US Army Corps of Engineers®
New York District

THE PORT AUTHORITY OF NY & NJ

Liberty State Park Environmental Resources Inventory

April 2004

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

CRIP	Comprehensive Restoration Implementation Plan
CRM	Common Reed/Mugwort
CRRNJ	Central Railroad of New Jersey Terminal
CRW	Common Reed-dominated Wetlands
DEM	Deep Emergent Marsh
ERC	Ecosystem Restoration Consultants
FFW	Floodplain Forest Wetland
HRE	Hudson-Raritan Estuary Environmental Restoration study
IC	Interpretive Center
LOI	Letter of Interpretation
LSC	Liberty Science Center
LSP	Liberty State Park
MF	Maritime Forest
MG	Maritime Grassland
MHW	Mean High Water
ML	Mowed Lawn
MLW	Mean Low Water
MS	Maritime Shrubland
NAVD	North American Vertical Datum
NJDEP	New Jersey Department of Environmental Protection
NJDPF	New Jersey Division of Parks and Forestry
NY/NJ Harbor	New York and New Jersey Harbor
PANYNJ	Port Authority of New York/New Jersey
RCRA	Resource Conservation and Recovery Act
ROAD	Unpaved/Paved Road
SEM	Shallow Emergent Marsh
SNH	Successional Northern Hardwood
SOF	Successional Old Field
SSB	Successional Shrubland
SSW	Shrub Swamp Wetland
TI	Texas Instruments, Inc.
USACE	United States Army Corps of Engineers
WET	Wetland Evaluation Technique
WRDA	Water Resources Development Act

EXECUTIVE SUMMARY AND CONCLUSIONS:

1. The Hudson-Raritan Estuary Environmental Restoration Study (HRE) was authorized by the U.S. House of Representatives Committee on Transportation and Infrastructure, and was designed to investigate the feasibility of environmental restoration opportunities that relate to water resources and sediment quality within the port district of New York and New Jersey. The HRE has two elements that are currently underway: the development of a Comprehensive Restoration Implementation Plan (CRIP) and the implementation of restoration opportunities where there is existing public support and potential for a cost share sponsor.

2. Liberty State Park (LSP), in Jersey City, New Jersey is one of the first restoration opportunities undertaken by the HRE. The NY District of the U.S. Army Corps of Engineers (USACE) is currently conducting an integrated Environmental Impact Assessment and Feasibility Study for the implementation of a habitat restoration project within the park.

3. Liberty State Park consists of 1,122 acres on the western bank of Upper New York Bay. The site offers waterfront views of the Manhattan skyline, the Statue of Liberty and Ellis Island. The park was once an intertidal mud flat and salt marsh that was filled and used as a railroad yard. The soils consist of historic fill materials that were deposited to stabilize the surface between 1860 and 1919 (MacFarlane 2001). These historic fill materials (e.g. debris from construction projects and refuse from New York City) overlie native marine clay. Between 1864 and 1967 the Central Railroad of New Jersey Terminal (CRRNJ) used the site as a rail yard for both freight and passenger service. In 1967 CRRNJ discontinued operations at the site, and the land was abandoned until it was acquired by the New Jersey Division of Parks and Forestry (NJDPF) (LSP 2003). LSP opened on July 4, 1976 (LSP 2003). NJDPF has improved the degraded site substantially since the acquisition by creating recreational and educational features in the park. The 215-acre area in the center of the park has remained undeveloped and is currently inaccessible to the public due to the presence of hydrocarbons, pesticides and metals that exceed New Jersey Department of Environmental Protection (NJDEP) clean up criteria (MacFarlane 2001).

4. Existing information from recent ecological surveys and the results of a 2003 sampling program were used to develop an Environmental Resources Inventory for LSP. This inventory provides a baseline on the plant and animal communities that can be used for environmental impact prediction for proposed habitat restoration activities, and for the design of post-implementation monitoring to evaluate the level of restoration attained.

5. Because of the presence of contaminants at levels that exceed limits established for New Jersey under the Resource Conservation and Recovery Act (RCRA), the NJDEP has entered into a Consent Decree that stipulates how these contaminated soils must be handled to prevent exposure to the public. These measures, such as capping and fencing any development or restoration that poses the opportunity for public exposure, must take place in such a manner that is consistent with the requirements of the Consent Decree.

6. The man-induced disturbances (primarily filling) which created the current landscape of the undeveloped portion of LSP are the dominant factors shaping the existing plant and animal communities and will be major factors in future ecological conditions with or without the proposed restoration. The existing plant communities can be expected to change over time with a corresponding change in animal communities. The rate of succession in plant communities will depend primarily on the timing of former disturbances among various areas of the site and the limiting factors associated with the substrates (nutrients and physical characteristics) and hydrology (water table) created by the filling. Intervention by man to correct adverse impacts associated with previous disturbances has the potential to direct future changes in an ecologically positive direction, and to accelerate the rate of positive change in existing plant and animal communities.

7. USACE has proposed a major ecological restoration effort for degraded habitats within Liberty State Park. There are four main restoration elements proposed for the LSP restoration site, including: (1) the restoration/creation of a 42-acre salt marsh within a dredged material storage area, along with a tidal connection; (2) the creation of a deep water emergent marsh system including treatment wetlands; (3) the enhancement of a complex of existing shallow water wetlands, and (4) the creation a berm grassland system for wildlife habitat in the southwestern portion of the site.

8. The recent ecological investigations by LSP staff and the current study confirms the ecological influences of former disturbances and documents changes in the plant and animal communities since 1996, when a major survey was conducted. Many vegetative communities are now dominated by invasive species and the animal population reflects the disturbed nature of available habitats and the isolation of the site from natural habitats which could serve as a source of species recruitment. Birds are well represented which reflects their ability to disperse across areas of unsuitable habitat, while amphibians, reptiles and mammals are poorly represented, presumably because there are no major corridors of natural habitat which could provide access for species with limited powers of dispersal.

9. The occurrence of threatened and endangered species on the site, particularly the northern harrier (*Circus cyaneus*), provides not only a focus for ecological management, but also a potentially limiting factor for diversifying the habitat on the site. The specialized habitat needs for foraging and breeding, and the large spatial requirements of the northern harrier relative to the size of the site, could be an impediment to comprehensive site restoration. Sensitive design and construction techniques should permit continued use of the site by the northern harrier.

10. The aquatic habitat in the North Cove contains typical invertebrate and fish assemblages found in adjacent harbor waters, with relatively low abundance and diversity. Invertebrate species known to be tolerant of polluted conditions occur in relatively high abundance in the cove. The aquatic life in North Cove would be expected to make use of a new wetland with a connection through the cove, and fish in the cove and nearby waters would benefit from the production of invertebrates and juvenile fish as a source of food.

11. A functional analysis of the existing habitats and habitats resulting from the proposed restoration plan was conducted to evaluate potential changes in ecosystem functional values throughout the site. A modified Federal Highway Administration methodology was used in order to tailor the analysis to the unique features of the site and the availability of recent site specific data. The analysis found a substantial increase in functional values with the restoration plan and an increase in cumulative functional values across all community types. This evaluation suggests that ecological value could be added to the site, both with new community types (tidal wetland complex and deep emergent marsh) and enhancement of functional values associated with existing communities.

12. A biobenchmarking study and tidal data analysis were used to establish optimum elevations for the vegetative communities proposed for the new tidal wetland. Existing, nearby, representative stands of key species were located and surveyed to provide discrete, species-specific elevations for this area of the estuary.

1. INTRODUCTION

The U.S. Army Corps of Engineers' (USACE) planning process for the Hudson-Raritan Estuary Environmental Restoration Study (HRE) was authorized under the Water Resources Development Act of 2000 (WRDA 2000) Section 905 (b) Preliminary Analysis and advanced with the "Needs and Opportunities Report". These studies identified potential restoration sites for which there is existing public support and the potential for a cost share sponsor.

With the New Jersey Department of Environmental Protection (NJDEP) as a cost share sponsor and immense public support for the project, Liberty State Park (LSP), in Jersey City, New Jersey is one of the first sites identified by the Needs and Opportunities Report for which an ecosystem restoration is planned. Under the HRE, USACE New York District (the District), along with its co-sponsor the Port Authority of New York and New Jersey (PANYNJ), is conducting an integrated Feasibility Study and Environmental Impact Statement for the restoration of a 225-acre portion of LSP (the LSP Restoration site). The restoration will include creation of a new tidal wetland habitat with a hydraulic connection to Upper New York Bay via the North Cove of LSP, enhancements to existing freshwater wetlands, enhancements to existing upland communities, and a managed public access program.

This Environmental Resources Inventory has been prepared under contract DACW51-01-D-0014, for the Implementation of Environmental Sampling for the Liberty State Park Draft Feasibility Report delivery order. The inventory includes a report of existing information, an Ecological Communities Report, and a discussion of the ecological communities functional assessment based on a survey conducted within the LSP Restoration site. This document is intended to be an appendix to the integrated Feasibility Report and Environmental Impact Statement (FR/EIS) being prepared by the District to support the restoration planned at LSP.

1.1 OVERVIEW OF THE HRE

The HRE is being carried out by the United States Army Corps of Engineers New York District under the General Investigations program, with the Port Authority of New York and New Jersey as a non-Federal study sponsor. The study was authorized by the Congress, and was designed to investigate the feasibility of environmental restoration opportunities that relate to water resources and sediment quality within the port district of New York and New Jersey. The two elements of the HRE that are currently underway

are: 1. the development of a Comprehensive Restoration Implementation Plan (CRIP); and 2. the implementation of restoration opportunities where there is existing public support and potential for a cost share sponsor.

The CRIP will be used as a framework to coordinate the restoration of degraded sites within the port district on a watershed basis. It will provide a set of goals and objectives to maximize the contribution of ecological value of HRE and non-HRE restoration initiatives covering the entire HRE project area. Technical guidance for implementing and maximizing ecological benefit will be provided in the CRIP. Environmental issues that exceed local and regional boundaries, such as water and sediment quality, will be addressed by the CRIP on a watershed-wide basis. The plan will be designed to ensure that the implementation of large and small environmental restorations within the port district will contribute to the accomplishment of the overall goals of improving sediment and water quality, and the restoration and creation of wetland, upland and shallow water habitat.

1.2 PROJECT OBJECTIVES

The Environmental Resources Inventory (ERI) was designed to result in a comprehensive description of the existing biological conditions within the LSP Restoration site, and to assess the change in ecosystem functions provided by the existing ecological communities that may result from the project. This effort included compiling existing biological information, and filling data gaps with biological sampling. The functions served by the regulated wetland communities were assessed for existing conditions and for proposed restoration conditions. Results of the investigations are presented in this ERI report. This document is intended to set the stage for the Liberty State Park FR/EIS by providing background and baseline information for the future impact assessment. Information in the report will also assist in the development of a post-implementation monitoring plan for the restoration effort.

1.3 LIBERTY STATE PARK

Liberty State Park is located on a 1,122-acre site on the west bank of Upper New York Bay (Figure 1-1). The site offers waterfront views of the Manhattan skyline, the Statue of Liberty and Ellis Island. Historically, the park was an intertidal mud flat and salt marsh that was filled and used as a railroad yard. The soils consist of historic fill materials that overlie the native marine clay. The materials, which consist primarily of

debris from construction projects and refuse from New York City, were deposited to stabilize the surface between 1860 and 1919 (MacFarlane 2001). Between 1864 and 1967 the Central Railroad of New Jersey (CRRNJ) used the site as a rail yard for both freight and passenger service. In 1967 CRRNJ discontinued operations at the site, and over the next few years the land was abandoned until it was acquired by the New Jersey Division of Parks and Forestry (NJDPF) (LSP 2003).

LSP opened on July 4, 1976 (LSP 2003). NJDPF has improved the degraded site substantially since the acquisition by creating recreational and educational features in the park. Park features include an 88-acre Green Park, four miles of paved walkways, the historic Central Railroad of New Jersey Terminal building, an Interpretive Center, Liberty Landing Marina, the Liberty Science Center, Caven Point Pier, and ferry service to the Statue of Liberty and Ellis Island. It is estimated that 4.3 million people visit the park annually (MacFarlane 2001).

In addition to the recreational and educational features, much of the park consists of undeveloped, vegetated and open water areas. Extensive subtidal and intertidal areas (523 acres) occur within the park boundary, including a 36-acre cord grass (*Spartina* sp.) dominated tidal wetland located behind the Interpretive Center, and the North Cove, a shallow open water cove located south of the railroad terminal building. In the center of the park is a 212-acre undeveloped area containing upland and freshwater wetland environments, which is currently inaccessible to the public, due to contaminated sediments containing levels of hydrocarbons, pesticides and metals that exceed the NJDEP clean up criteria (MacFarlane 2001).

Within the LSP Restoration site is a 42-acre dredged material storage area that is surrounded by associated containment structures (also referred to as "the impoundment"). The impoundment consisted of a series of 8-foot high earthen berms constructed from existing fill materials excavated on-site. In 1981, during the construction of the southern section of the seawall of the LSP causeway, approximately 93,000 cubic yards of dredged materials were placed in the impoundment. During the spring of 1987, an additional 255,000 cubic yards of dredged materials were placed into the impoundment, with this material obtained from an area between the South Cove and the Middle Cove during the completion of the Liberty Walk seawall project. In 1993, the NJDEP hired a contractor to excavate and regrade the berms surrounding the impoundment over the dredge spoil to form a cap over the material, and vegetative cover was subsequently established (From draft report, AMEC 2002).

US Army Corps of Engineers®
New York District

THE PORT AUTHORITY OF NY & NJ

Map Source: ESRI
Aerial Photo Source: USACE

Location of
Liberty State Park
Restoration Site
Jersey City, NJ

Figure 1-1

1.4 PROPOSED RESTORATION PROJECT DESCRIPTION

The environmental restoration effort planned for Liberty State Park includes the creation of a tidal marsh in the center of the park, and enhancements to the uplands and freshwater wetlands within the undeveloped area. Materials will be excavated from the future marsh area, capped and used to create a grassland berm in the southwestern section of the park. A narrow channel will connect the tidal marsh to the North Cove. Storm water will be collected from adjacent areas and will be diverted to feed freshwater wetlands on the site, creating shallow and deep emergent marshes. Nuisance plant species will be controlled, and native grasslands, shrublands and forests will be planted.

For this study, the LSP Restoration site (Figure 1-2) is defined as:

1. The 212-acre undeveloped parcel in the center of the park, bounded by Millennium Park to the north, Freedom Way to the east, Thomas McGovern Drive to the south and Phillips Street to the west. This area includes a soil stockpile area, a dredged material storage area, a forest/wetland complex, and a successional shrubland/forest complex.
2. A 4-acre portion of the Green Park between the undeveloped parcel and the North Cove, which is the proposed location for the tidal inlet and channel.
3. The 9-acre wetland and forested area located north of the Liberty Science Center, and generally bounded by Audrey Zapp Drive to the north, Phillips Street to the east, Liberty Science Center to the south, and Wilson Street to the west.

1.5 THE ENVIRONMENTAL RESOURCES INVENTORY

A comprehensive inventory of the existing environmental resources on the LSP Restoration site is necessary to evaluate potential impacts to these resources that may result from restoration efforts. A pre-restoration activity inventory with reproducible survey methodologies is also required to establish a baseline for the future monitoring program. This document presents the results of environmental investigations performed at Liberty State Park in 2003. The results of these surveys establish the existing conditions of the LSP Restoration site, and the protocols utilized can be replicated during the monitoring program.

US Army Corps of Engineers®
New York District

Map Source: LMS
Aerial Photo Source: USACE

THE PORT AUTHORITY OF NY & NJ

Liberty State Park Restoration Site

Figure 1-2

The following sections describe the existing conditions of the environmental resources on the proposed LSP Restoration project site:

Section 2. Terrestrial and Wetland Vegetation Communities
Section 3. Wildlife
Section 4. Endangered and Threatened Species
Section 5. North Cove Aquatic Communities

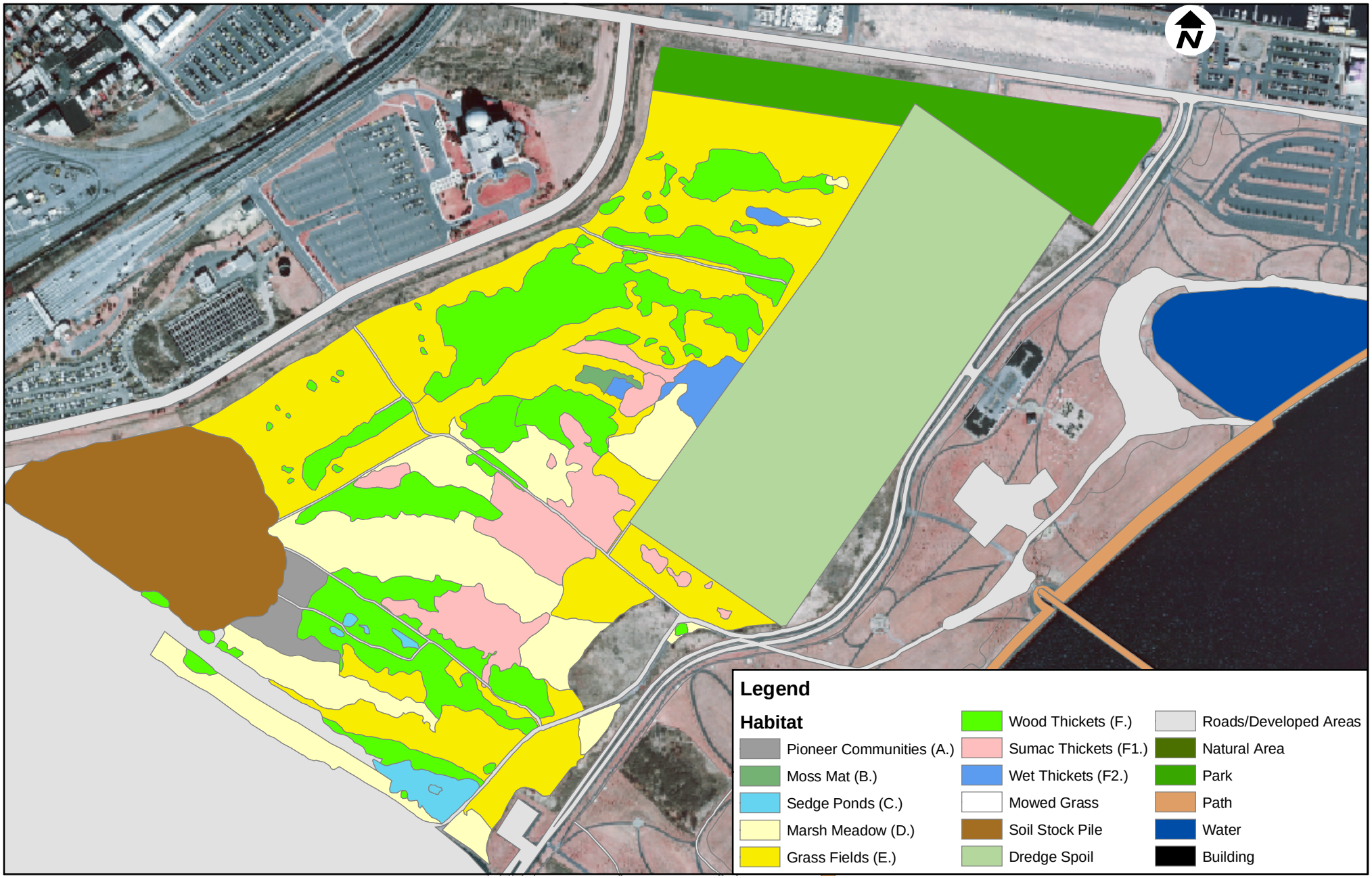
2. TERRESTRIAL AND PALUSTRINE VEGETATION COMMUNITITES

The vegetation communities within the LSP Restoration site were identified and categorized based on the descriptions and associations provided in *Ecological Communities of New York State* (Edinger *et al.* 2002). The community descriptions were slightly modified from Edinger *et al.* (2002) to more accurately characterize the disturbed and urban conditions found within the LSP Restoration site. Because of their special significance and regulation by USACE and NJDEP, wetland communities are discussed both here and in Section 2.2 Regulated Wetland Communities.

The LSP Restoration site is covered by vegetation communities that reflect decades of human alteration. The substrate is composed of fill material that was deposited on the site during the 19th and 20th centuries, when the site functioned as a rail yard. When the rail yard was closed in 1967, no site restoration was performed. Through natural succession and in response to an assortment of differing physical and chemical conditions, a variety of habitats have developed over a period of 36 years. Past construction has created compacted depressions with poor drainage, allowing for the formation of small isolated wetlands. Variability in substrate materials has created patchy distribution of soils and cinders, which has controlled the colonization of the substrate by plants. Vegetation grows sparsely in areas with cinder substrate, while trees and shrubs grow in dense stands over soil substrates. As a result, vegetation communities have developed on the fill material at different rates due to the varying soil and hydrologic conditions, and the timing of fill placement. This created a mosaic of community types within the LSP Restoration site. The community types present range from bare soil or lichens on coal ash to pioneer tree communities growing on soil deposits. Thus, the site displays variable stages of successional colonization, and provides habitat for a variety of terrestrial animal species.

2.1 COMMUNITY COMPOSITION

A natural resources inventory and vegetation community mapping were conducted in 1996, depicted in Figure 2-1 (MacFarlane 2001). This survey documented that the vegetation within the LSP Restoration site was in early successional stages at that time. An analysis of the communities present in 2003 was performed and is described in this section.



US Army Corps of Engineers®
New York District

Map Source: MacFarlane (2001)
Aerial Photo Source: USACE (2002)

THE PORT AUTHORITY OF NY & NJ

Liberty State Park
Vegetation Communities
Maped in 1996 by MacFarlane (2001)

Figure 2-1

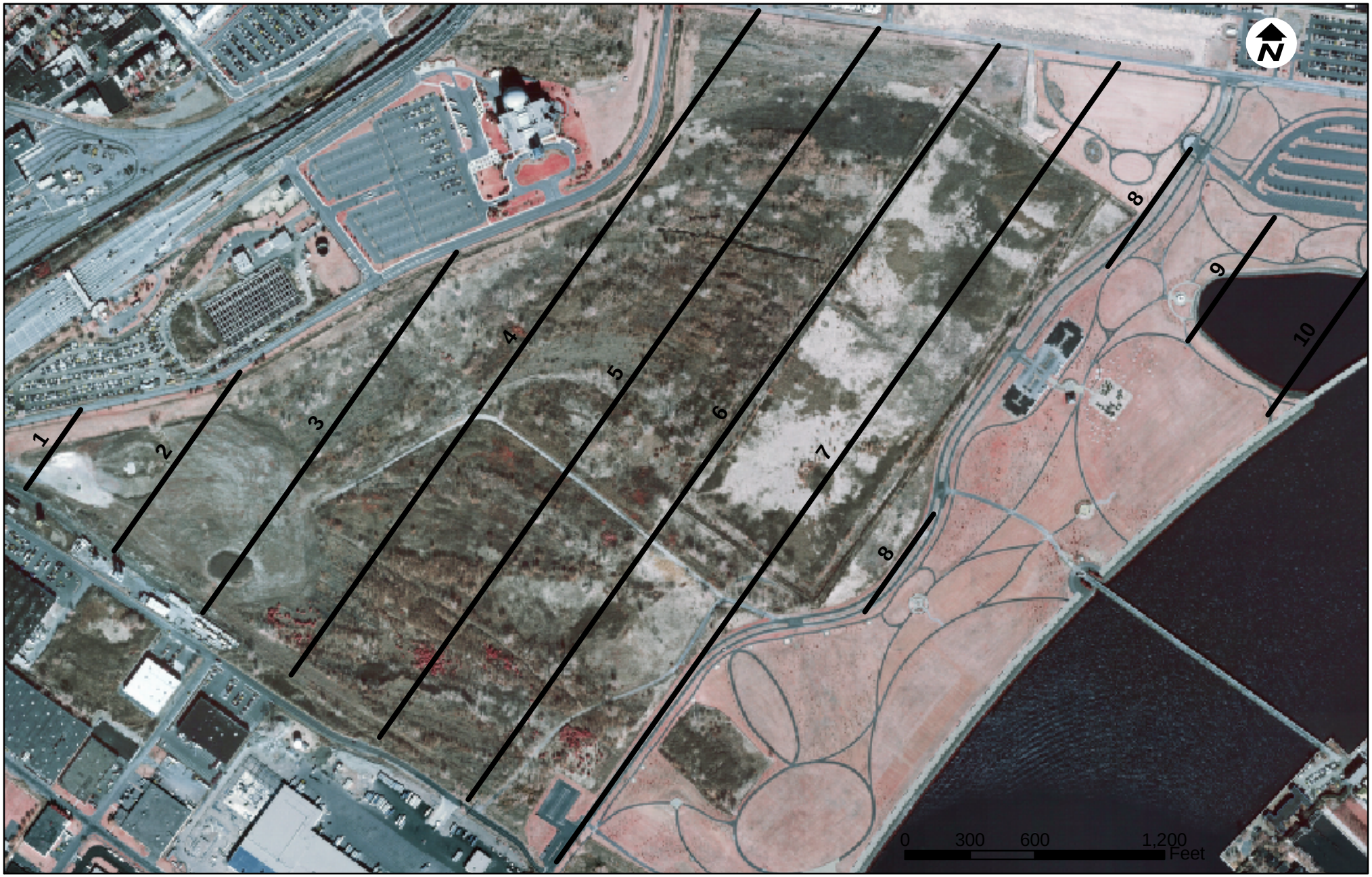
2.1.1 Methodology

The vegetation sampling program was conducted within the LSP Restoration site between 3 August 2003 and 21 August 2003 to determine the composition and coverage of plant communities. Previous vegetation surveys, wetland maps, and aerial photographs were used to plan the field effort.

Ten transects set 500 feet apart were established parallel to the shoreline in a north-south direction in an effort to intersect the maximum number of vegetative communities (Figure 2-2). A field crew walked the transects, noting distinct changes in vegetation composition, and noting the presence or absence of plant species that had been previously observed within the LSP Restoration site by MacFarlane (2001). At each transect segment where there was a vegetation community change, field crews attached colored flagging with notations at transect entry and exit points. Additional flagging was used to delineate the perimeter boundary of each community encountered along a transect. Field crews also traversed the area between each transect in an effort to insure that smaller communities between the transects were flagged in the same manner. The locations of the flags were later determined by GPS surveying methods to delineate the current vegetation community types within the LSP Restoration site.

2.1.2 Community Descriptions

Twelve vegetation community types were identified within the LSP Restoration site, consisting of eight terrestrial community types and four wetland community types. Four of the communities identified are characterized as "cultural communities" that are the result of substantial human alteration. This is the result of the site's extensive substrate alterations and land use patterns. Although largely altered by human activity and colonized by non-native invasive plant species, the site supports a minimum of 184 plant species of 125 genera and provides suitable habitat for a variety of wildlife species (Appendix A). Each vegetation community type and its dominant vegetation is described below, dominant species are presented in Table 2-1, and its aerial extent within the LSP Restoration site is shown in Figure 2-3.



US Army Corps of Engineers®
New York District

Map Source: LMS (2003)
Aerial Photo Source: USACE (2002)

THE PORT AUTHORITY OF NY & NJ

Locations of Transects Set for 2003 Community Mapping Effort

Figure 2-2

Table 2-1. Dominant vegetation by community type within the Liberty State Park Restoration site, Jersey City, NJ.

Community Type	Common Name	Scientific Name
TERRESTRIAL COMMUNITIES		
Successional Northern Hardwood		
	quaking aspen	*Populus tremuloidies*
	eastern cottonwood	*Populus deltoides*
	gray birch	*Betula populifolia*
	winged sumac	*Rhus copallina*
	steeplebush	*Spiraea tomentosa*
Successional Shrubland		
	cut-leaved blackberry	*Rubus laciniata*
	smooth sumac	*Rhua glabra*
	northern bayberry	*Myrica pensylvanica*
	Canada goldenrod	*Solidago canadensis*
	common reed	*Phragmites australis*
	Japanese knotweed	*Polygonum cuspidatum*
Successional Old Field		
	Chee reed grass	*calamagrostis epigeios*
	common mullein	*Verbascum thapsus*
	spotted knapweed	*Centauria maculosa*
	butter and eggs	*Linaria vulgaris*
	Canada goldenrod	*Solidago canadensis*
	staghorn sumac	*Rhus typhina*
	quaking aspen	*Populus tremuloidies*
	eastern cottonwood	*Populus deltoides*
Maritime Shrubland		
	winged sumac	*Rhus copallina*
	smooth sumac	*Rhus glabra*
	staghorn sumac	*Rhus typhina*
	Canada goldenrod	*Solidago canadensis*
	common reed	*Phragmites australis*
	mugwort	*Artemisia vulgaris*
	gray birch	*Betula populifolia*
	quaking aspen	*Populus tremuloidies*

Table 2-1. (Page 2 of 3). Dominant vegetation in the vegetation communities at Liberty State Park, Jersey City, NJ.

