The Harbor Herons Conservation Plan

New York/New Jersey Harbor Region

Written by:

The Harbor Herons Subcommittee
Habitat Workgroup
New York/New Jersey Harbor Estuary Program

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The Harbor Herons Conservation Plan was created as a collaborative effort involving numerous municipal, state, and federal agencies, non-governmental conservation organizations, academic institutions, and individuals.

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EXECUTIVE SUMMARY

The Harbor Herons Conservation Plan (HHCP) is part of the implementation phase of the *Comprehensive Conservation and Management Plan* (CCMP) produced by the US Environmental Protection Agency's Harbor Estuary Program (HEP) partnership to protect the New York/New Jersey Harbor Estuary, an estuary of national significance. The HHCP was written by members of the Harbor Herons subcommittee of HEP.

This document is a summary for a slice in time: 1980-2008. The intention is to update this document every five years to measure progress and make strategic adjustments to conservation priorities. Concurrent with the production of the HHCP, the Hudson-Raritan Estuary Comprehensive Restoration Plan (CRP) was released to the public in September 2009. The goal of the CRP, produced by the Army Corps of Engineers and the Port Authority of New York and New Jersey, is to be the blueprint for the physical reconstruction and restoration of the harbor, and it is also part of the implementation for the HHCP. Harbor Herons, play a key role in this plan as one of eleven Target Ecological Characteristics (TEC) of the estuary, referred to as "Islands for Waterbirds". These two plans set complementary restoration and acquisition goals.

The HHCP is a plan of action to protect and support the population of colonial waterbirds, the "Harbor Herons" that live and breed in Greater New York Harbor. Breeding and foraging habitats, loafing grounds, and areas used to stage for migration are all important aspects of Harbor Heron ecology. Approximately 17 islands (a total of 614 acres) in New York Harbor and tributary waterways support nine species of herons, egret, and ibis, and two species of gull, and one species of cormorant— all of which breed in the Harbor. The area that supports these birds is much larger. Harbor Herons cross two state borders (New York, New Jersey and Connecticut) to conduct their daily activities on the breeding and foraging grounds. Prior to and during migration, the tri-state harbor region serves as a safe haven to support migrants passing through from both farther north, and farther south, as some herons and egrets wander north following the breeding season.

A number of major threats to the Harbor Herons and their breeding and foraging habitats in the Greater NY/NJ harbor have been identified as a result of the research over the years and the planning process. These factors threaten the biological integrity of the habitat and persistence of the species in the harbor.

The most immediate threats to these birds are:

- Human disturbance in the colony (and adjacent to breeding areas) and in foraging areas
- Habitat degradation from development on mainland foraging and watershed areas
- Invasive and perceived to be overabundant species

- Pollutants and toxins
- Predators

Management actions identified in this plan include:

- Optimize habitat within the harbor estuary that is important for harbor herons
- Continue regular inventory and monitoring programs for harbor herons, gulls, and cormorants
- Foster communication among stakeholders and others that use the same aquatic habitats
- Encourage use of best management practices that will improve habitat and benefit birds within the Greater NY/NJ Harbor in context of the larger landscape
- Enhance land protection within, adjacent or proximal to the Important Bird Area by working with partners in establishment of easements or land

The overall goal of this plan is to develop a program to:

- Prioritize management actions to be taken by resource managers on and around nesting and foraging grounds to support a healthy, sustainable breeding population of wading birds.
- Foster communication among stakeholders in order to encourage best management practices that will support wading bird colonies and the health of the harbor.
- Develop educational messaging for stakeholders, managers, regulators, and the public, about the role of Harbor Herons in the Greater New York/New Jersey Harbor Estuary.
- Improve the legislative protection and ecosystem function of the overall foraging area habitat.
- Commit to on-going inventory, monitoring, and research programs to address the gaps in information on Harbor Herons as well as non-target species to measure the success of management actions and to determine trends over time.
- Investigate questions regarding the target species, their management, as well as other wildlife species.
- Present a history of nesting/breeding of the Harbor Herons species in the Harbor.

INTRODUCTION

The NY/NJ Harbor Estuary, an area of approximately 40,000 square kilometers, is home to twenty million people (NY/NJ HEP 1996) and a multitude of wildlife species. The Harbor Estuary encompasses an array of habitat types ranging from open water to saltwater marsh and adjacent upland areas. These areas provide essential ecosystem services for the NY/NJ harbor region and beyond including sediment filtration, organic matter consolidation, and breeding grounds for fish and shellfish. The Harbor Herons is the collective name given to a special assemblage of birds that live and/or breed during part of the year in the NY/NJ harbor estuary. This group includes herons, egrets, and ibises, and is one of the most visible and strikingly beautiful inhabitants in the NY/NJ Harbor region. Harbor Herons are consumers in the estuary and at the top of the food web. They live in large social groups, have high metabolic needs, and their presence – or absence – is conspicuous. Most species are easy to detect, although darker species are often difficult to census. The diversity of species and numbers of individuals in the Harbor Herons population reflect the quality of the resources they use: foraging habitat and prey quality as well as nesting and loafing area and habitat quality. Conserving the Harbor Herons is our responsibility, not only because of their beauty and intrinsic value but also because they are important members of complex food chains and reflect the condition of the estuary - our shared resource.

Through the mid-19th century, several species of herons and egrets used the NY/NJ Harbor as summer nesting and foraging grounds but were extirpated from the area in the latter half of the 19th century as a result of hunting and egg collecting as well as indirect human interference caused by the pollution of the estuary. Thanks to the 1972 Clean Water Act, Harbor Herons have returned to the NY/NJ Harbor and are once again breeding, nesting and foraging in the estuary. From the Tappan Zee Bridge in the North down to Sandy Hook and Jamaica Bay in the South, the Harbor Herons have reestablished themselves in the region.

Reestablishment of the Harbor Herons in the mid 1970‘s represents a clear sign that the harbor is becoming cleaner and more hospitable to wildlife. Some researchers believe that the return of these birds is a response to the habitat degradation and destruction in other portions of the Harbor Herons‘ range. Regardless of the reasons for their return, their presence in the region makes their conservation a top priority, especially as the Harbor Estuary faces habitat loss through development of wetlands areas and associated uplands.

In the past three decades much progress has been made towards the conservation of the Harbor Herons. The conservation effort has grown into a multi-organization, multidisciplinary, collaborative initiative consisting of habitat conservation and restoration, public outreach and education, and scientific research. The Harbor Herons Subcommittee (see Acknowledgments) was created as part of the Habitat Workgroup of the NY/NJ Region Harbor Estuary Program (HEP) to coordinate these projects and to serve as the nexus for Harbor Heron conservation efforts. The Harbor Herons Subcommittee has prepared this Conservation Plan in response to the need for a detailed report on the status of the Harbor Herons in the NY/NJ Harbor region and on the

conservation issues that they face.

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The recommendations in this conservation plan will steer much of the habitat-related work that will be done in the Harbor in the near future. As the recommended land parcels are targeted for restoration or acquisition, the amount of protected/conserved wetland in the Harbor area will increase by nearly 1,000 hectares (2,500 acres). Additionally, this analysis may again call attention to the wisdom of caring for those natural areas that do remain undeveloped.

The most immediate threats to these birds are human disturbance to the colonies and foraging areas, loss of high quality breeding habitat and foraging grounds, and toxicity from residual contaminants in harbor soil, sediment and water column. Management actions that address these threats will provide the best chances of success for persistent and self-sustaining bird populations. Additional protection efforts, research and monitoring of key resources, and outreach to the public on the islands and in the foraging areas region will provide the best chances of success for an enduring wading bird population in the NY/NJ Harbor and across state borders.

