Reformulation of the Shore Protection and Storm Damage Reduction Project
South Shore of Long Island, New York - Fire Island Inlet to Montauk Point

FINAL SMALL MAMMAL AND HERPETILE SURVEY SUMMARY REPORT MAY – AUGUST 2002

JANUARY 2004

Prepared by: **U.S. Army Corps of Engineers**
Planning Division
New York District
26 Federal Plaza
New York, New York 10278-0090

FINAL SMALL MAMMAL AND HERPETILE FIELD SAMPLING SUMMARY REPORT

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FOR THE

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1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE), New York District, is conducting a comprehensive feasibility-level reformulation of the shore protection and storm damage reduction project (Project) for the south shore of Long Island, New York, from Fire Island Inlet to Montauk Point. The Federally authorized Project area extends west from Montauk Point to Fire Island Inlet along the Atlantic Coast of Suffolk County, Long Island, New York (Figure 1). The Project was initiated in response to continued threat of significant economic losses and damages to commercial, residential, public and other infrastructure in the study area as a result of severe storms. The principal problems are associated with extreme tides and waves that can cause extensive flooding and erosion both within barrier island and mainland communities. The potential for continued breaching and inundation of the barrier islands along the south shore of Long Island poses a threat of flooding and economic losses, especially to the mainland communities bordering Shinnecock, Moriches and Great South bays.

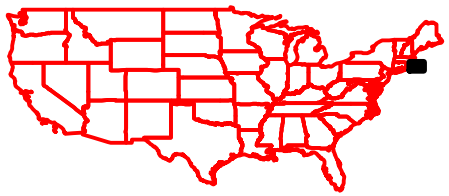
The USACE is undertaking a process of plan formulation to evaluate the range of possible alternatives to address these problems, including a screening of alternatives, detailed design, design optimization, and final design. Concurrent with the development of plans, site-specific information on aquatic and terrestrial communities has been collected to assist in the evaluation of these Project alternatives in order to identify the recommended plan of protection.

The USFWS conducted a study of fish and wildlife resources in 1982 for the USACE's Fire Island Inlet to Montauk Point, New York, Beach Erosion Control and Hurricane Protection Project Reformulation Study (USFWS 1983). Although the USFWS report presents information on mammal and herpetile use of habitats on the south shore barrier island, there is a need for more current detailed habitat information, and information on the seasonal usage of the island by mammal and herpetile species.

This report presents the results from a 4-month USACE survey of mammal and herpetile (i.e., reptiles and amphibian) communities on the barrier island. The USACE barrier island mammal and herpetile study (Study) was conducted between May 2002 and August 2002 over approximately 52 miles of the barrier island located along the south shore of Great South Bay, Moriches Bay, and Shinnecock Bay. The Study area extended west from Southampton, New York, to the westernmost point of Robert Moses State Park, New York (Figure 1). The focus of mammal sampling was to collect information on species composition and relative abundance during the spring and summer months on the barrier island within the proposed Project area. Surveys for herpetofaunal species were conducted to gather data based on incidental observations within the proposed Project area. In addition, herpetile surveys were supplemented with data collected by the Wildlife Conservation Society during surveys conducted from March to September 2002 (Brotherton et al. 2003).

The goal of this study was to inventory mammals and herpetiles on the island in order to develop a comprehensive list of species using the island and to relate species use to habitats, especially those that could potentially be impacted under a no-action scenario or various flood protection alternatives proposed for the Project. The following objectives were established to reach this goal: 1) conduct live capture surveys of small mammal species; and, 2) establish habitat

associations by recording micro-habitat variables at trap locations. A secondary objective of surveys included documentation of incidental observations of mid-large size mammals and herpetile species in the Study area. This report presents a summary of the 4-month mammal and herpetile study and includes the following: Study area description (Section 2.0), methodology (Section 3.0), results (Section 4.0), discussion (Section 5.0), implications for plan formulation (Section 6.0), and literature cited (Section 7.0). Photographic documentation is included in Appendix A and a printout of the database is provided in Appendix B.



Project Location

0 10 20 40

Scale in Miles

Shore Protection and Storm Damage Reduction Project, South Shore of Long Island, New York

Source: ESRI Data and Maps CD, 1999

Figure 1. Location of the Fire Island Shore Protection and Storm Damage Reduction Project and Mammal Study Area.

Prepared For: United States Army Corps of Engineers, New York District

Date: 11/03

Prepared By: NEA

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2.0 DESCRIPTION OF STUDY AREA

Typical of most barrier islands, the barrier island located along the south shore of Long Island is a narrow, low-lying landform consisting of beaches, sand dunes, saltwater marshes, herbaceous fields, scrublands, stunted forests, and tidal flats. The barrier island parallels the ocean coast of Long Island and is generally separated from the mainland by bays. The barrier beach is a dynamic landform, constantly moving and reshaping in response to storms, sea level changes, and wave action. Barrier islands serve as buffers against storms and wave action for the coastal mainland and shelter productive wetland habitats and provide essential nesting and feeding areas for many aquatic and terrestrial plants and animals, including rare species (NYSDEC 2003, USFWS 2003).

Located within the Study area is Fire Island, a 32-mile stretch of barrier island. In 1964, Congress declared 26 miles of Fire Island and surrounding waters to be a part of the National Park System. In addition, a 7-mile stretch, located on the eastern portion of Fire Island National Park was designated as a Federal wilderness area in 1980. This is the only Federally-designated wilderness area in New York and contains the "Sunken Forest", one of the last remaining maritime forests on the eastern seaboard. Within the park are 15 hamlets and 2 incorporated villages.

2.1 COMMUNITY TYPE DESCRIPTIONS

Eleven (11) specific community types (i.e., habitats) were documented and surveyed during mammal sampling on the barrier island. These community types included beach (which encompassed the intertidal zone, berm crest, wrackline, ephemeral pools, and supratidal zone), herbaceous communities, shrub, herbaceous/shrub, forest/herbaceous/shrub, forest, forest/shrub, *Phragmites*, *Phragmites*/shrub, saltwater marshes (which encompassed small coastal ponds and tidal creeks), and bay side intertidal flats. Appendix A provides photographic documentation of each community type. A description of each community follows.

Beach (INT-O)

The beach community included intertidal and supratidal areas and extended from the edge of the low tide line to the ocean side limit of the primary dune. The intertidal beach habitat of this community was located between the high and low tide marks, and generally contained wet sand and shallow ephemeral pools. Beyond the intertidal zone the supratidal zone contained sparse herbaceous vegetation with less than 5% cover, beach debris, tire ruts, small ephemeral pools, and old wrack lines. Herbaceous vegetation primarily consisted of American beach grass (*Ammophila breviligulata*). Trapping efforts focused on the vegetated portions of this community type.

Herbaceous (HRB)

The herbaceous community type included herb-dominated areas of the primary dune and dunes and swales located in inner-island areas. Herbaceous cover was patchily distributed and was interspersed with significant areas of bare sand. On the primary dune and inner-island areas, the

vegetated portions of this community was dominated by American beach grass and typically contained less dominant species such as spurge (*Euphorbia polygonifolia*), beach plum (*Prunus maritima*), seaside goldenrod (*Solidago sempervirens*), beach heather (*Hudsonia tomentosa*), and sea rocket (*Cakile edentula*). In low-lying wet areas located within the inner-island, the herbaceous community typically included a variety of sedges (*Carex* spp.), bulrushes (*Scirpus* spp.), rushes (*Juncus* spp.), swamp rose mallow (*Hibiscus palustris*), and goldenrods (*Solidago* spp.). Herbaceous cover was generally higher in the inner-island dune and swale areas located on the bay side of the primary dune.

Shrub (SS)

The shrub community type was located primarily in inner-island areas and was dominated (>50% cover) by shrub, vine, and/or tree species < 10 feet in height. As with the herbaceous community, this community was typically interspersed with significant areas of bare sand. The vegetated areas of the shrub community were dominated by shadbush (*Amelanchier canadensis*), bittersweet (*Celastrus scandens*), highbush blueberry (*Vaccinium corymbosum*), common juniper (*Juniperus communis*), Japanese honeysuckle (*Lonicera japonica*), bayberry (*Myrica pensylvanica*), bearberry (*Arctostaphylos uva-ursi*), raspberry (*Rubus* spp.), greenbriar (*Smilax* spp.), and poison ivy (*Toxicodendron radicans*). In low-lying wet areas located within the inner-dune, the shrub community was dominated by species such as groundsel tree (*Baccharis halimifolia*), marsh elder (*Iva frutescens*), blueberry, cranberry (*Vaccinium macrocarpon*), bearberry, poison ivy, and greenbriar.

Herbaceous/Shrub (HSS)

The herbaceous/shrub community was represented by a mixture of herbaceous and shrub species (see herbaceous and shrub descriptions for a list of representative species). The herbaceous/shrub community was generally found throughout inner-island dune and swale areas.

Forest/Herbaceous/Shrub (FHSS)

The forest/herbaceous/shrub community was a mixed community that consisted of forest, herbaceous, and shrub species (see forest, herbaceous, and shrub descriptions for a list of representative species). The forest/herbaceous/shrub community was generally found toward the bayside of inner-island areas where the forest community type transitioned into the shrub and herbaceous community types.

Forest (FOR)

The forest community was located on the bayside of inner-island areas and was dominated (>50% cover) by stunted (< 20 feet in height) tree species, including pitch pine (*Pinus rigida*), black oak (*Quercus velutina*), red cedar (*Juniperus virginiana*), American holly (*Ilex opaca*), sassafras (*Sassafras albidum*), and black cherry (*Prunus serotina*). This community typically had a relatively sparse understory of shrub and/or vine species that often included poison ivy, greenbriar, shadbush, or multiflora rose (*Rosa multiflora*). Forest communities were generally stunted due to the harsh weather conditions that barrier islands are subjected to. Included in this

community type is the Sunken Forest, a 200+ year-old stunted forest dominated by American holly, sassafras, and shadbush.

Forest/Shrub (FSS)

The forest/shrub community comprised a mixture of forest and shrub species (see forest and shrub descriptions for a list of representative species). The forest/shrub community was generally found on the bayside of inner-island areas.

Salt marsh (SM)

The salt marsh community was located primarily on the bayside of inner-island areas and was dominated by emergent salt marsh species such as saltmeadow cordgrass (*Spartina patens*), and saltmarsh cordgrass (*Spartina alterniflora*). Other species included goldenrod, sedge, and rush species. The salt marsh community was generally found in low-lying areas that received direct tidal input from the bay.

***Phragmites* (PH)**

Phragmites is a monotypic, invasive plant community that was located primarily on the bayside of inner-island areas. This cover type was dominated (>50% cover) by common reed (*Phragmites australis*).

***Phragmites*/Shrub (PHS)**

The *Phragmites*/shrub community type included *Phragmites* and a variety of scrub species, such as groundsel tree, blueberry, marsh elder, and poison ivy. This community was typically found along the transition zone from salt marsh communities and/or *Phragmites*-dominated communities into drier upland areas.

Bay Intertidal Flats (INT-B)

The intertidal flats community was located between the high and low tide marks. This community was un-vegetated and generally contained wet sand and/or mud, cobble, shallow ephemeral pools, and significant wrack and debris. Small mammal trapping was concentrated in the sparse patches of vegetation and on the wrack line in this community type.

2.2 PLACEMENT OF SURVEY TRANSECTS

Survey transects were the same as those used for the south shore barrier island avian survey that was conducted concurrently with small mammal surveys in support of the USACE shore protection project (USACE 2003).