Community Type	Common Name	Scientific Name
Maritime Grassland		
	saltmeadow cordgrass	*Spartina patens*
	butter and eggs	*Linaria vulgaris*
	common reed	*Phragmites australis*
	purple loosestrife	*Lythrum salicaria*
	eastern baccharis	*Baccharis halimifolia*
	marsh elder	*Iva frutescens*
	winged sumac	*Rhus copallina*
	staghorn sumac	*Rhus typhina*
	quaking aspen	*Populus tremuloidies*
	eastern cottonwood	*Populus deltoidies*
Common Reed/Mugwort		
	mugwort	*Artemisia vulgaris*
	common reed	*Phragmites australis*
	hemp dogbane	*Apocyanum cannibinum*
	common mullein	*Verbascum thapsus*
	purple loosestrife	*Lythrum salicaria*
	winged sumac	*Rhus copallina*
	quaking aspen	*Populus tremuloidies*
Mowed Lawn		
	annual bluegrass	*Poa annua*
Unpaved/Paved Road		
	mugwort	*Artemisia vulgaris*
	white sweet clover	*Melilotus alba*
	common mullein	*Verbascum thapsus*
	wild carrot	*Daucus carota*
	spotted knapweed	*Centauria maculosa*

Table 2-1. (Page 3 of 3). Dominant vegetation in the vegetation communities at Liberty State Park, Jersey City, NJ.

Community Type	Common Name	Scientific Name
PALUSTRINE COMMUNITIES		
Floodplain Forest Wetland		
	gray birch	*Betula populifolia*
	eastern cottonwood	*Populus deltoides*
	sensitive fern	*Onoclea sensibilis*
Shrub Swamp Wetland		
	cut-leaved blackberry	*Rubus laciniata*
	winged sumac	*Rhus copallina*
	staghorn sumac	*Rhus typhina*
	common reed	*Phragmites australis*
	purple loosestrife	*Lythrum salicaria*
	sensitive fern	*Onoclea sensibilis*
	quaking aspen	*Populus tremuloidies*
Shallow Emergent Marsh		
	purple loosestrife	*Lythrum salicaria*
	common reed	*Phragmites australis*
	wool grass	*Scirpus cyperinus*
	steeplebush	*Spiraea tomentosa*
	gray birch	*Betula populifolia*
Common Reed-dominated Wetland		
	common reed	*Phragmites australis*
	purple loosestrife	*Lythrum salicaria*
	sensitive fern	*Onoclea sensibilis*

US Army Corps of Engineers®
New York District

Map Source: LMS (2003)
Aerial Photo Source: USACE (2002)

THE PORT AUTHORITY OF NY & NJ

Existing Liberty State Park Vegetation Communities

Figure 2-3

2.1.2.1 Terrestrial Communities

Terrestrial Forested Upland Communities

Forested upland communities are defined as those communities with more than 60% tree canopy cover that grow on a substrate that is made up of less than 50% rocky outcrop or shallow soil over bedrock (Edinger *et al.* 2002). Only one type of terrestrial forest community, Successional Northern Hardwoods, was identified within the LSP Restoration site.

Successional Northern Hardwoods (SNH) is defined by Edinger *et al.* (2002) as a forest community located on previously disturbed or cleared sites where shrubs represent less than 50% of the vegetative cover. Successional forests are those where the canopy is dominated by light-requiring, wind-dispersed species, while the seedlings and sapling species are more shade tolerant. SNH tree communities are among the most widespread community type within the LSP Restoration site, being located throughout the site, and covering approximately 62.7 acres (Figure 2-3).

The dominant tree species in LSP Restoration site SNH communities are quaking aspen (*Populus tremuloides*), eastern cottonwood (*P. deltoide*s), and gray birch (*Betula populifolia*). Less dominant tree species included tree-of-heaven (*Ailanthus altissima*), big-toothed aspen (*P. grandidentata*), black locust (*Robinia pseudoacacia*), white pine (*Pinus strobus*), red maple (*Acer rubrum*), lombardy poplar (*Populus nigra*), and black oak (*Quercus velutina*). The shrub layer was dominated by winged sumac (*Rhus copallina*), smooth sumac (*R. glabra*), northern bayberry (*Myrica pensylvanica*), and staghorn sumac (*Rhus typhina*). Typical representatives of the herbaceous understory include Canada goldenrod (*Solidago canadensis*), cut-leaved blackberry (*Rubus laciniata*), common reed (*Phragmites australis*), mugwort (*Artemisia vulgaris*), and steeplebush (*Spiraea tomentosa*) (Table 2-1).

The tree species present represent early successional stages. Poplars and gray birch are referred to as pioneer species, which often colonize disturbed areas because they generally have high light requirements, can colonize bare mineral soils, are tolerant of poor soil conditions and can adapt to a variety of different growing habitats (MacFarlane 2001). Pioneer hardwood species are usually succeeded by species such as red maple and black oak that require less light and can establish themselves below the pioneer species' canopy. The shade-tolerant species eventually outcompete the pioneer trees for resources such as sunlight and water. The few maple saplings identified within the LSP

Restoration site suggest that shade-tolerant hardwoods may become more widespread in years to come.

This forest community provides breeding and foraging habitat for several species of year-round resident birds, including the American robin (*Turdus migratorius*), downy woodpecker (*Picoides pubescens*), and northern flicker (*Colaptes auratus*) (Bull and Farrand 1977). The edges of forest communities, especially when bounded by grasslands, are particularly good foraging habitat for birds. Raptors, such as Cooper's hawk (*Accipiter cooperii*), northern harrier (*Circus cyaneus*) and red-tailed hawk (*Buteo jamaicensis*) were observed foraging along the edges of the forest communities within the LSP Restoration site in 2003.

Terrestrial Open Upland Communities

Open upland communities are defined as those that have less than 25% tree canopy cover. Dominant vegetation types in these communities are shrubs, herbs and/or mosses and lichens (Edinger *et al.* 2002). Four open upland communities were identified within the LSP Restoration site, Maritime Shrubland, Successional Shrubland, Successional Old Field and Maritime Grassland.

Successional Shrubland (SSB) is defined by Edinger *et al.* (2002) as a shrubland community located on sites that have been cleared and are dominated by at least 50% shrub species. SSB communities in the LSP Restoration site have similar species as maritime shrublands, but are dominated by cut-leaved blackberry, and Japanese knotweed (*Polygonum cuspidatum*). Northern bayberry, present in maritime shrublands, is absent from the SSB communities. The herbaceous understory is dominated by Canada goldenrod and common reed (Table 2-1).

SSB communities covering approximately 4.2 acres are located in the Wetland/Forest Complex and the Dredged Material Storage Area of the LSP Restoration site (Figure 2-3). SSB communities within the site have likely developed from old fields and will probably succeed into SNH communities with the introduction of wind dispersed seeds.

Successional shrublands offer nesting and foraging habitat for many of the same bird species as maritime shrublands, and in addition, Cooper's hawk and downy woodpecker forage in these communities (Bull and Farrand 1977).

Successional Old Field (SOF) is defined by Edinger *et al.* (2002) as a meadow community located in areas that have been cleared and abandoned. These communities are dominated by non-woody herbs and grasses. SOF communities are the most diverse community type within the LSP Restoration site, with 67 identified plant types. Dominant species include Chee reed grass (*calamagrostis epigeios*), common mullein (*Verbascum thapsus*), Canada goldenrod, spotted knapweed (*Centauria maculosa*), mugwort, and butter and eggs (*Linaria vulgaris*). Other species identified included wild carrot (*Daucus carota*), hyssop-leaved boneset (*Eupatorium hyssopifolium*), hemp dogbane (*Apocyanum cannibinum*), common ragweed (*Ambrosia artemisiifolia*), and white sweet clover (*Melilotus alba*) (Table 2-1).

The SOF communities are located along the northern boundary of the LSP restoration site, and in the Soil Stockpile Area, and cover approximately 49.6 acres (Figure 2-3). Typical characteristics of plants found in SOF communities are annuals and biennials that establish and reproduce rapidly. SOF communities are early successional communities that gradually evolve into SSB areas with the introduction of new seeds.

SOF communities are important foraging grounds for most of the bird species observed within the LSP Restoration site. The seeds of many species provide a food source for wildlife species. An abundance of insects that inhabit SOF communities provide a source of food for insectivorous bird and small mammal species. The dense herbaceous vegetation also provides nesting and roosting cover, however, the lack of a tree/shrub canopy enables predatory birds to easily locate prey species such as the songbirds and small mammal species that frequent the SOF communities.

Maritime Shrubland (MS) is defined by Edinger *et al.* (2002) as a shrub community located near the ocean that is exposed to onshore winds and spray. These shrublands are usually located in shallow depressions and are typically dominated by shrubs between 6 and 9 feet tall and trees are sparse or absent (less than 25% canopy cover). While exposure to onshore salt spray is minimal within the LSP Restoration site, MS vegetation communities are present throughout the area. The MS community is represented by a diverse mix of species, but is largely dominated by winged and smooth sumac shrubs. Subdominant species include northern bayberry, Canada goldenrod, common reed, cut-leaved blackberry, gray birch, and quaking aspen (Table 2-1). Maritime Shrubland communities cover approximately 22.0 acres of the LSP Restoration site (Figure 2-3).

Succession of MS communities is dependent upon soil moisture. With adequate soil moisture, MS communities may succeed into wetland shrub communities, whereas drier MS communities are more likely to support successional upland forest species.

Several summer, winter and year-round resident birds use shrubland communities for foraging and breeding. American goldfinch (*Carduelis tristis*), yellow warbler (*Dendroica petechia*), eastern towhee (*Pipilo erythrophthalmus*) and red-winged blackbird (*Agelaius phoneiceus*) are likely to breed within these shrublands of LSP. Summer residents, such as the tree swallow (*Tachycineta bicolor*) and yellow warbler, and year-round residents including the American woodcock (*Scolopax minor*), chimney swift (*Chaetura pelagica*) and American kestrel (*Falco sparverius*), forage in or over the shrubland communities (Bull and Farrand 1977). Maritime shrublands also provide foraging habitat for winter residents.

Maritime Grassland (MG) is defined by Edinger *et al.* (2002) as a grassland community dominated by more than 50% grasses and few shrubs located near the ocean where onshore winds and spray are present. Although onshore winds and spray are minimal within the LSP Restoration site, MG communities developed near the trenches that are connected to drainage culverts in the North Cove and Morris Canal. These trenches may be tidally influenced, and saltwater from the harbor may be introduced, allowing for the development of adjacent MG communities. These communities are located primarily in the Dredged Material Storage Area, and the northwestern section of the site (Figure 2-3).

MG communities in the LSP Restoration site are dominated by grasses, mostly saltmeadow cordgrass (*Spartina patens*). Solitary and clustered shrubs identified in these herb-dominated were eastern baccharis (*Baccharis halimifolia L.*) and marsh elder (*Iva frutescens*). Other common species included common reed, mugwort, common mullein, Canada goldenrod, and hemp dogbane (Table 2-1).

All of the MG communities are located adjacent to monocultures of common reed, and it is likely that the reed stands will eventually expand and outcompete the grasses. These grasslands cover approximately 14.6 acres.

MG communities offer valuable nesting and foraging habitat for the northern harrier and several other wildlife species, many of which are also found in Successional Old Field habitat.

Terrestrial Cultural Communities

Terrestrial Cultural Communities are defined as systems that have been substantially altered by human activities and the resulting substrate and/or composition of the biological community is substantially different than before human influence. These communities include both areas that have been created and are maintained by human activities (e.g. mowed lawns), and communities where the physical properties of the substrate or the vegetation have been substantially altered but not maintained (e.g. dredged material deposits) (Edinger *et al.* 2002). Four terrestrial cultural community types were found within the LSP Restoration site, Common Reed/Mugwort, Mowed Lawn, Unpaved/Paved Road communities. The community descriptions are presented below.

Common Reed/Mugwort Communities (CRM) are characterized by more than 75% cover of the invasive herbs, mugwort, common reed, and/or Japanese knotweed. Although these communities are largely dominated by mugwort and common reed, twenty-five plant species were identified in CRM communities. The most frequently occurring subdominant species were purple loosestrife, hemp dogbane, and common mullein (Table 2-1).

CRM communities are among the most common type within in LSP Restoration site, covering approximately 38.7 acres. These communities are located throughout the Dredged Material Storage Area and along the boundaries of the site (Figure 2-3). Succession will most likely be repressed in these communities because the plant types within the community are invasive species that have adaptations that allow them to outcompete native herbaceous plants. Unlike most native herbaceous species that reproduce through seed dispersion, common reed primarily spreads through rhizomal colonization. Once a common reed community is established, it easily outcompetes neighboring plant communities by expansion of its rhizome system. Mugwort accumulates toxic allelochemicals in its roots, which inhibits the growth of other plant species (Inderjit 2001, Inderjit and Foy 1999).

Because mugwort, common reed and Japanese knotweed grow as monocultures in several areas, CRM communities provide little habitat diversity for wildlife. A relatively small number of birds forage and nest in these communities as preferred habitat.

Mowed Lawn (ML) is defined by Edinger *et al.* (2002) as a residential, recreational or commercial land in which the groundcover is dominated by clipped grasses and there is less than 30% cover of trees. The LSP Restoration site includes 5.6 acres of ML around the fringes of the site, in Millennium Park, and adjacent to the North Cove (Figure 2-3). This community provides foraging habitat for species such as the American robin, ring-billed gull (*Larus delawarensis*), and rock dove (*Columbia livia*).

Unpaved/Paved Road (ROAD) is defined by Edinger *et al.* (2002) as vegetation rooted in a road or path made of the parent material of the site and is maintained by regular trampling of the land surface. While in most locations no vegetation is present, common species identified in ROAD communities included mugwort, ragweed, white sweet clover, common mullein, tree-of-heaven, wild carrot, clovers and spotted knapweed (Table 2-1). This community is represented by two roads within the LSP Restoration site, one along the southern boundary of the Dredged Material Storage Area, and one bisecting the Wetland/Forest Complex, covering a total of 3.1 acres (Figure 2-3). Plant species that grow on roads are typically tolerant of compacted soil conditions and frequent trampling.

2.1.2.2 Wetland Communities

Forested Mineral Soil Communities

Forested Mineral Soil wetlands includes seasonally flooded forests, and permanently flooded or saturated swamps that are shaded by a minimum of 50% canopy cover. Only one type of Forested Mineral Soil Wetland, a Floodplain Forest, was identified within the LSP Restoration site.

Floodplain Forest Wetland (FFW) is a broadly-defined community type that consists (Edinger *et al.* 2002) of hardwood forests that grow in the low terraces of river floodplains and river deltas. This community type is flooded either regularly (lower areas) or irregularly (higher areas). The entire LSP Restoration site is located in the 100-year floodplain of the Upper New York Bay. One 0.3 acre FFW was identified in the Wetland/Forest Complex (Figure 2-3). Cottonwood, gray birch and sensitive fern (*Onoclea sensibilis*) are the dominant plant species (Table 2-1).

Similar to other forested communities, FFWs provide foraging and breeding habitat for a number of passerine and predatory birds. These forested wetlands also provide habitat

for the Fowler's toad (*Bufo woodhousii fowleri*), raccoons (*Procyon Iotor*), and cottontail rabbits (*Sylvilagus floridanus*).

Palustrine Open Mineral Soil Wetland Communities

Palustrine Open Mineral Soil Wetland Communities are defined by Edinger *et al.* (2002) as non-tidally influenced perennial wetlands that have less than 50% tree canopy cover. The substrate of these communities ranges from mineral soils to mucky organic soils. Water levels fluctuate in these wetlands, allowing aeration of the soils and decomposition of organic matter. There is little peat accumulation. Two types of open mineral soil wetland, shrub swamp and shallow emergent marsh, were found within the LSP Restoration site.

Shrub Swamp Wetland (SSW) Edinger *et al.* (2002) defines this community as an inland wetland located on mineral soil or muck substrate, dominated by tall shrubs (2002). Within the LSP Restoration site, SSW communities are dominated by winged sumac shrubs and common reed. Other species commonly associated with SSW are purple loosestrife and cut-leaved blackberry. Gray birch, sensitive fern, quaking aspen, mugwort and Canada goldenrod were also present in some of the SSW wetlands (Table 2-1).

Two small SSW communities, covering a total of 0.1 acres, are located within the Wetland/Forest Complex (Figure 2-3). Common reed and purple loosestrife, two of the common species in SSW, are typically very aggressive during establishment. Eventually, they may outcompete shrubs and other species in the community, thus succeeding into a Common Reed-dominated Wetland (described below).

SSW communities provide valuable breeding and foraging habitat for the same species of birds as the MS communities. Nine bird species that have been observed within the LSP Restoration site may breed within SSW communities, and 16 observed bird species use shrub swamps as foraging grounds (Bull and Farrand 1977).

Shallow Emergent Marsh (SEM) This community is defined by Edinger *et al.* (2002) as a wetland growing on mineral or mucky soils that are seasonally flooded, and saturated throughout the year. Within the LSP Restoration site, these wetlands are dominated by purple loosestrife, common reed, gray birch, wool grass (*Scirpus cyperinus*), and

steeplebush (Table 2-1). Nine SEM communities that cover a total of 10.2 acres were identified; all of which are located in the Wetland/Forest Complex (Figure 2-3).

Emergent marsh communities provide foraging habitat for several of the bird species present within the LSP Restoration site, including the northern harrier, chimney swift, American kestrel, tree swallow, and killdeer (*Charadrius vociferous*). Emergent marshes also provide potential breeding habitat for the bobolink (*Dolichonyx oryzivorous*) and the northern harrier.

Palustrine Cultural Communities

Palustrine Cultural Communities are defined as wetlands that have been created and maintained by human activity, or are modified by humans to such a degree that the substrate, hydrology and/or biological communities are substantially different than prior to human disturbance (Edinger 2002). One cultural wetland type, Common Reed-dominated wetlands was found in Liberty State Park.

Common Reed-dominated Wetlands (CRW) are located on dredged material substrate, and are dominated by common reed and/or purple loosestrife. Other subdominant species include winged sumac, sensitive fern, steeplebush and Canada goldenrod (Table 2-1).

Fifteen CRW communities, covering a total of 13.0 acres, were identified throughout the LSP Restoration site (Figure 2-3). Two of the CRWs are located on drainage ditches, one surrounding the Dredged Material Storage Area, and one along the western boundary of the site. Eleven of the CRW communities are located in the Wetland/Forest Complex.

Typically, it is difficult for other plant species to establish and reproduce in dense common reed communities and succession of such communities into a more diverse wetland community is unlikely without human intervention. Although common reed and purple loosestrife are not considered a preferred habitat because they do not provide a variety of food sources for wildlife, some wildlife species are able to use CRW wetlands as cover, nesting or roosting habitat. Within the LSP Restoration site, song sparrows (*Melospiza melodia*) and red-winged blackbirds (*Agelaius phoneiceus*) were infrequently observed utilizing CRW communities.

2.1.3 Summary

Thirty-seven years have passed since the area that is now Liberty State Park was an active rail yard and terminal. In this time period early successional vegetation communities have established on the undeveloped portion of the park defined as the LSP Restoration site. While some of these communities that have experienced the longest period to develop represent late successional types (e.g. northern hardwood forest), much of the area is vegetated with terrestrial open upland communities and open mineral soil wetland communities. This is likely due to the slower successional revegetation process that is occurring on areas that have poorer soils or other growth inhibitors, or due to interim disturbances that have occurred. The latter includes the use of a 42-acre area of the LSP Restoration site for disposal of dredged materials between 1981 and 1993, which eliminated the vegetation present at that time and reverted the surface back to an unvegetated state. Considering that the development of vegetation communities is an ongoing process, it is likely that there will be changes in their extent and composition without the implementation of any active restoration.

Forest communities will be dominated by native poplars and birches, with further growth of slow-growing maple and oak saplings under the tree canopy. Forest boundaries will continue to expand slowly into areas that are now covered by shrublands or grasslands. Maritime and successional shrubland communities are likely to expand over the successional old fields. Maritime shrubs are located throughout the old field communities, and the grasses acreage is likely to decrease as the shrubs become dominant. Existing native maritime grassland communities are located adjacent to monocultures of the invasive species common reed and mugwort (Figure 2-4). The invasive species will likely encroach upon the grasslands and eventually outcompete them for resources, and the maritime grasslands will likely be rare or non-existent within the LSP Restoration site in as little as ten years.

Wetlands within the LSP Restoration site may increase in area due to the accumulation of organic matter, but will likely decrease in value over the next ten years without the proposed restoration project. Common reed and/or purple loosestrife are common in most of the freshwater wetlands. It is likely that, with the exception of the floodplain forested wetland, existing wetlands will develop into monocultures of these invasive species.

US Army Corps of Engineers®
New York District

Map Source: LMS (2003)
Aerial Photo Source: USACE (2002)

THE PORT AUTHORITY OF NY & NJ

Liberty State Park Communities Dominated by Invasive Species (>75%)

Figure 2-4

2.2 REGULATED WETLAND COMMUNITIES

In New Jersey, freshwater wetlands and their adjacent areas are regulated by New Jersey Department of Environmental Protection Land Use Regulation Program under the New Jersey Freshwater Wetlands Protection Act (N.J.S.A. 13:9B). Any work that is proposed near a freshwater wetland should not be performed without receiving a Letter of Interpretation (LOI) from NJDEP to verify whether the project takes place within the regulated wetland boundary or its regulated transition area. Because the boundaries of wetlands can shift over time due to changes in hydrology, plant dominance, or land use patterns, LOIs are issued by NJDEP for 5 year periods.

Obtaining an LOI from NJDEP requires the submittal of data defining the basis for establishing the boundaries of the freshwater wetlands. Within the LSP Restoration site, wetland boundaries were defined using the methodologies described in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands of 1989 (1989 manual) (USFWS *et al*. 1989). In New Jersey, the Freshwater Wetland Regulatory Program has been determined to meet or exceed the requirements established under Section 404 of the Federal Clean Water Act, and the USACE regulatory program has thus been delegated to NJDEP for most wetlands. The New Jersey Freshwater Wetlands Protection Act requires wetland delineations be completed following the methodology outlined by the 1989 manual. The U.S. Army Corps of Engineers Wetlands Delineation Manual of 1987 (Environmental Laboratory 1987) is used by USACE to make a similar Jurisdictional Determination (JD) when required. USACE retains jurisdiction over wetlands within 1,000 feet of tidal waters; these wetlands would be jointly regulated by USACE and NJDEP. In addition, since the LSP restoration project would disturb tidal waters or wetlands, USACE would regulate all wetland impacts associated with the project, including freshwater wetland impacts within 1,000 feet of the high tide line.

Because the restoration planned at LSP will fall under the jurisdiction of two regulatory agencies (NJDEP and USACE New York District) that require wetland delineations be completed in accordance with different versions of the wetland delineation manual, both the 1987 and 1989 manuals were utilized in delineating the extent of regulated wetlands within the LSP Restoration site. Both manuals require a thorough investigation of vegetation, soil and hydrology in determining a wetland boundary. Both utilize a "three parameter" approach for defining wetlands, and define an area as wetland if the following criteria are present:

1. The land supports vegetation that is dominated (> 50%) by hydrophytes (wetland vegetation).
2. The substrate is a hydric soil being at least periodically saturated or inundated during a portion of the growing season.
3. The area shows signs of hydrology (i.e. indications of past or present hydrologic events).

Hydrophytes are plants that have the ability to grow in water or in a substrate that is at least periodically deficient in oxygen, due to periodic or permanent flooding of soils. The U.S. Fish and Wildlife Service (USFWS) prepared a list of plant species for the Northeast Region (Region I) to be used in determining the presence of a wetland (Reed 1988). The plant species listed in this publication are classified based on their affinity for wetlands, and percent likelihood that they will occur in wetlands.

The USACE and NJDEP definition of hydrophytes is based on the USFWS classification system. In general, any plant species that is found growing in wetlands more than 50% of the time is considered a hydrophyte. These plants include those classified by the USFWS as “facultative”, “facultative wetland”, or “obligate”.

Hydric soils are poorly drained soils that either are inundated or have the seasonal high water table within 6 inches of the surface for a portion of the growing season (Environmental Laboratory 1987). The subsoils are typically predominantly gray and mottled immediately below the "A" horizon and have thick, dark colored surface layers. A hydrogen sulfide odor, resulting from anaerobic respiration, is another diagnostic characteristic of hydric soils.

Hydrologic Indicators are evidence of periodic or permanent inundation. Morphological adaptations on trees such as buttressed or fluted trunks, or multiple trunks indicate that the trees spend part of their growing season under flooded conditions. Physical evidence of flooding is also considered indicative of wetland hydrology. Examples of physical hydrologic indicators include water stained leaves and drift lines on trees.

2.2.1 Methodology

The wetland delineation for the LSP Restoration site first involved a desktop review of existing maps, wetland boundary flagging and descriptions of mapped wetland community types based on the classification system described by Cowardin *et al.* (1979). The maps reviewed included the U.S. Department of the Interior National Wetland Inventory (NWI) map (Jersey City, NJ USGS Quad), the NJDEP Freshwater Wetland Map, and previous wetland delineation data.

The wetland field investigation was based on the three-parameter Routine Onsite Determination Method Plant Community Assessment Procedure described in the 1989 manual. This procedure involves the establishment of representative sampling points along the wetland line and at representative locations within each plant assemblage on the site. At each sampling point, data regarding the vegetation, soil and hydrology of the area was collected to determine whether the area met the definition of a wetland. In some areas, it was not possible to collect soil samples due to deep standing water or an unsuitable substrate. In these cases, wetland determination was based upon the presence of wetland vegetation and hydrological indicators. Wetland delineation data sheets are presented in Appendix B.

Twenty-five wetlands were identified within the LSP Restoration site. The wetlands are described below and their locations are presented in Figure 2-5.

2.2.2 Wetland Community Descriptions

The wetlands within the LSP Restoration site were described using the classification system presented in the USFWS publication, Classification of Wetlands and Deepwater Habitats of the United States (Cowardin *et al.* 1979). This hierarchical system was designed to describe every aquatic system within the United States, including waterbodies and the wetlands that are associated with those waterbodies. The systems are divided into subsystems and classes that relate to tidal regime, substrate and/or vegetation type. The wetland classes are further divided by their flooding patterns.

All of the wetlands within the LSP Restoration site fall under the palustrine system, because the wetlands are not subject to tidal influence. Palustrine wetlands can be found on the fringes of lakes or rivers as well as in isolated situations. The palustrine system includes several classes of wetland types. Palustrine wetlands of the emergent, scrub-

shrub and forested classes were identified within the LSP Restoration site. Table 2-2 provides a description of individual wetlands.

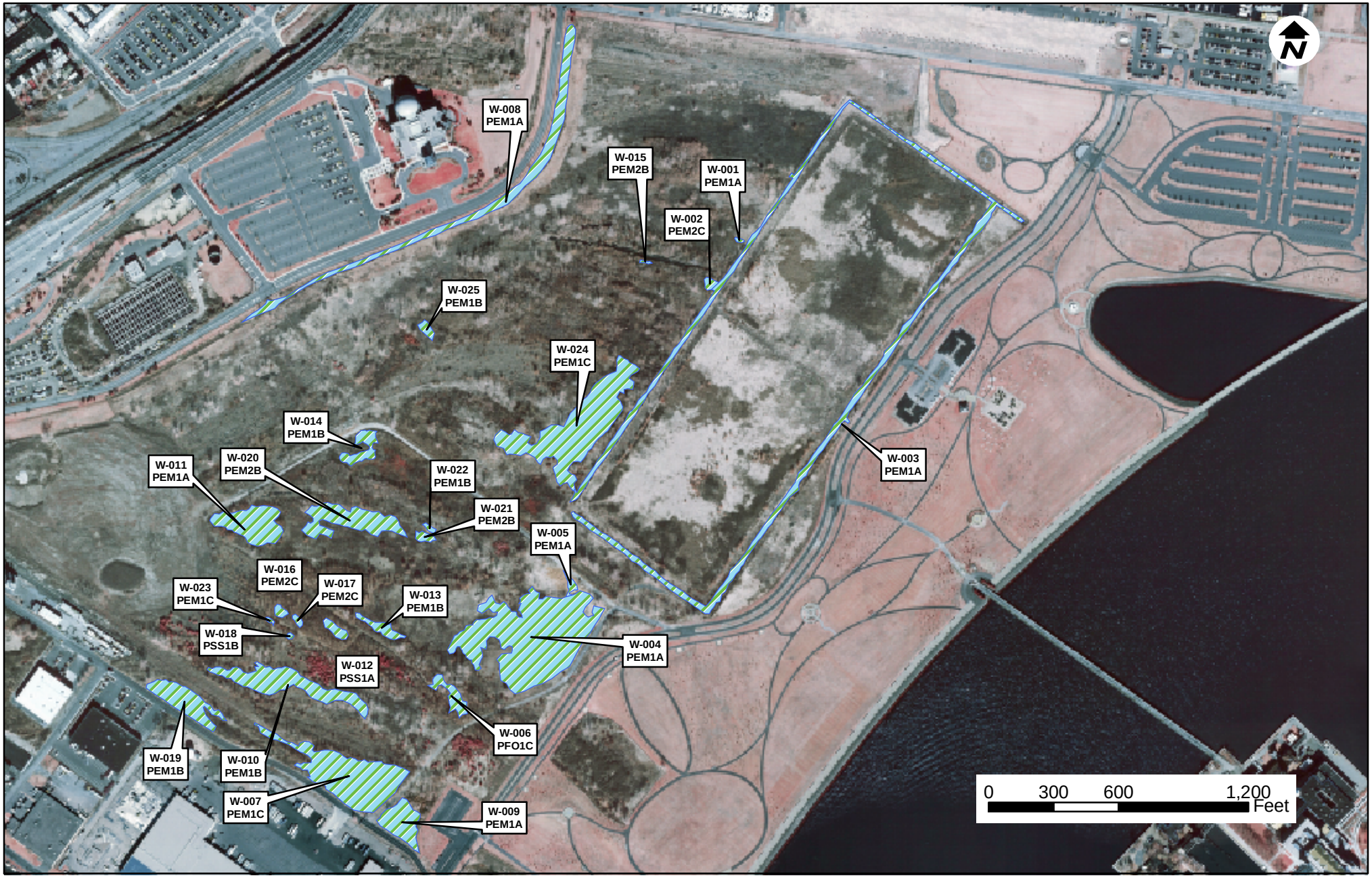
Palustrine Forested Wetlands

Palustrine forested wetlands are dominated by woody vegetation that is a minimum of 18 feet tall. One palustrine forested wetland that is dominated by broad-leaved deciduous tree species was identified within the LSP Restoration site (W-6 in Figure 2-5). This wetland type is further defined as a Temporarily-Flooded Broad-leaved Deciduous Palustrine Forested Wetland (PFO1C). The PFO1C wetland is located in the Wetland/Forest Complex, and covers approximately 0.26 acres. The wetland is significantly shaded by a canopy of cottonwood with an understory of gray birch saplings. Both species are classified as facultative species, indicating that their distribution is divided nearly evenly between wetland and upland habitats. The dominant plant in the herbaceous layer is purple loosestrife, a plant that is found most commonly in wetlands. The wetland is flooded during a portion of the growing season as a result of the accumulation of surface runoff into a depressional area (Table 2-2).

