deer onsite exceeded 700, or approximately 39 deer per km^2 (100 per mi^2). Normally a population density of 4 to 12 per km^2 (10 to 30 per mi^2) is considered an optimum sustainable level for a given area. Overpopulation can

Figure 7-1.
Tiger salamander *(Ambystoma tigrinum)*, a New York State-listed endangered species. Breeding habitats hve been found at vaious locations at BNL. The salamander was released immediately after the photograph was taken.

Figure 7-2.
Banded sunfish *(Enneacanthus obesus)*, a New York State "Special Concern" species. Photographed along with a quarter to show relative size of fish. This live specimen was returned to the water body immediately after photograph was taken.

Figure 7-3.
Student planting seedlings as part of the Global ReLeaf program in an area of the BNL site that experienced extensive damage as a result of the 1995 forest fires.

affect both animal and human health (e.g., deer ticks transmit Lyme Disease), decrease species diversity (due to selective grazing and destruction of habitat), and can also result in increased property damage and traffic accidents as animals forage into developed areas for food. Options for managing the deer population are under evaluation, and BNL will work with the regulators and the community if active management (such as culling the herd) is determined to be necessary.

7.1.4 COMPLIANCE ASSURANCE AND POTENTIAL IMPACT ASSESSMENT

BNL's National Environmental Policy Act (NEPA) program is one of the keys to ensuring that environmental impacts of a proposed action are adequately evaluated and addressed. BNL will continue to use NEPA, or NEPA equivalence under the Comprehensive Environmental Response, Compensation and Liability Act program, as the process for identifying potential environmental impacts associated with site activities (especially physical alterations). As appropriate, stakeholders such as the U.S. Environmental Protection Agency (USEPA), New York State Department of Environmental Conservation (NYSDEC), Suffolk County Department of Health Services (SCDHS), The Nature Conservancy, the Town of Brookhaven, the Citizens Advisory Board, and local environmental advocacy groups are involved in reviewing projects which have potential environmental impacts.

7.2 MONITORING

7.2.1 DEER SAMPLING

Deer in New York State typically grow to large sizes, with average weights of approximately 68 kg (150 lbs); females are slightly less at about 45 kg (100 lbs). However, deer on Long Island tend to be much smaller in size, with an average weight of less than 36 kg (80 lbs). The available meat on local deer ranges from 9 to 18 kg (20 to 40 lbs) per deer.

As in 1997, an offsite deer-sampling program was again conducted in cooperation with the NYSDEC Wildlife Branch. The NYSDEC samples provide data on deer moving beyond BNL boundaries that can be legally hunted. This program also provides control data on deer living in locations which are distant from BNL. The total number of samples obtained near the BNL site was very limited in 1998 due to a low response rate from hunters who were approached for samples at state check-points. In all, six deer were obtained onsite, while 13 were gathered from offsite locations.

BNL has been monitoring radionuclide levels in deer onsite since 1992. Onsite samples were collected primarily from deer killed in automotive incidents. Samples were analyzed for gamma-emitting radionuclides; results are shown in Table 7-1. It has been previously established that deer taken on BNL property contain concentrations of cesium-137 (half-life = 30 years) at levels above those taken from offsite (see the BNL Site Environmental Reports for 1996 and 1997 for data). This is most likely the result of deer grazing on vegetation growing in soils where elevated cesium-137 levels are known to exist. Cesium-137 in these soils can be transferred to aboveground plant matter via root uptake, where it then becomes available to browsing animals. Remediation of contaminated soil areas is being addressed as part of the site environmental restoration program.

The maximum onsite concentration of cesium-137 detected in all hind meat samples was 8.8 pCi/g (0.3 Bq/g), wet weight (the concentration prior to drying for analysis). The arithmetic average concentration of all samples of hind meat in which cesium-137 was detected was 4.9 pCi/g (0.2 Bq/g). This may be compared with the maximum and average hind-meat cesium-137 concentrations recorded in offsite samples of 4.3 and 1.1 pCi/g (0.2 and 0.04 Bq/g), respectively. Maximum and average cesium-137 concentrations in liver samples from deer collected onsite show a similar pattern of elevation. Figure 7-4 shows the ranges of cesium-137 concentrations in hind samples from onsite deer collected since 1996.