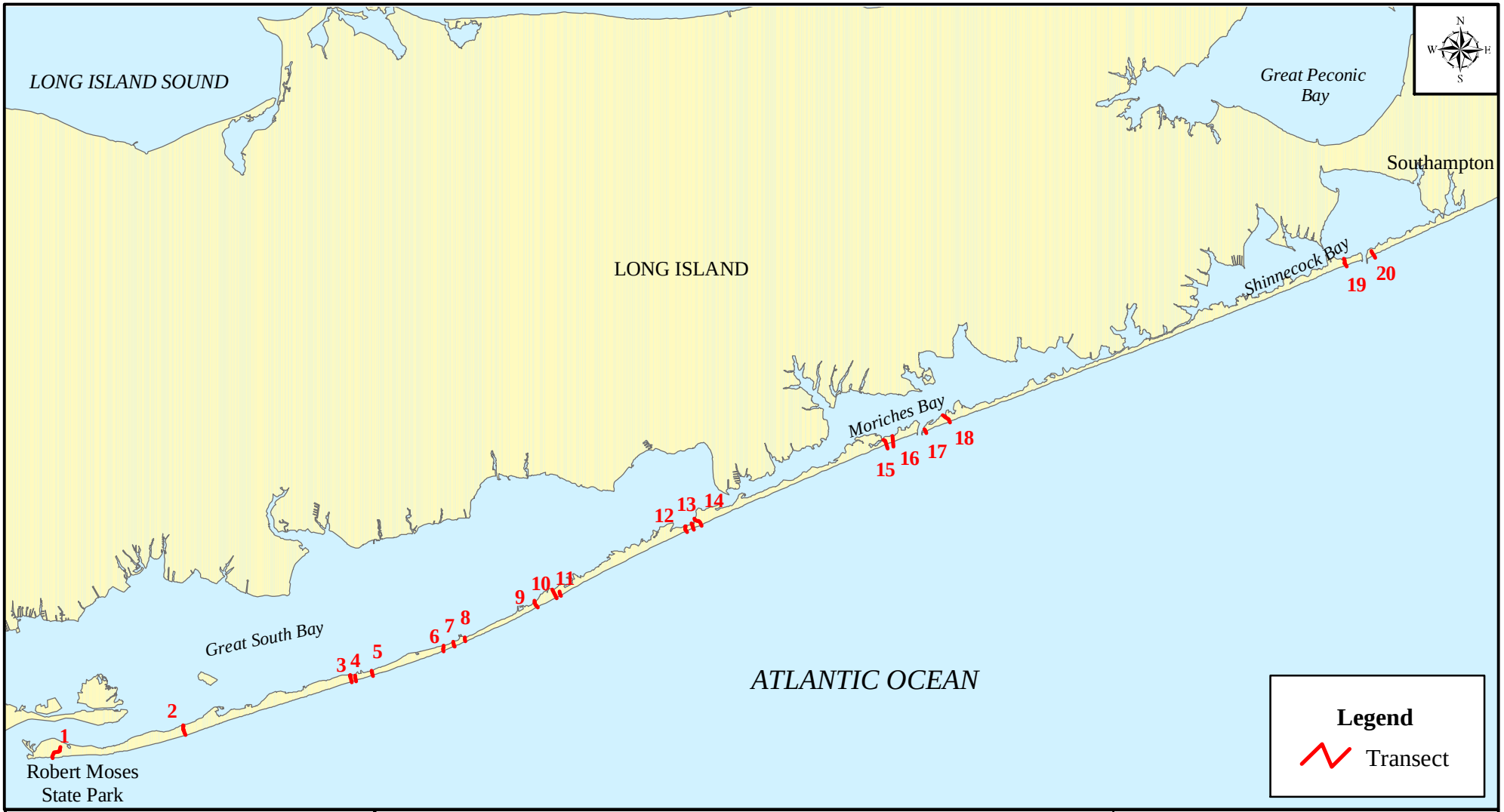
Survey transects were spread out across approximately a 52-mile section of the barrier island to ensure that a variety of community types found on the island were surveyed. Because the barrier island is so dynamic and subjected to microclimatic variations of wind, waves, and temperature,

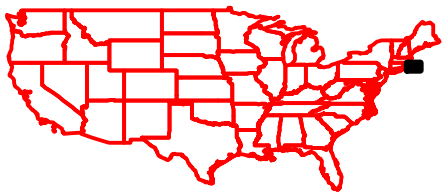
the various community types were found in a variety of locations, microsite types and extents. Therefore, sampling in the different locations helped to ensure that the diverse conditions found on the barrier island were investigated.

Transects were located from East Hampton westward to the western-most point of Robert Moses State Park (Figure 2). With the exception of the ponds and lakes targeted by the USFWS, the habitats surveyed during this Study were similar in vegetative composition to those areas surveyed by the USFWS in 1982 in support of the USACE's Fire Island Inlet to Montauk Point, New York, Beach Erosion Control and Hurricane Protection Project Reformulation Study (USFWS 1983). Twenty (20) transect lines were established in approximately north-south directions in eight general survey areas as follows, Robert Moses State Park (Transects 1 and 2), Sailors Haven (Transects 3, 4 and 5), Barrett Beach (Transect 6, 7 and 8), Watch Hill (Transects 9, 10, and 11), Old Inlet (Transects 12, 13, and 14), Smith Point (Transects 15 and 16), Cupscogue Beach (Transects 17 and 18), and Shinnecock Bay Inlet (Transects 19 and 20). Figures 3a through 3h show transect locations.

In general, the eight locations surveyed for this Study are similar to one another in the types of habitat encountered. However, some notable differences include significant stunted forest and forest/shrub communities within the Sunken Forest located near Watch Hill (Transects 3, 4, and 5), and the presence of salt marsh communities on Transects 10, 14, 15, 16, 17, 18, and 19. In addition, vegetation within transects 12, 17, 19, and 20 consists primarily of only herbaceous and low-growing sparse herbaceous/shrub and shrub. Sixteen (16) of the 20 transects contained some component of the invasive species *Phragmites*.

Typical of barrier islands, the spatial distribution of vegetated habitats is similar across the island (Figure 4). Forest, forest/shrub, and shrub communities are located primarily on the protected areas of the island, from the bay side of the island to approximately mid-way across the island. Salt marsh and *Phragmites* communities are associated with the low-energy bayside of the island. Hardy, low-growing herbaceous/shrub and herbaceous communities are typically located from the center of the island to the back and top of the primary dune. The face of primary dunes and beach supratidal areas contain sparse coverage of low-growing beach grass. The primary dunes generally range in height from 4 feet to 12 feet and have shear faces on the oceanside. The stratification of communities across the island, primary dune configuration, and stunted tree growth, result primarily from wind forces and wave action that cut across the island from the ocean toward the bay; the bayside of the island is generally more protected from such forces.





Project Location

0 2.5 5 10 15

Scale in Miles

Shore Protection and Storm Damage Reduction Project, South Shore of Long Island, New York

Source: ESRI Data and Maps CD, 1999

Figure 2. Location of Sampling Transects for the Fire Island Mammal Study.

Prepared For: United States Army Corps of Engineers, New York District

Date: 11/03

Prepared By: NEA

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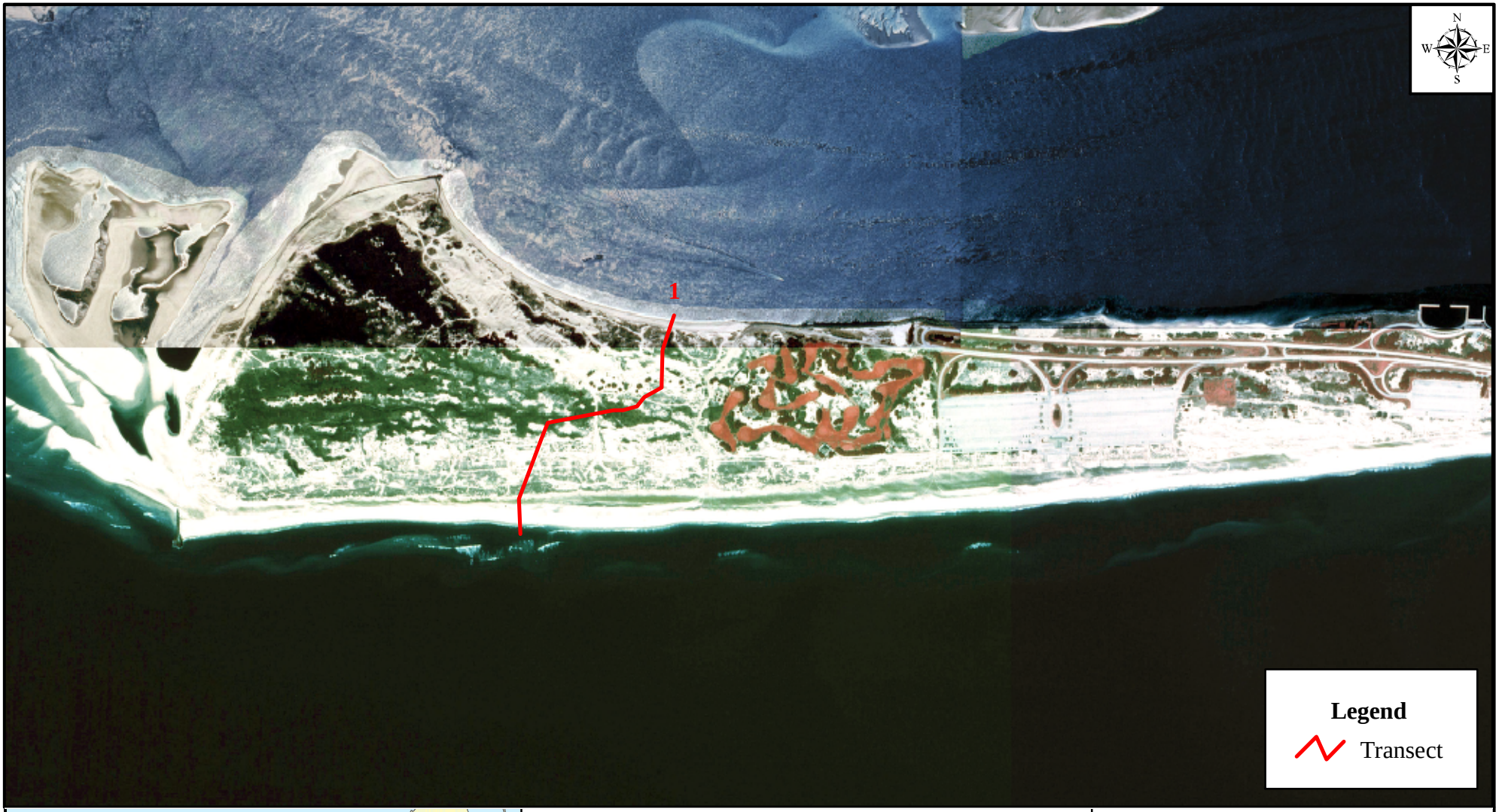

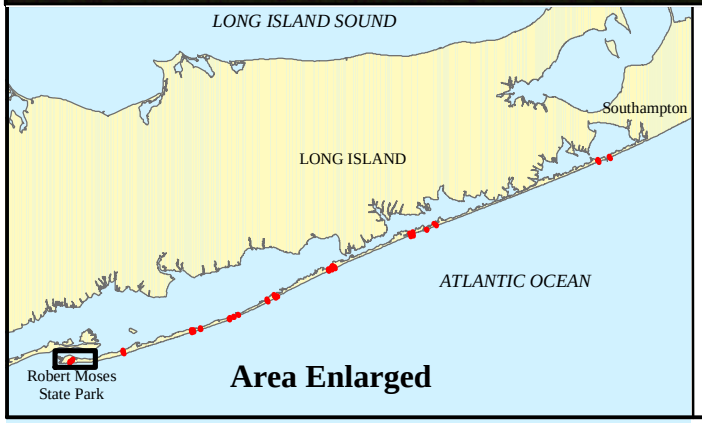

0 500 1,000 2,000 3,000

Scale in Feet

Shore Protection and Storm Damage Reduction Project, South Shore of Long Island, New York

Source: ESRI Data and Maps CD, 1999. New York DOQQ, 1999.

Figure 3a. Location of Transect 1 for the Fire Island Mammal Study.

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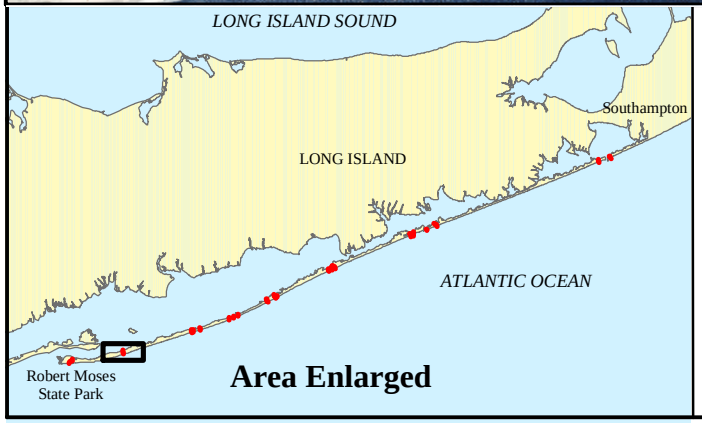

0 500 1,000 2,000 3,000

Scale in Feet

Shore Protection and Storm Damage Reduction Project, South Shore of Long Island, New York

Source: ESRI Data and Maps CD, 1999. New York DOQQ, 1999.

Figure 3b. Location of Transect 2 for the Fire Island Mammal Study.