Palustrine Scrub-Shrub Wetlands

Palustrine scrub-shrub wetlands include areas dominated by woody vegetation less than 20 feet tall. Cowardin *et al.* (1979) defined PSS1A wetlands as those palustrine scrub-shrub wetlands that are dominated by broad-leaved deciduous species, such as alders (*Alnus* spp.), willows (*Salix spp.*) and red osier dogwood (*Cornus stolonifera*), and are flooded for a portion of the growing season. Two of the freshwater wetlands within the LSP Restoration site are in this category. An isolated 0.12-acre Temporarily-Flooded Palustrine Scrub-Shrub Wetland with Broad-leaved Deciduous Plants (PSS1A) (W-12 in Figure 2-5) dominated by red maple saplings, purple loosestrife and steeplebush is flooded by surface runoff that collects in a depressional area with a high water table (Table 2-2).

A nearby small, isolated 0.02-acre saturated Palustrine Scrub-Shrub Wetland with Broad-leaved Deciduous Plants (PSS1B) (W-18 in Figure 2-5) is dominated by silky dogwood (*Cornus amomum*) and has saturated soils that result from a high water table within a depressional area (Table 2-2).



US Army Corps of Engineers®
New York District

Map Source: LMS (2003)
Aerial Photo Source: USACE (2002)

THE PORT AUTHORITY OF NY & NJ

Regulated Wetlands in Liberty State Park Jersey City, NJ

Figure 2-5

Table 2-2. Wetland indicators for regulated wetlands in Liberty State Park, Jersey City, NJ.

Wetland Number	Type	Ecological Community	Size (Acres)	Substrate	Wetland Indicators	Dominant Vegetation
W-1	PEM1A	Common Reed-dominated Wetland	0.01	Cinders	Standing Water; Surface water depth 2"; mottling present	Purple loosestrife (*Lythrum salicaria*): FACW+; Steeplebush (*Spiraea tomentosa*): FACW
W-2	PEM2C	Common Reed-dominated Wetland	0.06		Saturated soils at surface; Water table 4" below surface; Low chroma soils with mottling; Water stained leaves and shallow root sytsems	Sensitive fern (*Onoclea sensibilis*): FACW; Common reed (*Phragmites australis*): FACW; Gray birch (*Betula populifolia*): FAC
W-3	PEM1C	Common Reed-dominated Wetland	2.91		Saturated soils at surface; Water table 5" to 10" below surface; Low chroma soils with mottling	Common reed: FACW; Sensitive fern: FACW; Steeplebush: FACW; Purple loosestrife: FACW+; Peachleaf willow (*Salix nigra*): FACW+; Soft rush (*Juncus effuses*): FACW+
W-4	PEM1A	Common Reed-dominated Wetland	4.21		Standing water; Surface water depth 2" to 12"+	Common reed: FACW; Sensitive fern: FACW; Purple loosestrife: FACW+; and Cattails (*Typha spp.*): OBL; Reed canary grass (*Phalaris arundinacea*): FACW+

Table 2-2 (page 2 of 6). Wetland indicators for regulated wetlands in Liberty State Park, Jersey City, NJ.

Wetland Number	Type	Ecological Community	Size (Acres)	Substrate	Wetland Indicators	Dominant Vegetation
W-5	PEM1A	Common Reed-dominated Wetland	0.06		Saturated soils at surface	Common reed: FACW; Reed canary grass: FACW+
W-6	PFO1C	Floodplain Forest Wetland	0.26		Standing water; surface water depth 2"; Water table 6" below surface Buttressed tree trunks; Low chroma soils	Eastern cottonwood (*Populus deltoides*): FAC; Gray birch (*Betula populifolia*): FAC; Purple loosestrife: FACW+; Poison ivy (*Toxicodendron radicans*): FAC
W-7	PEM1C	Shallow Emergent Marsh	2.10	Disturbed sandy soils	Surface soil saturated; Water table 6" to 16" below surface Low chroma soils; Water stained leaves	Common reed: FACW; Purple loosestrife: FACW+; Steeplebush: FACW; Eastern cottonwood: FAC
W-8	PEM1A	Common Reed-dominated Wetland	1.56	Gravel	Standing water; Surface water depth from 0" to 12"	Common reed: FACW; Purple loosestrife: FACW+; Swamp rosemallow (*Hibiscus moschuetos*): OBL; Curlytop knotweed (*Polygonum lapathifolium*): FACW+

Table 2-2 (page 3 of 6). Wetland indicators for regulated wetlands in Liberty State Park, Jersey City, NJ.

Wetland Number	Type	Ecological Community	Size (Acres)	Substrate	Wetland Indicators	Dominant Vegetation
W-9	PEM1A	Common Reed-dominated Wetland	0.59		Surface soils saturated; Water table 6" below surface; Low chroma soils with mottling	Common reed: FACW; Purple loosestrife: FACW+; Eastern cottonwood: FAC
W-10	PEM1B	Common Reed-dominated Wetland	1.20	Disturbed sand and clay soils	Surface soils saturated; Water table 5" below surface; Low chroma soils with mottling	Common reed: FACW; Purple loosestrife: FACW+; Eastern cottonwood: FAC
W-11	PEM1A	Common Reed-dominated Wetland	0.90		Standing water; Surface water depth 2"; Water table 4" below surface; Low chroma soils	Common reed: FACW; Sensitive fern: FACW; Marsh fern (*Thelypteris palustris*): FACW+; Purple loosestrife: FACW+
W-12	PSS1A	Shrub Swamp	0.12	Gravel; sand; shell	Standing water; Surface water depth 1" in some areas; Water table 4" below soil surface; Water stained leaves, shallow root systems and buttressed trees	Red maple (*Acer rubrum*): FAC; purple loosestrife: FACW+; Steeplebush: FACW; Sensitive fern: FACW; Marsh fern: FACW+; Swamp azalea (*Rhododendon viscosum*): OBL; Gray birch (*Betula populifolia*): FAC

Table 2-2 (page 4 of 6). Wetland indicators for regulated wetlands in Liberty State Park, Jersey City, NJ.

Wetland Number	Type	Ecological Community	Size (Acres)	Substrate	Wetland Indicators	Dominant Vegetation
W-13	PEM1B	Common Reed-dominated Wetland	0.18	Coarse sand	Saturated soils; Water table 2" below soil surface; Low chroma soils	Common reed: FACW; Marsh fern: FACW+; Poison ivy: FAC; Gray birch: FAC
W-14	PEM1B	Common Reed-dominated Wetland	0.29	Debris and soil	Low chroma soils with mottling	Common reed: FACW; Canadian clearweed (*Pilea pumila*): FACW
W-15	PEM2B	Common Reed-dominated Wetland	0.01	Cinders	Standing water; Surface water depth 2"	Common reed: FACW; Sensitive fern: FACW; Gray birch: FAC
W-16	PEM2C	Shallow Emergent Marsh	0.06		Standing water; Surface water depth 12"+; water stained leaves	Woolgrass (*Scirpus cyperinus*): OBL; Common reed: FACW; Northern bayberry (*Myrica pensylvanica*): FAC; Gray birch: FAC; Red maple: FAC
W-17	PEM2C	Shallow Emergent Marsh	0.04		Standing water; Surface water depth 8"	Purple loosestrife: FACW+; Woolgrass: OBL; Northern bayberry: FAC; Gray birch: FAC; Red maple: FAC

Table 2-2 (page 5 of 6). Wetland indicators for regulated wetlands in Liberty State Park, Jersey City, NJ.

Wetland Number	Type	Ecological Community	Size (Acres)	Substrate	Wetland Indicators	Dominant Vegetation
W-18	PSS1B	Shrub Swamp	0.02		Saturated soils; Water table 16" below surface; Low chroma soils with mottling	Silky dogwood (*Cornus amomum*): FACW; Purple loosestrife: FACW+; Yellow nutsedge (*Cyperus esculentus*): FACW; Gray birch: FAC; Northern bayberry: FAC
W-19	PEM1B	Common Reed-dominated Wetland	0.72		Saturated soils; Low chroma soils with mottling; Water stained leaves	Common reed: FACW; Purple loosestrife: FACW+; Marsh fern: FACW+
W-20	PEM2B	Shallow Emergent Marsh	0.99		Saturated soils; Water table 16" below surface; Low chroma soils with mottling	Marsh fern: FACW+; Sensitive fern: FACW; Royal fern (*Osmunda regalis*): OBL; Narrowleaf cattail (*Typha angustifolia*): OBL; Steeplebush: FACW; Purple loosestrife: FACW+; Common reed: FACW; Canadian clearweed: FACW
W-21	PEM2B	Shallow Emergent Marsh	0.08		Saturated soils; Water stained leaves and water marks	Sensitive fern: FACW; Steeplebush: FACW; Purple loosestrife: FACW+; Common reed: FACW

Table 2-2 (page 6 of 6). Wetland indicators for regulated wetlands in Liberty State Park, Jersey City, NJ.

Wetland Number	Type	Ecological Community	Size (Acres)	Substrate	Wetland Indicators	Dominant Vegetation
W-22	PEM1B	Shallow Emergent Marsh	0.03		Saturated soils; Water stained leaves and water marks; Low chroma soils	Reed canary grass: FACW; Steeplebush: FACW; Eastern cottonwood: FAC; Gray birch: FAC
W-23	PEM1C	Common Reed-dominated Wetland	0.02		Standing water observed on several occasions.	Phragmites australis, FACW; Onoclea sensibilis, FACW.
W-24	PEM1A	Shallow Emergent Marsh	2.68		Saturated soils at surface;	Wool grass (*Scirpus cyperinus*): OBL; Soft rush: FACW+; Red maple (*Acer rubrum*): FAC; Common reed: FACW; purple loosestrife: FACW+
W-25	PEM1B	Common Reed-dominated Wetland	0.08		Frost in soil – soil saturated.	Phragmites australis, FACW; Onoclea sensibilis, FACW.

Palustrine Emergent Wetlands

Cowardin *et al.* (1979) defines emergent wetlands as those that are characterized by erect, rooted, herbaceous vegetation, excluding mosses and lichens, and that are usually dominated by perennial plants. This class is further divided into subclasses (depending upon vegetation type) and dominance types (depending upon flooding regimes). Most (22 of the 25) wetlands identified within the LSP Restoration site are palustrine emergent wetlands, and most of these wetlands are dominated by common reed and/or purple loosestrife (Figure 2-5). Descriptions of these wetlands by Cowardin, *et al.* (1979) category are described below.

Temporarily-Flooded Palustrine Emergent Wetlands with Persistent Vegetation (PEM1A)

PEM1A wetlands are dominated by herbaceous vegetation that persists (usually as dead standing stems) after the growing season. Surface water is present during some part of the growing season, but the water table is typically well below the soil surface.

Seven wetlands, covering 10.01 acres are classified as PEM1A wetlands (W-1, W-4, W-5, W-8, W-9, W-11 and W-24 on Figure 2-5). These wetlands are dominated by common reed and purple loosestrife, both species that have non-living stems that persist throughout the year (Table 2-2). These wetlands represent a range of hydrologic regimes including ditches that convey surface runoff, and isolated wetlands where water ponds due to a high water table. Standing water was observed in these wetlands in August 2003, but the water table had dropped below the soil surface by October 2003.

Saturated Palustrine Emergent Wetlands with Persistent Vegetation (PEM1B)

PEM1B wetlands are defined by Cowardin *et al.* (1979) as those that are dominated by herbaceous vegetation that stays erect throughout the year, where the surface soils are saturated at the surface for extended periods during the growing season, and where surface water is rare.

Six isolated wetlands totaling 4.12 acres are classified as PEM1B (W-10, W-13, W-14, W-19, W-22 and W-25 in Figure 2-5). Like the PEM1A wetlands, they are dominated by common reed and purple loosestrife (Table 2-2). These wetlands occur in topographic depressions or where drainage is restricted by roads or other impediments to flow. Surface soil permeability may be sufficient to prevent ponding, but saturated soils do occur.

Seasonally-Flooded Palustrine Emergent Wetlands with Persistent Vegetation (PEM1C)

PEM1C wetlands are defined by Cowardin *et al.* (1979) as being dominated by herbaceous vegetation that persists after the growing season, and have standing water for most of the growing season.

Three wetlands, (W-3, W-7 and W-23 in Figure 2-5) totaling 5.03 acres are classified as PEM1C. W-3 is located adjacent to the drainage ditch surrounding the Dredged Material Storage Area, and it is dominated by common reed. Drainage to this ditch maintains the presence of standing water in the W-3 ditch through much of the growing season. W-7, located in the southern portion of the site, is dominated by purple loosestrife, common reed, and steeplebush (Table 2-2). Surface drainage is contained by a roadway at the eastern end of W-7, creating water depths that exceed 3 feet following significant rain events, but drains to the extent that no water was present during the fall season. W-23, also located in the southern portion of the site, is dominated by common reed.

Saturated Palustrine Emergent Wetlands with Non-Persistent Vegetation (PEM2B)

Cowardin *et al.* (1979) defined PEM2B wetlands as those dominated by non-persistent herbaceous vegetation that falls to the soil surface after the growing season, where the soils are saturated at the surface for some part of the growing season. For much of the year the water table is below the soil surface.

Three small PEM2B wetlands (W-15, W-20, and W-21 on Figure 2-5) dominated by non-persistent ferns, specifically sensitive fern, marsh fern (*Thelypteris palustris*) and royal fern (*Osmunda regalis*), cover a total of 1.08 acres (Table 2-2). Two of these are located in proximity and may reflect topographic depressions related to the prior railyard layout (W-20 and W-21). The other, W-15, is adjacent to a linear drainage feature within the successional forest/shrub complex.

Seasonally-Flooded Palustrine Emergent Wetlands with Non-Persistent Vegetation (PEM2C)

PEM2C wetlands are defined by Cowardin *et al.* (1979) as being dominated by herbaceous vegetation that falls to the soil surface after the growing season, and have standing water for a large part of the growing season.

Three PEM2C wetlands covering 0.16 acre were identified within the LSP Restoration site (W-2, W-16 and W-17 on Figure 2-5). Wool grass and other hydrophytic herbaceous

vegetation dominated these wetlands (Table 2-2). One of these wetlands (W-16) is located in an isolated depression where water ponds for periods of the growing season, creating conditions suitable for these emergent species.

3. WILDLIFE

Many types of wildlife have been reported to utilize the vegetation communities documented within the LSP Restoration site. The mix of habitat types may provide suitable migratory, foraging, nesting and overwintering territories for a variety of birds including raptors, songbirds, waders, shorebirds and waterfowl. Mammals that inhabit the LSP Restoration site are typically small mammals that provide abundant prey for raptor species. The methodologies used to inventory each wildlife group and the results of the surveys conducted during 2003 are presented in the following sections.

3.1 AMPHIBIANS AND REPTILES

Amphibian and reptile surveys were designed to document the presence and habitat usage within the LSP Restoration site. Previous surveys (Texas Instruments [TI] 1976) suggested that amphibian and reptile use of the LSP Restoration site was minimal; only one amphibian (Fowler's toad) and one reptile (eastern painted turtle [*Chrysemys p. picta*]) were observed by TI in their 1976 surveys.

3.1.1 Methodology

Potential amphibian and reptile habitats were surveyed to determine habitat use by these groups. Possible turtle nesting sites included well-drained embankments, berms, and sand/gravel areas. Pools were surveyed with dip nets for amphibian eggs, larvae, and adults, and turtles and snakes. Throughout the surveys, rocks, logs and debris piles were overturned and checked for the presence of amphibians and reptiles. Amphibian and reptile populations were surveyed during April and August 2003. During April 2003 two evening surveys were conducted to identify calling frogs and toads.

3.1.2 Results

Three species of amphibians and four species of reptiles were identified in Liberty State Park. Amphibian species observed were Fowler's toad, green frog (*Rana clamitans melanota*) and wood frog (*Rana sylvatica*). Reptiles observed were the northern brown snake (*Storeria d. dekayi*), eastern garter snake (*Thamnophis s. sirtalis*), northern water snake (*Nerodia s. sipedon*), and northern diamondback terrapin (*Malaclemys t. terrapin*).

Although the LSP Restoration site appears to have suitable habitat for several amphibians and reptiles, many expected species were not found. As in the 1976 TI study, regionally

common wetland frogs, such as northern spring peeper (*Hyla crucifer crucifer*) were not observed. No salamanders were found, although northern redback salamander (*Plethodon c. cinereus*) is common in northern New Jersey. Reptiles were also under-represented, with only three snake species identified. No regionally-common northern ringneck snakes (*Diadophis punctatus edwardsi*), or eastern milk snakes (*Lampropeltis t. triangulum*) were found. Common turtles (e.g. snapping turtle [*Chelydra serpentina*], eastern painted turtle and eastern box turtle [*Terrapene carolina*]) were not observed.

3.2 BIRDS

Avian surveys were conducted to determine species richness, relative abundance, and habitat use by birds in the vegetative community types and open water areas within the LSP Restoration site.

3.2.1 Methodology

Early morning (sunrise to 3-4 hrs after) surveys conducted at observation (point count) stations for birds and other wildlife were conducted weekly from 4 to 30 August 2003. Three transects, oriented roughly southwest-northeast, were established, and seventeen observation stations were selected along these transects. Point count stations were selected to obtain a view of all habitat types on the LSP Restoration site. Each station was established in an area from which it would be possible to see multiple habitat types (Figure 3-1). At each station, observations (species, numbers, distance and habitat) of birds/wildlife were recorded over a five-minute survey period. In addition, weekly wildlife surveys were conducted at the North and South Coves at or near low water periods. Playback recordings were used to survey for raptors and marsh birds on an opportunistic schedule.

Additional observations of bird use of the LSP Restoration site were made by the project team during northern harrier surveys (described in Section 4, Endangered and Threatened Species), the April 2003 amphibian surveys, the October 2003 mammal surveys, and by Liberty Science Center (LSC) staff between 3 January and 6 June 2003. In addition, records of bird sighting within LSP were obtained from the LSP Interpretive Center (IC). These records date back to 2001.

US Army Corps of Engineers®
New York District

Map Source: LMS (2003)
Aerial Photo Source: USACE (2002)

THE PORT AUTHORITY OF NY & NJ

Liberty State Park Wildlife Observation Stations

Figure 3-1

3.2.2 Survey Results

During the August 2003 wildlife surveys (point counts and surveys at the North and South Coves), 758 individual bird observations representing 54 species were recorded (Table 3-1). Passerine species (songbirds) were the largest group represented by 24 species, and making up 61.7% of individual birds counted. Observations of rock and mourning doves and several species of gulls also represented a large number of the individual bird observations made during the surveys (13.1% and 10.8% respectively) (Table 3-1).

The majority (52.4%) of the individual observations were birds flying over the point count stations, and thus not associated with any specific habitat. Of the 343 observations of individual birds counted using a specific vegetative community, most were sighted in low lying upland habitats, (e.g. shrublands and forests). Of these, 18.7% of observations were of birds on Mowed Lawns, 5.5% were observed in Maritime Grasslands, 8.5% were observed in Successional Old Fields, 23.6% were observed in Maritime Shrubland habitat and its edges, and 28.3% were observed using Successional Northern Hardwood vegetation community and forest edges (including forest/shrub edge) (Table 3-2).

A limited number of the point stations encompassed freshwater wetland habitats and thus relatively few observations were made of birds utilizing freshwater wetlands; however, many birds were observed using wetlands and other aquatic habitats. Of the individual birds observed using upland and wetland habitats, 9.9% were seen using the Salt Marsh from the South Cove point station. Nine birds (2.6%) were seen in the shallow ponds in the Soil Stockpile Area. An additional 4.7% birds were counted in Shallow Emergent Wetlands, or in the edge habitat between these wetlands and forest or shrubland. Only 3.4% were observed using the upland areas covered by the invasive species, common reed and mugwort, despite the fact that these habitats were visible from several observation points. An additional 1.7% were recorded using the edges of Common Reed/Mugwort communities (Table 3-2). The seasonal use of the LSP Restoration site, and the foraging and breeding habitat requirements for bird species observed during the August 2003 wildlife surveys are presented in Table 3-3. This table includes species recorded during point counts as well as incidental sightings recorded by wildlife and vegetation survey crews.

Supplemental observations recorded during the northern harrier, amphibian and vegetation surveys, and by LSC staff yielded an additional 76 bird species, bringing the total to 131 species observed on or near the LSP Restoration site. Of the 131 species, 70 were observed on the LSP Restoration site and 61 were observed on open water or the South Cove Salt

Marsh, or in other habitats outside the proposed LSP Restoration site. A comprehensive list of birds observed in LSP habitats during the August 2003 point count, northern harrier, vegetation and spring amphibian surveys and supplemental sightings by LSC and IC staff is presented in Appendix A.

The point count bird surveys were conducted only during the month of August, and it is assumed that the observations do not represent all of the species that use the site. Additional sightings of migratory and overwintering populations during fall, winter and spring months are presented in Appendix A. A detailed discussion of the major groups of birds that have been observed on, or are expected to use, the LSP Restoration site follows.

Raptors

Migratory corridors tend to funnel raptors into the NY/NJ Harbor area (USFWS 1998). Raptors that are often observed within the vicinity of LSP include osprey (*Pandion haliaetus*), northern harrier, red-tailed hawk, common barn owl (*Tyto alba*), and peregrine falcon (*Falco peregrinus*). The small mammal and songbird populations of the area provide prey for resident and migratory raptor populations (USFWS 1998). Several raptors are known to utilize foraging, nesting and overwintering habitat within the NY/NJ Harbor area. Red-tailed hawk, northern harrier, osprey, common barn owl, and peregrine falcon are the most common species observed during the breeding season. Common winter residents include northern harrier, rough-legged hawk (*Buteo lagopus*), American kestrel, common barn owl, short-eared owl (*Asio flammeus*), long-eared owl (*Asio otus*), and peregrine falcon (USFWS 1998).

Twelve individuals of four raptor species were observed in Liberty State Park during the point count surveys (Table 3-1). One species of falcon (American kestrel), and three species of hawk (northern harrier, Cooper's hawk and red-tailed hawk) were observed flying over the point stations. Eight additional raptor species were sighted on or near the LSP Restoration site by LSC staff. Osprey and peregrine falcon were observed flying over or near the LSP Restoration site. Long-eared owls, short-eared owls and great horned owls (*Bubo virginianus*) were observed within or near the LSP Restoration site during the winter of 2003. Turkey vultures (*Cathartes aura*) and sharp-shinned hawks (*Accipiter striatus*) were sighted in the South Cove Salt Marsh. LSC staff have also observed merlin (*Falco columbarisus*) and snowy owl (*Nyctea scaniaca*) near the LSP Restoration site (Appendix A).

Table 3-1. Avian abundance during the August 2003 point count and North and South Cove surveys at Liberty State Park, Jersey City, NJ

Common Name	Scientific Name	No. of Individuals	Percent of Total Observed
Raptors			
American Kestrel	*Falco sparverius*	1	0.1%
Cooper's Hawk	*Accipiter cooperii*	1	0.1%
Northern Harrier	*Circus cyaneus*	5	0.7%
Red-tailed Hawk	*Buteo jamaicensis*	5	0.7%
	Total	**12**	**1.6%**
Passerines			
American Goldfinch	*Carduelis tristis*	20	2.6%
American Robin	*Turdus migratorius*	75	9.9%
Barn Swallow	*Hirundo rustica*	44	5.8%
Blue Jay	*Cyanocitta cristata*	1	0.1%
Brown Thrasher	*Toxostoma rufum*	2	0.3%
Brown-headed Cowbird	*Molothrus ater*	1	0.1%
Cedar Waxwing	*Bombycilla cedrorum*	6	0.8%
Common Grackle	*Quiscalu quiscula*	1	0.1%
Common Yellowthroat	*Geothlypis trichas*	12	1.6%
Eastern Kingbird	*Tyrannus tyrannus*	13	1.7%
Eastern Towhee	*Pipilo erythrophthalmus*	28	3.7%
European Starling	*Sturnus vulgaris*	93	12.3%
Field sparrow	*Spizella pusilla*	6	0.8%
Flycatcher	*Empidonax sp.*	1	0.1%
Gray Catbird	*Dumetella carolinensis*	77	10.2%
House Sparrow	*Passer domesticus*	2	0.3%
Northern Mockingbird	*Miimus polyglottos*	7	0.9%
Northern Oriole	*Icterus spurius*	1	0.1%
Red-winged Blackbird	*Agelaius phoneiceus*	15	2.0%
Song Sparrow	*Melospiza melodia*	49	6.5%
Sparrows unid.	*Melospiza sp.*	5	0.7%
Tree Swallow	*Tachycineta bicolor*	3	0.4%
Willow Flycatcher	*Empidonax traillii*	3	0.4%
Yellow Warbler	*Dendroica petechia*	3	0.4%
	Total	**468**	**61.7%**
Long-legged Waders			
Black-crowned Night Heron	*Nycticorax nycticorax*	2	0.3%
Great Blue Heron	*Ardea herodias*	3	0.4%
Great Egret	*Casmerodius albus*	1	0.1%

Table 3-1 (page 2 of 2). Avian abundance during the August 2003 wildlife surveys at Liberty State Park, Jersey City, NJ

Common Name	Scientific Name	No. of Individuals	Percent of Total Observed
Green Heron	*Butorides virescens*	2	0.3%
Snowy Egret	*Egretta thula*	1	0.1%
	Total	**9**	**1.2%**
Dabbling Ducks and Geese			
American Black Duck	*Anas rubripes*	10	1.3%
Canada Goose	*Branta canadensis*	12	1.6%
Mallard	*Anas platyrhynchos*	5	0.7%
	Total	**27**	**3.6%**
Shorebirds			
Greater Yellowlegs	*Tringa melanoleuca*	2	0.3%
Killdeer	*Charadrius vociferus*	5	0.7%
Lesser Yellowlegs	*Tringa flavipes*	4	0.5%
Sandpiper sp.		3	0.4%
Shorebirds unid		5	0.7%
	Total	**19**	**2.5%**
Gulls and Terns			
Greater Black Backed Gull	*Larus marinus*	1	0.1%
Herring Gull	*Larus argentatus*	19	2.5%
Laughing Gull	*Larus atricilla*	9	1.2%
Black Skimmer	*Rynchops niger*	1	0.1%
Common Tern	*Sterna hirundo*	1	0.1%
Least Tern	*Sterna antillarum*	1	0.1%
Ring-billed Gull	*Larus delawarensis*	53	7.0%
	Total	**85**	**11.2%**
Cormorants			
Double-crested Cormorant	*Phalacrocorax auritus*	11	1.5%
	Total	**11**	**1.5%**
Doves/Pigeons			
Rock Dove	*Columbia livia*	80	10.6%
Mourning Dove	*Zenaida macroura*	19	2.5%
	Total	**99**	**13.1%**
Swifts			
Chimney Swift	*Chaetura pelagica*	21	2.8%
	Total	**21**	**2.8%**
Woodpeckers			
Downy Woodpecker	*Picoides pubescens*	6	0.8%
Northern Flicker	*Colaptes auratus*	1	0.1%
	Total	**7**	**0.9%**

Table 3-2. Habitat use by birds at Liberty State Park, Jersey City, NJ

Community Type	No. Individuals Observed	Percent of Total
Successional Northern Hardwood	49	14.3%
Forest/Emergent Wetland Edge	9	2.6%
Forest/Field Edge[b]	21	6.1%
Forest/Common Reed/Mugwort Edge	3	0.9%
Forest/Shrub Edge[c]	15	4.4%
Maritime Shrubland	55	16.0%
Shrub[c]/Field Edge[b]	10	2.9%
Shrub[c] /Emergent Wetland Edge	3	0.9%
Shrub[c] /Common Reed/Mugwort Edge	3	0.9%
Successional Old Field	29	8.5%
Maritime Grassland	19	5.5%
Field[b]/Common Reed-dominated Wetland Edge	1	0.3%
Mowed Lawn	64	18.7%
Common Reed/Mugwort	12	3.5%
Salt Marsh	34	9.9%
Shallow Emergent Marsh	4	1.2%
Common Reed-dominated Wetland	3	0.9%
Open Water (shallow ponds)	9	2.6%
	343	**100.0%**

Notes:

[a] – Shrub edge includes the edges of Maritime and Successional Shrublands, and Shrub Swamp Wetlands.

[b] – Field edge includes the edges of Successional Old Field and Maritime Grassland communities.

- No point count stations were in view of the Forest Floodplain Wetland

Table 3-3. Habitat requirements of birds observed using the LSP restoration area during ERC surveys conducted in August and September 2003 at Liberty State Park, Jersey City, NJ.