I. COLONIAL WATERBIRDS AND URBAN HABITATS

Importance of Urban Habitat for Colonial Waterbirds

Colonial waterbirds breed in small to large social groups in localized areas referred to as colonies. Their population ecology (colony size, productivity, and population trends over time) and physiology (diet needs, energetic costs and effects of pollution) readily reflect the quality of their local environment. In large urban centers, mainland habitat is typically inappropriate for large colonies. The land is developed, polluted, and/or subject to a variety of human disturbances; however Great Blue Herons (*Ardea herodias*) and Yellow-crowned Night-Herons (*Nyctanassa violacea*) can nest there. Small urban islands are often undeveloped and less accessible to human disturbance or predator pressure. These islands offer safe haven to breeding colonial waterbirds.

Collectively known as the Harbor Herons, this suite of species includes: Great Egret (*Ardea alba*), Snowy Egret (*Egretta thula*), Glossy Ibis (*Plegadis falcinellus,* Little Blue Heron (*Egretta caerulea*), Cattle Egret (*Bubulcus ibis*), Tricolored Heron (*Egretta tricolor*), Green Heron (*Butorides striatus*), Black-crowned Night-Heron (*Nycticorax nycticorax*), and Yellow-crowned Night-Heron. Herons and their allies are not new to the NY metropolitan region (Bernick and Elbin, in preparation). Since enforcement of the Clean Water Act of 1972, the Harbor Herons have significantly colonized the NY/NJ Harbor Region. Water quality has improved (NJ Harbor Dischargers Group 2006), but quality wetland habitat has become scarce, degraded, and fragmented.. Birds of traditionally isolated habitats, secure from human disturbance, have adapted to human-altered landscapes (Parsons and Burger 1982). Some species thrive as _human subsidized‘ and learn to forage among landfills, loaf on the rip rap, and raise their young on islands nestled between barges and smoke stacks (Burger 1981a, Parsons 1987, 1990, Maccarone and Parsons 1994, Maccarone and Brzorad 1998)

Harbor Herons continue to face many challenges associated with breeding and foraging in an urban environment. Global threats such as global climate disruption and sea level rise require solutions on a large scale; harbor-specific threats, such as pollution and habitat loss can be addressed locally. Visitors and researchers need permits to access the nesting islands; enforcement is problematic. Resource agencies and non-profit environmental organizations participate in wetland mapping efforts and list priority sites for habitat restoration and acquisition; budget constraints and homeland security needs slow the process and create compromises. Active inputs of contaminants continue to occur through leaks and spills, industrial discharges, erosion of historically contaminated sediments, atmospheric deposition, sewage treatment plants, combined sewer overflows, atmospheric deposition and tributary runoff. Agencies such as the NY and NJ Department of Environmental Protection, and the Environmental Protection Agency (EPA) are engaged in plans to keep the waters clean and remove persistent toxic contamination (including PCBs, dioxins, mercury and polycyclic aromatic hydrocarbons).

The resurgence of colonial wading birds in the harbor may be linked to positive changes in the environmental health of the area, or to increased human disturbance elsewhere, subsequently driving birds to the decreasing number of available breeding sites in the region. The recovery may also be due to regional population level changes, or changes in prey populations (or the timing of availability of prey). One theory (K. Parsons pers. com) is that agricultural pesticides in rural areas led to reduced reproductive success for herons, causing them to abandon those colonies and seek safe haven on the islands of harbor. While the reasons for their settlement here are complex, our mission is to protect the integrity and quality of their urban habitat.

Importance of Colonial Waterbirds in Urban Habitats

Long-legged wading birds frequently attract bird watchers and naturalists to viewing areas within the cityscape. These bird species are keystone species - important predators on fish and crustaceans. They play a pivotal role in the food web, performing important ecosystem services as consumers of prey species, many of which are predators on smaller fish (meso-predator control). Moreover, as top consumers they serve as indicators and sentinels of ecosystem health. In urban centers, habitat for waterbirds is often usurped by development, polluted and subject to a variety of human disturbances. Different species have specific foraging habitat requirements, but individuals will typically forage within 10-15 miles of their breeding sites (Kushlan and Hafner 2000, Birds of North America species accounts). These species consume (and thereby sample) locally abundant fish, crustaceans, and other food items and can be used to track environmental damage and recovery of the waters and nearby wetland habitats. In several circumstances in the NY/NJ Harbor, island habitats are preserved and have become focal areas for breeding by colonial birds.

Changes in bird populations can be used to monitor what is happening to their (and thus our) environment over the long run (Temple and Wiens 1989). Specifically, colonial waterbirds have been used as indicators of environmental health for many decades

(Kushlan 1993, Kushlan and Hafner 2000). Among others, Hickey and Anderson (1968), Custer and Custer (1995), Burger and Gochfeld (1993), Parsons (1994) and Federick et al. (2002) have demonstrated the value of colonial waterbirds as biotic monitors at the population, community and/or ecosystem level (Kushlan 1993). Published reviews of colonial waterbirds illustrate their over-arching value as bioindicators (Fox and Weseloh 1987, Kushlan 1993). Even basic monitoring of species composition and abundance at colony sites over time can indicate health of bird populations and wetland habitat quality. For example, the Snowy Egrets from Brother Islands could tell us about the contaminant load of the fish in the Bronx River, or New Jersey Meadowlands. Glossy Ibis on Canarsie Pol would be able to indicate the state of invertebrates in Jamaica Bay, and the Black-crowned Night-Herons on Hoffman Island would inform us about the crabs along the Arthur Kill. The balance of species within a mixed-species heronry would indicate an abundance of fresh water (increasing numbers of Great Egret) or salt marsh (increasing number of Snowy Egret) situations (Strong et. al 1997).

II. BIOLOGICAL STATUS OF THE RESOURCE - TARGET AVIAN SPECIES AND THEIR HABITAT

Colonial waterbirds have had a long history of nesting and foraging in the greater NY/NJ Harbor. Before Manhattan‘s Fulton Street market became known for its fish, it, like other markets, sold birds by the barrel - not only exotic species like Labrador Ducks, Eskimo Curlews, and even Great Auks, but also herons and other local residents. In the face of such depredation, the birds moved among the Harbor‘s islands, managing to persist locally into the 19th Century (Davis 1897, Bernick 2007a). By then, wading birds and their extensive nesting colonies had largely disappeared from the Northeast. The Harbor Herons have returned to the NY/NJ Harbor Region for nearly four decades. The current state of the resource addresses not only the composition and population trends of breeding birds but also the quality of the nesting and foraging habitat and the challenges of surviving in an urban ecosystem.

Species Accounts

Species accounts follow for the 11 species comprising the Harbor Herons. Great Blue Herons are excluded from the accounts because while they forage along the coastal wetlands of the NY/NJ Harbor, they only breed further inland. Brief species accounts below include information on breeding phenology and behavior and habitat needs. Common names are followed by their four-letter alpha-code. Species profiles modified from the 2006 Mid-Atlantic/New England/Maritimes Waterbird Conservation Plan are attached as an Appendix to this report.

***Great Egret -GREG*:** Listed as Threatened in Connecticut, not listed in New York or New Jersey, BCR30 status is lowest concern. Within the United States this species breeds from southern Maine south along the coast to the Florida Keys and west throughout Texas, California and north to Washington (McCrimmon et al. 2001). Great Egrets are usually one of the first species to arrive at a colony and their presence may induce other species to nest in the same colony. In the NY/NJ Harbor, this species arrives in early to mid-March.

Great Egrets prefer to nest on or near the top of woody vegetation on islands or over open water (Burger 1978, 1979). The nests are comprised of long sticks with the lower region of the nest made from heavier materials for structural stability. On average, the female lays three eggs over seven days and incubates these eggs for 23 to 27 days. Incubation begins with the first egg (Maxwell and Kale 1977) or soon thereafter (Mock 1985, Dwyer 1988), resulting in asynchronous hatching. Parents brood the young for several weeks after hatching. Young leave nest by climbing for short periods beginning at 21 days of age, begin to fly around 51 days of age and fledge at 62 to 67 days. After gaining independence from their parents, young birds will fly to nearby foraging areas and return to the natal colony to roost. Little is known about fidelity to the breeding site.