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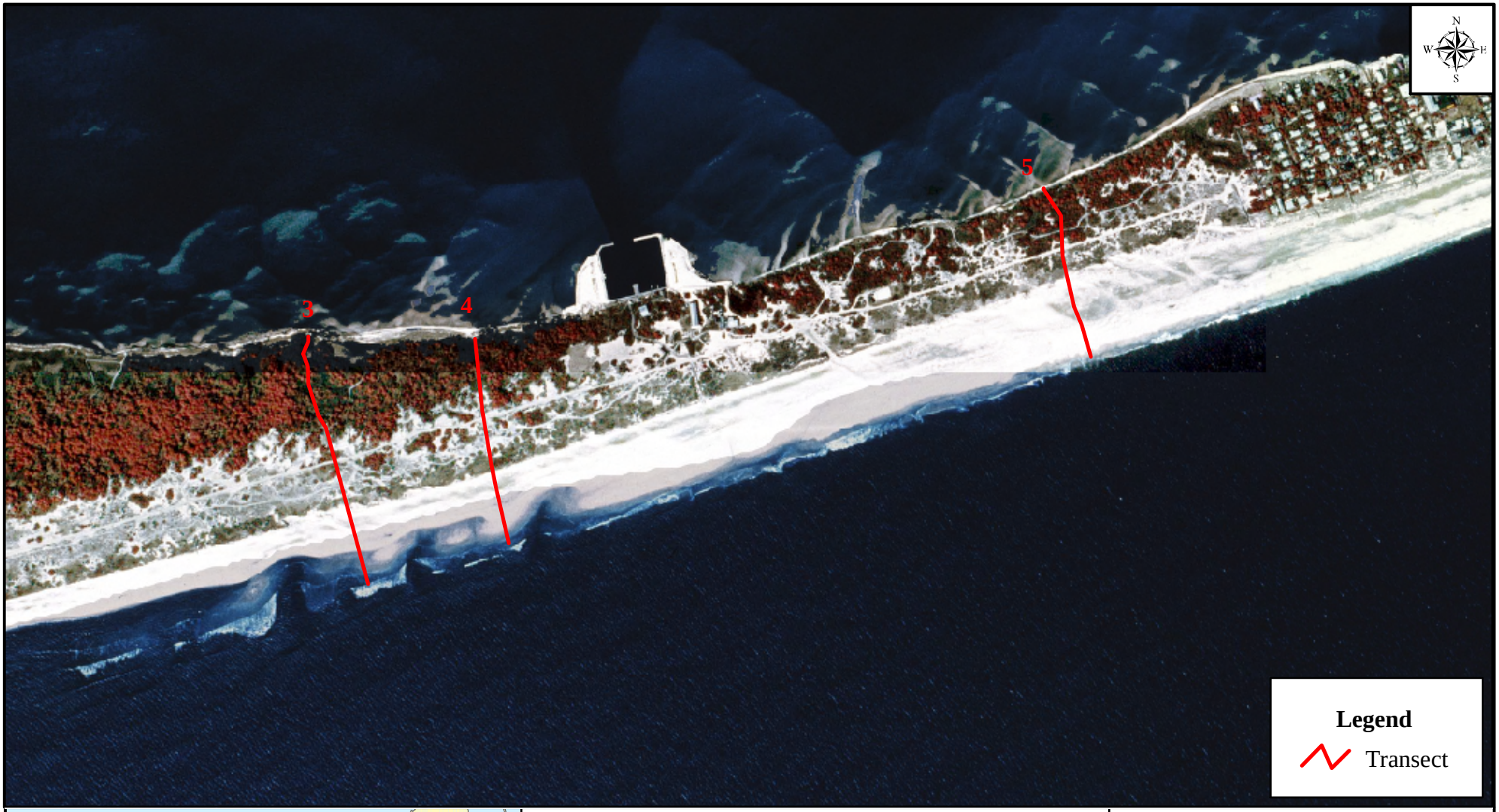

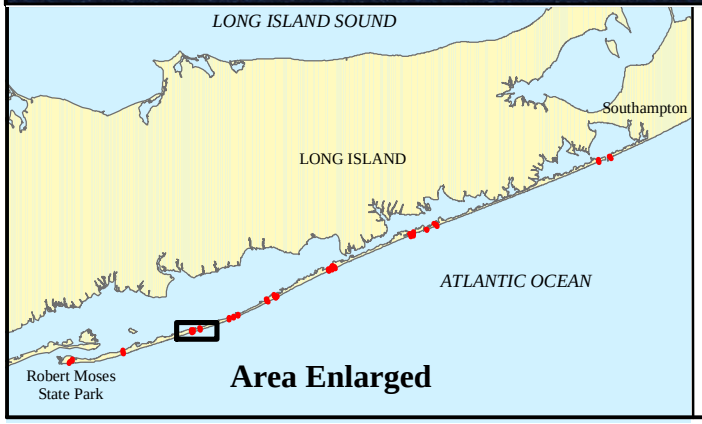

0 500 1,000 2,000

Scale in Feet

Shore Protection and Storm Damage Reduction Project, South Shore of Long Island, New York

Source: ESRI Data and Maps CD, 1999. New York DOQQ, 1999.

Figure 3c. Location of Transects 3, 4, and 5 for the Fire Island Mammal Study

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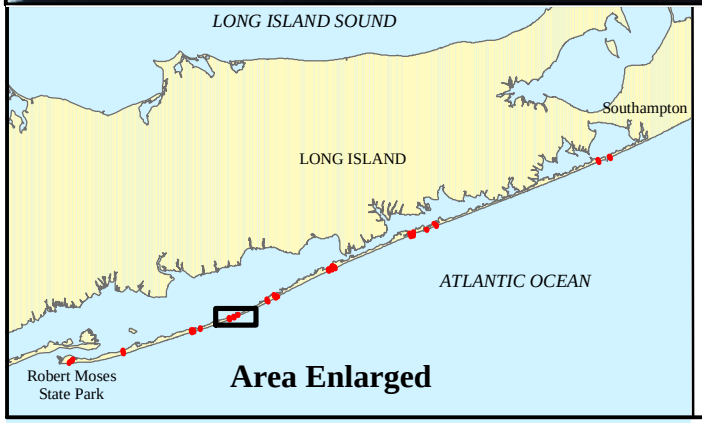

0 500 1,000 2,000

Scale in Feet

Shore Protection and Storm Damage Reduction Project, South Shore of Long Island, New York

Source: ESRI Data and Maps CD, 1999. New York DOQQ, 1999.

Figure 3d. Location of Transects 6, 7, and 8 for the Fire Island Mammal Study.

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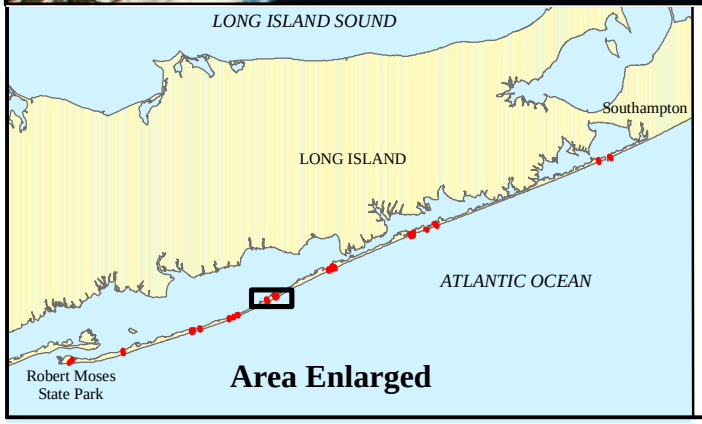

0 500 1,000 2,000

Scale in Feet

Shore Protection and Storm Damage Reduction Project, South Shore of Long Island, New York

Source: ESRI Data and Maps CD, 1999. New York DOQQ, 1999.

Figure 3e. Location of Transects 9, 10, and 11 for the Fire Island Mammal Study.

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Date: 11/03

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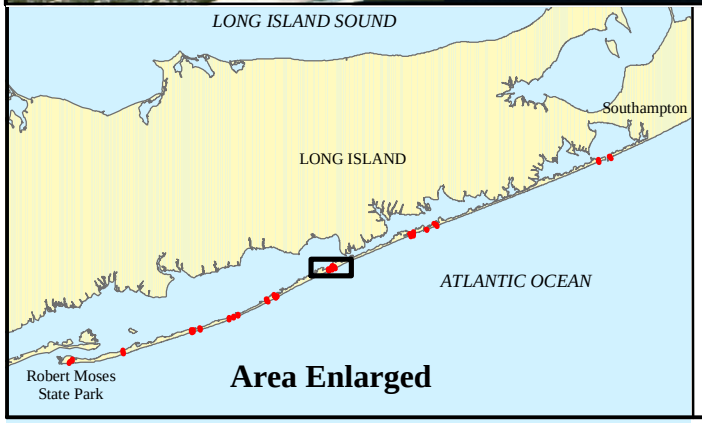

0 500 1,000 2,000

Scale in Feet

Shore Protection and Storm Damage Reduction Project, South Shore of Long Island, New York

Source: ESRI Data and Maps CD, 1999. New York DOQQ, 1999.

Figure 3f. Location of Transects 12, 13, and 14 for the Fire Island Mammal Study.

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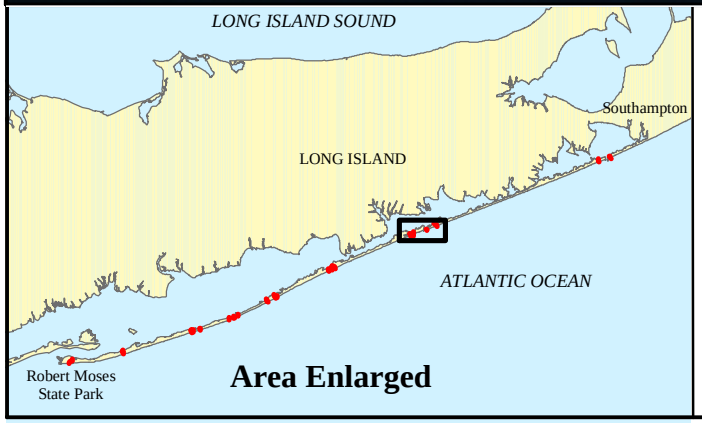

0 500 1,000 2,000 3,000

Scale in Feet

Shore Protection and Storm Damage Reduction Project, South Shore of Long Island, New York

Source: ESRI Data and Maps CD, 1999. New York DOQQ, 1999.

Figure 3g. Location of Transects 15, 16, 17, and 18 for the Fire Island Mammal Study.

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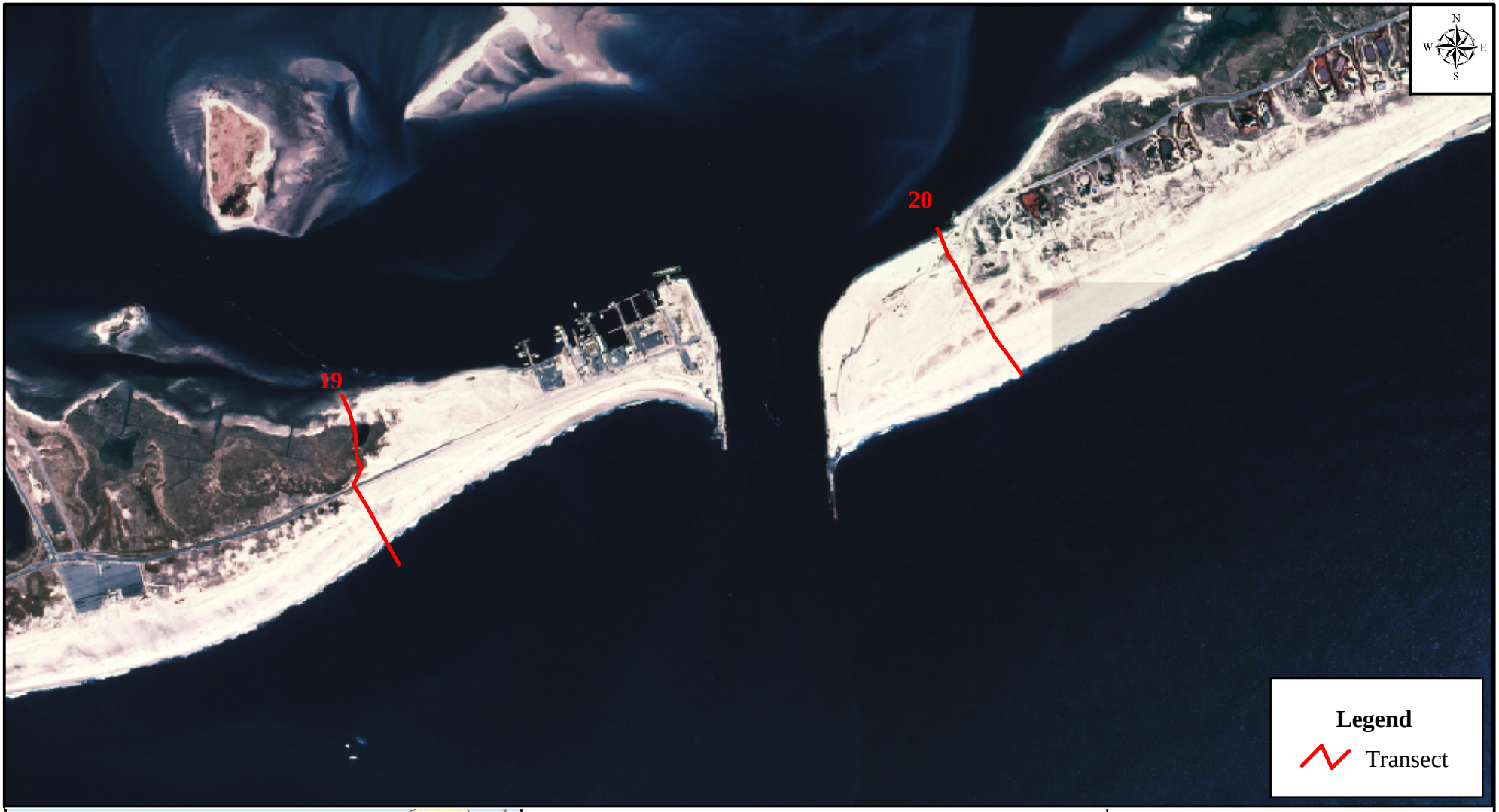

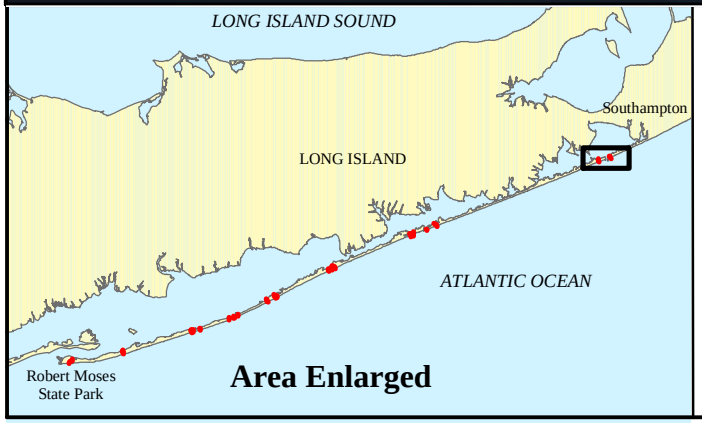

0 500 1,000 2,000 3,000

Scale in Feet

Shore Protection and Storm Damage Reduction Project, South Shore of Long Island, New York

Source: ESRI Data and Maps CD, 1999. New York DOQQ, 1999.