Common Name (*Scientific Name)*	Seasonal Use[a/]	Forest/ Woodland[b/]	Emergent Wetland[c/]	Shrubland[d/]	Successional Shrubland	Successional Field[e/]	Forest / Field Edge	Shrubland /Field Edge	North Cove
American Crow (*Corvus brachyrhynchos*)	R	F,B	F	F	F	F	F.B,O	F	
American Goldfinch (*Carduelis tristis*)	R		F	B, F	B,F,O	F	B	B,F,O	
American Kestrel (*Falco sparverius*)	R		F	F		F,O	B	F	
American Redstart (*Setophaga ruticilla*)	V	F,O		F	F,O	F		F	
American Robin (*Turdus migratorius*)	R	B,F		B, F	B,F	F,O	B,F	B,F	
American Woodcock (*Scolopax minor*)	R			F,O	F,B,O	F,O	f	F	
Barn Swallow (*Hirundo rustica*)	SR		F,O		F,O	F,O			
Bobolink (*Dolichonyx oryzivorus)*	V		F,B			F,B,O			
Brown Thrasher (*Toxostoma rufum*)	S				F,B,O	F		F,B,O	
Brown-headed Cowbird (*Molothrus ater*)	R	B		B	F,B	F,B	B	B,F,O	
Canada Goose (*Branta canadensis*)	R		F,B			F,B,O			
Cedar Waxwing (*Bombycilla cedrorum*)	W	F		F,O	B,O		F	F	
Chimney Swift (*Chaetura pelagica*)	SR		F,O	F	F,O	F,O		F	
Common Yellowthroat (*Geothlypis trichas*)	SR		B	F		F,B,O		F,B,O	

Table 3-3 (page 2 of 4). Habitat requirements of birds observed using the LSP restoration area during ERC surveys conducted in August and September 2003 at Liberty State Park, Jersey City, NJ.

Common Name (*Scientific Name)*	Seasonal Use[a/]	Forest/ Woodland[b/]	Emergent Wetland[c/]	Shrubland[d/]	Successional Shrubland	Successional Field[e/]	Forest / Field Edge	Shrubland /Field Edge	North Cove
Cooper's Hawk (*Accipiter cooperii*)	R	F,B,O			F	F	F,B	F	
Downy Woodpecker (*Picoides pubescens*)	R	F,B			F		F, B		
Eastern kingbird (*Tyrannus tyrannus*)	SR					F,B,O	F, B	F	
Eastern Towhee (*Pipilo erythrophthalmus*)	SR-M	F,O		F,B,O	F,O	F,B	F,O	F,O	
European Starling (*Sturnus vulgaris*)	R					F			
Field Sparrow (*Spizella pusilla*)	SR					F,B,O		F	
Flycatcher sp. (*Empidonax sp.*)	V					F,O	F		
Gray Catbird (*Dumetella carolinensis*)	SR			F,B,O	F,B,O	F,B,O	F,O	F,B,O	
Greater Yellowlegs (*Tringa melanoleuca*)	M		F,O						
Herring Gull (*Larus argentatus*)	R								F,O
House Sparrow (*Passer domesticus*)	R					F,O			
Killdeer (*Charadrius vociferous*)	R		F,O			F,O			
Lesser Yellowlegs (*Tringa flavipes*)	M		F,W,O						

Table 3-3 (page 3 of 4). Habitat requirements of birds observed using the LSP restoration area during ERC surveys conducted in August and September 2003 at Liberty State Park, Jersey City, NJ.

Common Name (*Scientific Name)*	Seasonal Use[a/]	Forest/ Woodland[b/]	Emergent Wetland[c/]	Shrubland[d/]	Successional Shrubland	Successional Field[e/]	Forest / Field Edge	Shrubland /Field Edge	North Cove
Mallard (*Anas platyrhynchos*)	R		F,B			F,O			F
Mourning Dove (*Zenaida macroura*)	R			B		F,O		B,O	
Northern Flicker (*Colaptes auratus*)	R	F,B			F		F,B,O		
Northern Harrier (*Circus cyaneus*)	R		F,B,O			F,B,W,O	O		
Northern Mockingbird (*Mimus polyglottos*)	R			F,B,O		F,B,W,O		F,B,O	
Baltimore Oriole (*Icterus galbula*)	S						F,O	F,O	
Red-tailed Hawk (*Buteo jamaicensis*)	R	B	F,O	F,O		F.O	F,B,O	F	
Red-winged Blackbird (*Agelaius phoeniceus*)	R		F,B,O	F,B		F,B,O		B	
Ring-necked Pheasant (*Phasianus colchicus*)	R			F	F	F,B,O		F,B,O	
Song Sparrow (*Melospiza melodia*)	R		F			F,B,W,O		F,B,O	
Spotted Sandpiper (*Actitus macularia*)	V		F						F,O
Tree swallow (*Tachycinta bicolor*)	SR		F,O	F	F	F,O	B		

Table 3-3 (page 4 of 4). Habitat requirements of birds observed using the LSP restoration area during ERC surveys conducted in August and September 2003 at Liberty State Park, Jersey City, NJ.

Common Name (*Scientific Name)*	Seasonal Use[a/]	Forest/ Woodland[b/]	Emergent Wetland[c/]	Shrubland[d/]	Successional Shrubland	Successional Field[e/]	Forest / Field Edge	Shrubland /Field Edge	North Cove
Willow Flycatcher (*Empidonax traillii*)	M				F	F,O	F	F	
Yellow Warbler (*Dendroica petechia*)	SR			F,B	F	F,O	F	F,B,O	

Key: F= Foraging habitat; B= Breeding habitat; W= winter habitat; O= Species observed in habitat type

Notes:
Species listed in this table are species recorded using the LSP restoration area during August – September 2003 (point counts, incidental sightings, and northern harrier surveys). Species flying over the site, using the South Cove Salt Marsh, or mowed lawn areas are not included.
a/ Seasonal use: R= Resident (may breed on-site); SR = Summer Resident (may breed on-site); M = Migrant (occurs in spring and fall); W = winter visitor (includes spring and fall); V = Visitor (occasionally occurs on-site). Source: Birds of Liberty State Park list.
b/ Forest/woodland includes successional northern hardwood and floodplain forest vegetative communities.
c/ Emergent wetland includes deep emergent marsh, shallow emergent marsh, and common reed dominated wetland vegetative communities.
d/ Shrubland includes maritime shrubland, successional shrubland, and shrub swamp vegetative communities.
e/ Successional field includes maritime grassland, successional old field, and common reed/mugwort vegetative communities.

Observations of the State-listed endangered and threatened raptors within the LSP Restoration site (northern harrier, short-eared owl, long-eared owl and Cooper's hawk) are discussed in Section 4, Endangered and Threatened Species.

Passerines

The New York and New Jersey Harbor (NY/NJ Harbor) area occupies a key location for migrating songbirds, as evidenced by the large number and variety of birds seen throughout the LSP Restoration site. Both short and long distance migrant songbirds pass through the Liberty State Park area; some of the species that nest in the NY/NJ Harbor area could nest in the LSP Restoration site, provided suitable habitat exists. Others may overwinter in the LSP Restoration site.

Breeding Bird Atlas data from New York and New Jersey indicate that up to 92 species of passerines are present in the NY/NJ Harbor area during the nesting season. The USFWS (1998) identified and described songbird species that are common breeders in urban areas near the Harbor. Nesting species include song sparrow (*Melospiza melodia*), American robin, gray catbird (*Dumatella carollinensis*), yellow warbler, and red-winged blackbird. Grassland birds such as grasshopper sparrow (*Ammodramus savannarum*), savannah sparrow (*Passerculcus sandwichensis*), and bobolink migrate through but rarely breed in the region. Because the NY/NJ Harbor area generally lacks large expanses of forest habitat forest interior species rarely breed in the region, but may pass through the area during migration.

Passerines were the most common group of birds observed during the August point count surveys. Observations of 24 species of passerines made up 61.7% of all bird observations. Most common species were European starling (*Sterna vulgaris*) (*n* = 93), American robin (*n* = 75), and gray catbird (*n* = 77). Other common species were song sparrow (*n* = 49), barn swallow (*Hirundo rustica*) (*n* = 44), eastern towhee (*n* = 26) and American goldfinch (*n* = 20) (Table 3-1). An additional 16 passerine species were identified on the LSP Restoration site by LSC staff, and 11 were sighted nearby.

Long-legged Waders

Breeding colonies of herons, egrets, and ibises exist in the Arthur Kill, Kill van Kull and Lower New York Bay (on Hoffman Island). Individuals from these colonies forage in shallow waters and marshes of the NY/NJ Harbor area. The most common waders in the Harbor are black-crowned night-heron (*Nycticorax nycticorax*), snowy egret (*Egretta*

thula), glossy ibis (*Plegadis falcinellus*), cattle egret (*Bubulcus ibis*), and great egret (*Casmerodius albus*) (USFWS 1998).

Although no wading birds were observed in the LSP Restoration site, yellow-crowned night heron (*Nyctanassa violacea*) (NJ threatened) black-crowned night heron (listed as threatened breeding populations), great egrets, snowy egrets, and green herons (*Butorides virescens*) were observed foraging in the South Cove Salt Marsh reference site during the August point count surveys (Table 3-1). In addition to the wading birds sighted during the August survey, LSC staff reported glossy ibis using the South Cove Salt Marsh.

Waterfowl

Thirty-two species of waterfowl utilize estuarine, riverine, palustrine wetlands and adjacent uplands of the NY/NJ Harbor area (USFWS 1998). The primary use of the harbor shoreline by waterfowl is for resting and feeding during the fall migration, which peaks in November, and as a wintering area. Waterfowl migrate down the Hudson River and/or along the Atlantic coast, stopping to rest and feed or to overwinter in the NY/NJ Harbor area. The northward migration from the NY/NJ Harbor estuary begins as early as February for some species, but for most occurs in March.

Common waterfowl species in the harbor area include: American black duck (*Anas rubripes*), mallard (*Anas platyrhynchos*), Atlantic brant (*Branta bernicla*) greater scaup (*Aythya marila*), canvasback (*Aytha valisneria*), and Canada goose (*Branta canadensis*), along with lesser numbers of bufflehead (*Bucephala albeola*), oldsquaw (*Clangula hyemalis*), red-breasted merganser (*Mergus serrator*), common goldeneye (*Bucephala clangula*), and American wigeon (*Anas americana*). Concentrations of waterfowl occur along the Staten Island shoreline, in Caven's Cove (Liberty State Park), in the Kill van Kull, and along the lower Hudson River. Up to 12 waterfowl species, including mallard and American black duck, nest in the NY/NJ Harbor area.

Although it is likely that several species of waterfowl use Liberty State Park as a resting stop during fall migration and as overwintering grounds, only three waterfowl species were observed during the August point count surveys. During the winter of 2003, LSC staff observed 10 species of waterfowl using the waters surrounding the LSP. In August 2003, mallard, American black duck, and Canada goose were observed flying over the point stations, as well as foraging in a ponded area in the southwestern portion of the LSP Restoration site, on the Mowed Lawn areas and in the South Cove Salt Marsh habitat.

Waterfowl are further discussed in two groups, based on feeding techniques, divers and dabblers.

Diving Ducks – Large overwintering rafts of diving ducks forage and rest within the NY/NJ Harbor area. About 15 species of diving ducks can be expected to pass through and use portions of the NY/NJ Harbor area for migration stopovers and for overwintering (Nichols 1995). Concentrations are composed primarily of canvasbacks, greater scaup, and buffleheads, with lesser numbers of mergansers (TI 1976; LMS 1984a, 1984b, 1987). These species and others are found along the mid-Atlantic Coast during winter with breeding occurring farther north and west in the Northeast, Midwest, Canada, and Alaska (Bellrose 1980).

LSC staff observed seven species of diving ducks in the winter of 2003. Bufflehead, canvasback, common goldeneye, mergansers (hooded and red-breasted), ruddy duck (*Oxyura jamaicensis*) and white-winged scoters (*Melanitta fusca*) were observed in the open waters surrounding the LSP Restoration site between January and April 2003 (Appendix A).

Dabbling Ducks breed and overwinter in the NY/NJ Harbor estuary. Mallards and American black ducks are common nesters in this area, and gadwall (*Anas strepera*), green-winged teal (*Anas crecca*), and blue-winged teal (*Anas discors*) are occasionally found nesting there (Andrle and Carroll 1988). Overwintering species include gadwalls, American black ducks, northern pintails (*Anas acuta*), and mallards (TI 1976; LMS 1984a, 1984b, 1987).

At least three species of dabbling ducks use the NY/NJ Harbor area to overwinter, and are expected to use the waters of the North and South Coves. Canada goose, American black ducks, and mallards are common species identified during the winter in the NY/NJ Harbor area (TI 1976; LMS 1984a, 1984b, 1987, 1996b), and were observed on the LSP Restoration site and/or the South Cove Salt Marsh during the August surveys. These species prefer marshes, bays, and estuaries for overwintering (Howe *et al.* 1978).

Twenty-seven observations of mallards and American black ducks made up 3.6% of all the bird sightings during the August 2003 point count surveys (Table 3-1). Five mallards were observed flying over the point count stations during the August wildlife surveys. Seven American black ducks were observed utilizing the Salt Marsh habitat of the South Cove of Liberty State Park during the point count surveys, and 3 were observed flying over point

stations. Several other species of dabbling ducks and geese were observed by LSC staff between January and March 2003, including American wigeon, brant, and gadwall.

Shorebirds

Up to 30 species of shorebirds migrate through the NY/NJ Harbor area. During migration, these shorebird species feed and rest in the marshes, mudflats, and shallow water areas of the Harbor. Migration of shorebirds occurs throughout much of the year; spring migration occurs between March and June, and fall migration begins in July and lasts through November (USFWS 1998). The most abundant shorebird species in the Harbor area are semipalmated sandpiper (*Calidris pusilla*), semipalmated plover (*Charadrius semipalmatus*), sanderling (*Calidris alba*), ruddy turnstone (*Arenaria interpres*), black-bellied plover (*Pluvialis squatarola*), dunlin (*Calidris alpina*), short-billed dowitcher (*Limnodromus griseus*), greater and lesser yellowlegs (*Tringa melanoleuca* and *T. flavipes*), and least sandpiper (*Calidris minutilla*).

Shoreline areas within the vicinity of the LSP Restoration site are characterized by a mixture of rip-rap shorelines, intertidal marsh, and mud flats. These areas provide foraging and resting habitat for shorebirds. The South Cove provides a relatively undisturbed intertidal mud flat, shoreline and marsh. The North Cove consists of hardened shoreline with a small mudflat area that is exposed at low tide. Four species of shorebirds (greater yellowlegs, lesser yellowlegs, spotted sandpiper, and least sandpiper) were recorded in the Salt Marsh habitat of the South Cove. Suitable habitat for shorebirds in the interior of the LSP Restoration site includes freshwater wetlands and shallow puddles in the Soil Stockpile Area. These shallow freshwater habitats are used for resting and foraging. Nineteen observations of shorebirds made up 2.5% of all birds observed during the point counts and northern harrier surveys (Table 3-1). Greater yellowlegs, lesser yellowlegs, and killdeer were sighted using the shallow puddles in the Soil Stockpile Area. Killdeer also used the Mowed Lawn areas.

LSC staff observed three additional shorebird species in LSP between April and June 2003, including black-bellied plover, Baird's sandpiper (*Calidris bairdii*), and spotted sandpiper (*Actitis macularia*) (Appendix A).

Gulls and Terns

Gulls are a common group in the NY/NJ Harbor area, where they nest, forage and overwinter. The shallow water shorelines of the North and South Coves of Liberty State

Park provide foraging habitat for gulls, while the Mowed Lawn picnic areas provide an additional food source. Gulls were commonly observed flying over the LSP Restoration site, and in the mowed lawn areas of the park. Four species of gulls were recorded during the wildlife surveys. Observations of herring gulls (*Larus argentatus*), greater black-backed gull (*Larus marinus*), ring-billed gull and laughing gull (*Larus atricilla*) comprised 10.8% of all individual bird observations during the avian surveys. Of these species, ring-billed gull was the most commonly observed (Table 3-1).

No terns were observed on the LSP Restoration site during the August 2003 point count surveys. Three species, common tern (*Sterna hirundo*), least tern (*Sterna antillarum*) and black skimmer (*Rynchops niger*), were observed using the off-site habitat of the South Cove. The least tern was sighted flying over the South Cove Salt Marsh, and the black skimmer was observed in the open water. Common terns were observed roosting on walkway railings and other structures and foraging over open water areas.

Cormorants

Observations of cormorants in the LSP Restoration site during the point count surveys were limited to 10 sightings of the double-crested cormorant (*Phalacocorax cardo*) flying over the point stations, and one double-crested cormorant observed in the South Cove Salt Marsh. Great cormorants (*Phalacocorax auritus*) were observed by LSC staff in March 2003.

Rails and Coots

Three species of rails (clapper rail [*Rallus longirostris*], Virginia rail [*Rallus limicola*], and sora [*Porzana carolina*]) and the American coot (*Fulica Americana*) may breed in the NY/NJ Harbor area (Andrle and Carroll 1988). No rails were observed during the point count surveys, but LSC staff sighted an American coot in March 2003 and heard clapper rails calling in May 2003 in the South Cove Salt Marsh (Appendix A).

Other Birds

Several other birds not falling under the major categories were observed on the LSP Restoration site and in the North and South Coves of Liberty State Park during the point count surveys and supplemental observations. During the August surveys, downy woodpeckers were observed on six occasions, five of which were in Successional Northern Hardwood habitat. Chimney swifts were observed on 21 occasions, most of which were flying over the site. LSC staff recorded observations of wild turkey (*Melegris gallopavo*) and ring-necked pheasant (*Phasianus colchicus*). Northern flicker

and red-bellied woodpecker observations were recorded during vegetation and northern harrier surveys.

3.2.3 Summary of Bird Surveys and Habitat

The interior and shorelines of the LSP Restoration site provide habitat for passerine birds, pigeons, gulls, and other wildlife species that frequent disturbed habitats and tolerate disturbance by humans, vehicles, and machinery. These species have adapted to an environment dominated by humans and may be common in or adjacent to residential and industrial areas. Shoal areas, marshes and bays, and deepwater areas (open water) provide roosting, foraging, and overwintering areas for gulls, waterfowl, and cormorants. The shoreline of LSP has one small cove (North Cove) and a larger cove/bay with adjacent marsh (South Cove). Although the existing rip rap along most of the shoreline does not provide quality habitat for shorebirds, waders, ducks, geese, and other species found in the ecozone between bay/estuary and upland spoil areas, several species of these birds were seen using the coves of Liberty State Park.

3.3 MAMMALS

A small mammal trapping study was conducted between 28 October and 1 November 2003 to determine species richness of small mammals and to identify the raptor prey base within the LSP Restoration site.

3.3.1 Methodology

Sampling grids were set at seven stations within the following habitat types: Maritime Grassland, Common Reed/Mugwort, Shallow Emergent Marsh, and Successional Northern Hardwoods. Each grid was approximately 150 square feet (ft^2) in area and contained nine sampling sites set 50 feet apart, and a number of trapping methods were employed within the grids, including:

- *Pit Traps with Drift Fences*- One pit trap/drift fence array was set near each grid center. The arrays consisted of a 20-foot length of silt fence dug six-inches into the ground with turn-backs placed at the ends, and three 6-inch diameter, 14-inch deep pits placed at the ends and center of the fencing. Food and bedding was placed in each pit to provide food and shelter for trapped mammals.
- *Live Traps-* One Sherman Live Trap (3x3x9-inch) and one Havahart Live Trap (4x4x10-inch) were baited with a mixture of peanut butter, oats and oat meal and set

at each station. One Victor single door live trap (6x6x18-inch) baited with Cat Passion scent was set at the hair snare stations (described below). The Sherman and Victor traps were set for four nights (between 28 and 31 October), and the Havahart traps were set for three nights (between 29 and 31 October).

- *Snap Traps* - One Museum Special snap trap baited with a mixture of peanut butter, oats and oat meal was set at each station (last two nights).
- *Scent Station with Hair Snare* - One 4x4-inch hair snare with a cotton ball soaked in beaver castor and a 2x2-inch Velcro patch was set approximately 10 inches above the ground. A cotton ball soaked with Canine Call (a long distance scent) was placed about 5 feet above the ground to attract mammalian predators to the station.
- *Cover boards* - Two cover boards were placed at each wildlife station during August 2003 and were checked for evidence (burrows, runways, nests, caches, scats/droppings, etc.) of small mammal use over the summer.

Live captures were identified to species, marked with water-based acrylic paint and released. Dead specimens were collected and frozen for possible future analysis of contamination concentrations.

During the summer wildlife surveys and the fall small mammal trapping, incidental mammal sightings and mammal signs (e.g., scat, bones, or carcasses) observed within the LSP Restoration site were recorded.

3.3.2 Results of Mammal Community Sampling

TI (1976) surveyed mid-sized mammals (cottontail, raccoon, fox) along 12 transects (400 ft long and 20 ft wide belt transects) at Liberty State Park in September 1975 and April 1976. They also conducted a small mammal trapping study along six transects (375 ft long) with Sherman live traps. TI (1976) identified five species; eastern cottontails and muskrats were observed and meadow voles, Norway rats, and house mice were captured in the Sherman Live Traps. TI (1976) found the numbers captured per 100 trap nights (TNs) of effort were 14.5 house mice, 1.3 meadow voles, and 0.5 Norway rats. No white-footed mice or shrews were captured. In 2003, ten species were identified (observed or trapped). The 2003 study results suggest changes in small mammal populations have occurred; more species and a shift from the abundant house mouse in 1976 to the abundant white-footed mouse in 2003. White-footed mice were not represented in the 1976 collections but appear to have replaced the house mouse in 2003. Meadow vole numbers per 100 TNs were low in both studies.

Ten mammal species were observed within several habitat types on the LSP Restoration site during August, September, and October 2003 (Table 3-4). During the small mammal trapping survey 99 individuals of four species were captured. White-footed mice (*Peromyscus leucopus*) were the most frequently encountered species, with 93 (0.9/100 TNs) individuals collected. Four meadow voles (*Microtus pennsylvanicus*) (0.04/100 TNs), one Norway rat (*Rattus norvegicus*) (0.01/100 TNs), and one house mouse (*Mus musculus*) (0.01/100 TNs) were also captured.

Meadow voles were less common than expected based on the available habitat and the prior TI study. Their numbers may fluctuate greatly as they are a primary prey species for many predators including northern harriers, red-tailed hawks, and barn owls, which forage within the LSP Restoration site year-round. Other species such as feral cats (*Felis catus*) and raccoons may also prey upon meadow voles. A second possible explanation for the low numbers of captures is that meadow voles may be a trap-shy species that is less likely to be caught in live traps; therefore, their numbers per 100 TNs may be under represented.

3.4 SUMMARY

Seventy species of birds have been observed in the LSP Restoration site during this study and by staff of the Liberty Science Center, and an additional 61 species were observed in the South Cove Salt Marsh, or in other LSP habitats outside of the proposed restoration site.

Relatively few amphibian, reptile and mammal species were found on the LSP Restoration site, despite the availability of suitable habitat. This is likely the result of the ecological communities forming in a highly urbanized area. A lack of habitat corridors from other ecological communities most likely impedes colonization of the LSP Restoration site.

Table 3-4. Mammals observed at Liberty State Park during the August 2003 wildlife survey and October small mammal trapping survey.

Common Name	Scientific Name	Relative Abundance In Liberty State Park
Eastern Cottontail	*Sylvilagus floridanus*	Uncommon
Woodchuck	*Marmota monax*	Uncommon
Gray Squirrel	*Sciurus carolinensis*	Uncommon
White-footed Mouse	*Peromyscus leucopus*	Very Common
Meadow Vole	*Microtus pennsylvanicus*	Common
Muskart	*Ondatra zibethicus*	Uncommon
Norway Rat	*Rattus norvegicus*	Uncommon
House Mouse	*Mus musculus*	Uncommon
Raccoon	*Procyon lotor*	Uncommon
Domestic Cat	*Felis catus*	Common
Feral Dog	*Canis familiaris*	Common

4. ENDANGERED AND THREATENED SPECIES

The use of the undeveloped portion of Liberty State Park (LSP) by species listed by the New Jersey Department of Environmental Protection (NJDEP) as threatened or endangered has been evaluated as a component of this ERI. This section presents the results of these evaluations.

4.1 ENDANGERED AND THREATENED VEGETATION

One New Jersey state-endangered plant, Torrey's rush (*Juncus torreyi*), was observed on the LSP Restoration site. This species was observed on vegetation Transect 6 in a maritime grassland community. Although the species was found in an upland plant community, Torrey's rush is a FACW plant that prefers wet habitats and is intolerant of shade. Shallow emergent marshes within the LSP Restoration site may provide suitable habitat for this species. This species is present in relatively low numbers on the LSP Restoration site.

4.2 ENDANGERED AND THREATENED WILDLIFE

Past documentation of endangered and threatened species (ETS) necessitated further investigations of ETS use of the LSP Restoration site. Five ETS bird species have been observed on the site by the staff of the Liberty State Park Interpretive Center (IC) and the Liberty Science Center (LSC). LSC staff provided a summary of bird observations for the period extending from January through June 2003 (Britt 2003). These records included: northern harrier, Cooper's hawk, long-eared owl (*Asio otus*), short-eared owl (*Asio flammeus*), and savannah sparrow (*Passerculus sandwichensis*) during the winter and spring of 2003. IC staff provided a summary of northern harrier sightings from 2001-2003. The status, habitat requirements and a summary of habitat use for ETS within the LSP Restoration site between 2001 and 2003 are presented in Table 4-1.

The following text describes the habitat requirements and the diets of the ETS that are known to use the LSP Restoration site.

Table 4-1. Status, habitat requirements, and records of sightings for New Jersey State-listed threatened and endangered species observed within the 225-acre study area at Liberty State Park.

Common name (*Scientific name*)	Status[1/]	Habitat requirements	Habitat use/sighting information for 225-acre study area
Northern harrier (*Circus cyaneus*)	NJ T/U	Forage, nest, and roost in marshes (freshwater and saltwater), wet meadows, grasslands, agricultural fields, shrublands, and riparian corridors (NJDEP 1995; Macwhirter and Bildstein 1996; Banner and Schaller 2001). Small rodents, particularly voles, and birds are the primary prey of adult northern harriers (Dechant et al. 2001). Nests on the ground in patches of dense vegetation, generally dominated by grasses. Preferred nesting habitat has few shrubs or with shrubs <1 foot tall (Banner and Schaller 2001). Habitat value may be reduced in areas with shrubs and trees >7 feet tall because this vegetation could provide habitat for predators (Banner and Schaller 2001). Patch size for nesting habitat ranges from 20 to 297 acres (Banner and Schaller 2001; Dechant et al. 2001).	• Nesting attempts within early successional habitat types in 2001, 2002, and 2003. • Winter 2003 - used fenced Dredge Material Storage Area as winter roost. • Summer/Fall 2003 – observed foraging or flying over early successional habitats numerous times.
Cooper's hawk (*Accipiter cooperii*)	NJ T/T	Forage, nest, and roost in deciduous forest, often near a field edge (Bull and Farrand 1977; Baicich and Harrison 1997). Commonly nest in open forests rather than those with dense stands of trees (Cornell Lab of Ornithology 1997). Nests generally located in deciduous trees 20-60 feet above the ground. During migration, documented using a wide variety of habitat types and can be associated with any habitat containing trees or shrubs (NJDEP 1995).	• Winter/spring 2003 - observed within 250-acre study area. • August/September 2003 – observed flying from forested floodplain habitat within 250-acre site. Also seen foraging at South Cove. • October 2003 – observed in successional hardwoods/maritime shrubland, near Wildlife Survey Point B-05.
Long-eared Owl (*Asio otus*)	NJ T/T	Nests in dense forest stands. In NJ, nesting habitat is commonly associated with hedgerows and woodlots interspersed with agricultural fields and forest openings. Winter roosts often in dense pines surrounded by fallow fields, Shrub habitat, and deciduous woodlots. Primary prey is voles; therefore, foraging habitat is generally fields and brushy habitats (NJDEP 1995).	• January 2003 – observed foraging over Dredge Material Storage Area. • Reported to roost in planted pines in southwestern corner of 250-acre site.
Short-eared Owl (*Asio flammeus*)	NJ E/U	Unconfirmed or possibly extant breeder in NJ (ENSP 2002a). Occurs widely as a winter resident. Breed, forage, and roost in freshwater and saltwater marshes, bogs, and old fields. Roosting has been documented in NJ at abandoned dumps, quarries, gravel pits, storage yards, dunes, and thickest. Often roosts communally with northern harriers (Schneider and Pence 1992; Dechant et al. 2001). May require areas >125 acres for foraging (NJDEP 1995).	• February 2003– one observed foraging over and flying high over fenced Dredge Material Storage Area.

Table 4-1 (page 2 of 2). Status, habitat requirements, and records of sightings for New Jersey State-listed threatened and endangered species observed within the 225-acre study area at Liberty State Park.

Common name (*Scientific name*)	Status[1/]	Habitat requirements	Habitat use/sighting information for 225-acre study area
Bobolink (*Dolichonyx oryzivorus*)	NJ T/T	Breed in hayfields, meadows, and marshes with taller grasses and forbs. Prefer moist to dry habitats for foraging and breeding. In northern NJ, breeding populations primarily found in Hunterdon, Warren, and Sussex Counties (NJDEP 1995).	• September 2003 – observed in dredge material mugwort/ maritime grassland community.
Savannah Sparrow (*Passerculus sandwichensis*)	NJ T/T	Open fields, meadows, pastures, salt marshes, and vegetated landfills dominated by grasses and forbs (Baicich and Harrison 1997; ENSP 2002b). Tolerant of early woody growth. Sometimes shares nesting habitat with bobolinks (Wander 1999). NJ is at southern limits of the species' breeding range (ENSP 2002b). Nesting habitat and non-breeding season habitat are similar.	• April 2003 – 14-16 individuals observed in dredge material mugwort community in northwest corner of 250-acre study area (in vicinity of Wildlife Observation Point C-01).
Torrey's rush (*Juncus torreyi*)	NJ E	Wet prairies, meadows, and sandy or muddy banks of rivers and streams (USGS undated). This species has a wetland indicator status of FACW[2/] and is intolerant of shade. It is also intolerant of saline environments (NRCS 2003).	• August 2003 – observed in maritime grassland community along Segment 6 of Transect 6.