Great Egrets feed in a wide variety of both salt and fresh water wetland habitats. They feed on a wide variety of prey items including fish, invertebrates and, to a lesser extent, amphibians, birds, and small mammals. They typically forage during the day and less than 10 km from the colony, usually in deeper water than do smaller herons, and primarily by walking slowly. They also regularly use stand-and-wait and peering techniques (Willard 1977, Rodgers 1983).

Northward dispersal of juveniles occurs from June through October, with peak numbers in August and September; status of adults in these dispersals is unknown. These same birds move to wintering grounds from September through December. On the Atlantic Coast, individuals from colonies along the southern part of the coast (North Carolina to Florida) disperse farther north than birds from more northern colonies (Rhode Island to Virginia), going as far north as coastal Massachusetts; large numbers appear inland in some years (Byrd 1978).

Snowy Egret - SNEG: Listed as Threatened in Connecticut and as Special Concern in New Jersey. This species is considered to be High Concern for BCR 30 (U.S. Fish and Wildlife Service 2008) and for all of North America (Kushlan et al 2002). Approximately 11% of the global population occurs in Bird Conservation Region (BCR) 30, which extends from southeastern Maine to coastal Virginia (Waterbird Working Group 2007). The Snowy Egret was among the most sought-after of all herons and egrets for its delicate, recurved back plumes used to adorn women‘s hats (Parsons and Master 2000).

Snowy Egrets breed from southern coastal Maine south to Florida, along the Gulf of Mexico with some inland colonies occurring in eastern Texas and Oklahoma, northern Nevada and Utah, southern Oregon and Idaho, and California (Parsons and Master 2000). In New Jersey and the NY/NJ Harbor, they arrive at the colonies by early-April.

This species prefers isolated nesting islands on the Atlantic seaboard and tends to nest in thick vegetation. Dredge-spoil islands are of particular importance when located near feeding areas. Nest-site stability is a factor in nest placement and nests are placed on tree branches or on the tops of woody vines. While Snowy Egrets prefer to nest around 1.5 m off the ground, some ground nesting has been reported in thick stands of *Phragmites*. In

New Jersey, they always nest with Black-crowned Night-Herons and Great Egrets. They also nest in *Iva* and other small bushes (Burger 1978, 1979). Nests are constructed of loosely woven twigs and small sticks. Snowy Egrets will lay another clutch if the first clutch is lost early in incubation. Incubation takes 20 to 21 days and young fledge at 53 to 56 days of age. Birds typically begin breeding at two years old (Parsons and Master 2000).

Snowy Egrets feed on a wide range of items such as freshwater and marine fish, aquatic and terrestrial invertebrates (e.g. shrimp, crabs, and crayfish), frogs and toads, and reptiles. However, adult birds feed their nestlings a narrower diet. Studies of nestling regurgitations have shown that 75% of the prey is fish and the remainder crustaceans. They have the broadest foraging behavior repertoire of all North American herons (Willard 1977) with behaviors that include standing, bill-vibrating (tongue-flicking), head-swaying, pecking, walking slowly, walking quickly, running, hopping, leapfrog feeding, wing-flicking, foot-stirring, foot-raking, foot probing, foot paddling, hovering, hover-stirring, dipping, disturb and chase, and foot-dragging. Greater visual acuity than most other wading birds may increase their feeding success and effectiveness (Caldwell 1981).

Snowy Egret populations breeding in the North American interior and along the N. Atlantic coast are completely migratory. During fall migration, noticeable southbound flights take place from late September through late October, peaking in mid-October (Walsh et al. 1999).

Black-crowned Night-Heron - BCNH: Listed as Threatened in New Jersey. This species arrives at the colonies in late March and early April and begins egg-laying late in April.

Black-crowned Night-Herons breed throughout North America in a wide variety of wetland habitats that are free from predators (Davis and William 1993). They use a large variety of nesting substrate such as tall trees (e.g. oaks, willow, swamp maple, black cherry), woody species (e.g. holly, crabapple, box elder, dogwood), including wetland vegetation, such as cattails, *Phragmites*, and bulrush. They will nest on the ground as well as in *Iva* and *Baccharis* (Burger 1979, Davis 1993) Nests have been found on the ground, although not in the harbor colonies, and up to 160 ft. high in tall trees. Nest construction is variable but nests tend to be bulky stick platforms either sturdy or loosely woven and may be lined (Davis 1993).

They lay two to three green-blue eggs, at two-day intervals. Incubation is shared by the male and female and starts when the first egg is laid, resulting in asynchronous hatching after 24 to 26 days. Nestlings are brooded continuously for up to ten days after hatching. Young can climb at 18 days and will abandon the nest at 29-34 days. Flight is achieved at six to seven weeks of age. It is suggested that 2.0 to 2.1 young per breeding pair are required to maintain a stable population (Henny 1972 as cited in Davis 1993).

Black-crowned Night-Herons are opportunistic foragers with varied diet, typically

feeding solitarily from evening to early morning at shallow, vegetated wetland margins. Adults defend feeding territories; young birds develop territorial reaction when they become independent. The diet includes earthworms, insects including moths, crabs and crayfish, mussels, squid, freshwater and marine fish, amphibians, lizards, snakes, rodents, birds, eggs, carrion, plant materials, and garbage/refuse at landfills (Parsons 1990). Young will fly to feeding areas with adults and beg for food (Davis 1993). Since Black-crowned Night-Herons are high on the food chain, cosmopolitan in their distribution, and colonial nesters, they make excellent indicators of estuarine contamination (Custer et al. 1991).

Post-breeding dispersal (which can be to the north, particularly of young birds in late summer and early fall) merges with a southerly migration through coastal regions to wintering grounds in southern coastal eastern U.S., the Caribbean (particularly Cuba), and Mexico and obscures patterns of fall migration (Byrd 1978).

***Yellow-crowned Night-Heron -YCNH*:** Threatened species in NJ and SGCN in NY and CT. Primarily coastal, they nest on barrier, dredge-spoil, and bay islands. In the NY/NJ Harbor nesting also occurs on the mainland. Distribution correlates with availability of crustacean prey. This species is a regular breeder from the Florida peninsula along the Atlantic Coast north to Connecticut, occasionally to Massachusetts. Along the Atlantic Coast onset of breeding depends on date of crab emergence in spring, which is temperature dependent. Typically in NY/NJ breeding starts in late April/early May.

Unlike the Black-crowned Night-Heron, which avoids nesting in close association with houses, Yellow-crowned Night-Herons frequently nest in wooded neighborhoods that have an open understory and a park-like appearance (Watts 1995). These birds can occur as scattered nesting pairs or small colonies. Nest height varies according to available substrate and reflects vegetation height. Nest typically consists of a platform of sticks with a slight depression in center (Watts 1995).

Yellow-crowned Night-Herons will lay 3-6 eggs, and incubation begins with the second or third egg. Both the male and female bird incubate the eggs for 24-25 days and brood the young almost continuously for up to two weeks after hatching. Young can stand erect at four to five weeks, and at six weeks can make short (5–10 m) flights (Watts 1995).

Across its range, the Yellow-crowned Night-Heron typically forages along water margins and specializes in taking crustaceans, especially crabs. A mostly sedentary forager, this species spends >80% of its time engaged in a ~~–st~~and and wait-walk slowly-stand and wait" approach to locate prey, and then move toward it (Rodgers 1983). Foraging activity peaks in early morning and evening, although it may be more closely tied to tidal fluctuations than time of day (Watts 1995).