Figure 3h. Location of Transects 19 and 20 for the Fire Island Mammal Study.

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Prepared By:	NEA	

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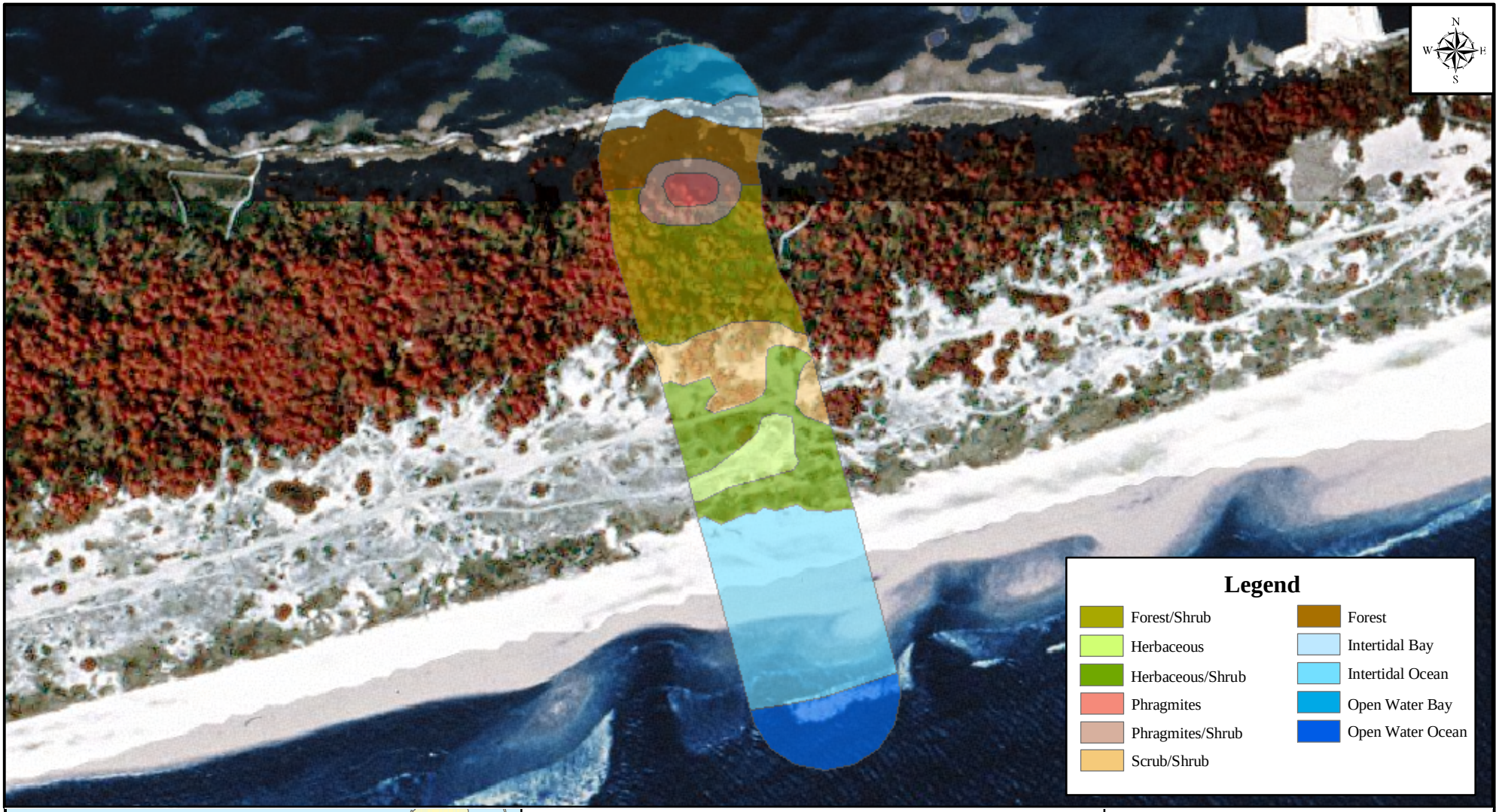

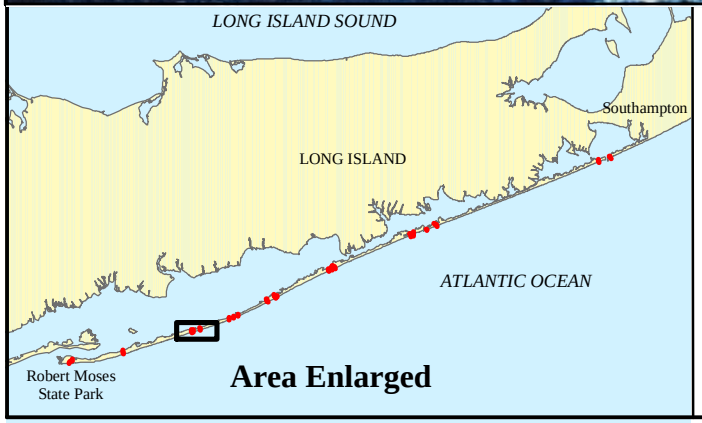

0 500 1,000

Scale in Feet

Shore Protection and Storm Damage Reduction Project, South Shore of Long Island, New York

Source: ESRI Data and Maps CD, 1999. New York DOQQ, 1999.

Figure 4. Typical Distribution of Barrier Island Community Types Surveyed for the Fire Island Mammal Study.

Prepared For:	**United States Army Corps of Engineers, New York District**	**Date:** 11/03
Prepared By:	NEA	

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3.0 METHODOLOGY

A variety of survey methods were utilized, and background data and documented studies were consulted, in order to identify mammalian and herptofaunal (i.e., reptiles and amphibians) species most likely to use the barrier island and to determine their habitat preferences. Field investigations were conducted by the USACE between May and August 2002. Research and review of background data regarding mammal and herpetile distribution in the Project area included the following sources: The Mammals of Long Island, New York (Connor 1971); Fish and Wildlife Studies for the Fire Island Inlet to Montauk Point, New York, Beach Erosion Control and Hurricane Protection Project Reformulation Study (USFWS 1983); New England Wildlife: Habitat, Natural History, and Distribution (DeGraaf and Rudis 1986); the New York Herpetile Atlas Program (NYDEC 2001); and, the Fire Island National Seashore Amphibian and Reptile Inventory (Brotherton et al. 2003).

3.1 SAMPLING DESIGN

The USACE utilized a combination of sampling techniques, including live and pitfall traps and direct observations of individuals and field signs to establish the presence of small to large-size mammals and herpetiles on Fire Island. Surveys were conducted along 20 transects that each traversed dominant community types found on Fire Island. Each transect bisected Fire Island from north to south (i.e., ocean to bay) and the transects were distributed from the extreme western end of Fire Island at Robert Moses State Park to the eastern end at Shinnecock Bay. Transect lines were recorded using a Trimble Pro-Mark IV Global Positioning System (GPS) and superimposed on habitat maps. Prior to each trap night, 25 Sherman live capture traps were baited and activated along each of the 20 transects. Synthetic cotton was placed in the Sherman traps when temperatures were cool to protect captured animals from hypothermia. Unbaited pitfall traps and baited Sherman traps were checked the following day. Trapped mammals were identified to species and released.

Twenty-five (25) Sherman live capture traps were placed at roughly regular intervals along each transect and baited with a peanut butter or a peanut butter/oatmeal mixture. To supplement this effort, pitfall traps were also used to capture mammal species that would not be attracted to the type of food used for bait in the live traps, such as insectivorous shrews. Pitfall traps were made from plastic containers (30 centimeters in diameter) and buried so that the lip of the container was slightly below the level of the ground surface. Pitfall traps were also used to establish the presence of small ground-dwelling herpetiles (e.g., salamanders, toads, frogs). In general, all traps were placed randomly, not less than 10 meters apart, and in areas where potential for capture success was considered to be highest (i.e., adjacent to fallen logs and at the base of trees).

A general reconnaissance for herptofaunal and mammal species was also conducted during each sampling event in the Study area. The general reconnaissance consisted of walking through the various community types and noting direct observations, field signs (i.e., tracks, scat, burrows, nests, eggs), and vocalizations of mammal and herptofaunal species.

In addition, observers documented the dominant community types within 75 meters of the transect centerline and produced a map of community types in the immediate area of transects. Community types based upon the primary, secondary, and tertiary dominant vegetation types within a 25-meter diameter circle centered on the trap also were identified for each trap location. During the June survey effort, additional variables were recorded at each trap using a 5-meter diameter circle centered on the trap as the evaluation area. These variables included percent tree cover, percent shrub cover, percent herbaceous cover, percent leaf litter, percent bare ground, and percent down and dead material.

Observers also noted general weather conditions and recorded miscellaneous comments regarding the condition of captured and observed species. Captured species were identified by using Peterson Field Guide to Mammals (Burt and Grossenheider 1980) and the National Audubon Society Field Guide to North American Mammals (Whitaker 1996). Herpetiles observed in the field were identified using Peterson Field Guide to Eastern/Central North American Reptiles and Amphibians (Conant and Collins 1991) and the Audubon Society Field Guide to North American Reptiles and Amphibians (Behler and King 1979).

3.2 SAMPLING EFFORT

Surveys were conducted by biologists from Northern Ecological Associates, Inc., during the months of May and June, and by USACE biologists during the months of July and August. Survey efforts targeted the major community types found on Fire Island and included herbaceous, scrub-shrub, forest, salt marsh, *Phragmites*-dominated habitats, and various combinations of such communities. Table 1 provides the total number of trap nights (i.e., one trap set for one night) surveyed in each community type. Community type descriptions are provided in Section 2.1.

Table 1. Total Trap Nights per Survey Month by Community Type on Fire Island. [1]

Community Type	May	June	July	August	Total
Forest/Herbaceous/Shrub (FHSS)	10	21	0	0	**31**
Forest (FOR)	49	64	137	95	**345**
Forest/Shrub (FSS)	10	29	0	0	**39**
Herbaceous (HRB)	121	108	77	94	**400**
Herbaceous/Shrub (HSS)	37	98	0	0	**135**
Phragmites (PH)	25	36	8	16	**85**
Phragmites/Shrub (PHS)	61	45	0	4	**110**
Salt Marsh (SM)	9	6	3	6	**24**
Shrub (SS)	172	143	125	187	**627**
Unknown	1	0	114	14	**129**
Total	**495**	**550**	**464**	**416**	**1925**

[1] A trap night is defined as one trap set for one night.

A total of 1,865 live trap nights and 60 pitfall trap nights were recorded during the four survey efforts (Table 2). During the May, July, and August surveys, live traps were used in conjunction with direct observations. During the June survey effort, live traps and direct observations were supplemented with pitfall traps.

Table 2. Summary of Trap Nights per Survey Event.

Survey Event	Live Trap Nights	Pitfall Trap Nights
May	495	0
June	490	60
July	464	0
August	416	0
Total	**1865**	**60**

3.3 DATA ANALYSIS

Information from surveys and incidental sightings were used to develop a comprehensive list of species in the Study area. However, data from incidental sightings were not included in calculations to determine relative abundance or habitat associations.

Capture results were standardized in terms of Captures per Unit Effort (CPUE) for each community type so that a useful comparison of abundance among community types could be made. CPUE is expressed in terms of number of small mammals captured per 100 trap nights of trapping effort. The number of trap nights is defined as one trap set for one night.

4.0 RESULTS

The following section presents a summary of species detections and the presence of threatened, endangered (T&E) and/or special concern species documented on Fire Island. In addition, a discussion of relative abundance and habitat associations is provided for those species that were captured during the USACE Study.

4.1 SPECIES DETECTIONS

Based on a review of background information and existing data, 41 species (26 mammals and 15 herpetiles) were categorized as likely to occur within the greater study area (Connor 1971, USFWS 1983, DeGraaf, and Rudis 1986, Brotherton et al. 2003). Table 3 provides a list of these species and identifies the species that have been confirmed on Fire Island through field-based surveys. Twenty-nine (29) of the 41 species (71%) listed as likely to occur on Fire Island were confirmed by at least one field-based survey that has been conducted on the barrier island since 1983. Twelve (12) of the 41 species (29%) have not been confirmed by the field-based surveys evaluated for this report. These species included six bats, two small mammals, two mid-sized mammals, and one reptile as identified in Table 3. Four additional species, not expected to occur on the barrier island, were confirmed during this Study and surveys conducted by Brotherton et al. 2003. Species included the woodland vole (*Microtus pinetorum)*, red-eared slider (*Chrysemys picta),* leatherback sea turtle (*Dermochelys coriacea)*, and loggerhead sea turtle (*Caretta caretta).*

Of the 41 species thought to inhabit the island, 17 species (13 mammal species and four herpetile species) were captured or observed during this Study. Five of the 13 mammal species were captured using live traps or pitfall traps, and the remainder of the mammals and all of the herpetiles were identified through direct observation, field sign, or vocalization.