1/ NJ State Status Descriptions: E – Endangered. T – Threatened. U – Undetermined. Status for animals separated by a slash (/) indicates dual status. The first status refers to the species breeding population. The second status refers to the species migratory or winter population.
2/ FACW: Facultative Wetland Species. The probability of this species being found in wetlands is 67-99%.

Northern Harrier

The northern harrier usually nests and forages in open marsh, field, or other early successional habitats. Northern harriers nest in large patches of grassland or old field habitat that are generally between 20 and 300 acres (Banner and Schaller 2001; Dechant et al. 2001) in size. Foraging and winter roosting habitat are similar to nesting habitat (NJDEP 1995; Dechant *et al.* 2001); but, uplands may be preferred over wetlands as winter roosts (Banner and Schaller 2001). Northern harriers are opportunistic feeders that typically forage over marshes and low vegetation such as grass meadows (Aslop 2001, Beans and Niles 2003, Conn. DEP 2003, Mass. DFW 2003). Common food items vary with season and availability but include small rodents such as voles and mice, as well as small birds, amphibians, reptiles, insects, crayfish, and carrion (Aslop 2001, Beans and Niles 2003, Conn. DEP 2003, Mass. DFW 2003). Northern harriers exhibit sexual dimorphism in prey selection, with the larger females able to secure larger prey, such as waterfowl, than the males (Beans and Niles 2003).

Vegetative communities within the LSP Restoration site that provide the most suitable foraging and nesting habitat for northern harriers include Shallow Emergent Marshes, Maritime Grassland, Successional Old Field, Common Reed-dominated Wetlands, and Common Reed/Mugwort.

Northern harriers are believed to nest in the 42-acre Dredged Material Storage Area, a block of early-successional habitat, which is within the estimated minimum nesting patch size. The Successional Old Field community in the Soil Stockpile Area also provides a block of suitable nesting habitat. Although the LSP Restoration site offers suitable nesting habitat, its value is somewhat diminished due to the presence of less than optimal habitat characteristics. Within the LSP Restoration site, potential northern harrier nesting habitat contains patches of shrubs and trees, which are believed to reduce the value of nesting habitat because they provide habitat for potential nest predators (e.g., American crows (*Corvus brachyrhynchos*) and great horned owls) (Macwhirter and Bildstein 1996; Banner and Schaller 2001).

Northern harriers may choose to roost on the LSP Restoration site because of the scarcity of nearby early-successional upland habitats in the region. Additionally, the fencing that surrounds the LSP Restoration site may make it less susceptible to human disturbance. The scattered cottonwood trees on the site serve as resting and vantage points for the harriers.

Cooper's Hawk

Cooper's hawks nest in woodlots and forests interspersed with fields and other open habitats (Bull and Farrand 1977). Nests are commonly located in deciduous trees, 20-60 feet off the ground, often near a field/forest edge (Cornell Lab of Ornithology 1997). During migration, they have been documented using a wide variety of habitat types and can be associated with any habitat containing trees or shrubs (NJDEP 1995).

The Cooper's hawk generally resides in wooded areas where they forage (Beans and Niles 2003). The Cooper's hawk diet consists primarily of birds such as thrushes, jays, woodpeckers or sparrows, while small mammals, fish, poultry, reptiles and amphibians are occasionally eaten (Aslop 2001, Beans and Niles 2003). The Cooper's hawk, like the northern harrier, exhibit sexual dimorphism in prey selection with the larger females able to secure larger prey.

The patchy environment of the LSP Restoration site and surrounding lands are consistent with literature descriptions of suitable Cooper's hawk foraging and nesting habitat; however, nesting attempts at LSP have not been documented.

Long-eared Owl

Long-eared owls are generally associated with field and meadow habitat interspersed by woodlots that are often dominated by dense conifers. This species usually nests in dense forests, but in New Jersey nesting most often occurs in hedgerows or woodlots associated with agricultural land (NJDEP 1995). Roosting habitat is similar to nesting habitat.

Long-eared owls' primary foraging habitat is open fields characterized by low-growing vegetation where they hunt for small mammalian prey (NJDEP 1995). The diet consists primarily of voles and small rodents, and includes small birds, snakes and insects (Aslop 2001, Beans and Niles 2003, Conn. DEP 2003, Lawrence 2001). Over forty species of mammals, some as large as snowshoe hares, have been identified in the diet of long-eared owls (Lawrence 2001).

Long-eared owls are associated with wooded and early-successional habitats within the LSP Restoration site. Conifers that were planted in the southern corner of the LSP Restoration site serve as a winter roost for long-eared owls (Gallagher 2003). Although

habitat within the LSP Restoration site may be suitable nesting habitat for long-eared owls, only wintering individuals have been observed.

Short-eared Owl

Short-eared owls inhabit coastal tidal and brackish marshes, fallow fields, pastures, and grasslands. The species nests and roosts on the ground (NJDEP 1995; Baicich and Harrison 1997). Short-eared owls commonly share winter roosts with northern harriers (Dechant *et al.* 2001). Published studies on short-eared owls suggest this species prefers large blocks of undisturbed habitat greater than 125 acres for foraging, roosting, and nesting (NJDEP 1995). Breeding has been documented in habitat patches ranging from 60 to over 300 acres (ENSP 2002a).

The short-eared owl preys mainly on small mammals such as voles, mice, shrews, rats and rabbits (Aslop 2001, Beans and Niles 2003, Conn. DEP 2003, Lawrence 2001, NYSDEC 2003). Voles are considered a large portion of the short-eared owl diet and consumption of two meadow voles per day has been recorded (Beans and Niles 2003, Lawrence 2001). The diet also includes insects and small birds (Aslop 2001, Beans and Niles 2003, Conn. DEP 2003, Lawrence 2001).

Although suitable nesting, foraging, and roosting habitat for short-eared owl is present in the interior portion of the LSP Restoration site, only one foraging individual was observed using the LSP Restoration site during the winter of 2003.

Bobolink

The bobolink is a Neotropical migrant that breeds from New Jersey west to Colorado and north to Newfoundland and British Columbia (Bull and Farrand 1977). In New Jersey, most breeding occurrences have been documented in northern and western portions of the state (NJDEP 1995). This species is generally associated with open agricultural, grass, forb or hay fields and wet meadows (Aslop 2001, Beans and Niles 2003).

The bobolink's diet varies with season and availability, but typically consists of seeds and invertebrates, including caterpillars, beetles, ants, spiders, centipedes and grasshoppers during summer, and seeds, corn and other grains during migration (Aslop 2001, Beans and Niles 2003).

At LSP, bobolinks are classified as migrants that may visit the park during the spring and fall (NJDEP 2003). Suitable foraging and resting habitat for bobolinks exists in the emergent wetlands and early-successional upland habitats on the LSP Restoration site.

Savannah Sparrow

Savannah sparrows inhabit open lands including fallow fields, grasslands, upland meadows, salt marshes, and vegetated landfills (Bull and Farrand 1977; Baicich and Harrison 1997; ENSP 2002b). The species is relatively tolerant of succession and will occupy fields that contain woody growth. Nests are located on the ground. During the non-breeding season, savannah sparrows use drier habitats including coastal dunes, roadside edges, pastures, and golf courses (ENSP 2002b). This species is a common migrant in New Jersey (Wander 1997).

The savannah sparrow feeds on seasonally abundant seeds, snails, and insects, such as beetles, grasshoppers, ants, butterflies/moths, dragonflies, and spiders (Aslop 2001, Beans and Niles 2003).

Savannah sparrows were observed using the Successional Old Field within the Soil Stockpile Area during April 2003. Although savannah sparrows were only seen in one vegetative community type within the LSP Restoration site, the Successional Shrubland, Shrub Swamp Wetland, Maritime Grassland, and Common Reed/Mugwort, communities also provide suitable habitat for this species.

4.2.1 Endangered and Threatened Bird Survey Methodology

Because the northern harrier has been documented using the LSP Restoration site throughout the year and has unsuccessfully attempted nesting for two consecutive years (Britt 2003, Gallagher 2003), it is the ETS bird species of particular concern for this project. The ETS survey methodology was designed to determine habitat use by northern harriers within the LSP Restoration site. Information collected from these surveys will help to determine minimization and avoidance strategies for the long- and short-term impacts to the northern harriers within the LSP Restoration site from the habitat restoration project. The design of the restoration effort will also be tailored to maximize habitat value for the northern harrier.

To assess the use of the LSP Restoration site, site-specific field surveys were conducted during the summer of 2003. Weekly surveys for northern harriers were conducted from

seven permanent survey stations between August 4 and September 5, 2003 (Figure 4-1). Six of these stations were located within the 225-acre LSP Restoration site, and two were located outside the perimeter. Station locations were selected within or adjacent to large blocks of suitable habitat where northern harrier activity had been previously reported. These stations allowed for longer observations of larger blocks of habitat while providing observers with different vantage points. Five stations offered observations of the Dredged Material Storage Area and two stations were located within the Soil Stockpile Area.

Surveys were conducted a minimum of once per week from each survey location over the five week survey period. Surveys began 15 minutes before sunrise. At each point, two observers watched for northern harriers and other wildlife over a 15-minute survey period. During this survey period, wildlife species that were seen or heard were identified to species and numbers of individuals were recorded.

4.2.2 Results of Endangered and Threatened Species Surveys

Cooper's hawks, bobolinks and northern harriers were observed on the LSP Restoration site during the ETS surveys. Cooper's hawks were seen flying to and from wooded portions of the LSP Restoration site. Bobolinks were observed in the Dredged Material Storage Area in September 2003 (Table 4-1).

Observations of northern harrier foraging were common during the ETS surveys; harriers were observed on twelve occasions. Field crews conducting vegetation surveys also sighted northern harriers regularly. A minimum of three individuals were observed on-site during the survey period: one male, one female, and one juvenile. Northern harriers were most frequently sighted in the Dredged Material Storage Area (the location of the proposed Salt Marsh restoration) and the Soil Stockpile Area (the location of the proposed Grassland Berm). On two occasions, individual birds were seen perched in trees (Table 4-2).

US Army Corps of Engineers®
New York District

Map Source: LMS (2003)
Aerial Photo Source: USACE (2002)

THE PORT AUTHORITY OF NY & NJ

Liberty State Park Northern Harrier Observation Stations

Figure 4-1

Table 4-2. Summary of northern harrier observations during the August 2003 ETS surveys at Liberty State Park, Jersey City, NJ.

Date	Observation Location	Number of Individuals Observed	Notes
5 Aug.	Dredged Material Storage Area	2	Male and juvenile perched in tree near northwest limits of dredge spoil area.
6 Aug	Soil Stock Pile Area	1	Over field, flying east
6 Aug	Center wetland (near Wildlife Observation Point A-02)	1	Male perched in tree
6 Aug	Road edge (near Wildlife Observation Point B-02)	1	Antagonistic encounter between Northern Harrier (NOHA) and Red-tailed Hawk (RTHA). Male NOHA chased RTHA from tree.
12 Aug	Dredged Material Storage Area	1	Female, flying over fenced Dredged Material Storage Area
12 Aug	Fenced area between Dredged Material Storage Area and Freedom Way	1	Male, foraging
13 Aug	Soil Stock Pile Area (from Wildlife Observation Point C-01)	1	Female, foraging
19 Aug	Flyover	1	Female observed flying east to west over site in vicinity of Wildlife Observation Point A-02 towards Wildlife Observation Point C-01.
20 Aug	South Cove	1	Flying towards Caven Cove
21 Aug	Soil Stock Pile Area (from Wildlife Observation Point C-01)	1	Female, foraging
21 Aug	Dredged Material Storage Area	1	Male, flying low
3 Sept	Dredged Material Storage Area	1	One individual flew from fenced Dredge Material Storage Area towards south cove.
29 Oct	Wildlife Observation Point A-04	1	Female, flying over maritime grassland/dredge material mugwort.

Table 4-2 (Page 2 of 2). Summary of northern harrier observations during the August 2003 ETS surveys at Liberty State Park, Jersey City, NJ.

Date	Observation Location	Number of Individuals Observed	Notes
29 Oct	Mammal Trapping Site X-06	1	Juvenile, flying over successional old-field adjacent to Millennium Park
31 Oct	Wildlife Observation Point B-04	1	Juvenile, foraging in successional old-field near Audrey Zapp Drive
31 Oct	Parking Lot Across from Interpretive Center	2	1 juvenile, 1 adult flying from north to south. Adult remained within 225-acre site. Juvenile continue south towards South Cove.

4.3 SUMMARY

Six state-listed bird species and one state-listed plant species have been documented within the LSP Restoration site. Of the six state-listed birds, only the northern harrier has been documented as having recently nested within the LSP Restoration site. However, the nesting success during the summer of 2003 is uncertain. Northern harriers are year-long residents of LSP, and along with long-eared owls, use the site as a winter roosting and/or foraging site. Short-eared owls have been observed foraging on the LSP Restoration site during the winter but have not been documented using the area for nesting or roosting. Cooper's hawks are considered potential year-round residents at LSP; however, their presence within the LSP Restoration site has only been documented during migration and winter. Savannah sparrows and bobolinks are known to use the LSP Restoration site during migration.

5. NORTH COVE AQUATIC COMMUNITIES

Estuaries are typically highly productive ecological systems, characterized by vegetated shorelines and tidal wetlands. However, intense coastal development with increasing urbanization and industrial use, often result in modification of estuaries as in the case of the Hudson–Raritan Estuary. This loss of marginal wetlands and shallows along with a variety of urban and industrial inputs has impacted the estuarine systems. Aquatic biotic communities associated with watersheds with high urban land use are generally characterized by lower species diversity, altered community composition and reduced habitat diversity (Dauer et al 2000). NY/NJ Harbor demonstrates the impacts of urbanization within an estuarine system. Despite extensive changes and urbanization of NY/NJ Harbor it is still a productive estuary supporting diverse communities of fish and invertebrates (Woodhead *et al.* 1999).

The North Cove is located in the northeast corner of Liberty State Park. The cove is approximately 800 feet long and is 850 feet at its widest point, with depths ranging from five to nine feet in the center of the Cove (Figure 5-1). The North Cove is characterized by a riprap shoreline, steep slopes and areas of unconsolidated sediments.

5.1 WATER QUALITY

The water quality data for both baseline conditions and wet weather conditions can be found in Appendix C. Additional water quality data is being collected by USACE from both surface water and ground water locations. The water quality data summarized in Appendix C will be analyzed with the additional data when it becomes available.

5.2 BENTHIC INVERTEBRATES

Benthic invertebrate communities are important links in the flow of energy and cycling of nutrients between the sediment and the water column in marine environments. The lower trophic levels in an estuary influence fish populations through their role as a major food source. The infaunal community (benthos) is composed of suspension and deposit feeders, represented by polychaete worms, crustaceans and bivalves. The benthos life strategies and sediment characteristics are tightly coupled with grain size, chemistry and physical properties of the sediment, which control benthic organism colonization. Benthic organisms can serve as bioindicators, because some organisms are more tolerant of pollution and poor water quality conditions than others. Community composition may be indicative of water and sediment quality.

US Army Corps of Engineers®
New York District

Map Source: LMS (2003)
Aerial Photo Source: USACE (2002)

THE PORT AUTHORITY OF NY & NJ

Sampling Stations in the North Cove of Liberty State Park

Figure 5-1

5.2.1 Methodology

The benthic invertebrate sampling program was designed to: (1) characterize the existing conditions of the benthic community in the North Cove of Liberty State Park; (2) collect baseline data to use in assessing the level of success attained in the restoration; (3) establish a benthic baseline for predicting bottom environments that may be created in the proposed tidal creek; and (4) assess possible impacts to the benthic environment that may result from the construction of the creek. The program included benthic grab sampling for both organisms and sediments, identifying the organisms to the lowest taxonomic level practicable, and sediment analysis for grain size distribution and organic content.

Twenty one samples were collected from seven stations (3 replicates at each station) within the North Cove using a standard Ponar grab ($0.05m^2$) on August 18, 2003. Four stations were located along a transect that began at the proposed mouth of the tidal creek and ended outside of the promenade. The remaining three stations were located in the shallowest water possible at the edge of the Cove and were taken in the intertidal zone at low tide (Figure 5-1). Sample station locations were documented with Global Positioning System (GPS).

In the field, the sediment collected in the benthic grabs was characterized at each station. The sediment texture and/or shell hash was recorded, and obvious odors such as hydrogen sulfide or petroleum or lack of odor were noted. The sediment from the grab samples was then washed through a 500-micron sieve, and the remaining organisms were collected and preserved for laboratory analysis.

Additional grab samples were taken from each of the stations to obtain sediments, which were collected and sent to Advance Testing Laboratory, Campbell Hall, NY for analysis of grain size distribution and organic content.

The benthic organism samples were sorted, enumerated and identified to the lowest practicable taxon at the LMS Nyack, NY laboratory. Only whole organisms or parts of organisms with heads were counted, but all identifiable fragments were saved.

The following indices were calculated to compare the benthic community sampled at each location:

1. Organism density – the number of organisms collected per meter square of sediment.

2. Organism biomass – the weight (g) of the organisms collected per meter square of sediment.
3. Taxa richness – the number of individual taxa collected in each sample
4. Diversity (Shannon-Weiner Function H') - This order is characterized by the number of individuals found for each species/category, and is calculated with the equation:

$$H' = -\sum P_i \ln P_i$$

where P_i = the # of individuals of species i ÷ the total # of individuals in the community

5.2.2 Results of Benthic Community Sampling

The sediment grain size and benthic community characteristics varied greatly between the seven stations in the North Cove. A summary of the sediment characteristics and the abundance, diversity, and biomass of major groups is presented in Table 5-1.

Coarse, odorless sediments were found close to the shoreline at stations B-1 and B-2, and in the center of the cove at Station B-5. Finer sediments were collected from stations B-7, B-6, B-4 and B-3. These fine-grained sediments were black soft muds containing a strong petroleum odor and oily globules. Organic content of the sediments ranged from 3.1% at Station B-2 to 10.2% at Station B-1 (Table 5-1).

The variability of sediment characteristics and wave energy within the North Cove has created a patchy distribution of organisms based on differing habitat requirements. The mean density of organisms from all samples (n=7) taken in the cove was 737 organisms/m^2. Density was highest at stations B-4 and B-7, located approximately 400 and 700 feet from the shoreline, respectively. The grab sample at Station B-4 collected 1,300 organisms, and the sample at Station B-7 collected 1,320 organisms. The fewest organisms were collected from the stations located nearest to the shoreline; both stations B-1 and B-3 contained 340 organisms.

Samples containing fine-grained sediment tended to contain a more diverse assemblage of organisms than those from coarse-grain substrates. The most diverse assemblage was collected from the fine-grain sediments at stations B-6 (located along the transect approximately 150 feet from the shoreline) and B-7. Ten taxa were collected at each of these stations. Only one type of organism was collected from the coarse sediments at Station B-2, located close to the shoreline. A complete list of the organisms collected in the North Cove is presented in Appendix A.

Table 5-1. Summary Data for Benthic Grab samples at the North Cove of Liberty State Park, Jersey City, NJ.

Station	Density (animals/m^2)	Biomass (g/m^2)	Richness (# taxa)	Diversity	Dominant Group (by biomass)	Dominant Group (by density)	Particle Size Distribution[1]		Organic Content (by Weight)
							Coarse	Fine	
1	320	0.59	3	1.01	Arthropoda	Arthropoda	98.0%	2.0%	10.2%
2	520	26.58	1	0.00	Arthropoda	Arthropoda	99.8%	0.2%	3.1%
3	340	177.59	6	2.42	Annelida	Arthropoda	25.9%	74.1%	8.6%
4	1300	38.08	6	0.87	Annelida	Annelida	11.0%	89.0%	6.8%
5	620	12.53	5	1.34	Annelida	Annelida	89.0%	11.0%	9.8%
6	740	133.17	10	2.58	Mollusca	Annelida	23.9%	76.1%	8.8%
7	1320	21.73	10	2.44	Annelida	Annelida	16.0%	84.1%	7.3%

[1] - "Coarse" includes Gravel and Sand particles; "Fine" includes Silt and Clay particles

Fine-grained sediments also contained greater biomass than coarse sediments. The mean biomass of infaunal communities from all seven stations in the North Cove was 59.0 g/m^2, but the biomass ranged from 0.6 g/m^2 at Station B-1, where gravel and sand made up 98% of the substrate, to 177.6 g/m^2 at Station B-3, where 74% of the substrate was composed of silt and clay (Table 5-1). A discussion of the benthic communities collected at each station is presented below.

Station B-1

The benthic community collected from the coarse sediments at Station B-1 contained the lowest density, 320 animals/m^2, and the lowest biomass, 0.6 g/m^2 (Figure 5-1) Two of the three replicate samples contained no organisms, and only three taxa were collected from the third sample. Two taxa of amphipods (Melitidae and *Gammarus* sp.) represented 67% of the infaunal community. Small polychaete worms (*Capitella* sp.) were also collected in low numbers. The sediments collected from Station B-1 had the highest content of organic materials, 10.2% by weight.

Station B-2

The coarse sediments collected from Station B-2 contained only horseshoe crabs (*Limulus polyphemus*). When compared to other North Cove stations, the infaunal community was low in abundance (520 animals/m^2), biomass (26.6 g/m^2), and diversity (0.0). The organic content of the sediments was the lowest for all stations, 3.1% by weight.

Station B-3

The sample collected from Station B-3 was low in organism abundance, 340 animals/m^2, however species diversity was highest among the seven stations. Polychaetes worms (*Capitella* sp., *Leitoscoloplos* sp., and *Glycera* sp.) dominated the benthic community. Low numbers of gastropods and hermit crabs were also present. The mean infaunal biomass was high due in part to gastropod shells, 177.6 g/m^2. Polychaetes comprised 12% of the biomass. The substrate was fine grain sediments, predominately silt and clay. The organic content of these sediments was one of the highest, 8.6% by weight.

Station B-4

At Station B-4, the fine-grained sediments contained low densities (340 animals/m^2) of several different groups. Polychaete worms (mainly *Leitoscoloplos* sp. and *Capitella sp*) made up about 83% of the catch. The bivalve, *Mulinia lateralis* and other polychaetes were also present in low numbers. The mean biomass contained in the replicate samples

was 38 g/m^2. The benthic community from this station was approximately four times more abundant than sites along the beach at the back end of the cove. The substrate was silt and clay particles that contained a strong petroleum odor. The organic content of the sediments was 6.8%, by weight.

Station B-5

The coarse sediments collected at Station B-5 contained only polychaete worms, with *Leitoscoloplos* sp. and *Capitella* sp. making up 96% of the organisms. The sample contained relatively low organism densities (620 animals/m^2) and biomass (13 g/m^2). The organic content of the sediments at Station B-5 was the second highest for all stations, 9.8%, by weight.

Station B-6

Polychaetes and oligochaetes dominated the benthic community collected from the fine-grained sediments at Station B-6. The infaunal community had the highest species diversity, 2.58 and the biomass was relatively high, 133 g/m^2. Three taxa of polychaete worms (*Leitoscoloplos* sp., *Capitella* sp., and Paraonidae) were most abundant, comprising 70% of the infaunal community. Gastropods (*Illynassa obsoleta*), mysid (*Neomysis americana*) and amphipods (Melitidae) were also present. The mean abundance of the community was 740 animals/m^2. The organic content of the sediments was 8.8%, by weight.

Station B-7

The benthic community collected from the fine grain sediments at Station B-7 contained the highest density of organisms, 1320 animals/m^2, and diversity with 10 taxa. Eight taxa of polychaetes (including the bioindicators *Leitoscoloplos* sp., *Capitella* sp., and *Streblospio benedicti*) were the most abundant organisms, comprising 80% of the infaunal community. Other infaunal organisms present in small numbers included amphipods (Melitidae) and shrimp (*Crangon septemspinosa*). The mean biomass was 22 g/m^2. The sediments collected from Station B-7 had the second lowest content of organic materials, 7.3%, by weight.

5.2.3 Summary

The Hudson-Raritan Estuary has undergone intense urbanization; nevertheless, it supports a productive invertebrate community. The physical characteristics of the North Cove are typical of low energy coastal environments where settling of silt and organic matter occurs near the shoreline and wave action re-suspends fine particles in the water

column on which zooplankton can feed. The high organic content in the sediments near the shoreline of the North Cove (10.2%) could be attributed to runoff and/or sewage from nearby combined stormwater outfalls.

The samples were dominated by polychaete worms, which were collected at all seven sampling sites. Polychaetes are bioindicators of environmental stress due to their ability to tolerate poor environmental conditions such as low dissolved oxygen and high turbidity. Different species of polychaetes exhibit different levels of tolerance to environmental stress. Several of the polychaetes found in the North Cove (*Capitella* sp., *Leitoscoloplos* sp., *Streblospio benedicti* and *Nephtys* sp.) are often found in sediments associated with impacted environments impacted by petroleum hydrocarbons or other stressors (Llanso 1991, NOAA 2003). *Capitella* sp., *Leitoscoloplos* sp., *Streblospio benedicti* and *Nephtys sp* are often found in environments with low oxygen levels, high organic matter and sewage content. *Capitella* sp. are also tolerant to petroleum pollution; they are often one of the first groups to recolonize an area impacted by dredging or an oil spill (Llanso 1991, NOAA 2003).

Amphipods were present in two of the seven stations. *Gammarus* sp. and Melitid amphipods feed on detritus and are found in muddy and sandy substrates. They are an important food source for fish. The absence of the amphipod *Ampelesca abdita* is an environmental indicator, because this species is reported to be sensitive to pollutants such as petroleum compounds and are typically not found in highly polluted sediments (NOAA 2003).

Horseshoe crabs were collected at Station B-2, in the shallow water along the western edge of North Cove (Figure 5-1). They are environmental generalists and can survive within a wide range of environmental conditions including variations in salinity and oxygen levels (Shuster 1982). Currently, there is little information to suggest unusual sensitivity by horseshoe crabs to low dissolved oxygen, high turbidity or urban pollution (Botton 1995).

In surveys of benthic habitats found in NY/NJ Harbor, Iocco *et al.* (1995) found that sediments were dominated by opportunistic or pollution tolerant species. The organisms Iocco *et al.* (1995) reported were similar to those found in the North Cove. Common infaunal species of Upper New York Bay include capitellid worms, *Streblospio benedicti* and the bivalve *Mulinia lateralis*. Species diversity and relative abundance for the North Cove are consistent with the species found at other Upper New York Bay locations with

similar environmental conditions. Organism density was greater in samples collected by Iocco *et al.* (1995) throughout the harbor, than in the samples collected at the North Cove. A possible explanation for this difference is that organism densities vary with season, with low densities typically recorded during the summer when bottom dissolved oxygen levels are lowest. Also when comparing studies, one has to take into account the different physical properties, wave action and currents, that could effect sedimentation in a cove versus a bay.

Colonization of the seabed by macrobenthos in stressed habitats (such as polluted sediments) typically follows the Pearson – Rosenberg paradigm (Pearson – Rosenberg 1978). For infauna distributed along a gradient of decreasing organic input, this paradigm suggests that an area of sediments with no organisms is followed by an assemblage of small opportunistic organisms (worms and tube dwelling amphipods). Further from the source of organic input, the opportunists are gradually replaced by larger burrowing species (Zappala 2001). The open seabed in the North Cove consisted of unconsolidated fine black mud, which contained oily globules. The predominate organisms found living in the black mud were small, opportunistic polychaete worms. The sediments close to the back of the cove were coarser and there was no apparent petroleum odor. The colonization of the sediments in the North Cove appears to resemble the early opportunistic stage in the Pearson-Rosenberg stress gradient model.

5.3 VERTEBRATES

The North Cove (the Cove) at LSP was surveyed during late summer to early fall 2003 to determine the fish species that use the Cove. Baseline data were needed to identify the species that use the tidal creek habitat proposed to extend from the base of the Cove into the 42-acre Dredged Material Storage Area. These data will also be used to determine how the species composition in the cove may change with construction of tidal creek habitat.

5.3.1 Methodology

To collect adequate representation of the fish communities that use the North Cove, active and passive gear types were used to sample three stations in the cove (Figure 5-1). Seining was conducted as an active method of fish capture to collect species that may inhabit shallow areas of the Cove as short-term residents. Trap nets were set as a passive capture method to target predatory species that move in and out of the Cove during the crepuscular period (i.e., dawn and dusk) and during the night.

The three sampling stations were located along the shoreline of the North Cove. Station F-2 is located on the small beach area at the west end of the Cove. This area represents the only shallow beach habitat in the cove at low tide. Station F-1 was located along the south shoreline of the Cove and F-3 was located along the north shoreline. At the time of sampling, the shoreline at these two stations was characterized by steep sloping banks covered with riprap. Details of the sampling dates and sampling locations for each method are provided in Table 5-2.