Yellow-crowned Night-Herons were first observed nesting in the NY/NJ Harbor in 1986, and since that time the number of nesting pairs observed on islands has increased from 2 to 15 (36%). Additionally, small nesting clusters of Yellow-crowned Night-Herons have been found on mainland habitat in recent years. These include a groups of nests found in

the New Jersey Meadowlands at Schmitt's Woods and at Harmon Cove, Secaucus (NJ Birds 2009, H. Corolla, pers. comm.) and a cluster of 30 nests found in the Rockaways (Bernick, 2006).

Atlantic Coast populations appear to migrate south along coast and out to the West Indies; many presumably funnel through Florida, but migrants are regular on Bermuda (Wingate 1982).

***Glossy Ibis - GLIB*:** Listed as a species of Special Concern in New Jersey and considered Moderate Concern in Bird Conservation Region (BCR) 30, (Waterbird Working Group 2007). This species breeds at coastal sites in eastern North America from southern Maine to Florida. Glossy Ibis have expanded their range enormously in twentieth century in North America. This species was first recorded in New Jersey in 1817 and by 1957 F. Buckley (1978) reported more than 1,500 pairs in 23 colonies in the state. The first nesting report in New York was in 1961, and by 1977, 892 pairs nested in 17 colonies (Buckley and Buckley 1980). Currently populations appear to be in decline. This species initiates nesting in the NY/NJ Harbor later that the other colonial waterbird species, typically in mid to late May, although this is less true farther south in NJ.

Glossy Ibis that nest in coastal habitats often forage inland in fresh water. They are gregarious year-round and nest colonially, usually with a variety of heron species. Preferred habitats include marshes, swamps, and lakes. They nest in trees in wooded areas near water, particularly on islands, possibly reflecting a strategy against predation. Usually they nest in mixed-species colonies in dense vegetation. Nests are bulky and consist of compact platform of twigs or reeds, often lined with leaves or other vegetation They typically lay three to four eggs, and initiate incubation when the last egg is laid. Incubation period lasts 21 days. By age 14 days, young can readily walk about the surrounding branches. At 42 days, young fly to foraging areas with adults, but are still fed by adults. At seven weeks after hatching they are fully independent of their parents (Davis and Kricher 2000).

Tactile foragers, they probe the substrate with their bills to locate invertebrates, including aquatic larvae and insects, crickets and grasshoppers, worms and various small mollusks. Glossy Ibis locate their prey visually on land but use tactile probing in aquatic habitat and muddy substrates and use a variety of foraging behaviors. They often forage in single-species flocks that may number from a few individuals to several hundred or in mixed-species associations with herons. Snowy Egrets appear to use Glossy Ibises as "beaters," taking prey disturbed by nonvisually feeding ibises (Davis and Kricher 2000).

Glossy Ibises disperse widely after breeding and can cover large distances. One first-year bird banded in May in New Jersey was recovered in Nova Scotia in September, suggesting a broad dispersal pattern (Byrd 1978). One bird banded as a chick on Hoffman Island was seen in Lancaster, PA, two months later (S. Elbin, unpublished data). After postbreeding dispersal, they migrate south to wintering grounds in Florida or along the Gulf Coast, or through Florida to the Bahamas, Greater Antilles, Central America, and northern South America (Hancock et al. 1992). In New Jersey, migrating flocks begin moving south by mid July, and numbers of remaining birds decline in early August

(Master 1992), with stragglers remaining through late November (Sibley 1997).

Little Blue Heron - LIBH: Listed as a Species of Special Concern in CT, SGCN for NY and NY, and high concern for BCR30. They breed from southeastern Maine to Florida and along the Gulf Coast to Texas (Rodgers and Smith 1995b). Little Blue Herons tend to nest in lower shrubs and small trees in protected sites below the canopy. Nests are constructed from dead twigs 25 to 40 cm long and tend to be lined with green vegetation.

Clutch size is three to five eggs and the egg size overlaps with Snowy Egret eggs. Egg color, however, is slightly greener than that of Snowy Egret. Research has shown that nestlings are capable of thermoregulation at 11 to 16 days of age. Young begin flying around day 28 and fledge after five weeks of age. Little Blue Herons begin breeding as yearlings (Rodgers and Smith 1995b).

Little Blue Herons are opportunistic foragers, feeding on small fish, amphibians, and terrestrial and aquatic invertebrates. They tend to prefer more forested or heavily vegetated fresh or estuarine wetlands than do other Harbor Heron species (Rodgers and Smith 1995b).

Green Heron - GRHE**:** A relatively small, dark, compact, crested wading bird and a common species of wetland thickets throughout much of North America. No regional populations are considered to be threatened. Although Green Herons are typically solitary nesters, they sometimes nest socially in loose colonies of up to 20 pairs (David and Kushal 1994).

These birds nest in various habitat types: swamps, marshes, lakes, ponds, human-made or human-regulated habitat such as storm-water control impoundments and retention basins. Nests are usually built on or over water, but water may be up to 0.8 km away (Kaiser and Reid 1987). Single-species aggregations or colonies are small. Colonies in Jamaica Bay, NY, during the 1960s were: 70, 41, 17, and 8 pairs (Meyerriecks 1960, 1962).

Clutch size ranges from three to five eggs, and both parents share the 19-21 day incubation, which starts at the completion of the clutch. Research has shown that nestlings are capable of thermoregulation at 11 to 16 days of age. Young begin flying by day 28 and fledge around five weeks of age.

They feed day or night, standing patiently in shallow water waiting for fish, slowly stalking them through the shallows or diving on them from above. They are among the few tool-using birds, fabricating various baits that lure fish to places where they can be captured (Davis and Kushlan 1994).

Tricolored Heron - TRHE**:** Listed as species of greatest conservation need in NY and NJ, and high concern in BCR 30. Found only in the New World and probably declining throughout their North American range. The Tricolored Heron is more commonly associated with coastal habitats than are all other herons. Food availability and, indirectly, the amount and type of habitat appear to control the number of breeding attempts.

They nest in dense, well-shaded shrubs and small trees, between 0.15 and 3.7 m above ground or water. During courtship and early egg laying, males guard the nest, territory, and female, usually without breaks for feeding (Rodgers 1978). The clutch size is three–four eggs. The first egg hatches at approximately 22-24 days (Frederick 1997). Male and female birds share incubation (Frederick and Collopy 1989). Brooding begins immediately upon hatching, decreasing as the chick reaches 12 days of age. By 24 days, the young birds only return to the nest platform to be fed, and by 35 days they are fledged. Young birds follow their parents as they move about in the colony and on long flights. This behavior suggests that young birds eventually follow foraging adults (possibly parents) from colony to foraging grounds on their first flights away from colony (Frederick 1997).

Diet consists almost entirely of small estuarine and marsh fishes, which it acquires through a diverse array of foraging behaviors. This species is among the most studied of the North American herons: its breeding behavior and displays are particularly well documented (Rogers 1978), as are many aspects of its foraging ecology and behavior (Kushlan 1978, Rodgers 1983, Kent 1986) and nesting ecology (Jenni 1969, Maxwell and Kale 1977, Post 1990, Frederick et al. 1992).

Great Blue Heron - GBHE: Listed as a species of Special Concern in NJ and parts of CT, lowest concern in BCR 30. These largest herons in North America are widespread and remarkably adaptable. They feed mostly in slow moving or calm freshwater, as well as along seacoasts and can nest in trees, bushes, on ground and artificial structures (Butler 1992). While their colonies can be found in either fresh or salt water habitats, along the eastern coast of the U.S they avoid nesting in marine habitats favoring inland sites (Spendelow and Patton 1988). They are not found breeding in the NY/NJ Harbor colonies, although they share many of the foraging sites with species breeding on those islands.