A total of 1,865 live trap nights and 60 pitfall trap nights were completed during this study, resulting in the capture of 548 total small mammals. The white-footed mouse (*Peromyscus leucopus*) was the most common species captured during the USACE live trap survey events with 518 individuals captured (95% of all captures). Other species (in order of capture rate) were meadow vole (*Microtus pennsylvanicus*) with 25 individuals captured (4% of all captures), masked shrew (*Sorex cinereus*) with 2 individuals, and the woodland vole, Norway rat (*Rattus norvegicus*), and house mouse (*Mus musculus*), with one individual of each captured. The most common species, white-footed mouse and masked shrew, were also the most common small mammal species captured during surveys conducted by the USFWS (1983) and Brotherton et al. (2003) on the barrier island.

The mammals most commonly observed through incidental observations during this Study were the white-tailed deer (*Odocoileus virginianus*), cottontail rabbit (*Sylvilagus floridanus*), and red fox (*Vulpes vulpes).* Although relative abundance of these species can not be determined by incidental observations alone, evidence of these species was found on nearly all transects and during nearly every survey event. Other relatively common species (based on incidental observations) also included muskrat, gray squirrel, and raccoon. In March 2002, one harbor seal (*Phoca vitulina*) was observed on the intertidal portion of the beach on the oceanside of the

barrier island. The seal was observed within the Study area during USACE avian surveys conducted in support of the Project (USACE 2003).

Table 3. Mammal and Herpetile Species of the South Shore of Long Island, New York.

Scientific Name	Common Name	Likely to Occur[3]	Species Documented by		
			USACE	Brotherton	USFWS
Mammals					
Blarina brevicuada	Short-tailed shrew	x	-	-	-
Didelphius marsupialis	Opossum	x	-	-	x
Eptesicus fuscus	Big brown bat	x	-	-	-
Laisonycteris noctivagans	Silver-haired bat	x	-	-	-
Lasiurus borealis	Red bat	x	-	-	-
Lasiurus cinereus	Hoary bat	x	-	-	-
Mephitis mephitis	Striped skunk	x	-	-	-
Mus musculus	House mouse	x	x	-	x
Microtus Pennsylvanicus	Meadow vole	x	x	-	x
Microtus pinetorum	Woodland vole	-	x	-	-
Mustela frenata	Longtail weasel	x	-	-	-
Mustelka vison	Mink	x	-	-	-
Myotis lucifugus	Little brown bat	x	-	-	x
Myoits keenii	Keen's myotis	x	-	-	-
Odocoileus virginianus	White-tailed deer	x	x	-	x
Ondatra zibethicus	Muskrat	x	x	-	-
Peromyscus leucopus	White-footed mouse	x	x	x	x
Phoca vitulina[1]	Harbor seal[1]	x	x	-	-
Pipistrellis subflavus	Eastern pipistrell	x	-	-	-
Procyon lotor	Raccoon	x	x	-	x
Rattus norvegicus	Norway rat	x	x	-	x
Sciurus carolinensis	Gray squirrel	x	x	-	-
Scalopus aquaticus	Eastern mole	x	-	-	-
Sorex cinereus	Masked shrew	x	x	x	x
Sylvilagus floridanus	Cottontail rabbit	x	x	-	x
Vulpes vulpes	Red fox	x	x	-	-
Zapus hudsonius	Meadow jumping mouse	x	-	-	-

Table 3. Mammal and Herpetile Species of the South Shore of Long Island, New York (continued).

Scientific Name	Common Name	Likely to Occur[3]	Species Documented by		
			USACE 2002	Brotherton 2003	USFWS 1983
Herpetiles					
Bufo woodhousei	Fowlers toad	x	x	x	x
Caretta caretta[1]	Loggerhead turtle[1]	-	-	x	-
Chelydra serpentina	Common snapping turtle	x	x	x	x
Chrysemys picta	Red-eared slider	-	-	-	x
Chrysemys picta picta	Eastern painted turtle	x	-	-	x
Clemmys guttata[2]	Spotted turtle[2]	x	-	x	-
Coluber constrictor-	Northern black racer	x	-	x	-
Dermochelys coriacea[1]	Leatherback turtle[1]	-	-	x	-
Heterodon platyrhinos[2]	Eastern hog-nosed snake[2]	x	-	-	-
Kinosternon subrubrum[1]	Mud turtle[1]	x	-	x	-
Malaclemys terrapin	Diamond-backed terrapin	x	-	x	x
Pseudacris crucifer	Spring peeper	x	-	-	x
Rana catesbeiana	Bullfrog	x	-	x	-
Rana clamitans melanota	Green frog	x	-	-	x
Scaphiophus holbrookii[2]	Spadefoot toad[2]	x	-	-	x
Terrapene carolina[2]	Box turtle[2]	x	x	x	x
Thamnophis sirtalis	Garter snake	x	x	x	x

[1] Federal or state-listed threatened or endangered species, or species with special protection status
[2] Federal or state-listed species of special concern
[3] Likely to occur on the barrier island, based on a background review of published life history information, distribution maps, and survey data

The herpetile species most commonly observed (through incidental observation) during this Study was the Fowler's toad (*Bufo woodhousei*). This result is consistent with surveys conducted by the USFWS (1983) and Brotherton et al. (2003), who also reported the Fowler's toad as the most common herpetile encountered on the barrier island. This Study also documented the common snapping turtle *(Chelydra serpentina)*, box turtle (*Terrapene carolina*), and garter snake (*Thamnophis sirtalis*) in the Study area. These species were also documented by previous studies conducted on the barrier island. However, species documented on other surveys on the barrier island and not found during this Study include the eastern spadefoot toad (*Scaphiopus holbrookii holbrookii*), spring peepers (*Hyla crucifer*), bullfrog (*Rana catesbeiana*), loggerhead sea turtle, spotted turtle (*Clemmys guttata*), leatherback sea turtle, mud turtle (*Kinosternon subrubrum*), diamond-back terrapin (*Malaclemys terrapin*), and northern black racer (*Coluber constrictor constrictor*).

4.2 HABITAT ASSOCIATIONS

The majority of the 1,865 small mammals captured were located in *Phragmites*/shrub communities. The fewest number of individuals were captured in salt marsh communities. In general, habitats with a diverse shrub component such as forest/shrub, forest/herb/shrub, herb/shrub, shrub and *Phragmites*/shrub, had the highest relative abundance of species captured per 100 trap nights. Table 4 presents a comparison of the relative abundance of small mammals found per 100 trap nights in various community types within the Study area.

Table 4. Relative Abundance of Small Mammals in Each Community Type per 100 Trap Nights.

Community Type	White-footed mouse	Meadow vole	Masked shrew	Woodland vole	House mouse	Norway rat	Total
FHSS	29.0	0	3.2	0	0	0	32.2
FOR	28.7	0	0	0.3	0	0	29.0
FSS	28.2	2.6	0	0	0	2.6	33.4
HRB	16.8	2.8	0	0	0.3	0	19.9
HSS	34.8	1.5	0	0	0	0	36.3
PH	29.4	2.4	0	0	0	0	31.8
PHS	43.6	0	0.9	0	0	0	44.5
SM	12.5	4.2	0	0	0	0	16.7
SS	32.1	1.1	0	0	0	0	33.2
Unknown	29.0	0	0	0	0	0	29.0

White-footed mouse (*Peromyscus leucopus*)

The white-footed mouse was the most common mammal species captured, comprising approximately 95 percent of all species captured. A total of 518 individuals were captured, and it was found in every habitat type within the Study Area. The white-footed mouse was most abundant in *Phragmites*/shrub communities (43.6 captures per 100 trap nights), and it was least abundant in salt marsh communities (12.5 captures per 100 trap nights). The relative abundance of white-footed mice within the Study area is depicted in Table 5.

Meadow vole (*Pennsylvaniana maniculatus*)

A total of 25 meadow voles were captured, comprising approximately 4 percent of all individuals captured. Meadow voles were most abundant in herbaceous and shrub habitats. Forty-six (46) meadow voles captured per 100 trap nights were found in herbaceous communities and 29 per 100 trap nights were found in shrub communities. In addition, eight meadow voles per 100 trap nights were found in mixed herbaceous/shrub communities. Furthermore, three individuals were captured in *Phragmites* and salt marsh communities per 100 trap nights. The relative abundance of meadow voles within the Study area is depicted in Table 6.

Table 5. Relative Abundance of White-footed Mouse per Community Type.

Community Type	Number of Individuals Captured	Total Number of Traps	Captures per 100 Trap Nights
FHSS	9	31	29.0
FOR	99	345	28.7
FSS	11	39	28.2
HRB	67	400	16.8
HSS	47	135	34.8
PH	25	85	29.4
PHS	48	110	43.6
SM	3	24	12.5
SS	201	627	32.1
Unknown	8	129	6.2
Total	**510**	**1,925**	**26.4**

Table 6. Relative Abundance of Meadow Vole per Community Type.

Community Type	Number of Individuals Captured	Total Number of Traps	Captures per 100 Trap Nights
FHSS	0	31	0
FOR	0	345	0
FSS	1	39	2.6
HRB	11	400	2.8
HSS	2	135	1.5
PH	2	85	2.4
PHS	0	110	0
SM	1	24	4.2
SS	7	627	1.1
Unknown	1	129	0.8
Total	**25**	**1,925**	**1.3**

Masked shrew (*Sorex cinereus*)

Two individuals were captured in two separate pitfall traps placed along Transect 14. One individual was captured in a mixed community consisting of forest/herbaceous/shrub habitat and the second was captured in a *Phragmites*/shrub community.

Woodland vole (*Microtus pinetorum*)

The woodland vole was only captured in a forested community. One individual was captured in a live trap that was placed on Transect 1 in the Robert Moses State Park.

House mouse (*Mus musculus*)

The house mouse was only captured in the herbaceous community type. In fact, only one individual was captured in a live trap that was placed in an herbaceous community near a pile of recently dumped wooden debris.

Norway rat (*Rattus norvegicus*)

One individual was captured in a live trap that was placed in a forest/shrub community in an area near the National Park Service campgrounds.

White-tailed deer and cottontail rabbit were observed at all transects except one that was dominated entirely by beach grass. Fox tracks and dens were located within 100 meters of all transects. Gray squirrels (*Sciurus carolinensis*) were observed on some transects, primarily where oaks (*Quercus* spp.) were present. Raccoon (*Procyon lotor*) and muskrat (*Ondatra zibethicus*) tracks and trails were primarily associated with wetland habitats. All of these species are typically considered to be "generalists" that are adapted to utilize a wide diversity of habitats and typically have relatively stable population numbers. The habitat requirements for most of these species are so diverse that they are quickly able to adapt to changes in the availability of one community type by using another suitable habitat nearby.

Only four herpetile species were documented during this Study. Observations of herpetile species were too infrequent to make meaningful associations regarding habitat preferences. However, based on general observations, box turtles were found in upland herbaceous/shrub habitat located immediately behind the crest of the primary dune, and in forest/shrub habitat; snapping turtles were observed in ponded areas; and, the garter snake was observed in the herbaceous community. The Fowlers toad was documented through vocalizations only and therefore the location was not documented. Based on habitat associations for these species documented in life history reports and findings from other studies, amphibians and herpetiles are generally most closely associated with wetland and aquatic habitat types (Behler and King 1979, Burt and Grossenheider 1980, USFWS 1983, Conant and Collins 1991, Whitaker 1996, Brotherton et al. 2003). However, life histories of these species can be complex. Several species require water or wetland habitats for most of their life cycle and are dependant upon specific upland habitat types that are located in close proximity to wetlands or waterbodies for nesting and/or foraging purposes.

4.3 THREATENED, ENDANGERED AND SPECIAL CONCERN SPECIES

No T&E species were identified during this Study. However, the Federal and state-listed endangered leatherback sea turtle, the Federal and state-listed threatened loggerhead sea turtle, the state-listed endangered mud turtle, and the state-protected harbor seal, have been documented during other studies conducted in the Study area (USFWS 1983, Brotherton et al. 2003, USACE 2003).

Three state-listed species of special concern, spotted turtle, spadefoot toad, and box turtle, were also documented in the Study area (USFWS 1983, Brotherton et al. 2003). Only the box turtle

was confirmed during this Study. Threatened, endangered, and special concern species, are identified in Table 3 (NYSDEC 2003, USFWS 2003).

5.0 DISCUSSION

The following section presents a discussion of the mammal and herpetile species that have been documented on the barrier island. Life history summaries are provided for those small mammal and herpetile species that were observed during this Study.

5.1 SPECIES OCCURRENCES

Twenty-nine (29) of the 41 species (71%) identified as likely to occur on the barrier island have been documented either by this Study or by surveys conducted by the USFWS (1983) and Brotherton et al. (2003). The common species captured and/or observed during this Study are consistent with the species that were expected to occur on Fire Island for the survey area and survey methodology used. Common generalist species, which are able to utilize a wide variety of habitat types and are relatively insensitive to human disturbance, were the most captured/observed species. These species include Fowler's toad, white-footed mouse, meadow vole, white-tailed deer, cottontail rabbit, gray squirrel, and red fox. Other studies (USFWS 1983, Brotherton et al. 2003) also documented the common status of these species on the barrier island.