Seine hauls were conducted during daylight hours with a 50-foot bag seine (1/4-inch mesh). The depth of the Cove required the hauls to be conducted by fixing one end of the seine on shore and working the other end out from shore and enclosing a semicircular area along the shoreline. The North Cove fish community was sampled via seine on 28 August, 8 September and 24 September 2003 (Table 5-2). A total of five seine hauls were conducted during the program. Seine hauls were conducted on each date (n=3) at the F-2 sampling location. Seine hauls at the other two sample locations (F-1 and F-3) were not attempted after 28 August because riprap on the shoreline caused the seine to snag, prohibiting effective seining. Although fish were collected on the first sample date at F-1 and F-3, the catch must be interpreted with caution because snagging potentially allowed fish to escape from the net.

Three 20-foot long trap nets (3x6-ft box frame, ¼ -in. mesh, and 40- ft long lead) were set perpendicular to the shoreline for approximately 14-hours from dusk to dawn. All fish were identified to species level, enumerated and an unbiased selection of up to 30 specimens from each species was measured for total length (nearest mm). Trap nets were not set on the first sampling date. Trap nets were set at all three sampling locations during the September sampling dates. The nets sampled for a total of 84 trap nets hours over the two sample dates. On the 8 September sampling date, no fish were collected in the trap nets set at F-2 or F-3. During the 24 September sampling date, fish were collected at all three sample locations.

Table 5-2. Description of fish sampling effort during August and September 2003 at Liberty State Park North Cove, Jersey City, NJ.

Date	Gear	Station	Station Depth	Start Latitude	Start Longitude	Number of Fish Caught	Number of Species Caught
8/28/2003	50-ft Beach Seine	F-2	3.7	40 42.32	74 02.54	50	3
8/28/2003	50-ft Beach Seine	F-3	3.5	40 42.36	74 02.57	32	6
8/28/2003	50-ft Beach Seine	F-5	8	40 42.36	74 02.43	53	4
9/8/2003	Trap Net	F-2	6	40 42.31	74 02.53	0	0
9/8/2003	50-ft Beach Seine	F-3	4.9	40 42.36	74 02.57	52	2
9/8/2003	Trap Net	F-3	5	40 42.36	74 02.57	19	8
9/8/2003	Trap Net	F-5	10	40 42.37	74 02.43	0	0
9/24/2003	Trap Net	F-2	7	40 42.31	74 02.53	5	3
9/24/2003	50-ft Beach Seine	F-3	4	40 42.36	74 02.57	18	3
9/24/2003	Trap Net	F-3	4	40 42.36	74 02.57	21	7
9/24/2003	Trap Net	F-5	9	40 42.37	74 02.43	7	5

5.3.2 Results of Vertebrate Community Sampling

At total of 257 fish representing 15 species were collected during the beach seine hauls and trap net surveys (Table 5-2). Nine species were collected via seine, while 12 species were collected in the trap nets. Bay anchovy (*Anchoa mitchilli*) and Atlantic menhaden (*Brevoortia tyrannus*) were the most common species collected by number during the seine survey. White perch (*Morone americana*) and striped bass (*Morone saxatilis*), both temperate basses, were the most common species collected in the trap nets, followed closely by winter flounder (*Pseudopleuronectes americanus*). Six species (alewife, [*Alosa pseudoharengus*]; hogchocker, [*Trinectes maculates*]; oyster toadfish, [*Opsanus tau*]; scup, [*Stenotomus chrysops*]; summer flounder, [*Paralichthys dentatus*]; and tautog, [*Tautoga onitis*]) were each represented by only one fish.

Total lengths were measured from 207 fish during the sampling program (Table 5-3). Total lengths varied by species and life stage. In general, juvenile fish were most common in the catch. Bay anchovy ranged in lengths from 65 mm to 92 mm with an average length of 81 mm. Several other species were represented primarily by juveniles, including Atlantic menhaden (average length = 48 mm), striped bass (82 mm) and winter flounder (67 mm). Several species were collected primarily as adults, notably white perch (244 mm), summer flounder (359 mm) and American eel (*Anguilla rostrata;* 395 mm). Only one yearling striped bass (205 mm) was collected; the remainder of the striped bass ranged in length from 56 mm to 97 mm. Several species were represented by only one fish, thus there was no interpretation of length data. The following sections provide a brief description of the spatial and temporal occurrence as well as the life history of the most common species collected in the Cove.

Bay Anchovy

The bay anchovy, the dominant species collected during the survey, range widely from temperate to subtropical waters along the Atlantic and Gulf coasts between Maine and Mexico (Hildebrand and Schroeder 1928). In most estuaries within their range, bay anchovy are an important trophic link between plankton and piscivores (Dorsey *et al.* 1996). The importance of anchovies as forage for larger coastal fishes and birds has been recognized in estuarine and coastal ocean systems over wide geographic range (Allen *et al.* 1995). Adults are found in a variety of habitats that include near-shore waters off sandy beaches, seagrass beds, freshwater rivers, and shallow to deep onshore waters (Morton 1989). Bay anchovy are particularly abundant in estuaries, near-shore coastal waters and bays (Springer and Woodburn 1960). The bay anchovy is an invertebrate feeder (Winemiller and Rose 1992), with the principal food source being zooplankton.

Table 5-3. Total length (mm) of species collected during August and September 2003 from Liberty State Park North Cove, Jersey City, NJ

Common Name	Number of Individuals Captured	Minimum Total Length (mm)	Maximum Total Length (mm)	Average Total Length (mm)
Alewife	1	85	85	85
American Eel	5	251	645	395
Atlantic Menhaden	71	37	74	48
Atlantic Silverside	7	82	103	92
Bay Anchovy	116	65	92	81
Hogchocker	1	106	106	106
Northern Pipefish	3	122	171	146
Oyster Toadfish	1	157	157	157
Scup	1	71	71	71
Striped Bass	19	56	205	82
Summer Flounder	1	359	359	359
Tautog	2	38	42	40
Weakfish	7	65	140	110
White Perch	14	220	260	244
Winter Flounder	8	55	86	67

Atlantic Menhaden

The Atlantic menhaden was also common in the North Cove vertebrate survey, is a polyhaline species that utilizes habitats along the entire eastern seaboard and adjacent shelf waters throughout its life cycle (Rogers and Van Den Avyle 1989; Hall 1995). Distributed from Nova Scotia to Florida, Atlantic menhaden undertake extensive north-south seasonal migrations and inshore-offshore movements along the eastern seaboard. Adult menhaden form large schools during feeding migrations, which often take them into nearshore coastal waters (ASMFC 1992). Juveniles use estuaries as nurseries for the first year of their lives (Curley *et al.* 1974). Most juveniles remain in their nursery estuaries until they attain a total length of 55–140 mm (2.2–5.5 in), after which time they begin migrating toward the adjacent shelf waters.

Striped Bass

The striped bass is an anadromous species that ranges along the Atlantic Coast from the St. Lawrence River, Canada, to the St. Johns River, FL, and in the Gulf of Mexico from Florida to Louisiana (Bigelow and Schroeder 1953). Major spawning populations exist in the Hudson River, Chesapeake Bay, and the Roanoke River-Albemarle Sound system. Descriptions of movements of striped bass during their first year in the Hudson River (McFadden *et al.* 1978*;* Dovel 1992), Delaware River, and Potomac River (Mihursky *et al.* 1976) generally are consistent. During their first summer, striped bass generally move shoreward and downstream of their natal spawning area to shallow-water nursery areas in the lower tidal river. In the fall, they move to deeper waters, and they may overwinter in the lower tidal river or leave the river completely to overwinter in bays or adjacent sounds. The following spring, yearling striped bass generally leave the overwintering areas, moving downstream toward the ocean. In summer, they are distributed throughout the tidal river and lower bays of their respective estuaries and are most abundant in the shore zone.

White Perch

White perch are endemic to estuaries along the Atlantic coast. The species has also been introduced or has invaded freshwater systems, including the lower Great Lakes and some mid-western reservoirs (Stanley and Danie 1983). White perch occur predominantly in fresh and brackish water from the Pee Dee River, South Carolina, to Cape Breton Island, Nova Scotia (Scott and Crossman 1973*;* Burgess 1980). They are most abundant between the Hudson River and the Chesapeake Bay region (Scott and Crossman 1973) where they are commonly distributed from the lower tidal reaches into the non-tidal portions of rivers and creeks. A semi-anadromous species, white perch undertakes seasonal

migrations to complete its life cycle. After overwintering in the deeper, more saline waters of bays and estuaries, adults move upriver in early spring to spawn in the freshwater and brackish areas (less than 3 ppt salinity) of the estuary (Beck 1995). The adults move into lower salinity foraging areas after spawning. After hatching, larval white perch begin to disperse downriver during the post-yolk-sac stage and gradually move shoreward to brackish nursery areas as they develop through the juvenile stage (Mansueti 1964*;* Dovel 1971). Shallow shore zones and embayments serve as the primary habitat for juvenile white perch (Mansueti 1964*;* Dovel 1971; Kelso 1994).

Winter Flounder

Winter flounder is a migratory species that inhabit estuaries of the Atlantic coast from Labrador south to Georgia (Able and Fahay 1998). Winter flounder exhibit small-scale seasonal migrations; spawning occurs in estuaries in the winter months followed by offshore movements in the summer months when estuary water temperatures begin to warm. Young of the year winter flounder remain in the estuary for most of their first year (Stone *et al.* 1994).

5.3.3 Summary

The majority of the fish collected in the North Cove, based on total length data, represent juveniles of their respective species - or fish spawned in 2003 (Able and Fahay 1998). The use of shallow water habitats by early lifestages of fish is a common occurrence, especially in coastal estuaries where many species spawn. Shallow water habitats provide protection from predators and foraging opportunities. Coves and backwater areas are also lower energy environments that promote the settling of sediments and nutrients. These areas often exhibit greater biological activity than adjacent water bodies.

The species collected in the North Cove are all common species in estuaries of the Middle Atlantic Bight and NY/NJ Harbor. The species composition is represented by a mix of resident and migratory species that are likely use cove habitat in different ways depending on life-stage, season, and time of day. The occurrence of juvenile bay anchovy and Atlantic menhaden suggests that the North Cove is currently providing foraging habitat for these pelagic species, as well as providing protection from predators.

6. FUNCTIONAL ASSESSMENT OF ECOLOGICAL COMMUNITIES

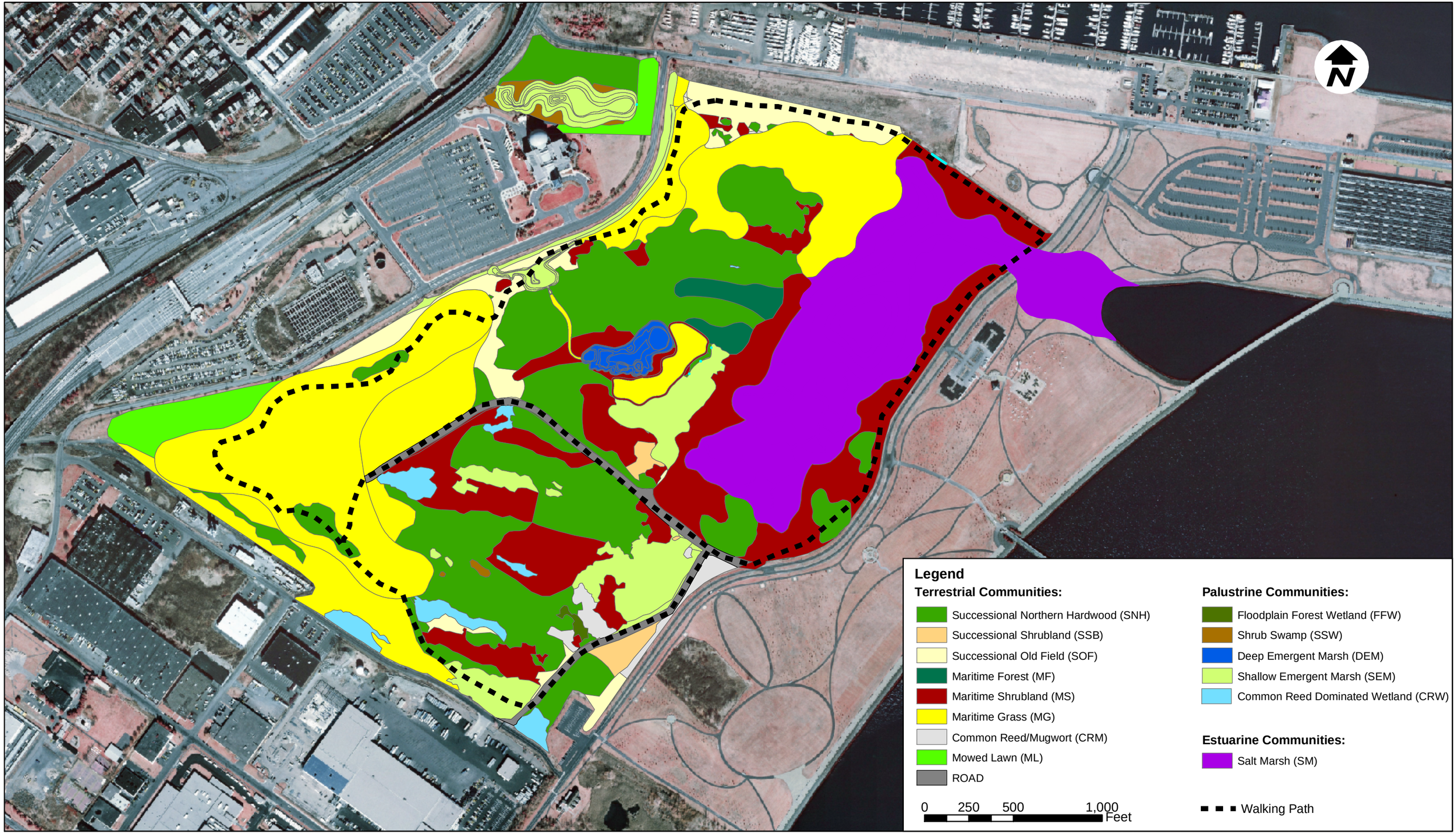
The following sections describe the general approaches that will be used to restore habitat in the Liberty State Park interior section. This is a preliminary description based on the proposed conceptual plan shown in Figure 6-1 and was developed from the goals and objectives established from the Needs and Opportunities Report (Appelton 2003), the CRIP, The Regional Reports (USACE, 2004), and the Liberty State Park General Management Plant (NJDEP 2001). Specific plan elements were developed through a series of meetings with NJDEP, Friends of Liberty State Park, USACE, ERC, NOAA (personal communication with Carl Alderson), and USFWS. In addition feedback was obtained from a public Scoping Meeting held at LSP Interpretive Center on 16 October 2002.

6.1 PROPOSED RESTORATION PLAN

There are four main elements illustrated in the conceptual plan (Figure 6-1). These include: (1) the restoration/creation of a 42-acre salt marsh within the Dredged Material Storage Area, along with a tidal connection; (2) the creation of a deep water emergent marsh system including treatment wetlands; (3) the enhancement of a complex of shallow water wetlands, and (4) the creation a berm grassland system for wildlife habitat in the Soil Stockpile Area.

6.1.1 Tidal Salt Marsh Restoration

The Salt Marsh restoration/creation area is located on the western side of the interior portion of the park and half way between the Liberty Science Center and the Bay. It is a rectangular area approximately 2,300 feet long by 82 feet wide or about 45-acres. This system will be constructed by excavating the central portion of this area down to approximately Mean Low Water (MLW). This elevation has been documented using tide gauges and reference wetlands in the biobenchmarking investigation. Based on the data, the elevation of -2.77 (NAVD) has been established as approximate MLW. Open channels will be about 1-2 feet deeper than this elevation to maintain permanent water flow and aquatic life access.



US Army Corps of Engineers®
New York District

Map Source: LMS (2003)
Aerial Photo Source: USACE (2002)

THE PORT AUTHORITY OF NY & NJ

Maximum Habitat Plan

Figure 6-1

Adjacent to the channels will be mudflats that will go from around MLW to approximately the mean tide level. The next highest zone would be Low Salt Marsh that will extend from mean high water (MHW) to mean tide or about 0.2 feet (NAVD, Liberty Park). This will be the largest and most productive area and will cover the majority of the 42-acre area. The preliminary conceptual plan includes a High Marsh area above MHW, which will grade into upland areas. The details of all these features will be established in the design phase of the project.

The wetland communities of the Salt Marsh restoration are as follows:

1. Tidal creek – open water channels below the mean tide level. Creek bottoms will be permanently flooded but the banks will be exposed at low tide; water will be brackish to saline (salinity between 0.5 and 30.0 ppt). Plants may include widgeon grass (Ruppia maritima) and various cyannobacteria.
2. Mudflat – semi-permanently flooded areas between midtide and MLW. Plants may include spongy arrowhead (Sagitaria calycina var. spongiosa) and tapegrass (Vallisneria americana).
3. Low marsh – intertidaly inundated areas between MHW and mid-tide. Plant community will be dominated by cordgrass (Spartina alterniflora)
4. High marsh – located between spring high tide and MHW. Plant community will be dominated by salt-meadow grass.
5. Maritime shrub – located in the transition zone between upland and high marsh. Plant community will be dominated with groundsel tree and saltmarsh elder.

The purpose of these salt marsh communities is to replace the mostly phragmites and mugwort dominated upland habitat, as well as to recreate habitat lost over the last 100 years as the underlying open water, mudflat and salt marsh were filled Therefore, the Salt Marsh restoration/creation area will consist primarily of tidal marsh and open water. Some restoration goals include:

- Restore functional values to the Hudson – Raritan Estuary, lost through the filling of the historic estuary, particularly: aquatic habitat function, wildlife habitat function and water quality treatment.
- Create a diverse pattern of tidal plant communities that, when added to the surrounding variety of communities will support a diverse wildlife community.
- Provide educational, recreational and aesthetic values to what is presently a fenced off area dominated by invasive species.

6.1.2 Freshwater Wetland System.

The freshwater wetland system, including a new Deep Emergent Marsh (DEM) will be located adjacent to the restored salt marsh. A sequence of wetlands will be created in an effort to bring additional freshwater to the interior zone. This deep, freshwater wetland will be constructed by grading upland areas of the site to elevations that will allow the diversion of freshwater from parking areas into the interior. Treatment wetlands will receive direct parking lot runoff and will be hydrologically connected to additional wetland areas. Final elevation of the downstream area will also be slightly below groundwater elevations. Groundwater elevations are being documented using monitoring data collected from the site (USACE – NYD 2004). Since the site is very flat, as a means of getting positive flow to the wetland, a sequence of treatment and freshwater wetlands will be designed as a series of slightly descending depressions, directing the water from the western NJ Transit parking area to the eastern deep water wetland. Runoff from the NJ Transit parking lot flows east toward the Liberty Science Center wetland (elevation approximately 6 feet). Groundwater elevation here is between 3 and 4 feet. The surface water elevation of the Liberty Science Center wetland varies form 5.5 to 6.6 feet. Flowing east, the water will pass through another biofiltering wetland and eventually be delivered to the permanently inundated DEM at an elevation between 4 and 5 feet. These wetlands will also receive surface flow directed from NJ Transit and Liberty Science Center parking areas west of the Liberty Blvd. via pipes and/or drainage swales that run along the road.

The sequence of wetlands will be graded to allow water to flow from one depression to the next. Log dikes, rock water falls, grass swales and or pipes will connect these wetlands and provide a natural appearance to the sequence. If groundwater contamination is detected, the pools and channels will be lined with a clay layer to prevent contamination to the wetland system. The deep water wetland will most likely have a weir for its outlet and will create a number of wetland zones. Below mean groundwater level will be a semi-permanently flooded zone; the zone between groundwater and the weir inlet will be seasonally flooded, and the zone between the invert and the overflow will be temporarily flooded. Above the overflow elevation will be a transition to upland areas.

Freshwater Wetland Plant Communities. Four wetland communities will be established among the sequence of wetlands leading to the DEM. These wetland communities will enhance existing habitat on the site that consists of uplands and shallow emergent wetlands that dry out at the end of the growing season. The DEM will provide a

permanent water supply for wildlife. Water depths within each community will vary spatially and seasonally.

From the wetter to the drier zones the four vegetation communities will include:

1. Palustrine emergent marsh – a semi-permanently flooded wetland excavated below the groundwater level
2. Wet meadow – a seasonally flooded community between groundwater level and invert
3. Scrub-shrub wetland – temporarily flooded wetland located between invert and overflow
4. Scrub-shrub or forested transition zone – located above overflow elevation
5. Upland (above top of weir)

6.1.3 Shallow Wetland Enhancement Area

The existing shallow wetlands will be enhanced to provide a greater diversity of habitats and a more dynamic hydrology. Some regrading may occur; however enhancement will primarily consist of vegetation management, such as invasive species control. Enhancements will allow more diverse communities and provide greater habitat functional value, particularly for amphibians which are not well represented in the area. Enhanced wetland plant communities will likely include: (1) emergent marshes, (2) open water depressions and (3) wet meadows. In addition, upland hummocks could be incorporated to provide topographic diversity and potential habitat for small mammals, amphibians and birds.

6.1.4 Upland Enhancement Area

Materials excavated from the creation of the Salt Marsh will be placed on the existing Soil Stockpile Area to create a berm that will buffer the noise from industrial development, will direct runoff to the existing wetlands and will enhance the visual aesthetics of the southern section of the park. Maritime Grassland species with small pockets of maritime trees will be planted to provide additional foraging and nesting habitat to the northern harrier and other grassland species. Existing SNH communities in the northern section of the LSP Restoration site will be managed to promote the succession of native hardwood species, and Maritime Forest species will be planted near the created Salt Marsh. Invasive species (i.e. tree-of-heaven) will be controlled in the

northern forested sections. In the southern section of the LSP Restoration site, existing forests will remain a mixture of successional northern hardwood and invasive species. A walking trail will be established around the perimeter and through the interior section of the LSP Restoration site, to allow public access for recreational and educational purposes.

6.2 METHODOLOGY

A functional analysis was performed on each Liberty State Park ecological community type for both the existing scenario and future project conditions scenario. Proposed project conditions were defined as the restoration of a salt marsh within the 42-acre Dredged Material Storage Area, along with the enhancement of on-site freshwater wetlands and the creation of deep emergent marshes. The analysis was developed to quantify impacts to community functions and values resulting from the proposed project. This evaluation had three major objectives: (1) identify the functions and values provided by the existing communities; (2) evaluate potential functions and values of the proposed restoration plan; and (3) compare the change in functional value of the proposed plan compared to existing conditions.

6.2.1 Evaluation Methodology Selection

There are a number of methodologies available for functional assessment of wetlands. The project team reviewed a number of wetland functional assessment systems, including the Federal Highway Administration (FHWA) system; USFWS Habitat Evaluation Procedure (USFWS 1980); the Hollands-Magee method (Hollands and Magee 1986, Brinson 1993); the USACE wetland evaluation technique (WET 2.0); the hydrogeomorphic (HGM) approach developed by USACE Waterways Experiment Station (WES); and the New England USACE Highway Methodology.

Because relatively detailed field data was available for the LSP site, the project team wanted a methodology that would enable the assessment of wetland functions and values by utilizing a combination of professional opinion and an interpretation of the data collected in the field. The Highway Methodology recommended by the US Army Corps of Engineers – New England Division was selected as the most appropriate methodology. This "Descriptive Approach" to wetland functions and values incorporates both wetland science and human judgment of values. It was ideally suited to Liberty State Park since of it incorporates field data into the assessment of both wetland and upland functions and values. It also enabled the ability to synthesize the information and develop habitat units for each ecological community as described below.

Other methods were evaluated and discarded for a variety of reasons. The HGM Approach (Smith *et al*. 1995) takes the lead as technically the most progressive and frequently applied methodology. The hydrogeomorphic approach has the greatest potential to improve the precision, consistency, reliability, and timeliness of functional assessments. The HGM approach was developed to satisfy the requirements of the 404 Program, but was also intended for use in a wide range of assessment situations. However, other than for riparian wetlands and tidal wetlands (Expert HGM) the system is still being developed. HGM Approach was not adequately tested for other communities (e.g. upland habitats). The use of this approach for Liberty State Park which requires the analysis of both tidal and freshwater wetlands along with an upland assessment would not be the most cost effective approach.

Initially, ERC applied the USACE Wetland Evaluation Technique (WET) to each of the ecological communities on the site. WET was developed by Adamus, et al. (1987) and revised by 17 federal agencies and the National Wetland Technical Council. While accepted by most federal agencies, the methodology has fallen out of favor and has now been replaced by other methods. WET was the first comprehensive approach to wetland assessment and uses "predictors" of physical, chemical or biological processes (ie. functions) and assigns value to function in terms of Social Significance.

WET has been specifically developed for wetlands, using features of a wetland's watershed, topography, vegetation, and other factors to estimate a probability rating of "High", "Moderate", or "Low" for each function. The team applied this approach to both wetlands and uplands on the site, but the standard questions are not relevant to upland conditions and the estimated functions were not realistic, thus the system was unusable.

The functional evaluation method selected utilized a modified version of the "Highway Methodology" recommended by the New England Division of USACE. Using the assessment teams best professional judgment in applying the "Highway Methodology", a functional analysis was prepared for each ecological community type within the LSP Restoration site. The analyzed wetland functions, and the rating criteria are described in Table 6-1.

Table 6-1. Description of Functions Evaluated with the Modified Highway Methodology Based on the Federal Highway Methodology[1]

Function/Value	
Groundwater Recharge/Discharge	
Description	This function considers the potential for a habitat to serve as a groundwater recharge and/or discharge area. It refers to the fundamental interaction between habitats and aquifers, regardless of the size or importance of either.
Considerations & Qualifiers	Downstream wells, impervious "substrate", water course association, signs of recharge, discharge or variable water levels, water temperature, piezometer data.
Ranking Criteria	"None" (0) = No qualifiers met; "Low" (1) = 1 to 3 qualifiers met; "Moderate" (2) = 4 to 8 qualifiers met; "High" (3) > 8 qualifiers met.
Floodflow Alteration	
Description	(Storage and Desynchronization) - This function considers the effectiveness of the habitat in reducing flood damage by water retention for prolonged periods following precipitation events and the gradual release of floodwaters. It adds to the stability of the habitat/wetland ecological system or its buffering characteristics and provides social or economic value relative to erosion and/or flood prone areas.
Considerations & Qualifiers	Location, size, capacity, flood storage potential of habitat, impervious surface area in watershed, downstream development and flooding history, water course association, vegetation and soils of habitat.
Ranking Criteria	"None" (0) = No qualifiers met; "Low" (1) = 1 to 5 qualifiers met; "Moderate" (2) = 6 to 9 qualifiers met; "High" (3) > 9 qualifiers met.

Table 6-1 (Page 2 of 7). Description of Functions Evaluated with the Modified Highway Methodology Based on the Federal Highway Methodology

Function/Value	
Freshwater Fish/Shellfish Habitat	
Description	This function considers the effectiveness of seasonal or permanent watercourses associated with the habitat in question for fish and shellfish habitat.
Considerations & Qualifiers	Forest cover in watershed, cover objects/shade vegetation present, width and depth of water body and watercourses, food, spawning habitat, water velocity and persistence able to support fish.
Ranking Criteria	"None" (0) = No qualifiers met; "Low" (1) = 1 to 4 qualifiers met; "Moderate" (2) = 5 to 9 qualifiers met; "High" (3) > 9 qualifiers met.
Sediment/Toxicant/Pathogen Retention	
Description	This function reduces or prevents degradation of water quality. It relates to the effectiveness of the habitat as a trap for sediments, toxicants, or pathogens in runoff water from surrounding uplands, or upstream eroding wetland areas.
Considerations & Qualifiers	Sources of sediment, toxicants and pathogens in watershed, slow moving water, fine grained or organic soils with aerobic areas present, wells present downstream, wetlands 50+ years old with no drainage ditches.
Ranking Criteria	"None" (0) < 2 qualifiers met; "Low" (1) = 2 to 5 qualifiers met; "Moderate" (2) = 6 to 10 qualifiers met; "High" (3) > 10 qualifiers met.

Table 6-1 (Page 3 of 7). Description of Functions Evaluated with the Modified Highway Methodology Based on the Federal Highway Methodology

Function/Value	
Nutrient Removal/Retention/Transformation	
Description	This function considers the effectiveness of the habitat as a trap for nutrients in runoff water from the surrounding uplands of contiguous habitats, and the ability of the habitat to process these nutrients into other forms of trophic levels. One aspect of this function is to prevent ill effects of nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers or estuaries.
Considerations & Qualifiers	Habitat size, excess nutrients in watershed, potential to trap sediments, presence of open water, saturated soils and organic/fine grained sediment deposits present, vegetation density, ability of biota to use nutrients.
Ranking Criteria	"None" (0) = No qualifiers met; "Low" (1) = 1 to 5 qualifiers met; "Moderate" (2) = 6 to 10 qualifiers met; "High" (3) > 10 qualifiers met.
Production Export (Nutrient)	
Description	This function evaluates the effectiveness of the habitat to produce food or useable products for man and living organisms.
Considerations & Qualifiers	Food sources, detritus and economic or commercial products present, wildlife and vegetation diversity and abundance, water course association, evidence of export, presence of flowering plants.
Ranking Criteria	"None" (0) = No qualifiers met; "Low" (1) = 1 to 5 qualifiers met; "Moderate" (2) = 6 to 9 qualifiers met; "High" (3) > 9 qualifiers met.