The potential radiological dose resulting from deer meat consumption is discussed in Chapter 9. The NYSDOH has formally assessed the potential public health risk associated with the elevated cesium-137 levels in onsite deer and determined that neither hunting restrictions nor formal health advisories are warranted (NYSDOH, 1999).

With respect to health of the onsite deer population, the International Atomic Energy Agency (IAEA) has concluded that chronic

Table 7-1. Radiological Analysis of Deer Tissue

Location	Collect Date	Tissue	K-40 (pCi/g, wet)	Cs-137 (pCi/g, wet)
BNL				
Bell Ave. at Grove St.	02/25/98	Hind	1.86±0.32	ND
Bell Ave. at Grove St.	02/25/98	Liver	2.84±0.53	ND
BNL Observatory	04/09/98	Hind	5.26±1.58	0.24±0.15
BNL Observatory	04/09/98	Liver	3.19±2.21	ND
BNL Princeton Rd.	04/16/98	Hind	4.07±0.97	ND
BNL Princeton Rd.	04/16/98	Liver	1.77±0.43	ND
0.25 mi. S of South Gate	12/20/98	Hind	4.15±1.05	8.79±1.54
0.25 mi. S of South Gate (*)	12/20/98	Hind	2.51±0.44	7.01±1.21
RHIC	12/22/98	Hind	2.22±0.42	1.92±0.32
RHIC	12/22/98	Liver	4.72±1.15	14.59±2.88
0.25 mi. E of Main Gate	12/29/98	Hind	2.55±0.43	6.56±1.10
0.25 mi. E of Main Gate	12/29/98	Liver	2.11±0.48	1.85±0.42
Offsite				
Bridge Hampton	01/07/98	Hind	2.81±0.53	0.05±0.02
Camp Wauwepea, Ridge	01/12/98	Liver	2.23±0.39	ND
Camp Wauwepea, Ridge (*)	01/12/98	Liver	2.70±1.26	0.14±0.14
Lilco Substation	01/12/98	Hind	3.80±0.66	0.24±0.05
Intersection of Rt. 111 / Rt. 51	01/18/98	Hind	2.26±0.47	0.53±0.10
Intersection of Rt. 111 / Rt. 51 (*)	01/18/98	Hind	2.50±0.42	0.66±0.11
Ridge, 5 mi. N of Rt. 25	02/10/98	Hind	2.40±0.64	ND
Brookhaven State Park	08/18/98	Liver	2.29±0.39	ND
Wm Floyd Pkwy, N of Rt. 251	08/18/98	Hind	2.24±0.50	ND
Brookhaven State Park	08/19/98	Liver	3.34±1.42	0.41±0.18
Brookhaven State Park (*)	08/19/98	Liver	2.84±1.00	ND
Brookhaven State Park	08/19/98	Thyroid	21.23±18.14	4.30±2.87
Brookhaven State Park	08/20/98	Hind	3.12±0.74	2.14±0.40
Brookhaven State Park	08/20/98	Liver	2.15±0.58	0.27±0.06
Brookhaven State Park	08/30/98	Hind	2.63±0.60	0.99±0.18
Brookhaven State Park	08/30/98	Liver	4.44±1.22	2.16±0.45
Middle Island Conservtion Center	09/30/98	Hind	6.32±1.46	3.20±0.65
Middle Island Conservtion Center	09/30/98	Liver	0.99±0.16	0.26±0.04
Wm Floyd Pkwy, 0.25 mi. N of BNL	12/20/98	Liver	1.15±0.21	ND
Wm Floyd Pkwy, 0.25 mi. N of BNL (*)	12/20/98	Liver	1.86±0.54	0.35±0.08
Wm Floyd Pkwy, 0.5 mi. N of BNL	12/20/98	Hind	3.20±0.76	ND
BNL Hind Meat Average	7 samples		3.2±0.9	4.9±2.7
Offsite Hind Meat Average	10 samples		3.1±0.8	1.1±0.7
BNL Liver Average	5 samples		2.9±1.0	8.2±7.9
Offsite Liver Average	10 samples		2.4±0.6	0.6±0.5

Notes:
1. ND = Not Detected.
2. All values shown with 95% confidence interval.
3. (*) = duplicate analysis, a second sample from the same animal.
4. All summary statistics include duplicate analysis results.

dose rates of 100 millirad per day (1 mGy/d) to even the most radiosensitive species in terrestrial ecosystems are unlikely to cause detrimental effects in animal populations (IAEA, 1992). A deer containing a uniform distribution of cesium-137 at the highest levels observed to date would carry a total body burden of about 0.2 uCi (0.007 MBq). Under these conditions, such an animal would receive an absorbed dose of approximately 3 millirad per day (0.03 mGy/d), or 33 times less than the threshold evaluated by the IAEA.