Cattle Egret – CAEG: This species has undergone a remarkable worldwide range expansion starting at the end of the 19th century and continuing today. It arrived in North America in the early 1950s and has become common in many regions. While Cattle Egrets still nest in Southern NJ, the breeding population in the Harbor has declined since1994, when it peaked at 155 pairs. Since 1999, there have been fewer than six pairs of nesting birds in the Harbor. (NYCA unpublished data).

Waterbird Population Dynamics and Trends

Population Trends Pre-1993

Concerted effort has been made from 1985 to the present to document the nesting populations of the colonial wading birds in the NY/NJ Harbor region (see Figure 1 for site map). The most comprehensive surveys, dating from 1982, have been nest site censuses conducted by New York City Audubon. From 1986-1995 New York City Audubon partnered with Manomet Center for Conservation to conduct in-depth studies on nesting and foraging ecology. Additional surveys have been done by the New York City Department of Parks & Recreation, New Jersey Department of Environmental Protection, US Fish and Wildlife Service, Francine and Paul Buckley, and New Jersey Audubon. It is from these data sources that we have developed an understanding of the

colonization of the harbor by long-legged wading birds, which began with 50 nesting pairs observed on Shooter‘s Island in 1974 (Galli 1978), and currently comprises approximately 1,850 nesting pairs observed on ten islands (Bernick 2008). (See Table 1). Presentation here of population trends is broken down into pre- and post- 1990 time frames. In 1990, a series of 684 oil spills released 5.7 million liters of oil into the NY/NJ Harbor. The largest single spill of 2.1 million liters occurred in January 1990, resulting in approximately 100 km of contaminated shoreline between NY and Raritan Bay, NJ (Burger 1994). Black-crowned Night-Herons exhibited a decline in nesting activity the year of the spill (700 nests in 1989, 595 nests in 1990). Snowy Egrets and Glossy Ibis exhibited declines the following year (279 nests in 1990 to 246 nests in 1991; 242 nests in 1990 to 142 nests in 1991). Great Egret nest numbers were increasing steady from 1982 through 1991. Although most species had the highest nest numbers in 1993, Great and Cattle Egrets were the exception (Figures 2a and 2b).

A trend of wading bird colony expansion occurred in the Harbor even as a regional decline of 25-30% was occurring in suburban areas. The harbor population peaked at over 2,200 nests in 1993, has been replaced more recently by a fairly stable population size that is approximately 78% of the 1993 level (Figure 2a). The Huckleberry Island heronry was not considered to be crowded during the years when their numbers peaked, in the late 80s and early 90s (Burger and Gochfeld 1993a) (Figure 3). It remains unclear whether this decline is part of normal population dynamics, a regional trend, or if nesting is impacted by local stressors: increased human disturbance, increased predation (e.g., owls and raccoons), reduced or compromised foraging habitat, environmental contaminants or, more likely, a combination of effects. The Huckleberry Island colony did not exhibit the same species increase in 1993 as did the rest of the Harbor. One way this question can be addressed is by assessing productivity of the colony – documenting nest contents, fledging success, and mortality. David Kunstler, New York City Parks, has been following individual nests, from clutch completion to fledging, for wading bird nests on Goose Island. (Note: these data need to be carefully analyzed, as wading bird nesting has declined precipitously on Huckleberry Island, Figure 3). Examinations of hatching success and tissue analysis (freshly laid eggs, blood, feathers, etc) for contaminant loads are important techniques to use in addressing questions of colony condition.

Figure 1. Location of Harbor Heron nesting colonies within the NY/NJ Harbor. Colony sites are color coded for activity as of 2009. Red circles indicate nesting; black circles indicate no nests found. Map is courtesy of the Harbor Estuary Program.

Table 1. Numbers of nests found each year, by species, throughout the harbor. The number of islands is the number of islands surveyed for activity within a given year. Data are from NYC Audubon Annual Nest Survey reports.

Year	# Islands Surveyed	Great Egret	Cattle Egret	Snowy Egret	Black-crowned Night-Heron	Yellow-crowned Night-Heron	Little Blue Heron	Glossy Ibis	Green Heron	Tricolored Heron	Un Identi-fied	**Total**
1982	2	5	85	55	170	0	0	9	9	0	0	**333**
1985	2	22	266	70	277	0	1	51	1	0	0	**688**
1986	3	48	177	212	320	2	6	111	3	0	92	**971**
1987	4	45	58	204	519	5	2	142	6	0	21	**1002**
1988	4	62	131	138	855	9	2	180	9	0	53	**1439**
1989	4	48	83	177	700	6	2	180	3	0	18	**1217**
1990	4	89	152	279	597	4	3	242	8	0	93	**1467**
1991	6	206	145	246	1091	9	2	142	8	0	0	**1849**
1992	6	113	158	301	997	10	5	254	3	0	0	**1841**
1993	6	152	137	313	1343	11	10	264	3	0	0	**2233**
1994	6	166	155	243	932	25	5	246	10	0	110	**1892**
1995	6	136	40	302	1211	14	2	271	10	0	129	**2115**
1996	7	190	27	264	857	16	2	235	12	0	234	**1837**
1997	7	265	24	201	1017	10	3	237	6	0	26	**1789**
1998	-	-	-	-	-	-	-	-	-	-	-	**-**
1999	10	241	6	192	1089	6	4	178	1	1	24	**1742**
2000	13	189	4	200	1022	5	4	115	0	0	21	**1560**
2001	13	216	3	225	1049	2	4	125	0	2	29	**1717**
2002	14	215	3	204	932	6	4	149	0	6	0	**1655**
2003	14	182	2	217	1092	8	4	329	0	1	1	**1519**
2004	15	230	6	240	854	7	11	350	1	2	24	**1836**
2005	8	247	4	201	936	6	11	348	0	2	24	**1725**
2006	-	-	-	-	-	-	-	-	-	-	-	-
2007	15	361	2	308	802	15	14	254	3	2	85	**1872**
2008	-	-	-	-	-	-	-	-	-	-	-	**-**
2009	14	308	1	295	750	**28**	5	205	1	2	29	**1624**

Figure 2a. Wading bird nesting activity on all surveyed islands in the New York/New Jersey Harbor from 1982 through 2009. Total nests are the sum of nests for wading bird species on each island.