Table 6-1 (Page 4 of 7). Description of Functions Evaluated with the Modified Highway Methodology Based on the Federal Highway Methodology

Function/Value	
Sediment/Shoreline Stabilization	
Description	This function considers the effectiveness of a habitat to stabilize stream banks and shorelines against erosion.
Considerations & Qualifiers	Sediment sources present, indications of erosion, siltation, gradient and sharp banks, type and density of vegetation, high flow velocity, channelized flow, fetch and boating activity present.
Ranking Criteria	"None" (0) = No qualifiers met; "Low" (1) = 1 to 4 qualifiers met; "Moderate" (2) = 5 to 7 qualifiers met; "High" (3) > 7 qualifiers met.
Wildlife Habitat (Including Breeding, Foraging and Dependancey) based on Wildlife Matrix	
Description	These functions consider the ability of a habitat to support a diverse, native wildlife community.
Considerations & Qualifiers	Number of local wildlife species known to breed and/or forage in the habitat type, and number of species that depend upon that habitat type for survival.
Ranking Criteria	"None" (0) = Habitat type ranked below the 10th percentile in supporting large numbers of valuable species; "Low" (1) = Ranked between 10th and 40th percentile; "Moderate" (2) = Ranked between 40th and 70th percentile; "High" (3) = Ranked in the top 30th percentile.

Table 6-1 (Page 5 of 7). Description of Functions Evaluated with the Modified Highway Methodology Based on the Federal Highway Methodology

Function/Value	
Recreation (Consumptive and Non-Consumptive)	
Description	This value considers the suitability of the habitat to provide recreational opportunities such as hiking, canoeing, boating, fishing, hunting or other passive or active recreational activities. Consumptive opportunities consume or diminish the plants, animals or other resources that are intrinsic tot he habitat. Non-consumptive opportunities do not consume or diminish these resources.
Considerations & Qualifiers	Location in the watershed and community, ongoing recreational activities, wildlife habitat, watercourse association, open water present, visual/aesthetic quality, access, parking.
Ranking Criteria	"None" (0) < 2 qualifiers met or if no public access exists; "Low" (1) = 3 to 5 qualifiers met; "Moderate" (2) = 6 to 9 qualifiers met; "High" (3) > 9 qualifiers met.
Educational/Scientific Value	
Description	This value considers the suitability of the habitat as a site for an "outdoor classroom" or as a location for scientific study or research.
Considerations & Qualifiers	Disturbance level, threatened, endangered, rare species present, biota diversity, habitat value, location, habitat enhancement, watercourse association, open water present, safety hazards, access, parking, current uses.
Ranking Criteria	"None" (0) < 2 qualifiers met; "Low" (1) = 2 to 7 qualifiers met; "Moderate" (2) = 8 to 9 qualifiers met; "High" (3) > 8 qualifiers met.

Table 6-1 (Page 6 of 7). Description of Functions Evaluated with the Modified Highway Methodology Based on the Federal Highway Methodology

Function/Value	
Uniqueness/Heritage	
Description	This value considers the effectiveness of the habitat to provide certain special values. These may include archeological sites, critical habitat for endangered species, its overall health and appearance, its role in the ecological system of the area, its relative importance as a typical habitat for this geographic location. These functions are clearly valuable habitat attributes relative to aspects of public health, recreation, and habitat diversity.
Considerations & Qualifiers	Open water, flowering plants, critical habitat and unique features present, nearby development, location, access, parking, habitat variety, safety hazards, water quality, visual aspects, archeological sites, hydrology.
Ranking Criteria	"None (0)", 2 qualifiers met; "Low" (1) = 3 to 8 qualifiers met; "Moderate" (2) = 8 to 13 qualifiers met; "High" (3) > 13 qualifiers met.
Visual Quality/Aesthetics	
Description	This value considers the visual and aesthetic quality or usefulness of the habitat.
Considerations & Qualifiers	Habitat variety, vegetation and animal diversity, visible local land use, noise levels, odors, sight lines within the habitat, access, presence of trash, debris and signs of disturbance, development.
Ranking Criteria	"None" (0) = No qualifiers met; "Low" (1) = 1 to 4 qualifiers met; "Moderate" (2) = 5 to 7 qualifiers met; "High" (3) > 7 qualifiers met.

Table 6-1 (Page 7 of 7). Description of Functions Evaluated with the Modified Highway Methodology Based on the Federal Highway Methodology

Function/Value	
Endangered Species Habitat	
Description	This value considers the suitability of the habitat to support threatened or endangered species.
Considerations & Qualifiers	Threatened and/or endangered species present and/or area contains critical habitat for listed species.
Ranking Criteria	0 and "Low" (1) = No qualifiers met; "Moderate" (2) = 1 or 2 qualifiers met based on usage and observations; "High" (3) = 2 qualifiers met based on usage and observations.
Fish and Shellfish Habitat (Marine)	
Description	This function considers the effectiveness of the habitat to support marine resources such as fish, shellfish, marine mammals, and sea turtles.
Considerations & Qualifiers	Presence of special aquatic sites, spawning habitat, presence of commercially and/or recreationally important species or suitable habitat exists, prey for higher trophic levels present, migratory habitat for anadromous fish.
Ranking Criteria	"None" (0) = No qualifiers met; "High" (3) > 3 qualifiers met. No Ranking Criteria of 1 or 2 awarded.

Note: [1] – For details on the considerations and qualifiers, and for functional assessment evaluation sheets for the evaluated communities see Appendix F.

The Highway Methodology relies primarily on existing data to evaluate the functionality of wetlands. In an effort to tailor the analysis to the LSP Restoration site, which includes both upland and wetland ecosystems, additional emphasis was placed on habitat functions for wildlife. An additional analysis technique for wildlife habitat was developed using observations from the August 2003 wildlife surveys and published literature on habitat requirements for birds of the NY/NJ Harbor area. The following wildlife habitat functions were analyzed:

- Wildlife Breeding Habitat
- Wildlife Foraging Habitat
- Habitat Dependency (i.e. habitats that are required by local species)

6.2.2 Existing Data

Before conducting the functional assessment, the team reviewed existing data and regional ecological information. This effort included obtaining maps, aerial photographs, and other information necessary for evaluation of the wetlands and other ecological communities within a 5-mile radius. For this site, it included piecing together a total of six quads from the USGS (topography and drainage), NWI maps, and NJDEP freshwater wetland maps to allow regional analysis of other wetlands. The existing Natural Resource Inventory of Liberty State Park was also reviewed.

6.2.3 Modified Highway Methodology

Based on the field delineation, there are 12 existing ecological community types that cover 251.5 acres (Figure 2-3). It is anticipated that the final proposed plan will include all of these, and three additional community types.

The ecological communities evaluated include the following:

A. Wetland Communities:
   1. Floodplain Forest Wetland (FFW)
   2. Shrub Swamp (SSW)
   3. Shallow Emergent Marsh (SEM)
   4. Common Reed Dominated Wetland (CRW)
   5. Deep Emergent Marsh (DEM)*
   6. Salt Marsh (SM)*

B. Upland Communities:

1. Successional Northern Hardwoods (SNH)
2. Successional Shrublands (SS)
3. Successional Old Fields (SOF)
4. Common Reed/Mugwort (CRM)
5. Maritime Forest (MF)*
6. Maritime Shrubland (MS)
7. Maritime Grassland (MG)
8. Mowed Lawn (ML)
9. Road (ROAD)

* - Proposed conditions only

Each community was evaluated for the functions and values by the study team, which included ERC wetland scientists, wildlife biologists, and aquatic biologists. The methodology lists a number of statements (or "considerations/qualifiers") that are true for communities that perform each function. The decision concerning the ability of an ecological community to perform a function is related to the number of considerations/qualifiers that are true for that community. As a means to quantify these functions and generate scores for each community, a number was assigned to each function based on the number of considerations that were true. A range of 0 ("none") to 3 ("high") was assigned for each function. A list of the considerations/qualifiers for each function is presented in Appendix F along with the Wetland Function-Value Evaluation forms that were prepared for each community.

Each ecological community was assessed in terms of the functions and values according to the methodology explained above. Numerical scores were assigned to each of the 13 functions and values listed in the "Highway Method". These were then combined with the three additional wildlife functions.

6.2.4 Wildlife Functional Assessment

The functional values of each community type for wildlife were determined based on the number and type of species that use that community for foraging and breeding, and whether it is critical for the survival of one or more species. Using existing information on wildlife habitat requirements, a matrix was developed to quantify three functional habitat values for existing and proposed community types: wildlife breeding value, foraging value, and habitat dependency. The approach required ranking the relative

importance of wildlife species, identifying the ecological community types used by each species, and calculating functional values for each community type.

A comprehensive list of wildlife species known to exist near NY/NJ Harbor, including all species documented using the LSP Restoration site and species that may potentially use the site, was compiled. A total of 10 mammals, 145 birds, 2 amphibians and 4 reptiles were the basis for this analysis. Each species was assigned a rank for several biological characteristics, based on Brooks and Croonquist (1990) *Wetland, habitat, and trophic response guilds for wildlife species in Pennsylvania.*

Of the biological characteristics described by Brooks and Croonquist (1990), trophic level, habitat specificity and regulatory status were selected to determine relative species' importance. Table 6-2 provides a summary of the selected Brooks and Croonquist (1990) biological characteristics and rank designations, and the number of evaluated species that fall within each rank. A rank between 1 and 5 was assigned for trophic level, with higher numbers indicating species with specialized diets, and all carnivores, and lower ranks assigned to omnivores and herbivores. Habitat specificity ranks ranged from 1 to 5 with higher ranks assigned to species with specialized habitat requirements, and lower ranks assigned to species that are able to exist in degraded areas, or on the edges of communities. Endangered and threatened species were assigned a regulatory status rank of 5, commercially or recreationally valuable species were assigned a rank of 3, and other indigenous species were assigned a value of 1. The mean value of the ranks is the species value. Non-native species were considered to have no value.

Community types were evaluated as potential foraging or breeding grounds for each of the listed species. For each species that used a community for foraging, the community was assigned a score of 1 multiplied by the species value. The sum of this product for all evaluated species is considered a community's foraging value. Because breeding habitat is more critical than foraging habitat for many species, the communities were assigned a score of 2 multiplied by the species value for each of the species known to breed in that habitat type (breeding value). If a community type was considered obligate habitat for a species it was assigned a score of 2 multiplied by the species value of each species that requires the habitat (habitat specificity value). Table 6-3 shows an example of the functional analysis for wildlife in Maritime Shrubland communities within the LSP Restoration site, and Appendix F shows the data for all communities.

Table 6-2. Brooks and Croonquist (1990) biological characteristics and rank designations, and the number of evaluated wildlife species that fall under the ranks.

Trophic Level			Habitat Specificity			Regulatory Status		
Description	**Rank**	**No. of Species**	**Description**	**Rank**	**No. of Species**	**Description**	**Rank**	**No. of Species**
Carnivore, Specialist	5	5	Alpha species (Specialist)	5	24	Endangered/ Threatened	5	18
Carnivore, Generalist	4	85	Gamma species (Landscape dependent)	3	58	Commercial, Recreational value	3	17
Herbivore, Specialist	3	5	Beta species (Generalist)	1	77	Other Native species	1	116
Herbivore, Generalist	2	10				Exotics	0	8
Omnivore	1	54						

To standardize the results to fit within the Modified Highway Methodology used to evaluate the other vegetative community functions, the foraging, breeding and habitat specificity functional values were translated into rankings between 0 ("none") to 3 ("high"). Community types that ranked in the lowest 10th percentile for a function were considered to have no habitat value for that function. Communities that ranked between the 10th and 40th percentile were considered to have low value, and those that ranked between the 40th and 70th were considered to have moderate value. High functional values were assigned to communities that ranked higher than 70th percentile.

6.2.5 Evaluation

The results of the analysis were evaluated in two ways, for two purposes: (1) to determine the cumulative functional values for the existing and proposed conditions, in an effort to estimate whether implementation of the proposed restoration plan will change the effectiveness of the LSP Restoration site in performing any of the 16 evaluated functions; and, (2) to calculate the relative value of each community type, in order to assign a number of "habitat units".

The cumulative functional values of the LSP Restoration site (for both existing conditions and the proposed conceptual plan), were calculated by multiplying each functional score for a community by its acreage, and summing the products for each of the 16 functional categories.

The relative value of each community type was calculated by summing the 16 functional values for that community type, which provided the number of habitat units per acre of habitat. The total number of habitat units for each community type is the product of the score per acre and the number of acres. The number of habitat units for existing and proposed conditions can be calculated as the sum of the total habitat units for each community type.

6.3 EVALUATION RESULTS

Hydrologically isolated wetlands and several drainage ditches (see section 2.2 Regulated Wetland Communities) are the most common wetland communities on the site. Results from the analysis indicate that the functional value of the existing conditions will be improved from a total of 3,568.8 habitat units within the LSP Restoration site to 5,601.2 habitat units if the proposed restoration plan is implemented.

Table 6-3. Example of wildlife functional analysis for Maritime Shrubland communities at Liberty State Park[1], Jersey City, NJ.

Community Type: Maritime Shrubland

Common Name	Habitat Specificity[2]	Trophic Level[2]	Status[2]	Species. Value	Breeding	Foraging	Hab. Dep.[3]
Cottontail Rabbit	1	2	3	2.00	--	2.00	--
Feral Cat	1	4	0	0.00	--	0.00	--
Feral Dog	1	4	0	0.00	--	0.00	--
Meadow Vole	1	2	1	1.33	2.67	1.33	--
White-footed Mouse	1	1	1	1.00	2.00	1.00	--
American Crow	1	1	1	1.00	--	1.00	--
American Goldfinch	1	2	1	1.33	2.67	1.33	--
American Redstart	1	4	1	2.00	--	2.00	--
American Robin	1	1	1	1.00	2.00	1.00	--
American Tree Sparrow	1	2	1	1.33	--	1.33	--
American Woodcock	3	5	3	3.67	7.33	3.67	--
Brown-headed Cowbird	1	1	1	1.00	2.00	--	--
Cedar Waxwing	1	3	1	1.67	--	1.67	--
Common Yellowthroat	1	4	1	2.00	4.00	2.00	--
Cooper's Hawk*	3	4	5	4.00	--	4.00	--
Downy Woodpecker	1	4	1	2.00	--	2.00	--
Golden-crowned Kinglet	3	4	1	2.67	--	2.67	--
Gray Catbird	1	1	1	1.00	2.00	1.00	--
Mourning Dove	1	2	1	1.33	2.67	--	--
Savannah Sparrow*	1	1	5	2.33	--	2.33	--
Sharp-shinned Hawk	3	4	1	2.67	--	2.67	--
Snowy Owl	3	4	1	2.67	--	2.67	--
Song Sparrow	1	1	1	1.00	2.00	1.00	--
Tree swallow	5	4	1	3.33	--	3.33	--
Wild Turkey	3	1	3	2.33	--	2.33	--
Yellow Warbler	1	4	1	2.00	4.00	2.00	--
Eastern Garter Snake	1	4	1	2.00	4.00	2.00	--
Northern Brown Snake	1	4	1	2.00	4.00	2.00	--
Additional species							
Total Functional Value ($\sum$ of functional values for all species)					**49.33**	**95.33**	**0.00**

Notes: [1] – List does not represent total species list for Maritime Shrubland communities

[2] – Based on Brooks and Croonquist (1990): *Wetland, habitat, and trophic response guilds for wildlife species in Pennsylvania.*

[3] – Habitat Dependency

* - New Jersey State Endangered or Threatened Species

Each of the evaluated functions will improve under the proposed maximum habitat plan. Public access will be allowed, increasing the recreation functional score from 5.6 habitat units under existing conditions to 390.6 under the proposed plan. Sediment and toxicant reduction, marine fish habitat, and shoreline stabilization will also be increased substantially under the proposed plan. The change in functional values for the existing and proposed conditions is illustrated in Figure 6-2.

In general, results from the analysis indicate that wetlands score higher than uplands for most functions. The number of habitat units (per acre) ranges from 0 for roadways to 41 for Salt Marsh. Emergent marshes scored among the communities with the most value; Deep Emergent Marsh communities have 39 habitat units per acre. Shallow Emergent Marshes have 27 habitat units per acre under the existing conditions, and with improved access and invasive species control, will have 38 habitat units per acre under the proposed conditions. Cultural communities scored the lowest of all community types. Mowed Lawn and Common Reed/Mugwort communities have 6 and 7 habitat units per acre, respectively. Common Reed-dominated Wetlands have 14 habitat units per acre. Results of the Highway Methodology and wildlife functional assessment are summarized in Table 6.4, and are discussed below.

6.3.1 Wetland Communities

Floodplain Forest Wetland (FFW). The principal FFW functions are flood flow alteration and groundwater recharge. The flood flow alteration function is reasonably significant due to the absence of a downstream outlet, and the presence of small ponded areas throughout the wetland. Effective flood storage is small or non-existent upslope of or above the wetland. The wetland loses water to the underlying strata via infiltration and contributes to groundwater recharge. Secondary functions of FFW communities are production export, and wildlife habitat. Because this community is unique on the site, once the park is open to the public it would provide passive recreation, educational and scientific value, and visual quality and local uniqueness.

The functional score of FFW was 24 habitat units (per acre), however since the area is so small, the total score for existing conditions was only 6.2. Under the proposed conditions, however, increased public access, recreational and scientific value will increase the functional score slightly to 25 habitat units per acre, and the FFW will have a total of 6.4 habitat units (Table 6-4).

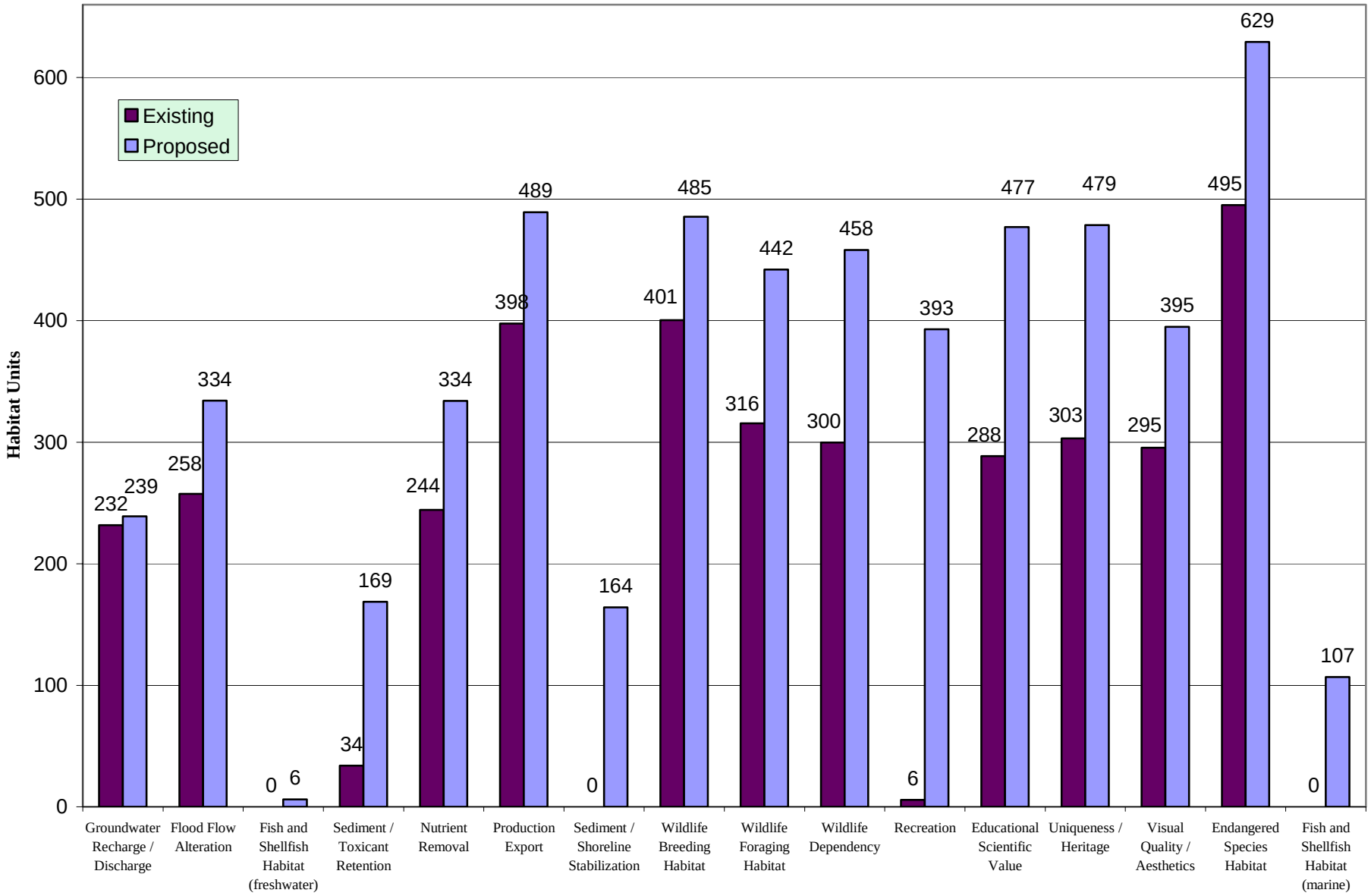


Figure 6-2. Cumulative functional values for existing conditions and the proposed habitat restoration plan at the Liberty State Park Restoration site, Jersey City, NJ.

Table 6-4. Functional assessment scores for existing and proposed conditions at Liberty State Park, Jersey City, NJ

Evaluated Ecological Community	Acreage	Groundwater Recharge / Discharge	Flood Flow Alteration	Fish and Shellfish Habitat (freshwater)	Sediment / Toxicant Retention	Nutrient Removal	Production Export	Sediment / Shoreline Stabilization	Wildlife Breeding Habitat	Wildlife Foraging Habitat
Existing Conditions										
Terrestrial Communities										
Successional Northern Hardwood (SNH)	62.62	1	1	0	0	1	2	0	2	2
Successional Shrubland (SSB)	4.22	1	1	0	0	1	2	0	1	2
Successional Old Field (SOF)	49.60	1	1	0	0	1	2	0	3	2
Common Reed/Mugwort (CRM)	38.69	1	1	0	0	1	1	0	0	0
Mowed Lawn (ML)	5.63	1	1	0	0	1	1	0	0	0
Maritime Forest (MF)	0.00	--	--	--	--	--	--	--	--	--
Maritime Grassland (MG)	14.55	1	1	0	0	1	2	0	3	2
Maritime Shrubland (MS)	22.03	1	1	0	0	1	2	0	2	1
Road (ROAD)	3.06	0	0	0	0	0	0	0	0	0
Palustrine Communities										
Forested Floodplain Wetland (FFW)	0.26	2	2	0	1	1	2	0	3	3
Shrub Swamp Wetland (SSW)	0.13	2	1	0	1	1	2	0	2	1
Shallow Emergent Marsh (SEM)	10.23	2	2	0	2	2	2	0	2	3
Deep Emergent Marsh (DEM)	0.00	--	--	--	--	--	--	--	--	--
Common Reed Wetland (CRW)	13.04	1	3	0	1	2	2	0	1	0
Estuarine Communities										
Salt Marsh (SM)	0.00	--	--	--	--	--	--	--	--	--
Total	224.06									

Table 6-4 (page 2 of 4). Functional assessment scores for existing and proposed conditions at Liberty State Park, Jersey City, NJ.

Evaluated Ecological Community	Acreage	Wildlife Dependency	Recreation	Educational Scientific Value	Uniqueness Heritage	Visual Quality / Aesthetics	Endangered Species Habitat	Fish and Shellfish Habitat (marine)	Habitat Units per Acre	Total Habitat Units
Existing Conditions										
Terrestrial Communities										
Successional Northern Hardwood (SNH)	62.62	2	0	2	2	1	3	0	**19**	**1189.78**
Successional Shrubland (SSB)	4.22	0	0	1	1	1	1	0	**12**	**50.64**
Successional Old Field (SOF)	49.60	2	0	1	1	2	3	0	**19**	**942.38**
Common Reed/Mugwort (CRM)	38.69	0	0	1	1	1	0	0	**7**	**270.80**
Mowed Lawn (ML)	5.63	0	1	0	0	1	0	0	**6**	**33.78**
Maritime Forest (MF)	0.00	--	--	--	--	--	--	--	**0**	**0.00**
Maritime Grassland (MG)	14.55	3	0	1	2	2	3	0	**21**	**305.55**
Maritime Shrubland (MS)	22.03	0	0	1	1	1	3	0	**14**	**308.46**
Road (ROAD)	3.06	0	0	0	0	0	0	0	**0**	**0.00**
Palustrine Communities										
Forested Floodplain Wetland (FFW)	0.26	3	0	2	2	1	2	0	**24**	**6.20**
Shrub Swamp Wetland (SSW)	0.13	2	0	1	2	1	2	0	**18**	**2.41**
Shallow Emergent Marsh (SEM)	10.23	3	0	2	2	2	3	0	**27**	**276.21**
Deep Emergent Marsh (DEM)	0.00	--	--	--	--	--	--	--	**0**	**0.00**
Common Reed Wetland (CRW)	13.04	0	0	1	1	1	1	0	**14**	**182.56**
Estuarine Communities										
Salt Marsh (SM)	0.00	--	--	--	--	--	--	--	**0**	**0.00**
Total	224.06						**Number of Existing Habitat Units**			**3,568.77**

Table 6-4 (Page 3 of 4). Functional assessment scores for existing and proposed conditions at Liberty State Park, Jersey City, NJ

Evaluated Ecological Community	Acreage	Groundwater Recharge / Discharge	Flood Flow Alteration	Fish and Shellfish Habitat (freshwater)	Sediment / Toxicant Retention	Nutrient Removal	Production Export	Sediment / Shoreline Stabilization	Wildlife Breeding Habitat	Wildlife Foraging Habitat
Proposed Conditions										
Terrestrial Communities										
Successional Northern Hardwood (SNH)	50.83	1	1	0	0	1	2	0	2	2
Successional Shrubland (SSB)	1.53	1	1	0	0	1	2	0	1	2
Successional Old Field (SOF)	9.21	1	1	0	0	1	2	0	3	2
Common Reed/Mugwort (CRM)	1.96	1	1	0	0	1	1	0	0	0
Mowed Lawn (ML)	5.45	1	1	0	0	1	1	0	0	0
Maritime Forest (MF)	2.61	1	1	0	0	1	2	0	3	3
Maritime Grassland (MG)	55.42	1	1	0	0	1	2	0	3	2
Maritime Shrubland (MS)	34.58	1	1	0	0	1	2	0	2	1
Road (ROAD)	3.06	--	--	--	--	--	--	--	--	--
Palustrine Communities										
Forested Floodplain Wetland (FFW)	0.26	2	2	0	1	1	2	0	3	3
Shrub Swamp Wetland (SSW)	0.82	2	1	0	1	1	2	0	2	1
Shallow Emergent Marsh (SEM)	17.04	2	3	0	3	3	3	3	2	3
Deep Emergent Marsh (DEM)	2.02	1	3	3	3	3	3	3	0	3
Common Reed Wetland (CRW)	3.62	1	2	0	1	2	2	0	1	0
Estuarine Communities										
Salt Marsh (SM)	35.64	1	3	0	3	3	3	3	2	3
Total	224.05									

Table 6-4 (page 4 of 4). Functional assessment scores for existing and proposed conditions at Liberty State Park, Jersey City, NJ.

Evaluated Ecological Community	Acreage	Wildlife Dependency	Recreation	Educational Scientific Value	Uniqueness / Heritage	Visual Quality / Aesthetics	Endangered Species Habitat	Fish and Shellfish Habitat (marine)	Habitat Units per Acre	Total Habitat Units
Proposed Conditions										
Terrestrial Communities										
Successional Northern Hardwood (SNH)	50.83	2	2	3	2	1	3	0	**22**	**1118.26**
Successional Shrubland (SSB)	1.53	0	1	1	1	1	1	0	**13**	**19.83**
Successional Old Field (SOF)	9.21	2	2	2	2	2	3	0	**23**	**211.83**
Common Reed/Mugwort (CRM)	1.96	0	1	1	1	1	0	0	**8**	**15.72**
Mowed Lawn (ML)	5.45	0	1	0	0	1	0	0	**6**	**32.70**
Maritime Forest (MF)	2.61	2	2	2	2	1	3	0	**23**	**60.03**
Maritime Grassland (MG)	55.42	3	2	2	2	2	3	0	**24**	**1330.08**
Maritime Shrubland (MS)	34.58	0	1	1	2	1	3	0	**16**	**553.28**
Road (ROAD)	3.06	--	--	--	--	--	--	--	**0**	**0.00**
Palustrine Communities										
Forested Floodplain Wetland (FFW)	0.26	3	1	2	2	1	2	0	**25**	**6.46**
Shrub Swamp Wetland (SSW)	0.82	2	0	1	2	1	2	0	**18**	**14.76**
Shallow Emergent Marsh (SEM)	17.04	3	2	2	3	3	3	0	**38**	**647.52**
Deep Emergent Marsh (DEM)	2.02	3	2	3	3	3	3	0	**39**	**78.78**
Common Reed Wetland (CRW)	3.62	0	1	1	1	1	1	0	**14**	**50.68**
Estuarine Communities										
Salt Marsh (SM)	35.64	3	2	3	3	3	3	3	**41**	**1461.24**
Total	224.05						**Number of Proposed Habitat Units**			**5,601.17**

Shrub Swamp Wetland (SSW). Primary SSW functions are groundwater recharge and wildlife breeding habitat. The physical configuration of the wetlands confirms the groundwater recharge function. The wetlands have no defined inlet, but trap precipitation and some runoff with steep sloping areas adjacent to the wetlands; when water level raises they overflow and water moves laterally into the adjacent pervious soil. This recharges the groundwater.

The functional score of SSW was 18 habitat units (per acre), and the 0.1 acre of SSW in the existing plan have a total number of 2.4 habitat units. Under the proposed conditions, the acreage of SSW will increase to 0.8, and the functional value will be 14.8 (Table 6-4).