7.2.2 FISH SAMPLING

BNL, in collaboration with the NYSDEC Fisheries Division, maintains an ongoing program for the collection of fish from the Peconic River and surrounding fresh water bodies. In 1998, various species of fish were collected from onsite portions of the Peconic River and from offsite locations such as Donahue's Pond, Forge Pond, Swan Pond, Hempstead Lake, Lake Ronkonkoma, Lower Lake (Yaphank) and the Carmans River (see Figure 6-7 in Chapter 6 for geographic loca-

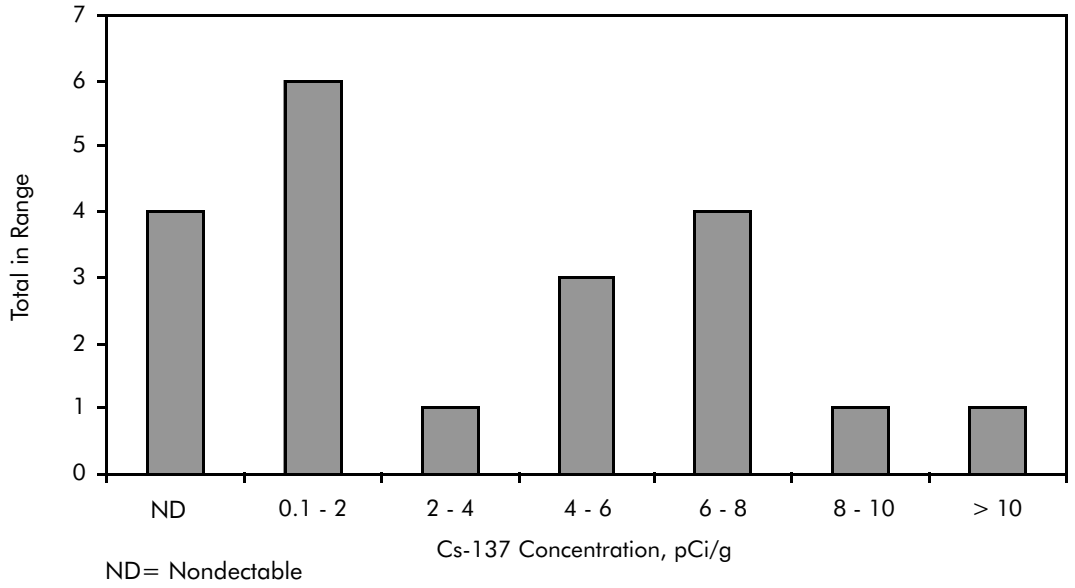

Figure 7-4. Ranges of Cs-137 concentrations detected in onsite deer samples since 1996 (hind tissue only).

Figure 7-5. BNL Staff and a Department of Environmental Conservation (DEC) Fishery Biologist use a hoop net at Swan Pond to capture fish.

tions). See Figure 7-5 for a photograph of fish sampling activities. Hempstead Lake, Lake Ronkonkoma, Lower Lake and the Carmans River are not connected to the Peconic River system and are, therefore, used as control locations to indicate environmental background conditions. Brown bullhead *(Ictalurus nebulosus),* chain pickerel *(Esox niger),* largemouth bass *(Micropterus salmoides),* bluegill *(Lepomis macrochirus),* pumpkinseed *(Lepomis gibbosus),* creek chubsucker *(Erimyzon oblongus),* and yellow perch *(Perca flavescens)* species were collected in 1998. Gamma spectroscopy analysis was performed on these samples. Specific information regarding the sampling point, species collected and analytical results is presented in Table 7-2. All sample results are presented as wet weight concentrations.