Most of the species that were expected to occur, but not previously confirmed in the Study area, were not captured or observed primarily due to the sampling methodology used during recent surveys. For example, seven of the 12 (58%) species are bats and two (17%) are mid-sized mammals. Bats and mid-sized mammals require sampling techniques that were not utilized in this Study or in studies conducted by the USFWS (1983), or Brotherton et al. (2003). In addition, sampling techniques used in the USACE, USFWS, and Brotherton et al. surveys were likely adequate to capture the remaining species (short-tailed shrew, eastern mole, and eastern hog-nosed snake). However, the lack of captures for the short-tailed shrew and eastern mole was expected due the lack of preferred habitat (i.e., moist loamy soils) in the specific areas sampled on the barrier island by these surveys.

5.2 HABITAT ASSOCIATIONS

Based on actual captures, habitats with a diverse shrub component had the highest relative abundance of species per acre of habitat. However, this result is based primarily on captures of white-footed mouse and meadow vole, which combined represent 99 percent of all small mammal captures. The white-footed mouse and meadow vole had highest capture rates in *Phragmites*/shrub and salt marsh habitats, respectively. However, these two species are typically considered to be "generalists" that are adapted to utilize a wide diversity of habitats and are quickly able to adapt to changes in the availability of one community type by using another suitable habitat nearby. For example, the white-footed mouse was captured in nine of the nine habitats surveyed and the meadow vole was captured in seven of the nine habitats.

Sample sizes for the remaining four small mammal species captured in this Study and the herpetile and mammal species documented through incidental observations, were too infrequent to make meaningful associations regarding habitat preferences. Habitat use and relative abundance of species in the study area are likely underestimated in these cases due to few captures of the species or lack of documentation of habitat for species confirmed solely by incidental observation. Limited sightings of a species in one habitat are useful in confirming the

use of the island by a given species. However, it is not an accurate representation of the overall number of habitat types preferred by the species. Despite the low capture rate for many of the small mammal species and infrequent observation of herpetiles in the habitats surveyed, none of the species are considered to be specialists that are dependant upon one or two habitat types.

5.3 THREATENED, ENDANGERED, OR SPECIAL CONCERN SPECIES

Three of the Federal or state-listed T&E species are marine species. Marine mammals, such as the harbor seal, and reptiles such as the leatherback sea turtle and loggerhead sea turtle are known to occur sporadically in the waters in the vicinity of Long Island. However, these species are not known to come ashore on the barrier island unless dead or injured. The two sea turtles documented by Brotherton et al. (2003) were dead and the harbor seal that was documented during winter avian surveys conducted by the USACE on Fire Island (USACE 2003) appeared to be injured. The State-listed mud turtle was documented on two occasions during surveys by Brotherton et al. (2003). One sighting was of a shell, the other was a live individual that was captured in Bigfoot Pond, Fire Island National Seashore. This species prefers soft-bottomed slow moving fresh to brackish water with abundant vegetation. Suitable breeding habitat exists on the barrier island for this species, however, Long Island is at the northern most edge of this species range.

Four species of special concern are likely to occur on the barrier island. Of these, the eastern hog-nosed snake was reported as likely to occur on the island by McCormick (1975), but has not been documented during any of the surveys reviewed for this study (USFWS 1983, Brotherton et al. 2003). The remaining three species, spotted turtle, spadefoot toad, and box turtle, have been captured on the island. But, the spadefoot toad was not documented during this Study or any of the studies conducted on the island since 1983 (Brotherton et al. 2003). The USFWS surveys (1983), documented the spadefoot toad only in the ponds and intertidal beach areas of Napeague Beach. This area is located outside of the area surveyed in this Study and by Brotherton et al. and is likely the primary reason this species has not been documented during recent surveys.

5.4 LIFE HISTORY INFORMATION

The following section provides a discussion of the general life history of the small mammal and herpetile species documented in this Study.

White-footed mouse (*Peromyscus leucopus*)

The white-footed mouse is a common small mammal throughout the eastern United States. This species is a habitat generalist that prefers interiors and edges of deciduous, coniferous, or mixed forests and shrublands, but also may occupy open fields and pastures, riparian habitats, wetlands, and buildings. The white-footed mouse is generally herbivorous and prefers seeds, acorns, nuts, fruits, green vegetation, insects, and a small amount of carrion (DeGraaf and Rudis 1986). Home ranges for this species are typically 0.5 to 1.5 acres in size (Burt and Grossenheider 1980). Northern populations of this species, including populations within the Survey area, breed in March–June and September–November (Burt and Grossenheider 1980). Females reach sexual maturity at 10–11 weeks of age and may have up to four litters per year (Burt and Grossenheider

1980). The gestation period for this species is 22–25 days (DeGraaf and Rudis 1986). The typical litter size is three to four, although litters of up to seven are not uncommon (DeGraaf and Rudis 1986).

This study documented that the white-footed mouse is the most abundant and generally distributed small mammal within the Study Area. This species was observed in nearly every community type surveyed during the study. These results are similar to the findings of the USFWS (1983) and the New York State Museum & Science Service (Connor 1971), which also indicated that the white-footed mouse is the most widespread or generally distributed small mammal in the Study Area. However, according to Connor (1971) it may not be the most numerous. Only the masked shrew is similar to the white-footed mouse in its ability to adapt to the various environments on Fire Island (Connor 1971). Within the Study Area, the white-footed mouse is known to occur in all types of forested areas, cedar swamps, and sphagnum bogs, and less likely to occur in salt marshes and open, herbaceous areas (Connor 1971, USFWS 1983). Therefore, it can be categorized as a habitat generalist occurring in a wide range of habitats.

Meadow vole (*Pennsylvaniana maniculatus*)

The meadow vole is commonly found throughout the northern portion of the United States in habitats similar to those in the Study Area. It is not typically found in a variety of habitats but is known to occur in loose, organic soils of grassy areas, salt marshes, fields, and bogs (Connor 1971). The preferred food of the meadow vole is herbaceous material including grass, bulbs, cambium of roots and stems, as well as seeds, and grains (DeGraaf and Rudis 1986). Home ranges for this species are typically 0.1 to 1.0 acre in size (Burt and Grossenheider 1980). Breeding occurs throughout the year and generally peaks between April and October (DeGraaf and Rudis 1986). Females reach sexual maturity at 25 days of age and are known to have several litters throughout the year (Burt and Grossenheider 1980). The gestation period for this species is 21 days (DeGraaf and Rudis 1986). The typical litter size is four to five, although litters of up to 10 are not uncommon (DeGraaf and Rudis 1986). Populations tend to fluctuate with highs occurring every 3 to 4 years (Burt and Grossenheider 1980).

Data collection for this study indicates a low abundance of meadow voles in the Study Area. Several individuals were captured during this survey with a majority of captures in salt marsh communities. These results are similar to the findings of the USFWS (1983) and the New York State Museum & Science Service (Connor 1971).

Masked shrew (*Sorex cinereus*)

The masked shrew was once considered to be quite abundant on Long Island (Connor 1971). It is the smallest mammal known to occur on the island and often eludes observation for this reason. This species inhabits a variety of community types and is most often found in dense herbaceous areas, sphagnum bogs, salt marshes, and damp, deciduous and coniferous woodlands, possibly occurring within the Sunken Forest (Connor 1971). Mainly insectivorous and carnivorous, the masked shrew forages among litter on forest floors in search of worms, spiders, snails, slugs, and small amounts of vegetable matter (DeGraaf and Rudis 1986). Individuals can eat more than their own weight in food each day (Burt and Grossenheider 1980). Home ranges

for this species are typically 0.10 acres in size (DeGraaf and Rudis 1986). Breeding may occur between March and October (Burt and Grossenheider 1980). Females reach sexual maturity at 20–26 weeks of age and may have up to three litters per year (DeGraaf and Rudis 1986). The gestation period for this species is approximately 18 days (DeGraaf and Rudis 1986). The typical litter size can range from two to 10, averaging between four and five (DeGraaf and Rudis 1986).

This study documented that the masked shrew is present within forest/herbaceous/shrub and *Phragmites*/shrub communities within the Study area. Because the masked shrew is not attracted to the bait placed in live traps, pitfall traps were also utilized in this study. However, due to the small number of pitfall traps implemented during the study, the number of captured individuals likely does not accurately represent the abundance of this species on Fire Island. According to studies conducted by the New York State Museum & Science Service (Connor 1971), the masked shrew was captured in almost every habitat type on Long Island.

Woodland vole (*Microtus pinetorum*)

The woodland vole was once considered one of the most common mammals on Long Island (Connor 1971). However, it eludes observation because it spends much of its life in underground tunnels and under the leaf litter of dry, deciduous woodlands (Connor 1971). This species forages among litter on forest floors in search of seeds, nuts, fruits, bark, and leaves and underground for tubers, roots, and bulbs (DeGraaf and Rudis 1986). Populations of the woodland vole are known to fluctuate wildly (Burt and Grossenheider 1980). Home ranges for this species are typically 0.25 acres in size (Burt and Grossenheider 1980). Northern populations of this species, including populations within the Survey area, breed between January and October (Burt and Grossenheider 1980). Females reach sexual maturity at 2 months of age and may have up to four litters per year (DeGraaf and Rudis 1986). The gestation period for this species is approximately 24 days (DeGraaf and Rudis 1986). The typical litter size is usually three or four, and it can have from two to seven litters per year (Burt and Grossenheider 1980).

This study did not provide much information about the abundance or habitat preference of the woodland vole. However, the only capture of this species occurred within a forested community, which is consistent with findings from a similar study conducted by the New York State Museum & Science Service (Connor 1971). In addition, this species is difficult to detect even when present in an area due to its habit of burrowing underground and in leaf litter. Increasing the number of pitfall traps within preferred habitats may have increased captures of the woodland vole.

House mouse (*Mus musculus*)

The house mouse was introduced to the United States about 200 years ago and is generally closely associated with humans and human development. It is typically found in open fields and seeks shelter in existing buildings and establishments (Connor 1971). This species is a colonial and highly social animal. Evidence suggests that individuals may construct communal nests (DeGraaf and Rudis 1986). It is mainly nocturnal and is active throughout the year (DeGraaf and Rudis 1986). It typically feeds on fruits, grains, seeds, vegetables, plant roots, and insects (DeGraaf and Rudis 1986). Home ranges for this species are typically 1,560 to 3,925 square feet

in size (DeGraaf and Rudis 1986). Breeding may occur throughout the year and typically peaks in the early spring to late summer months (DeGraaf and Rudis 1986). Females reach sexual maturity at 8 weeks of age and may have up to 12 litters per year (DeGraaf and Rudis 1986). The gestation period for this species is 18–21 days (Burt and Grossenheider 1980). The typical litter size is five to eight, averaging six per year (DeGraaf and Rudis 1986).

This study did not provide much information about the abundance or habitat preference of the house mouse. The low capture success rate may indicate that this species is being out-competed by more abundant native species. In addition, the capture of one individual near a pile of recently dumped wooden debris is indicative of this species' preference for developed areas, which are not common in the Study area.

Norway rat (*Rattus norvegicus*)

The Norway rat was introduced to the United States and is now considered one of the most destructive small mammals on Long Island (Connor 1971). It is usually associated with humans and human development and is typically found in and around buildings, preferably near water. This species will feed on most anything ranging from other animals to herbaceous material. Home ranges for this species are typically 25 to 50 square yards in size (DeGraaf and Rudis 1986). Breeding may occur throughout the year and typically peaks in the spring and fall months (DeGraaf and Rudis 1986). Females reach sexual maturity at 80–85 days and may have up to 12 litters per year (DeGraaf and Rudis 1986). The gestation period for this species is 21–22 days (DeGraaf and Rudis 1986). The typical litter size averages around nine, but may range from two to 14 (DeGraaf and Rudis 1986).

This study did not provide much information about the abundance or habitat preference of the Norway rat. This species prefers areas with high levels of human disturbance. Therefore, the lack of human development on Fire Island may discourage the Norway rat from nesting.

Fowler's toad (*Bufo woodhousei*)

The Fowler's toad is found from southern New England to the southern portion of the United States. It is typically found in sandy areas near marshes, irrigation ditches, and temporary rain pools (Behler and King 1979). The Fowler's toad primarily feeds on earthworms, slugs, insects, and spiders (DeGraaf and Rudis 1986). This species typically hibernates in underground burrows from October to April (DeGraaf and Rudis 1986). The breeding period begins after emergence from hibernation in March to August (Behler and King 1979). Females reach sexual maturity at three to four years of age (DeGraaf and Rudis 1986). The female typically lays between 4,000 and 12,000 eggs in long curling strings amidst aquatic vegetation (DeGraaf and Rudis 1986). Eggs usually hatch in approximately three to 12 days with tadpoles developing in five to 10 weeks (DeGraaf and Rudis 1986).

Presence of the Fowler's toad was confirmed upon hearing vocalizations from within the Study Area. Habitat and general condition of the species could not be determined. In studies conducted by the USFWS, this species was commonly found in freshwater ponds near the primary dune, but were not present in ponds adjacent to roads or houses (USFWS 1983).

According to distribution maps provided by NYDEC (2001), this species has been documented in various areas all over Fire Island.