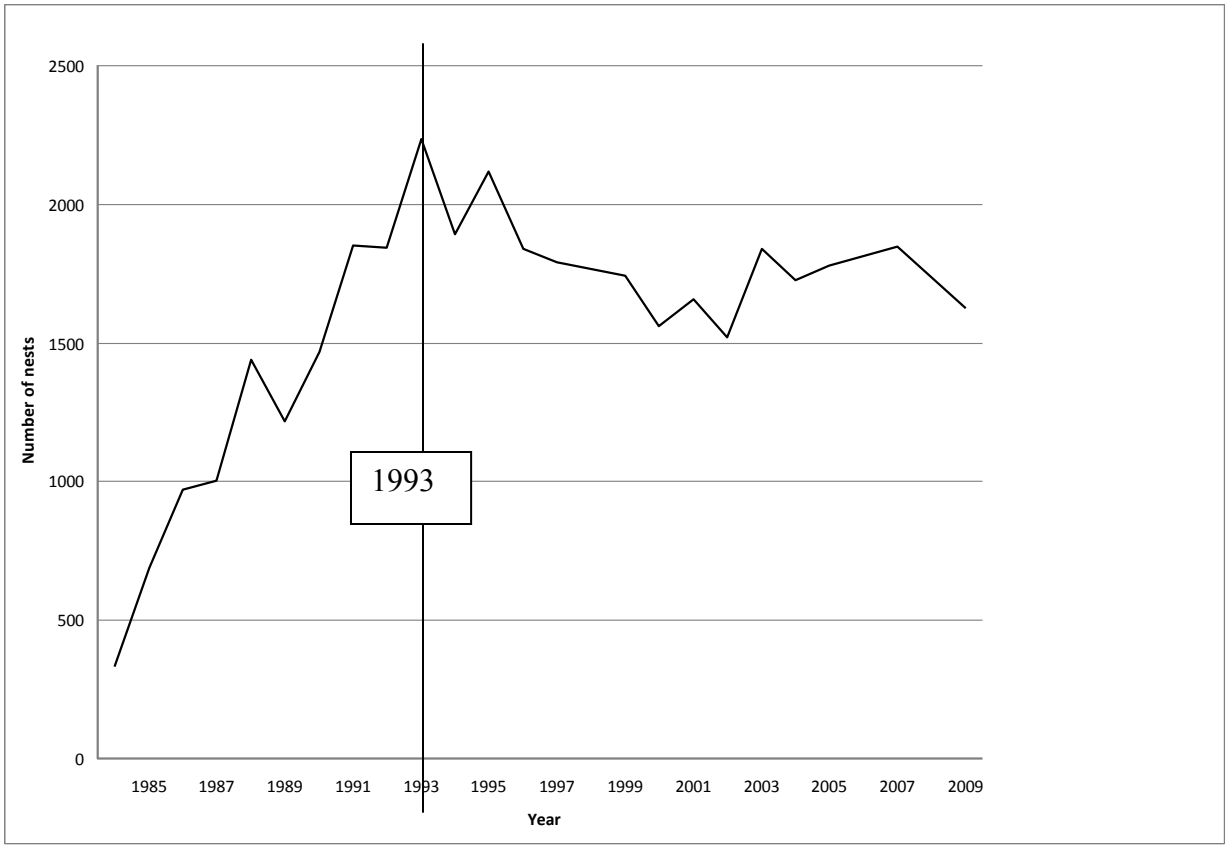


Figure 2b. Nesting activity for four species of wading birds: Black-crowned Night-Heron, Great Egret, Snowy Egret, Cattle Egret, and Glossy Ibis, on all surveyed islands in the New York/New Jersey Harbor from 1982 through 2009. The height of each bar represents 100% of the Harbor Herons population each year. Colored segments of the bar represent species composition, by percent of the total. Two years are highlighted: 1990 was the summer after the Exxon oil spill, 1993 was peak nesting activity in the Harbor. Data are from Table 1.

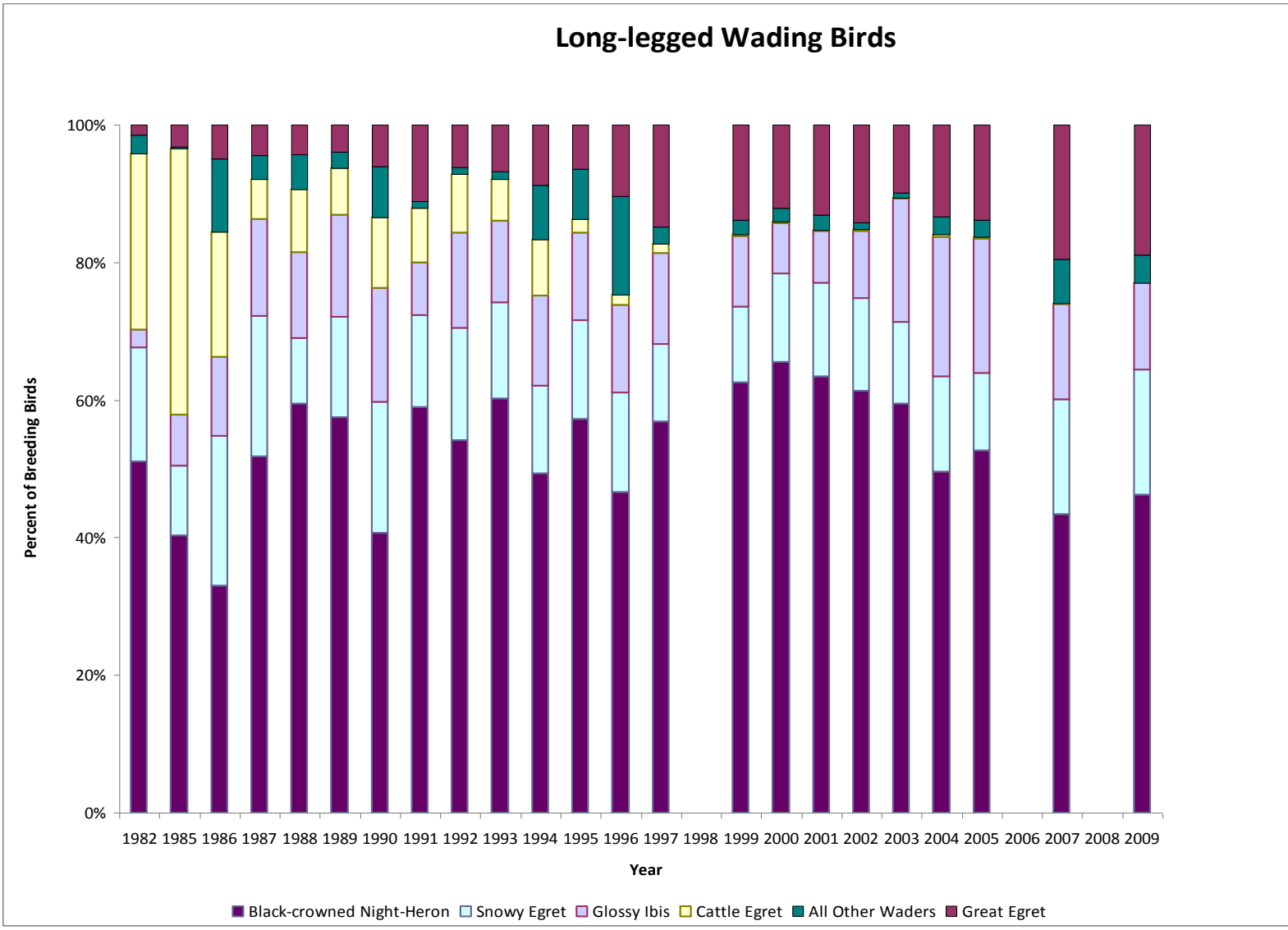
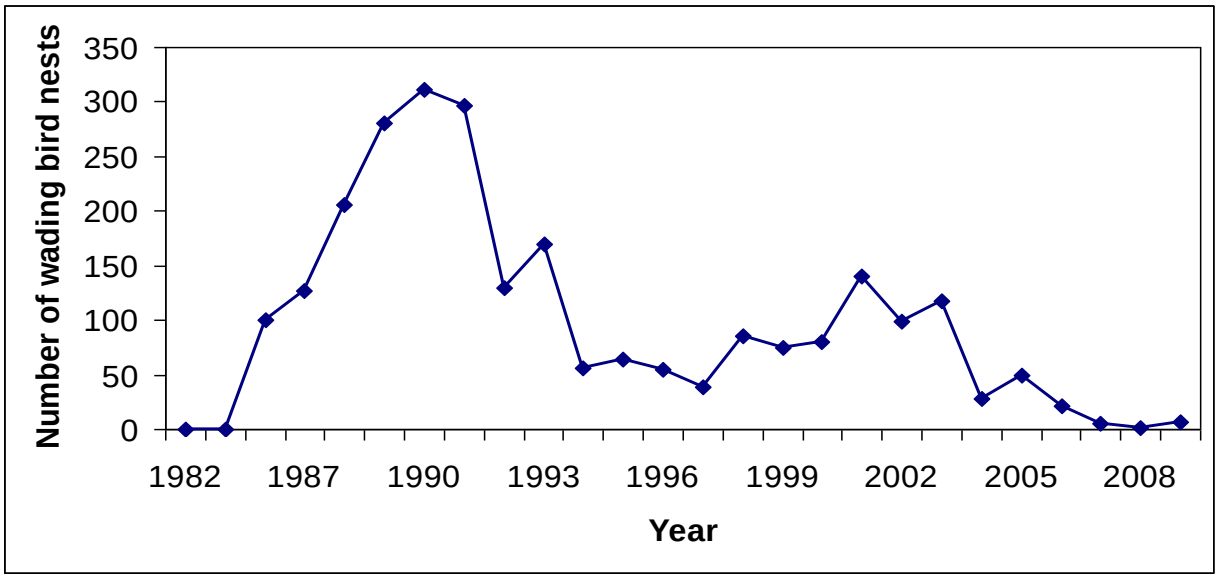


Figure 3. Wading bird nesting activity on Huckleberry Island. At peak occupancy (1988) species composition was: GREG, SNEG, and BCNH. Data are from David Kunstler.