Note that in most cases analyses were performed separately on the flesh and skin, the viscera and bones, and the whole fish. Segregating the tissues in this way provides information regarding the localization of radionuclides in certain parts of the fish. Segregated analysis also allows for more realistic dose calculations to be performed since different radionuclides may become localized in different discrete tissues due to specific chemical characteristics. If the tissue in which a radionuclide concentrates is an inedible one, the source of intake is eliminated.

Concentrations of naturally occurring potassium-40 (a radionuclide common to soil and vegetation) were observed to be very consistent between Peconic River and control location fish, validating the comparability of the data. The only anthropogenic (man-made) radionuclide found in any fish sample, control or otherwise, was cesium-137. (Note that in 1998, the special analysis required for strontium-90 was not performed on fish samples. See Section 7.8.1 of the 1996 BNL Site Environmental Report for the most recent data.)

As discussed in Chapter 4, cesium-137 is detectable throughout the environment of the Northern Hemisphere as a result of global fallout. This is evident when examining the analytical results of control-location fish. Cesium values up to 0.43 pCi/g (16 mBq/g) were found in yellow perch flesh taken from Swan Pond. In order to account for the different feeding habits and weights of various species, it is important to compare similar

Table 7-2. Radiological Analysis of Fish from the Peconic River System and Background Locations

Fish/ Sample Type	K-40 (pCi/g, wet)	Cs-137 (pCi/g, wet)
Donahue's Pond		
Bluegill (whole)	2.94±0.83	0.14±0.06
Golden shiner (whole)	3.51±0.78	0.20±0.06
Yellow perch (flesh & skin)	3.40±0.65	0.40±0.08
Yellow perch (bone & viscera)	2.77±0.81	0.32±0.10
Chain pickerel (flesh & skin)	3.64±0.62	0.41±0.07
Chain pickerel (bone & viscera)	3.22±0.67	0.38±0.08
Brown bullhead (whole)	1.89±0.33	0.15±0.03
Brown bullhead (whole)	2.15±0.37	0.16±0.03
Forge Pond		
Largemouth bass (whole)	ND	ND
Bluegill (whole)	1.96±0.37	0.09±0.02
Bluegill (whole)	1.98±0.46	0.11±0.03
Brown bullhead (viscera & bone)	1.20±0.22	0.03±0.01
Brown bullhead (flesh & skin)	3.97±0.66	0.13±0.03
Peconic River, BNL Station HM		
Brown bullhead (whole)	2.87±0.56	0.37±0.08
Chain pickerel (whole)	3.29±0.61	0.41±0.08
Chain pickerel (flesh & skin)	4.58±1.04	0.73±0.17
Chain pickerel (bone & viscera)	1.93±0.46	0.26±0.06
Peconic River, North St.		
Brown bullhead (whole)	1.92±0.33	0.25±0.05
Brown bullhead (viscera & bone)	3.06±1.07	0.34±0.13
Brown bullhead (flesh & skin)	3.22±0.53	0.34±0.06
Creek Chub Sucker (whole)	2.27±0.43	0.42±0.08
Chain Pickerel (whole)	2.59±0.47	0.60±0.11
Peconic River, STP outfall		
Chain pickerel (whole)	3.74±0.83	0.36±0.08
Swan Pond (control)		
Yellow perch (whole)	2.41±0.46	0.23±0.05
Yellow perch (flesh & skin)	4.00±0.91	0.43±0.10
Yellow perch (bone & viscera)	2.84±0.74	0.34±0.08
Pumpkinseed (whole)	1.59±0.33	0.05±0.02
Brown bullhead (whole)	1.98±0.34	0.06±0.01
Brown bullhead (flesh & skin)	2.49±0.41	0.10±0.02
Brown bullhead (viscera & bone)	1.46±0.27	0.05±0.01
Hempstead Lake (control)		
Carp (whole)	1.69±0.30	0.02±0.01
Carp (whole)	2.03±0.36	0.03±0.01
Lake Ronkonkoma (control)		
White perch - flesh & skin	2.53±0.43	0.08±0.02
White perch - viscera & bone	2.85±0.93	ND
White perch - whole	2.24±0.38	0.08±0.02
Lower Lake, Yaphank (control)		
Yellow perch (whole)	2.38±0.48	ND
Yellow perch (flesh & skin)	4.02±0.83	ND
Yellow perch (bone & viscera)	2.52±0.68	ND
Brown bullhead (whole)	2.09±0.37	0.01±0.01
Brown bullhead (flesh & skin)	2.73±0.48	0.03±0.01
Brown bullhead (viscera & bone)	1.75±0.37	0.02±0.01

Notes:
1. ND = Not Detected.
2. All values shown with 95% confidence interval.