Common snapping turtle *(Chelydra serpentine)*

The common snapping turtle is found throughout the eastern portion of the United States. It is typically found in freshwater ponds, but may also be found in brackish waters (Behler and King 1979). Home range for this species is approximately 0.69 square miles in size (DeGraaf and Rudis 1986). The common snapping turtle is an omnivore and primarily feeds on crayfish, reptiles, birds, and some plant material (DeGraaf and Rudis 1986). This species typically hibernates from October to April (DeGraaf and Rudis 1986). The breeding period begins after emergence from hibernation in April to November (Behler and King 1979). Females reach sexual maturity when the carapace has developed to a length of 25 centimeters (DeGraaf and Rudis 1986). The female typically lays 20–50 eggs in a deep cavity in mid-June (Behler and King 1979). The incubation period usually lasts between 80–91 days with hatchlings emerging between late August and early October (DeGraaf and Rudis 1986).

Presence of the common snapping turtle was confirmed by direct observation in the Study Area. In studies conducted by the USFWS (1983), this species was commonly found near permanent freshwater ponds on the eastern portion of Fire Island. According to distribution maps provided by NYDEC (2001), this species has been documented in various areas all over Fire Island.

Box turtle (*Terrapene carolina*)

The box turtle is found throughout the eastern portion of the United States. It is typically found in moist forested areas, but may also be found in wet meadows and pastures (Behler and King 1979). Home ranges for this species are typically 150 to 750 square feet in size (DeGraaf and Rudis 1986). Younger individuals are primarily carnivorous and feed on earthworms, slugs, snails, and insects while herbivorous older individuals primarily feed on leaves, grass, berries, and fruit (DeGraaf and Rudis 1986). Box turtles typically hibernate from late fall to early April (DeGraaf and Rudis 1986). The breeding period begins after emergence from hibernation in May to July (Behler and King 1979). Females reach sexual maturity at five to seven years of age and typically lay three to eight eggs in a deep cavity (Behler and King 1979). The incubation period usually lasts between 87–89 days with hatchlings emerging between August and September (DeGraaf and Rudis 1986).

During this study, the box turtle was observed in forest, forest/shrub, and herbaceous communities within the Study area. In studies conducted by the USFWS (1983), this species was commonly found in woodlands and in the transition zone between the woodlands and the primary dune area. According to distribution maps provided by NYDEC (2001), this species has been documented in various areas all over Fire Island.

Garter snake (*Thamnophis sirtalis*)

The garter snake is found throughout the eastern portion of the United States. It is most often found near water in wet meadows, marshes, drainage ditches, and damp woodlands. Home ranges for this species are typically 5 square acres in size (DeGraaf and Rudis 1986). This

species feeds primarily on earthworms, amphibians, carrion, and insects (DeGraaf and Rudis 1986). The garter snake typically hibernates from October to March or April and is one of the earliest snakes to emerge after winter (DeGraaf and Rudis 1986). The breeding period begins after emergence from hibernation in mid-March to May and occasionally in the fall before hibernation (Behler and King 1979). Females reach sexual maturity at 2 years of age and typically give birth to 14 to 40 young between July and September (DeGraaf and Rudis 1986). The gestation period for this species usually lasts 3 to 4 months (DeGraaf and Rudis 1986).

The garter snake was the only snake observed during this study. According to distribution maps provided by NYDEC (2001), this species has been recorded on the eastern portion of Fire Island. In studies conducted by the USFWS (1983), this species was commonly found near freshwater ponds and urban areas of Fire Island.

6.0 IMPLICATIONS FOR REFORMULATION STUDY

Beaches and dunes are dynamic systems whereby sand and sediments are under the influence of waves, tides, currents and winds that may move sand onshore, offshore, or along the shoreline, depending on the combination of these elements at work at any given time. Studies conducted on Fire Island have documented extensive beach widening in some areas along the island and narrowing in others (Taney 1961, Bokuniewicz et al. 1988, Zimmerman et al. 1989). For example, studies conducted on East Hampton Beach since 1979 have shown that in 1988 the average beach width was 90 feet wider than documented in 1979 (Bokuniewicz et al. 1988, Zimmerman et al. 1989). While the average width increased, some sections of the beach were significantly narrower than previously documented. The changes from month to month in beach width can be significant. The studies of East Hampton Beach found that beach width varied from 26 feet to 188 feet over a 1-year period (Bokuniewicz et al. 1988, Zimmerman et al. 1989).

In this dynamic system, occasional breaching of the protective primary dune occurs when forces deteriorate the beach and primary dune, and water is able to cross over the island and into the bay. The most dramatic result can be extreme flooding of areas located adjacent to the bay. The USACE's Fire Island reformulation project is investigating the feasibility of beach re-nourishment as one alternative for flood control in areas along the barrier island that exhibit highest potential for beach/dune erosion and potential breaching. This activity would involve depositing sand on the existing beach to increase beach width and sand volume. Other alternatives have yet to be determined, but would presumably involve impacts only to nearshore, beach, and/or dune areas.

Negative impacts typically associated with beach re-nourishment, and similar flood control alternatives, include short-term impacts to wildlife such as disturbance to fish, benthic communities, birds, and mammals due to noise and activities associated with construction along the beach. Some direct mortality can be expected to species with limited mobility that occur in the impact area. However, most mobile species, such as fish, birds, mammals, and herpetiles will flee the impact area during construction activities and return within a relatively short period, so long as activities are scheduled to avoid breeding, spawning, and nesting activities. Some habitat impacts that may disrupt normal breeding, nesting, or spawning activities, are likely to occur as potentially suitable areas are covered with additional volumes of sand.

Beach re-nourishment activities are expected to impact only the nearshore ocean, intertidal, supratidal, and primary dune communities surveyed during this study. Accordingly, species that depend upon the beach/dune community for foraging, breeding, and nesting are most susceptible to impacts from beach re-nourishment, or similar, flood protection activities. These impacts may be positive and or negative depending on the species and timing of construction activities.

Forty-four (44) species have been identified as likely to occur on the barrier island based on background research. Of these, 10 species to include the loggerhead sea turtle, leatherback sea turtle, harbor seal, spadefoot toad, white-footed mouse, red fox, white-tailed deer, cottontail rabbit, box turtle, and meadow vole, have been observed in beach and/or dune habitats on the barrier island during this Study and others (USFWS 1983, Brotherton et al. 2003). None of these species are known to depend upon these habitats for breeding, nesting, and/or foraging activities

on Fire Island (Connor 1971, USFWS 1983, DeGraaf, and Rudis 1986, USFWS 2003). Although documented in beach or primary dune areas, these species are not believed to be at risk from the proposed project because occurrences of these species are either sporadic (i.e., transient individuals) or the species is known to use a number of other suitable habitats that are present throughout the Study area.

Although the small mammal and herpetile species documented on Fire Island are not strongly linked to the beach/dune communities, many may exhibit some avoidance to the Project area during construction activities due to the noise and human activity. However, the avoidance is not likely to cause significant negative impacts to the species because they are not dependant upon beach/dune communities for foraging, breeding, and/or nesting. Ongoing activities not associated with beach re-nourishment, such as loss of habitat, encroachment by humans, and increases in human activities within preferred foraging, breeding, and/or nesting areas, are the leading threats to these species.

7.0 LITERATURE CITED

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Appendix A

Photographic Documentation

NORTHERN ECOLOGICAL ASSOCIATES, INC.

PHOTOGRAPHIC RECORD

Company: USACE - New York District

Project: Reformulation of the Shore Protection and Storm Damage Reduction Project for the South Shore of Long Island, New York

Photographer: B. Schaeffer

Date: May 2002

Comments:

Herbaceous community, primarily consisting of beachgrass, located on ocean side of dune.

Photographer: B. Schaeffer

Date: May 2002

Comments:

Herbaceous/shrub community commonly found behind beach dune.

NORTHERN ECOLOGICAL ASSOCIATES, INC.

PHOTOGRAPHIC RECORD

Company: USACE - New York District

Project: Reformulation of the Shore Protection and Storm Damage Reduction Project for the South Shore of Long Island, New York

Photographer: B. Schaeffer

Date: May 2002

Comments:
Shrub community.

Photographer: B. Schaeffer

Date: May 2002

Comments:
Stunted conifer forest community.

NORTHERN ECOLOGICAL ASSOCIATES, INC.

PHOTOGRAPHIC RECORD

Company: USACE - New York District

Project: Reformulation of the Shore Protection and Storm Damage Reduction Project for the South Shore of Long Island, New York

Photographer: S. Grove

Date: May 2002

Comments:

B. Schaeffer setting Sherman live trap.

Photographer: S. Grove

Date: May 2002

Comments:

Sherman live trap – baited and set.

NORTHERN ECOLOGICAL ASSOCIATES, INC.

PHOTOGRAPHIC RECORD

Company: USACE - New York District

Project: Reformulation of the Shore Protection and Storm Damage Reduction Project for the South Shore of Long Island, New York

Photographer: B. Schaeffer

Date: May 2002

Comments:

The most commonly captured small mammal, the white-footed mouse.

Photographer: B. Schaeffer

Date: May 2002

Comments:

Fox den located in shrub community.

NORTHERN ECOLOGICAL ASSOCIATES, INC.

PHOTOGRAPHIC RECORD

Company: USACE - New York District

Project: Reformulation of the Shore Protection and Storm Damage Reduction Project for the South Shore of Long Island, New York

Photographer: B. Schaeffer

Date: May 2002

Comments:
Box turtles mating.

Appendix B

Database Printout

Summary of Small Mammal Survey

Species	Community Type	Station Number	Comments
MIPI	FOR	1-2	
MUMU	HRB	19-14	
PELE	HSS	3-4	
PELE	SS	9-21	
PELE	PHS	9-19	
PELE	PHS	9-18	
PELE	SS	9-16	
PELE	SS	9-25	
PELE	SS	9-10	
PELE	SS	10-13	
PELE	SS	9-9	
PELE	SS	9-8	
PELE	SS	9-7	
PELE	SS	9-6	
PELE	SS	9-4	
PELE	SS	9-3	
PELE	SS	9-14	
PELE	SS	11-11	
PELE	PHS	12-8	
PELE	PHS	12-6	
PELE	PHS	12-4	
PELE	SS	11-23	
PELE	SS	11-22	
PELE	SS	11-18	
PELE	FOR	9-23	
PELE	SS	11-12	
PELE	SS	8-6	
PELE	SS	11-10	
PELE	SS	11-9	
PELE	SS	11-8	
PELE	SS	11-5	
PELE	HSS	11-3	
PELE	FOR	10-15	
PELE	SS	11-17	
PELE	HSS	4-9	
PELE	SS	8-14	
PELE	SS	5-16	
PELE	SS	5-13	
PELE	SS	5-10	
PELE	SS	5-6	
PELE	HRB	5-5	
PELE	PHS	5-24	

Species	Community Type	Station Number	Comments
PELE	HSS	4-7	
PELE	FOR	6-1	
PELE	FHSS	4-13	
PELE	FHSS	4-15	
PELE	FHSS	4-16	
PELE	PH	4-23	
PELE	PHS	4-24	
PELE	PH	3-20	
PELE	HRB	5-3	
PELE	FSS	7-6	
PELE	HRB	13-2	
PELE	SS	8-5	
PELE	SS	8-4	
PELE	SS	7-23	
PELE	SS	7-22	
PELE	SS	7-15	
PELE	SS	5-17	
PELE	SS	7-9	
PELE	SS	8-13	
PELE	HRB	7-1	
PELE	SS	6-24	
PELE	PHS	6-19	
PELE	PHS	6-18	
PELE	FOR	6-6	
PELE	FOR	6-2	
PELE	SS	7-14	
PELE	PH	19-9	
PELE	SS	1-6	
PELE	SS	1-5	
PELE	SS	20-23	
PELE	HRB	20-19	
PELE	HRB	20-7	
PELE	PHS	18-16	
PELE	HRB	19-18	
PELE	HRB	1-23	
PELE	FOR	18-25	
PELE	FOR	18-23	
PELE	PHS	18-20	
PELE	PHS	18-19	
PELE	PHS	18-18	
PELE	HSS	12-12	
PELE	HRB	20-6	
PELE	PHS	2-14	
PELE	SS	3-3	

Species	Community Type	Station Number	Comments
PELE	HSS	3-2	
PELE	SS	18-16	
PELE	SS	2-22	
PELE	PHS	1-22	
PELE	FOR	2-18	
PELE	SS	1-9	
PELE	PHS	2-15	
PELE	SS	1-22	
PELE	PHS	2-13	
PELE	HSS	2-10	
PELE	SS	2-8	
PELE	HSS	2-7	
PELE	HSS	2-5	
PELE	PHS	18-15	
PELE	FOR	2-17	
PELE	PHS	13-20	
PELE	PH	14-16	
PELE	PHS	14-9	
PELE	PHS	14-7	
PELE	SS	14-6	
PELE	HSS	14-1	
PELE	PHS	18-17	
PELE	PHS	13-21	
PELE	HRB	14-24	
PELE	PHS	13-18	
PELE	SS	13-13	
PELE	HRB	13-10	
PELE	SS	13-6	
PELE	SS	13-4	
PELE	HSS	3-3	
PELE	SS	13-24	
PELE	SS	16-14	
PELE	PHS	18-14	
PELE	SS	18-10	
PELE	SS	18-9	
PELE	SS	18-8	
PELE	SS	18-4	
PELE	HRB	17-15	
PELE	SS	14-20	
PELE	PHS	16-23	
PELE	SS	14-23	
PELE	PHS	16-4	
PELE	PHS	16-3	
PELE	HRB	15-21	