Population Trends Post 1993

Population trends among individual species vary significantly over time. Black-crowned Night-Heron populations across the northeast U. S. region have declined by 45% since the 1970s, and Snowy Egret have declined by 20-30%; Great Egret have increased by approximately 100% (Waterbird Working Group 2007). Throughout the past three decades, Black-crowned Night-Herons, Glossy Ibises, Snowy Egrets, and Great Egrets have remained ubiquitous in the region, and in particular the Glossy Ibis has dramatically increased since 1982 (by approximately 28 fold). On the other hand, the Cattle Egret has declined dramatically in the Harbor (by over 99%), as has the Black-crowned Night-Herons (by 40%). The other four wading bird species (Yellow-crowned Night-Heron and Little Blue, Green, and Tricolored Herons) are not nearly so common (Table 1), though this may be explained by the life history of these species. Both the Tricolored Heron and Little Blue Heron are at the northern extreme of their range. In addition, the Yellow-crowned Night-Heron and Green Heron are not colonial nesters and are therefore not typically found in great abundance anywhere in their range.

During the most recent comprehensive nesting survey of 2007, four species of long-legged wading birds in the family Ardeidae, Black-crowned Night-Heron, Great Egret, Snowy Egret, and Glossy Ibis, comprised 92% of the 1872 nesting pairs in the Harbor (Bernick 2007). Other long-legged wading bird species identified as breeding in the area include the Little Blue Heron, Cattle Egret, Yellow-crowned Night-Heron, Tricolored

Heron, and Green Heron. It is important to note that several of these (Yellow-crowned Night-Heron and Green Heron) may nest in loose colonies or even as single pairs in isolated woodlots. Thus their population in the region may be historically underestimated, though probably not substantially. (See Appendix I for bird species information.)

Survey data from previous years suggest that the total nest count in the region has remained fairly stable. However, there have been species-specific population changes over the years. Compared to the 1993 peak, the data show declining nest counts for Black-crowned Night-Herons (down 40%) and Cattle Egrets (down 98%). Conversely, nest counts for Great Egrets have increased by 37% over the same time period.

With the dramatic declines in long-legged wading bird populations taking place throughout the Northeast, it remains unclear whether the Harbor Herons population functions as a sink or a source for the Eastern Seaboard. While the current annual indices (i.e., number of active nests) are a good measure of the status of local populations, an analysis of recruitment, productivity, and growth rates at colonies throughout the region could provide useful information about the population dynamics of these birds.

Productivity

Since the presence of breeding wading bird populations was first discovered in NY City in 1974, various aspects of their reproductive biology have been examined, including the number of nesting pairs by colony, nest chronology, egg size, hatching success, nestling growth rates, components of diet, and environmental contaminant loads in eggs and nestlings.

From their first year in 1982, New York City Audubon‘s Harbor Herons Nesting Surveys have provided information on breeding activity of the Harbor‘s wading birds. From 1986 to 1995, rigorous studies of wading bird nesting and reproductive success were conducted by Katherine Parsons (Parsons 1994, 1997, 2001) in the Arthur Kill and Kill Van Kull estuaries in western Staten Island (i.e., Prall‘s Island, Isle of Meadows, and Shooters Island), focusing on the Black-crowned Night-Heron, Snowy Egret, Glossy Ibis, and Cattle Egret. Because she had already collected baseline data, Parsons (1994) was able to document decreased productivity in Glossy Ibises and Snowy Egrets occurring after the oil spills of 1990. Black-crowned Night-Herons and Cattle Egrets were not noticeably affected.

In addition to the Parsons‘ studies, Harbor Herons survey team leaders for NYC Audubon have been collecting nest contents at the time of the survey, and David Kunstler, NYCPR, has been making detailed nest observations on Goose Island. These data are presented in the annual survey reports and will be part of future analyses.

Habitat Status and Needs

Approximately 20,000 acres of tidal wetlands remain in the NY/NJ Harbor Estuary, only a fraction (20-25%) of the historical marsh area in the Harbor, while almost all of the freshwater wetlands have disappeared (Steinberg et al. 2004). Island colony sites total 614.44 acres (248.63 hectares). Some of those islands and much (50%) of the coast

would benefit from restoration.

Nesting Colony Sites

Almost all known nesting colonies of the Harbor Herons have been or currently are located on uninhabited islands. All but two of the nesting colony sites are designated Important Bird Areas, IBAs, for New York State. National Audubon characterizes a site as an IBA if it provides essential habitat for bird species of conservation need with restricted range or habitat, or occurring in congregations (or colonies). IBAs include sites for breeding, wintering, and/or migrating birds. Some of the harbor islands have been used as colony sites continuously throughout the past three decades. For instance, South Brother Island has had active colonies since 1978 (Parsons 1987). Other colonies with consistent use include Goose Island and Huckleberry Island, flanking both sides of Pelham Bay Park, although numbers of nesting pairs have decreased on Huckleberry Island in recent years. The most recently established island colony was observed on Mill Rock Island in the East River in 2004 and supports mainly Black-crowned Night-Herons, but also small numbers of Great Egrets. (See Figure 1 for site locations.)

The last year for waterbird nesting activity in the Kill van Kull and Arthur Kill was 2001, with a concurrent influx of nesting birds appearing on Hoffman Island, Canarsie Pol, and North and South Brother Islands. In 2004 nesting started to decline on North Brother Island, and by 2008 no active wading bird nests were found. The major nesting islands are listed below, grouped by location.

Table 2. Islands of the greater NY/NJ Harbor on which Harbor Herons have nested. Islands are group by water body. Ownership is current as of 2008, NYCEPR = NY City Parks and Recreation; NPS = National Park Service

Island Location	Ownership (as of 2008)
Long Island Sound	
Goose Island	NYCDPR
Huckleberry Island	Huckleberry Indians, Inc.
East River	
North Brother	NYCDPR
South Brother	NYCDPR
U Thant	NYCDPR
Arthur Kill-Kill Van Kull	
Shooter‘s Island	NYCDPR
Prall‘s Island	NYCDPR
Isle of Meadows	NYCDPR
Lower New York Harbor	
Swinburne Island	NPS
Hoffman Island	NPS
Jamaica Bay	
Elders Point West	NPS
Canarsie Pol	NPS
Ruffle Bar	NPS
Little Egg Marsh	NPS
Subway Island	NPS
Mainland – Far Rockaway	

Redfern Houses NYC Housing Authority

Aids to Navigation

Raritan Bay/Arthur US Coast Guard

Kill/Kill Van Kull

During the 2007 Harbor Herons nest survey (Bernick 2007), nesting substrate (i.e., tree, shrub, or vine species) was recorded and a partial list of island plants was compiled. The resulting plant lists provide a record of the vegetation baseline to be used when assessing habitat change over time (Table 3).