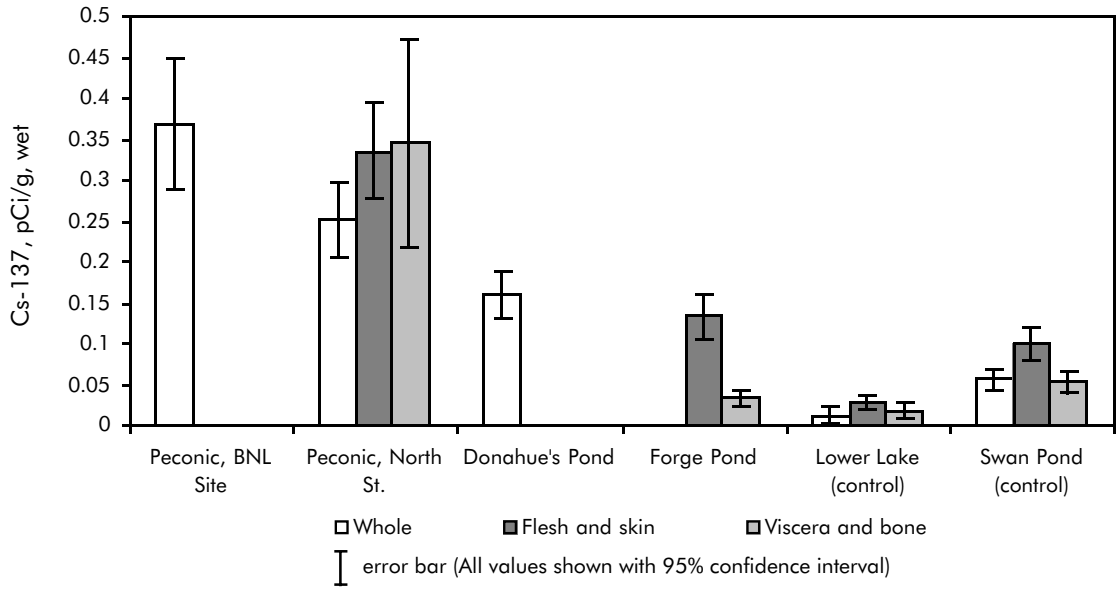

Figure 7-6. Concentration of Cs-137 in Brown Bullhead collected from Peconic River System

species to each other. A comparison of cesium-137 concentrations in brown bullheads collected from Peconic and control locations is plotted in Figure 7-6. (Each location does not show all three segregation categories since not all fish were segregated for analysis in the same manner.) It can be seen that cesium-137 concentrations in bullheads collected near the BNL Sewage Treatment Plant outfall are somewhat elevated in comparison to the control locations. The elevations become less pronounced with increasing distance from the Sewage Treatment Plant outfall (see Donahue's Pond and Forge Pond values).

Though it is clear from discharge records and sediment sampling that historical BNL operations have contributed to anthropogenic radionuclide levels in the Peconic River system, most of these nuclides (with the exception of tritium) were released between the late 1950's and early 1970's. Radionuclides in Peconic River fish have been measured since 1974 by the NYSDOH. Both the NYSDOH and BNL data indicate a continuing decrease in radionuclide concentrations in all fish species over time (NYSDOH, 1996). This is due to a lack of significant new radioactive discharges and the radioactive decay of materials discharged in the past.

7.3 VEGETATION SAMPLING

Vegetation samples were collected from several farms surrounding BNL (see Figure 7-7). Samples included typical farm vegetables such as potatoes, peppers and tomatoes. These samples were analyzed by the BNL Analytical Services Laboratory for gamma-emitting radionuclides. Direct monitoring of radioactive emissions and effluents discharged from BNL facilities indicates that no influence on local crops would reasonably be expected. The results shown in Table 7-3 confirm this, indicating only the presence of naturally occurring potassium-40 at levels which are typical of these types of samples. No radionuclides attributable to BNL operations were observed.