Species	Community Type	Station Number	Comments
PELE	SS	15-3	
PELE	SS	15-2	
PELE	HRB	12-16	
PELE	PHS	16-25	
PELE	SS	7-10	
PELE	HSS	7-20	
PELE	HSS	7-21	
PELE	FOR	7-22	
PELE	FOR	7-23	
PELE	HSS	7-25	
PELE	PH	3-18	
PELE	FOR	7-11	
PELE	HSS	7-13	
PELE	FOR	7-7	
PELE	SS	7-6	
PELE	SS	6-24	
PELE	HRB	6-22	
PELE	SS	6-21	
PELE	FOR	6-20	
PELE	HRB	7-1	
PELE	FHSS	8-6	
PELE	SS	9-8	
PELE	SS	9-7	
PELE	SS	9-6	
PELE	HRB	9-2	
PELE	HRB	9-1	
PELE	PH	8-1	
PELE	FOR	7-16	
PELE	FHSS	8-4	
PELE	FOR	7-14	
PELE	FSS	8-15	
PELE	SS	8-17	
PELE	SS	8-18	
PELE	SS	8-19	
PELE	HSS	8-25	
PELE	PH	6-15	
PELE	PH	8-2	
PELE	HSS	2-5	
PELE	PH	6-18	
PELE	HRB	13-1	
PELE	PHS	12-22	
PELE	SS	12-17	
PELE	SS	12-11	
PELE	PHS	2-16	

Species	Community Type	Station Number	Comments
PELE	SS	13-3	
PELE	SS	2-9	
PELE	HSS	13-4	
PELE	HSS	2-4	
PELE	HRB	2-3	
PELE	HSS	1-6	
PELE	HRB	1-11	
PELE	FSS	1-17	CONIFEROUS
PELE	PHS	1-20	
PELE	PHS	2-14	
PELE	FOR	6-2	
PELE	FOR	9-13	
PELE	SS	6-13	
PELE	SS	6-12	
PELE	FOR	6-10	
PELE	SS	6-9	
PELE	FOR	6-8	
PELE	HRB	13-2	
PELE	FHSS	6-4	
PELE	PH	6-16	
PELE	FHSS	6-1	
PELE	SS	13-17	
PELE	SS	13-16	
PELE	SS	13-15	
PELE	SS	13-14	
PELE	SS	13-11	
PELE	FOR	6-6	
PELE	SS	14-8	
PELE	HSS	11-21	
PELE	SS	14-23	
PELE	PHS	14-17	
PELE	HSS	14-15	
PELE	PHS	14-13	
PELE	HSS	14-12	
PELE	PHS	15-4	
PELE	PH	14-9	
PELE	PHS	15-5	
PELE	HSS	14-7	
PELE	SS	14-6	
PELE	FHSS	14-5	
PELE	HSS	14-2	
PELE	HRB	12-3	
PELE	SS	9-9	
PELE	PHS	14-11	

Species	Community Type	Station Number	Comments
PELE	PHS	16-5	
PELE	SS	2-24	
PELE	HSS	3-1	
PELE	HSS	18-4	
PELE	SS	18-1	
PELE	HRB	17-12	
PELE	HRB	17-8	
PELE	HSS	15-2	
PELE	FHSS	16-7	
PELE	HSS	11-20	
PELE	PHS	16-3	
PELE	SS	15-16	
PELE	FSS	15-13	
PELE	FSS	15-12	
PELE	HSS	15-9	
PELE	HSS	15-8	
PELE	HSS	17-1	
PELE	FOR	9-23	
PELE	FSS	11-25	
PELE	SS	10-5	
PELE	HRB	10-4	
PELE	HRB	10-3	
PELE	HRB	10-1	
PELE	SS	9-PF-5	
PELE	SS	10-8	
PELE	SS	9-PF-1	
PELE	HSS	10-9	
PELE	HRB	9-19	
PELE	SS	9-18	
PELE	SS	9-17	
PELE	SS	9-16	
PELE	SS	9-15	
PELE	SS	3-9	
PELE	SS	9-PF-4	
PELE	HSS	10-23	
PELE	HSS	11-13	
PELE	FSS	11-12	
PELE	SS	11-7	
PELE	HSS	11-6	
PELE	SS	11-5	
PELE	HRB	11-4	
PELE	HSS	10-7	
PELE	FOR	10-PF-4	
PELE	SS	9-10	

Species	Community Type	Station Number	Comments
PELE	PHS	10-19	
PELE	FOR	10-18	
PELE	FSS	10-17	
PELE	FOR	10-16	
PELE	FOR	10-15	
PELE	FSS	10-13	
PELE	HRB	11-2	
PELE	FOR	4-10	
PELE	SS	19-18	
PELE	FOR	5-3	
PELE	SS	4-23	
PELE	SS	4-19	
PELE	FOR	4-15	
PELE	SS	5-11	
PELE	FOR	4-12	
PELE	HRB	5-16	
PELE	FOR	4-7	
PELE	FOR	4-2	
PELE	HRB	3-11	
PELE	FOR	3-3	
PELE	SS	1-13	
PELE	SS	14-8	
PELE	FOR	4-13	
PELE	HRB	6-10	
PELE	FOR	7-5	
PELE	FOR	7-2	
PELE	FOR	7-1	
PELE	FOR	6-20	
PELE	FOR	6-19	
PELE	FOR	5-6	
PELE	FOR	6-17	
PELE	SS	19-17	
PELE	FOR	6-9	
PELE	FOR	6-5	
PELE	FOR	6-4	
PELE	HRB	5-20	
PELE	HRB	5-18	
PELE	HRB	5-17	
PELE	FOR	6-18	
PELE	SS	16-1	
PELE	SS	1-5	
PELE	FOR	16-10	
PELE	FOR	16-9	
PELE	SS	16-7	

Species	Community Type	Station Number	Comments
PELE	FOR	2-19	
PELE	HRB	17-8	
PELE	SS	3-5	
PELE	HRB	17-12	
PELE	FOR	15-21	
PELE	HRB	15-19	
PELE	SS	15-9	
PELE	SS	15-4	
PELE	SS	14-25	
PELE	SS	14-24	
PELE	PH	16-5	
PELE	SS	18-16	
PELE	PH	19-13	
PELE	SS	18-25	
PELE	SS	18-23	
PELE	SS	18-22	
PELE	SS	18-21	
PELE	HRB	17-2	
PELE	PH	18-17	
PELE	FOR	7-11	
PELE	SS	18-14	
PELE	SS	18-10	
PELE	SS	18-9	
PELE	SS	18-8	
PELE	FOR	18-5	
PELE	FOR	18-4	
PELE	SS	18-19	
PELE	SS	13-2	
PELE	FOR	7-6	
PELE	SS	15-11	
PELE	PH	15-9	
PELE	PH	15-8	
PELE	SS	14-9	
PELE	SS	16-1	
PELE	SS	13-16	
PELE	PHS	16-3	
PELE	HRB	11-24	
PELE	HRB	11-23	
PELE	HRB	11-21	
PELE	FOR	11-15	
PELE	FOR	11-14	
PELE	SS	11-12	
PELE	PH	14-2	
PELE	HRB	17-13	

Species	Community Type	Station Number	Comments
PELE	SS	18-12	
PELE	SS	18-11	
PELE	SS	18-10	
PELE	SS	18-8	
PELE	SM	18-5	
PELE	SS	15-15	
PELE	HRB	17-14	
PELE	SS	11-8	
PELE	HRB	17-9	
PELE	HRB	17-4	
PELE	SS	16-13	
PELE	PH	16-9	
PELE	PH	16-7	
PELE	PHS	16-4	
PELE	SM	18-1	
PELE	SS	8-8	
PELE	X	10-5	
PELE	X	10-2	
PELE	X	10-1	
PELE	SS	8-20	
PELE	FOR	8-16	
PELE	SS	11-11	
PELE	SS	8-11	
PELE	X	10-8	
PELE	SS	8-6	
PELE	HRB	7-23	
PELE	SS	7-20	
PELE	FOR	7-19	
PELE	FOR	7-13	
PELE	SS	16-2	
PELE	SS	8-15	
PELE	HRB	10-20	
PELE	FOR	7-8	
PELE	SS	11-7	
PELE	SS	11-5	
PELE	SS	11-2	
PELE	SS	11-1	
PELE	SS	20-9	
PELE	X	10-6	
PELE	HRB	10-21	
PELE	X	10-7	
PELE	HRB	10-19	
PELE	HRB	10-18	
PELE	HRB	10-17	

Species	Community Type	Station Number	Comments
PELE	X	10-11	
PELE	X	10-9	
PELE	SS	11-9	
PELE	HRB	10-22	
PELE	SS	20-22	
PELE	SS	3-25	
PELE	SS	3-21	
PELE	SS	3-20	
PELE	HRB	3-10	
PELE	FOR	3-3	
PELE	FOR	1-7	
PELE	PH	18-21	
PELE	SS	20-23	
PELE	FOR	4-6	
PELE	SS	20-21	
PELE	HSS	20-9	
PELE	HSS	20-8	
PELE	SS	19-14	
PELE	SM	19-1	
PELE	FOR	6-20	
PELE	SS	20-24	
PELE	FOR	5-7	
PELE	FOR	6-10	
PELE	FOR	6-9	
PELE	SS	14-7	
PELE	SS	5-14	
PELE	SS	5-13	
PELE	SS	5-12	
PELE	FOR	4-3	
PELE	FOR	5-9	
PELE	FOR	4-4	
PELE	FOR	5-4	
PELE	FOR	5-3	
PELE	FOR	5-2	
PELE	FOR	4-14	
PELE	FOR	4-13	
PELE	FOR	4-9	
PELE	PH	18-20	
PELE	SS	5-11	
PELE	HSS	4-1	
PELE	FOR	4-20	
PELE	FOR	4-19	
PELE	FOR	4-18	
PELE	FOR	4-12	

Species	Community Type	Station Number	Comments
PELE	FOR	4-11	
PELE	HSS	4-10	
PELE	FOR	18-23	
PELE	HSS	4-5	
PELE	PHS	4-24	
PELE	PH	3-25	
PELE	PHS	3-20	
PELE	PHS	3-19	
PELE	PHS	3-17	
PELE	PHS	3-15	
PELE	FSS	3-13	
PELE	SS	4-7	
PELE	SS	5-22	
PELE	PH	18-19	
PELE	HSS	18-14	
PELE	HSS	18-13	
PELE	HSS	18-11	
PELE	HSS	18-9	
PELE	HSS	18-7	
PELE	FSS	4-21	
PELE	SS	5-24	
PELE	PH	4-23	
PELE	SS	5-21	
PELE	SS	5-13	
PELE	SS	5-11	
PELE	SS	5-10	
PELE	SS	5-8	
PELE	SS	5-7	
PELE	HRB	5-19	
PELE	SS	5-25	
PELE	SS	9-22	
PELE	FOR	9-8	
PELE	SS	10-16	
PELE	SS	9-11	
PELE	HRB	11-24	
PELE	SS	11-21	
PELE	SS	11-17	
PELE	SS	11-9	
PELE	SS	11-3	
PELE	SS	11-1	
PELE	SS	9-13	
PELE	SS	9-19	
PELE	FOR	6-21	
PELE	HRB	11-25	

Species	Community Type	Station Number	Comments
PELE	HRB	10-24	
PELE	HRB	10-23	
PELE	FOR	10-1	
PELE	SS	10-20	
PELE	SS	10-18	
PELE	FOR	10-5	
PELE	FOR	10-9	
PELE	SS	10-17	
PELE	SS	10-12	
PELE	SS	10-13	
PELE	SS	10-15	
PELE	SS	9-18	
PELE	FOR	8-8	
PELE	FOR	7-3	
PELE	FOR	6-24	
PELE	HRB	13-24	
PELE	FOR	7-7	
PELE	FOR	7-9	
PELE	FOR	7-11	
PELE	FOR	7-13	
PELE	FOR	7-15	
PELE	SS	9-10	
PELE	PH	14-5	
PELE	FOR	7-1	
PELE	SS	8-5	
PELE	FOR	7-18	
PELE	SS	8-11	
PELE	FOR	6-22	
PELE	SS	8-12	
PELE	HRB	8-19	
PELE	HRB	8-20	
PELE	SS	12-20	
PELE	HRB	8-22	
PELE	HRB	12-18	
PELE	HRB	8-23	
PELE	SS	12-15	
PELE	FOR	9-6	
PELE	FOR	9-7	
PEMA	FSS	7-7	
PEMA	HRB	17-11	
PEMA	HSS	18-3	
PEMA	SS	1-PF-4	
PEMA	SS	18-2	
PEMA	HRB	19-1	

Species	Community Type	Station Number	Comments
PEMA	HRB	5-24	
PEMA	HSS	18-5	
PEMA	HRB	9-3	
PEMA	X	3-16	
PEMA	HRB	8-21	
PEMA	HRB	19-24	
PEMA	HRB	19-11	
PEMA	HRB	19-10	
PEMA	SS	20-8	
PEMA	HRB	19-2	
PEMA	SS	18-13	
PEMA	PH	19-4	
PEMA	SS	20-6	
PEMA	HRB	5-23	
PEMA	SS	18-20	
PEMA	PH	18-18	
PEMA	SS	7-24	
PEMA	SM	19-3	
PEMA	HRB	19-3	
RANO	FSS	11-10	
SOCI	FHSS	14-PF-4	
SOCI	PHS	14-PF-5	