Deep Emergent Marsh (DEM). The principal DEM functions are wildlife habitat, flood flow alteration and nutrient removal. There is no existing DEM habitat on the site; however, a DEM system is proposed for the restoration. Wildlife function is the primary reason for adding this wetland community to the proposed restoration plan. Creating a permanent pool of water where presently none exists will result in a significant increase in wildlife function throughout the year. Both wildlife foraging habitat and wildlife dependency functions will increase due to the addition of a range of hydrologic conditions and habitat diversity to the site.

The flood flow alteration function is reasonably significant due to the restricted outlet to the downstream side of the wetland created by a spillway. The area of the wetland is large relative to its watershed (+22 acres watershed to +5 acres wetland), and detention will occur in small ponded areas included in the wetland design, and in the well-saturated hydric soils. The wetland will receive and retain overland or sheet flow runoff from the surrounding uplands and two catchment areas (NJ Transit lot and Liberty Science Center). Effective flood storage is small or non-existent for the catchment areas that will be diverted to this system.

Nutrient removal is another principal function of the DEM, because of its relative size within the watershed, the presence of open water, and its potential to trap sediments. The physical configuration of the wetland, such as the various zones and the presence of a spillway, gives this wetland high potential to trap nutrients that are currently being discharged directly into the bay.

Secondary functions of this wetland include groundwater discharge, sediment and toxicant removal, production export, passive recreation, educational and scientific value, visual quality and local uniqueness.

The functional score of DEM communities is 39 habitat units per acre. The proposed plan will include a 2.0-acre DEM, which will receive a total functional score of 78.8 habitat units (Table 6-4).

Shallow Emergent Marsh (SEM). SEMs perform several of the same wetland functions as DEM wetlands. SEMs support a large abundance of breeding ducks and other waterfowl because complexes of depressional wetlands and surrounding uplands provide these birds with the diverse habitat they need for feeding, breeding, nesting, and brood-rearing. SEM wetlands are also important stopovers and staging areas for migratory species.

Many depressional wetlands, like SEM, are vernal pools that experience temporal variation in hydrology, drying out for a part of the year. Annual drying precludes organisms that require permanent water and favors species adapted to fluctuating water levels. These conditions are favorable for breeding amphibians.

Shallow Emergent Marshes also perform some groundwater recharge. Detention occurs in small ponded areas throughout the wetland and in the well-saturated hydric soils. Field observation with hand augers indicates that some of these wetlands are underlain by impervious layer that may restrict water loss to the deeper ground water system. In the absence of surface water outlets and ground water connections, water loss is primarily through evapotranspiration. However, water removal can occur through shallow flows, even when movement to deeper groundwater system is restricted. Additional data is required to determine whether groundwater plays a role in SEM wetlands within the LSP Restoration site.

The functional score for existing SEM wetlands is 27 habitat units per acre under existing conditions. Approximately 10.2 acres of SEM exists within the LSP Restoration site, and the total habitat units are 276.2. Increased public access, recreational and scientific value, and improved hydrological regime in the proposed future conditions increases the functional score for SEM to 38 habitat units per acre. The proposed plan increases the

acreage of SEM wetlands to 17.0, and the total number of habitat units to about 647.5 (Table 6-4).

Salt Marsh (SM). The proposed salt marsh system will be the largest wetland system on the site. It will be located in the Dredged Material Storage Area. Primary functions of SM communities are production export, flood flow alteration, water quality, wildlife habitat and aquatic habitat. These functions in conjunction with its large proposed acreage make this the most significant system within the restored plan. It has been frequently asserted that salt marshes are amongst the world's most productive ecosystems (Whittaker 1975). Important values to this system will include primarily education/scientific value and visual quality/aesthetics. A secondary value will be passive recreation considering its proximity to and access from the nearby Interpretive Center.

Salt Marsh communities received a functional score of 41 habitat units per acre, and the proposed 35.6 acre marsh will have a total of 1,461.2 habitat units. This habitat rating is the highest for any community as is the accrued total habitat units.

Common Reed-dominated Wetland (CRW). The principal function and values associated with these wetlands are flow alteration and retention transformation. The flat nature of the site and low runoff gives these wetlands a limited potential for trapping sediment and only a limited capacity for nutrient removal. The hydric soils have some ability for absorbing and retaining water, giving the wetlands a limited function of flood flow alteration.

Of all wetlands, CRW received the lowest functional score of 14 habitat units per acre in both the existing and the proposed restored conditions. The 13.0 existing acres of CRW have a total 182.6 habitat units. The proposed restoration plan calls for the removal of 9.4 CRW acres, and the total number of habitat units will be reduced to 50.7 (Table 6-4).

6.3.2 Upland Communities

Successional Northern Hardwoods (SNH). The principal functions of SNH communities are habitat value, production export and endangered species habitat. The total functional value of this community type under existing conditions is 19 habitat units per acre, and the total value is 1,189.8 habitat units for the 62.6 acres. Under the proposed plan, public access, recreational and scientific values are increased, resulting in the increased score of 22 habitat units per acre. Acreage of the SNH communities will decrease under the

proposed restoration plan, and the 50.8 acres will have a total of 1,118.3 habitat units (Table 6-4).

Successional Shrublands (SSB). Relatively small areas of SSB are currently located along the southeast boundary of the LSP Restoration site. Based on functional assessment results, these areas provide production export, wildlife foraging habitat including some endangered species' habitat. Contributing reasons for these functions are: they provide a source of food for wildlife, detritus development is present, vegetation density is high, and evidence of wildlife, including endangered species was documented.

Under existing conditions, SSB communities have a total of 50.6 habitat units for the 4.2 acres. Implementation of the proposed restoration plan will decrease the size of SSB to 1.5 acres and the functional score to 19.8 habitat units (Table 6-4).

Successional Old Field (SOF). SOF communities provide several functions at a moderate level, including production export, wildlife foraging habitat and dependency, and aesthetics. SOF also provides quality Endangered and Threatened Species (ETS) and wildlife breeding habitat. Grassland obligate species, such as the northern harrier, breed in SOF communities.

The functional score for SOF communities is 19 habitat units per acre under existing conditions, and the total score for the existing 49.6 acres of SOF is 942.4 habitat units. Under the proposed restoration plan, increased recreational and scientific value will result in an increased functional score of 23 habitat units per acre. Implementation of the restoration plan will decrease the habitat units assigned to SOF, because the plan calls for a reduction in SOF acreage. The total functional score of SOF will be 211.8 habitat units (Table 6-4).

Maritime Forest (MF). The principal functions of MF communities are wildlife breeding habitat, wildlife foraging habitat and endangered species habitat. Secondary functions include production export and uniqueness and heritage.

This community type will have a score of 23 habitat units per acre. Under the proposed restoration plan, approximately 2.6 acres of MF will be created, resulting in a total of 60.0 habitat units (Table 6-4).

Maritime Shrubland (*MS*). Primary functions of MS communities are production export and wildlife breeding habitat at a moderate level and endangered species habitat at a high level. Contributing factors for these functions and values are the same as those identified for SSB above. In the future, MS communities could offer a moderate level of heritage function based on the opportunity for wildlife observation, scientific research and proximity to and access from the nearby Interpretive Center.

Existing MS communities have a moderately low functional score of 14 habitat units per acre. The total score for the 22.0 acres of MS communities on the site is 308.5 habitat units. Proposed restoration implementation will increase the size of MS communities to 34.6 acres. Increased recreational and scientific value of these communities will increase the score to 16 habitat units per acre, and the total score under the proposed restoration will be 553.3 habitat units (Table 6-4).

Maritime Grassland (*MG*). Primary functions of MG communities include wildlife breeding habitat, wildlife dependency and endangered species habitat. Secondary functions include production export, wildlife foraging habitat, uniqueness and heritage, and aesthetics. As with SOF, the presence of wildlife including ETS and the identification of critical breeding habitat for northern harrier in these communities are the primary reason for its high rating for these functions.

The functional score for existing MG communities is 21 habitat units per acre, and the total score for the 14.6 acres is 305.6 habitat units. Under the proposed restoration plan, increased public access, recreational and scientific values will increase the score to 24 habitat units per acre of MG. Because Maritime Grassland is critical breeding habitat for the northern harrier, the proposed plan calls for an increase in the size of MG communities to 55.4 acres, resulting in a total score of 1,330.1 habitat units (Table 6-4).

Common Reed/Mugwort (*CRM*). CRM was identified throughout the LSP Restoration site with large areas concentrated in the northern portion of the site and the Dredged Material Storage Area. This community type provides limited functions (groundwater recharge and discharge, flood flow alteration, nutrient removal, aesthetics and production export) at a low level. None of the remaining functions assessed are provided by CRM communities.

The functional score for existing and future CRM communities is 7 habitat units per acre, and the total functional score for the existing 38.7 acres is 270.8 habitat units. The proposed restoration plan calls for the removal of most of these communities, leaving only about 2 acres. Increased public access will raise the functional value of CRM to 8 habitat units per acre. The total functional value for the proposed plan is 15.7 habitat units (Table 6-4)

Mowed Lawn (ML). ML, which is found along the northern boundary of the LSP Restoration site and surrounding the North Cove, provides six functions at a low level including ground water recharge, flood flow alteration, nutrient removal, production export, recreation and aesthetics.

The functional score for existing and future ML is 6 habitat units per acre, and the 5.6 existing acres have a functional score of 33.8 habitat units. The proposed plan calls for a decrease in ML acreage of ML to 5.5 acres, resulting in an increase functional score of 32.7 habitat units.

Road (ROAD). The roadways in the LSP Restoration site provide no functional value. The existing 3.1 acres of roadway will be converted to a walking trail under the proposed restoration plan (Table 6-4).

6.4 SUMMARY

The project's restored, created and enhanced wetlands are proposed to restore historic losses of wetland functions and values while enhancing the developing upland communities and their associated wildlife. The salt marsh will add an entirely new host of functions and values that are not currently present on the LSP Restoration site, particularly aquatic habitat. The deep emergent marsh will provide new habitat functions and values that presently do not exist, including deep water habitat for waterfowl. The shallow persistent open water depressions will provide the important function of groundwater recharge and habitat value. The palustrine emergent marsh will provide bird, mammal and amphibian habitat value. The wet meadow community along the salt marsh will assist important wetland functions of wildlife habitat and flood storage. The scrub-shrub wetland will provide flood flow attenuation to adjacent areas wildlife habitat value. The entire restoration plan provides upland, and wetland complex that will be a mosaic of habitats similar to what is present with two additional important ecosystems, the

saltmarsh system and deep water marsh system. Opening the site to the public with a system of walkways and observation platforms will add both aesthetic and educational value to the Liberty State Park interior that does not exist today. Table 6-4 and Figure 6-2 provide a graphic representation of changes in vegetation community functions and values between existing conditions and the proposed ecological restoration plan.

7. REFERENCES

Able, K.W. and F.P. Fahay. 1998. The First Year in the Life of Estuarine Fishes in the Middle Atlantic Bight. Rutgers Univ. Press, New Brunswick, NJ 400 p.

Adamus, P.R., E.J. Clairain, Jr., R.O. Smith, and R.E. Young. 1987. Wetland Evaluation Technique (WET): Volume II: Methodology. Operational Draft Technical Report FHWA-IP-88-029. US Army Waterways Experiment Station. Vicksburg, MI. 279pp.

Allen, D.M., W.S. Johnson and V. Ogburn-Matthews. 1995. Trophic relationships and seasonal utilization of salt-marsh creeks by zooplanktivorous fishes. Environmental Biology of Fishes. 42:37-50.

Andrle, R.F., and J.R. Carroll. 1988. The Atlas of Breeding Birds in New York State. Cornell University Press. 550 pp.

Aslop, Fred J. III. 2001. Smithsonian Birds of North America. DK Publishing, Inc. New York, NY. 1008p.

ASMFC (Atlantic States Marine Fisheries Commission). 1992. Fishery management plan for Atlantic menhaden. 1992 revision. September 1992.

Baicich, P.J., and C.J.O. Harrison. 1997. A guide to the nests, eggs, and nestlings of North American Birds. Academic Press, New York, NY.

Banner, A., and S. Schaller. 2001. USFWS Gulf of Maine Watershed Habitat Analysis. Gulf of Maine Program. Retrieved July 31, 2003, from

http://r5gomp.fws.gov/gom/habitatstudy/Gulf_of_Maine_Watershed_Habitat_Analysis.htm

Beans, Burce E. and Larry Niles. 2003. Endangered and threatened wildlife in New Jersey. Rutgers University Press. New Brunswick, NJ. 303p.

Beck, S. 1995. White perch. Pages 235-243. in L.E. Dove and R.M. Nyman. editors. Living resources of the Delaware estuary. The Delaware Estuary Program.

Bellrose, F.C. 1980. Ducks, Geese, and Swans of North America. Harrisburg, PA: Stackpole Books. 540 pp.

Bigelow, H. B., and W. C. Schroeder. 1953. Fishes of the Gulf of Maine. Bull. U.S. Fish Wildl. Serv., Fish. Bull. 74.

Botton, M. L. 1995. "Horseshoe crab." In Living Resources of the Delaware Estuary, edited by L. E. Dove and R. M. Nyman, 51–57. Philadelphia: U.S. Environmental Protection Agency

Brinson, M.M. 1993. "A Hydrogeomorphic Classification for Wetlands," Technical Report WRP-DE-4, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Britt, M. 2003. Half-year report summarizing bird observations at Liberty State Park. Unpublished report submitted to F. Gallagher, NJDEP, Division of Parks and Forestry.

Bull, J. 1974. Birds of New York State. Comstock Publishing, Ithaca, NY.Bull, J., and J. Farrand, Jr. 1977. The Audubon Society field guide to North American Birds. Alfred A. Knopf, New York, NY.

Bull, J., and J. Farrand, Jr. 1977. The Audubon Society field guide to North American Birds. Alfred A. Knopf, New York, NY.

Burgess, G. H. 1980. Morone americana (Gmelin), white perch. Page 573 in D.S. Lee, et al., editors. Atlas of North American freshwater fishes. N.C. State Mus. Nat. Hist., Raleigh.

Clark, K.E., and L.A. Gelvin-Innvaer. 1995. Migratory shorebirds. Pages 441-447 in L.E. Dove and R.M. Nyman (eds.), Living Resources of the Delaware Estuary. The Delaware Estuary Program.

Connecticut Department of Environmental Protection. 2003. Wildlife in Connecticut Endangered and Threatened Species Series: Long-Eared Owl (Asio otus). Bureau of Natural Resources, Wildlife Division. Hartford, CT. http://dep.state.ct.us/burnatr/wildlife/factshts/leowl.htm. January 2000.

Connecticut Department of Environmental Protection. 2003. Wildlife in Connecticut Endangered and Threatened Species Series: Northern Harrier (Circus cyaneus). Bureau of Natural Resources, Wildlife Division. Hartford, CT. http://dep.state.ct.us/burnatr/wildlife/factshts/harrier.htm. January 2000.

Connecticut Department of Environmental Protection. 2003. Wildlife in Connecticut Endangered and Threatened Species Series: Short-Eared Owl (Asio flammetus). Bureau of Natural Resources, Wildlife Division. Hartford, CT. http://dep.state.ct.us/burnatr/wildlife/factshts/searowl.htm. January 2000.

Cornell Lab of Ornithology. 1997. Birds in forested landscapes. Cornell Lab of Ornithology, Ithaca, NY.

Curley, J.H., R.P. Lawton, D.L. Chawick, K. Reback, and J.M. Hickey. 1974. A study of the marine resources of the Taunton River and Mount Hope Bay. Monograph Series Number 15. Division of Marine Fisheries, Massachusetts Department of Natural Resources.

Dauer D.M., J.A. Ranasinghe, and S.B. Weisberg. 2000. Relationship between benthic community condition, water quality, sediment quality, nutrient loads and land use patterns in Chesapeake Bay. Estuaries 23(1):80-96.

Dechant, J.A., M.L. Sondreal, D.H. Johnson, L.D. Igl, C.M. Goldade, M.P. Nenneman, and B.R. Euliss. 2001. Effects of management practices on grassland birds: Northern Harrier. Northern Prairie Wildlife Research Center, Jamestown, ND. Northern Prairie Wildlife Research Center Home Page.

http://www.npwrc.usgs.gov /resource/literatr/grasbird/harrier/harrier.htm (Version 17FEB2000).

Dorsey, S. E., E. D. Houde, and J. C. Gamble. 1996. Cohort abundances and daily variability in mortality of eggs and yolk-sac larvae of bay anchovy, Anchoa mitchilli, in Chesapeake Bay. Fishery Bulletin 94:257-267.

Dovel, W.L. 1992. Movements of immature striped bass in the Hudson estuary. Pages 276-300 in C.L. Smith, editor. Estuarine research in the 1980s: the Hudson River Environmental Society Seventh Symposium on the Hudson River Ecology. State Univ. of New York Press, Albany, NY.

Edinger, G.J., D.J. Evans, S. Gebauer, T.G. Howard, D.M. Hunt, and A.M. Olivero (editors). 2002. Ecological Communities of New York State. Second Edition. A revised and expanded edition of Carol Reschke's Ecological Communities of New York State. (Draft for review).

ENSP. 2002b. Savannah sparrow, Passerculus sandwichensis. New Jersey Division of Fish and Wildlife, Conserve Wildlife Webpage. Retrieved 10/14/03 from http://www.state.nj.us/dep/fgw/tandespp.htm.

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1. Prepared for the U. S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Gallagher, F. 2003. Personal communication between R. Zwier of URS and F. Gallagher of NJDEP, Division of Parks and Forestry on 9/25/03.

Garbish, E. W. 1986. Highways and wetlands: Compensating for Wetland Losses. US DOT, FHA Report No. FHA Report No. FHWA-IP-86-22, 60 pp.

Garbish, E. W. 1989 Wetland enhancement, restoration, and construction. Pages 261-275 in S.K. Majuday, R.P. in Brooks, F.J. Brenner, and R.W. Tiner (eds.) Wetland ecology and conservation: Emphasis in Pennsylvania. The Pennsylvania Academy of Science, Philadelphia.

Garbish, E.W. and Garbish, J.L. 1994. Control of Upland Bank Erosion Through Tidal Marsh Construction of Restored Shores: Application in the Maryland Portion of Cheasepeake Bay.

GretagMacbeth. 2000. Munsell Soil Color Charts: Year 2000 Revised, New Windsor, CT. Hall, W.R. 1995. Atlantic Menhaden. pp 219 - 226. In: L.E. Dove and R.M. Nyman [eds.], Living Resources of the Delaware Estuary. Report of the Delaware Estuary Program. July 1995.

Hardy, J.D., Jr. 1978. Development of fishes of the Mid-Atlantic Bight: An atlas of the egg, larval and juvenile stages, volume III. Aphredoderidae through Rachycentridae. FWS/OBS-78/12. U.S. Fish Wildl. Serv., Biol. Serv. Prog.

Hildebrand, S. F. 1963. Family: Clupeidae. Pages 152-249 in Fishes of the western North Atlantic. Mem. Sears Found., Mar. Res. Mem. 1(3):1-630.

Hollands, G.H. and McGee, D.W. 1985. A Method for Assessing the Functions of Wetlands, Proceedings of the National Wetlands Assessment Symposium, J.A. Kusler (Ed.) Association of State Wetland Managers, Berne, New York (1985) pp. 108-118.

Howe, M.A., R.B. Clapp, and J.S. Weske. 1978. Marine and Coastal Birds. New York Sea Grant Institute. MESA N.Y. Bight Atlas Monograph 31. 87 pp.

Iocco L., p. Wilbur, R. Diaz, D. Clarke and B. Will. 2000. Benthic Habitats of New York/ New Jersey Harbor: 1995 Survey of Jamaica, Upper, Newark, Bowery and Flushing Bays. Final Report for United States Army Corps.

Inderjit. 2001. Soil: environmental effects on allelochemical activity. Agron. J. 93:79-84.

Inderjit and C. L. Foy. 1999. Nature of the interference mechanism of mugwort (Artemisia vulgaris). Weed Technol. 13:176-182.

Kelso, D.P. 1994. Spatial and seasonal variation in fish communities in the tidal freshwater Potomac River. Bulletin of the Ecological Society of America 75 (2):108.

Kennard, W.C., M.W. Lefor, and D. L. Civco. 1983. Analysis of Coastal Marsh Ecosystems: Effect of Tides on Vegetational Change. Univ. of Connecticut, Institute of Water Resources, Storrs, CT. Res. Proj, Tech. Completion Rept. B-014 CONN. 140pp.

Lawler, Matusky Skelly Engineers LLP (LMS). 1996. Biological survey of Newark Bay shoal areas and adjacent Kill Van Kull and Arthur Kill Channels. Prepared for the Port Authority of New York and New Jersey.

Lawler, Matusky Skelly Engineers (LMS). 1987. Preliminary draft environmental impact statement, River Walk. Prepared on behalf of Related Properties, Inc., for the City of New York Environmental Quality Review.

Lawrence, R.D. 2001. Owls: the silent fliers. Revised edition. Firefly Books, Canada 176 p.

Liberty State Park (LSP) 2003. History of Liberty State Park.

http://www.libertystatepark.com/1/lsp_history/history.htm

Llanso Roberto J. 1991. Tolerance of low dissolved oxygen and hydrogen sulfide by the polychaete Streblospio benedicti. Journal of Experimental Marine Biology Ecology. 153:165-178.

MacFarlane, D.W. 2001. The Ecology of Liberty State Park: A Historical Perspective

Macwhirter, R.B., and K.L. Bildstein. 1996. Northern Harrier, Circus cyaneus. In A. Poole and F. Gill (eds.) The Birds of North America, No. 210. The Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, D.C.

Mansueti, R.J. 1964. Eggs, larvae, and young of the white perch, Roccus americanus with comments on its ecology in the estuary. Ches. Sci. 5:3-45.

Massachusetts Division of Fisheries & Wildlife. 2003. Massachusetts Threatened Wildlife: Northern Harrier (Circus cyaneus). Natural Heritage & Endangered Species Program. Westborough, MA.

http://www.state.ma.us/dfwele/dfw/nhesp/nhfacts/Circya.pdf. January 2003.

McFadden, J.T., Texas Instruments, Inc., and Lawler, Matusky & Skelly Engineers. 1978. Influence of the proposed Cornwall pumped storage project and steam electric generating plants on the Hudson River estuary with emphasis on striped bass and other fish populations. Prepared for Consolidated Edison Co. of NY, Inc.

Mihursky, J.A., W.R. Boynton, E.M. Setzler, K.R. Wood, H.H. Zion, E.W. Gordon, L.Tucker, P. Pulles, and J. Leo. 1976. Final report on Potomac estuary fisheries study: ichthyoplankton and juvenile investigations. Univ. of Maryland CEES Ref. No. 76-12-CBL.

Morton, T. 1989. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)-Bay Anchovy. U.S. Fish and Wildlife, Biological Report 82(11.97), TR EL-82-4. 13 p.

New York Natural Heritage Program, New York Department of Environmental Conservation, Albany, NY.ENSP. 2002a. Short-eared owl, Asio flammeus.

New York State Department of Environmental Conservation. 2003. Short-eared owl fact sheet. Endangered Species unit, Albany, NY. Retrieved March 2003 from:

http://www.dec.state.ny.us/website/dfwmr/wildlife/endspec/seowfs.html.

New Jersey Department of Environmental Protection (NJDEP). 2003. Birds of Liberty State Park. NJDEP, Division of Parks and Forestry, Trenton, NJ.

New Jersey Department of Environmental Protection (NJDEP). 2001. Liberty State Park General Management Plan for the Parks Interior Section. New Jersey Department of Protection – Division of Parks and Forestry. 29pp.

New Jersey Department of Environmental Protection (NJDEP). 1995. Protocols for the establishment of exceptional resource value wetlands pursuant to the freshwater wetlands protection act (N.J.S.A. 13:9B-1 et seq.) based on the documentation of state or federal endangered or threatened species. A cooperative effort between the Land Use Regulation Program, Office of Natural Lands Management, Division of Parks, and Forestry, and the Endangered and Nongame Species Program, Division of Fish, Game, and Wildlife. Trenton, NJ.NOAA. 2003. Mudworms. Capitella sp..

www.csc.noaa.gov/lcr/nyharbor/html/gallery/sgstrebl.html

New Jersey Division of Fish and Wildlife, Conserve Wildlife Webpage. Retrieved 10/10/03 from

http://www.state.nj.us/dep/fgw/tandespp.htm.

Nichols, T.C. 1995. Diving ducks. Pages 353-358 in C.E. Dove and R.M. Nyman, (eds.), Living Resources of the Delaware Estuary. The Delaware Estuary Program.

NOAA. 2003. Mudworms. Streblospio benedicti.

www.csc.noaa.gov/lcr/nyharbor/html/gallery/sgstrebl.html

NOAA. 2003. Other benthos: Amphipod.

www.csc.noaa.gov/lcr/nyharbor/html/gallery/sgstrebl.html

NRCS. 2003. Conservation plant characteristics for Torrey's rush. Retrieve 10/10/03 from http://plants.usda.gov/cgi_bin/plant_attributes.cgi?symbol=JUTO

Pearson T.H. and R. Rosenberg. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanography and Marine Biology: an Annual Review. 16:229-311.

Ralph, J.C., G.R. Geupel, P. Pyle, T.E. Martin, and D. F. DeSante. 1993. Handbook of field methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Dept. of Agriculture.

Reed, Porter B. 1988. National List of Plant Species that Occur in Wetlands: Northeast (Region 1). Biological Report 88(26.1). Prepared for the National Wetlands Inventory, U. S. Fish and Wildlife Service (USFWS), Washington, DC.

Reschke, C. 1990. Ecological Communities of New York State. New York Natural Heritage Program, NYS DEC, Latham, New York.

Rogers, S.G., and M.J. Van Den Avyle. 1989. Species Profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic) - Atlantic Menhaden. U.S. Fish & Wildlife Service Biological Report 82 (11.108). U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg MS. Technical Report EL-82-4.

Schneider, K.J. and D.M. Pence, eds. 1992. Migratory Nongame birds of management concern in the Northeast. US Dept. of the Interior, Fish and Wildlife Service, Newtown Corner, MA.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Bd. Can. Bull. 184.

Shuster, C. N. Jr. 1982. "A pictorial review of the natural history and ecology of the horseshoe crab, Limulus polyphemus, with reference to other Limulidae." In Physiology and biology of horseshoe crabs: Studies on normal and environmentally stressed animals, edited by J. Bonaventura et al. New York: Alan R. Liss, Inc.

Springer, V. G. and D. D. Woodburn. 1960. An ecological study of the fishes of the Tampa Bay area. Florida Board Conserv. Mar. Lab. Prof. Pap. Ser.1. 104 p.

Stanley, J.G. and D.S. Danie. 1983. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic)—white perch. U.S. Fish and Wildlife Service Publication No. FWS/OBS-82/11.7.

Stone, S.L., T.A. Lowery, J.D. Field, C.D. Williams, D.M. Nelson, S.H. Jury, M.E. Monaco, and L. Andreasen. 1994. Distribution and abundance of fishes and invertebrates in Mid-Atlantic estuaries. ELMR Rep. No. 12. NOAA/NOS Strategic Environmental Assessments Division, Silver Spring, MD. 280 pp.

Texas Instruments (TI). 1976. Liberty State Park ecological study. Prepared for the Port Authority of New York and New Jersey.

Tiner, R. W., Jr. 1985. Wetlands of New Jersey. U.S. Fish and Wildlife Service, National Wetlands Inventory, Newton Center, MA. 117 pp.

U.S. Army Corps of Engineers (USACE). 2004. Liberty State Park Hydrology and Hydraulics of Freshwater Wetlands.

U.S. Army Corps of Engineers (USACE). 1995. Wetlands Delineation Manual. (Revised November 16 1995) http://www.wetlands.com/coe/87manp3b.htm Environmental Technical Services Co., 834 Castle Ridge Rd., Austin, TX 78746-5152

U.S. Army Corps of Engineers (USACE). 1993. The Highway Methodology Workbook, US Army Corps of Engineers New England Division. 28 pp. NEDEP-360-1-30

U.S. Department of Agriculture, Soil Conservation Service (SCS). 1989. New York Hydric and Soils with Potential Hydric Inclusions. SCS: Syracuse, NY.

U.S. Fish and Wildlife Service (USFWS). 1998. Assessment of the dredged material management plan for the port of New York and New Jersey. Draft Fish and Wildlife Coordination Act Section 2(b) Report.

U. S. Fish and Wildlife Service, U. S. Army Corps of Engineers. 1989. Federal Manual for Delineating Jurisdictional Wetlands: An Interagency Cooperative Publication, Washington, DC.

U.S. Fish and Wildlife Service 1980. Habitat Evaluation Procedures (HEP) Manual (102 ESM), Washington, D.C. (1980) Paginated variously.

Wander, W. 1999. Grassland birds. Presentation at the course on Threatened and Endangered Species in New Jersey. Cook College Office of Continuing Education, New Brunswick, NJ March 15-16, 1999.

Wang, J.C.S., and R.J. Kernehan. 1979. Fishes of the Delaware estuaries: a guide to early life histories. Ecological Analysts, Inc.

Whittaker, R.H. 1970. Communities and Ecosystems. Macmillan, New York. 162 p. illus.

Winemiller, K.O., and K.A. Rose. 1992. Patterns of life-history diversification in North American fishes: implications for population regulation (Includes Database). Can. J. Fish. Aquat. Sci. 49: 2196-2218.

Woodhead PMJ, T. Rotunno and S. Zappala. 1999. New York Harbor Habitat Assessment Project. Biological assessment of fish habitat associated with shipping piers in New York Harbor. State University of New York, Stony Brook, NY.

Zappala, Sarah. 2001. The growth and development of epibenthic and benthic communities associated with waterfront shipping piers in New York Harbor. Masters Thesis. State University of New York, Stony Brook.