7.4 PECONIC RIVER SEDIMENTS

During Operable Unit V Peconic River characterization studies under the Environmental Restoration program, some sediment samples were found to contain americium-241. There are two possible explanations for the presence of this radionuclide. The first is that it may have been released directly to the BNL sanitary system at some time in the past. The second is that it is a decay product from plutonium-241. To assess these possibilities, exploratory sampling of Peconic River sediments on the BNL site and just beyond the boundary was conducted in 1998. The analytical results were ambiguous. A number of factors were responsible, including insufficient analytical sensitivity and background concentration data. To address these unresolved issues, a more comprehensive sampling plan was developed and will be executed in 1999 as

Figure 7-7.
Vegetation Sampling near the HM Monitoring Sie

Table 7-3. Radioogical Analysis Results for Local Vegetation Samples

Location	Sample Type	K-40 (pCi/g)
Lewin's Farm	Tomatoes	2.53±0.42
Lewin's Farm	Radish (Leaves)	0.99±0.19
Lewin's Farm	Bell Peppers	1.95±0.34
Lewin's Farm	Eggplant	1.25±0.21
Lewin's Farm	Turnip Stems	3.63±0.77
Lewin's Farm	Beet Root	3.93±0.65
Lewin's Farm	Potatoes	3.38±0.55
Lewin's Farm	Turnip (Leaves)	1.67±0.29
Lewin's Farm	Radishes	2.62±0.45
May's Farm	Corn Kernels (Yellow)	1.89±0.32
May's Farm	String Beans	2.45±0.41
May's Farm	Bell Peppers	0.25±0.04
May's Farm	Tomatoes	2.48±0.41
May's Farm	Zucchini	2.23±0.36
May's Farm	Eggplant	2.16±0.46

Notes:
1. All values shown with 95% confidence interval.
2. No anthropogenic radionuclides were detected in any local vegetation samples.

part of the cleanup project for Operable Unit V. The plan will address the confounding factors encountered during the 1998 sampling round. Available results will be discussed in the 1999 Site Environmental Report.

7.5 TOXICITY TESTING AT THE SEWAGE TREATMENT PLANT

Under the SPDES discharge permit, BNL conducts toxicity testing for the Sewage Treatment Plant effluent. Two species are evaluated—the fathead minnow *(Pimphales promelas)* and the water flea *(Ceriodaphnia dubia)*. Results from this testing program are presented in Chapter 3.

7.6 WILDLIFE MANAGEMENT EDUCATION, OUTREACH AND RESEARCH

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

In 1998, a Smithtown High School student completed a follow-up study of the BNL Gamma Forest. The Gamma Forest was a research project that began in 1961, which examined the effects of long-term irradiation on a forest ecosystem. No evaluations of the area had been done since the project was terminated in 1979. In the follow-up study, an innovative method of depicting population/habitat relationships, in particular with regard to sediment chemistry and types, was developed. The student's research qualified him as a finalist in an INTEL Science Competition. Another study by a Smithtown High School student was conducted on succession communities in the woodlands at BNL as compared to those at the NYSDEC Rocky Point Preserva-

tion area and the Dwarf Pine Plains. This student was a semi-finalist in the Westinghouse Science competition.

A third study was conducted by BNL and Suffolk Community College staff to evaluate the effects of woodland clearing on forest types in the Long Island Pine Barrens. Both BNL and the NYSDEC preserve at Rocky Point were evaluated. The study focused on areas subject to extensive clearing involving removal of all vegetation and scraping of the surface deep into the subsoil. The results indicated that pitch pine *(Pinus rigida)* are "pioneer" species. Areas at both sites where disturbance was less severe experienced more traditional succession from grass to shrubs, etc. (Naidu, et al, 1997).

Finally, the 106 Rescue Group at the Westhampton Air Force Base conducted a project funded by a Department of Defense Legacy Grant which compared woodlands at BNL to the Westhampton site. Complete biological, chemical and geological surveys were carried out at both locations. The study received a Department of Defense Environment Management Award. Data from both of these studies is being incorporated into the BNL environmental database and the Wildlife Management Plan.

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