Table 3. Nesting trees, shrubs, and vines were identified for wading birds on seven islands in 2007 as described below. Each number represents the number of nests found for each species of bird in each type of vegetation on specific islands. A list of flora found on each island is presented as an Appendix. In the table below, the following acronyms are used: BCNH – Black-crowned Night-Heron; SNEG – Snowy Egret; GREG – Great Egret; GLIB – Glossy Ibis; LBHE- Little Blue Heron; YCNH – Yellow-crowned Night-Heron.

Island Name Tree species	**Number of nests for each species**						
Mill Rock	BCNH	SNEG	GREG	GLIB	LBHE	YCNH	total nests
Red Mulberry	35	0	1	0	0	0	36
Norway Maple	4	0	0	0	0	0	4
North Brother Island							
Black Cherry	4	0	0	0	0	0	4
Mulberry spp	2	0	0	0	0	0	2
Asiatic Bittersweet	5	0	0	0	0	0	5
Crabapple	1	0	0	0	0	0	1
Asiatic Bittersweet/chain-link fence	1	0	0	0	0	0	1
Huckleberry Island							
Norway Maple	3	0	0	0	0	0	3
Black Cherry	2	0	0	0	0	0	2
Multiflora Rose	1	0	1	0	0	0	2
Subway Island							
Cherry/Bittersweet	1	0	0	0	0	0	1
Black Cherry/Bayberry/Bittersweet/Virginia Creeper	1	0	0	0	0	0	1
Swinburne Island							
Mulberry	1	0	0	0	0	0	1
South Brother Island							
Black Cherry	73	3	14	0	0	0	90
Mulberry sp.	69	0	0	0	0	0	69
Box Elder	36	1	2	0	0	0	39
Asiatic Bittersweet	9	17	9	0	0	0	35
Multiflora Rose	5	87	1	0	0	0	93

Sycamore Maple	5	0	0	0	0	0	5
Hickory sp.	4	0	0	0	0	0	4
Elderberry	2	5	0	0	0	0	7
Crabapple	1	0	0	0	0	0	1
Black Locust	1	0	0	0	0	0	1
Black Cherry/bittersweet	42	16	46	0	0	0	104
Box Elder/bittersweet	38	0	5	0	0	0	43
Mulberry/bittersweet	18	1	35	0	0	0	54
Tree-of-heaven/bittersweet	9	0	0	0	0	0	9
Hackberry/bittersweet	2	0	0	0	0	0	2
Elderberry/bittersweet	2	2	0	0	0	0	4
Multiflora Rose/bittersweet	0	2	5	0	0	0	7
Hoffman Island							
Black Cherry	31	3	34	6	0	1	75
Mulberry sp	56	41	55	26	3	0	181
Box Elder	0	2	2	4	0	0	8
Asiatic Bittersweet	0	0	0	10	0	0	10
Multiflora Rose	35	54	10	11	3	0	113
Privet sp.	14	0	0	3	0	0	17
Black Cherry/Bittersweet	0	2	9	9	0	0	20
Box Elder/Bittersweet	3	0	0	0	0	0	3
Mulberry/Bittersweet	20	0	32	12	0	0	64
Tree-of-heaven/Bittersweet	11	0	0	0	0	0	11
Hackberry/Bittersweet	1	0	1	0	0	0	2
Multiflora Rose/Bittersweet	2	0	0	0	0	0	2
Mulberry/Multiflora Rose	8	0	3	0	2	0	13
Black Cherry//Multiflora Rose	1	0	0	0	0	0	1
Privet/Bittersweet	2	3	2	0	0	0	7

These colonies are all within a major metropolis. It is not surprising that each site shares a common history of wilderness, followed by dramatic human alteration, then a long period of abandonment, and finally recolonization by the herons. Most of the islands were at one point cleared of vegetation, and many even have extensive paved or developed areas. Following a period of abandonment, habitat on an island progresses rapidly through successive stages of vegetation. The resulting dense, shrubby woodlands have characteristically provided the impenetrable thickets that herons have preferred as nest sites. Such thickets conceal the nests and adults, and discourage predators and minimize human disturbance. The woodlands on many of these islands are now reaching a state of maturation where tree height increases, tree density decreases, and crown architecture expands to a far more open state. Such changes in vegetative structure may also be a factor in the shifts in heron nesting colony locations over time.

The reason for the abandonment of the three Arthur Kill colony sites in the early 1990s remains an unanswered question. Proposed causes include predation, nest site unsuitability, contaminants, nest-site parasites, lack of foraging opportunities as well as harassment from gulls. There has been some evidence that the heron rookeries along the Arthur Kill were preyed upon by raccoons, crows, and owls (Kerlinger, 1998). Other

researchers have examined the nest site preferences (tree species, height, crown architecture) and have concluded that maturing vegetation at some sites is slowly rendering them less appropriate for nesting (Carl Alderson, personal communication). Others believe that ongoing contamination and toxicity issues are leading to decreased fledgling survival rates, which in turn are causing adult herons to look elsewhere for more successful breeding sites.

Additional relevant perturbations include storm surge-induced high tides that cause island flooding and saltwater intrusion (cf. tree mortality on Pralls Island following 6 foot higher tidal amplitude during nor'easter in 1991 and 1992); altered hydrology in foraging area watersheds resulting in diminished freshwater foraging habitat (cf. Goethal's Bridge Pond); and cormorant guano phyto-toxicity or storm surges reducing suitable trees for nest sites (cf. Huckleberry Island).

Description of Major Breeding Colony Islands (P. Blanchard and P.Kerlinger, 2001) (Tabulated results for vegetation type by island are presented in Appendix 2.)

1. Lower NY –Southern Staten Island

Hoffman Island is a manmade island approximately eleven acres in size and is surrounded by a seawall and jetties. Hoffman lies within Gateway National Recreation Area. Large stands of *Ailanthus* trees, privet, and low shrubs are the dominant vegetation in the north end of the island. The southern half is forested with black locust, *Ailanthus*, black cherry, hackberry, and white mulberry. Wading birds started to nest here in the 1990's.

Swinburne Island is a two-acre, manmade island surrounded by boulders and a seawall. Vegetation is low. Hackberry, black locust, and mulberry trees dominate the northern part of the island. Three dilapidated building structures characterize the non-vegetated portion of the island.

2.Jamaica Bay

Canarsie Pol is a natural island of 283 acres surrounded by sandy beach, peat bank, and salt marsh. Trees include black cherry, cottonwood, and gray birch. Poison ivy, greenbrier, Japanese bittersweet, and other vines form an impenetrable understory across most of the island.

3. East River

South Brother Island is just under six acres in area. The island is surrounded by a sandy beach and rocky outcroppings. The center of the island is fairly open and dominated by black locust trees. Vegetation represented in the rest of the island includes box elder, white mulberry, and cottonwood woodlands and dense shrubland and vineland dominated by the invasive exotic multifora rose, Asiatic bittersweet, and porcelainberry. Poison ivy is ubiquitous.

North Brother Island is a well-forested site lying to the north of South Brother and about twice its size. Derelict buildings are still standing on the site – remains of the Riverside Hospital, a city-owned infectious disease quarantine hospital where Typhoid Mary lived out her last years. A Norway maple forest with an understory solely composed of English

Fry dominates the center of the Island. Skirting the island's edges is a vegetative mosaic composed of a dense tangle of Asiatic bittersweet and porcelainberry that has trellised over chain link fence and small white mulberry, black cherry, Ailanthus and box elder trees. It appears that Harbor Herons nested in these trees when the trees were vine covered but still alive and in abandoned the island after the vines killed the trees. Since 2004, City of NY Parks & Recreation Natural Resources Group (NRG) has been removing mature Norway Maple trees and replacing them with native forest tree saplings including gray birch, Sycamore, tuliptree, and red oak, funded by a grant from NYC Audubon. Docks and a seawall surround the island. A tangle of vines overlies shrubs and fencing on the west-southwest corner of the island. .
Mill Rock lies about 1,000 feet (300 m) off Manhattan's East 96th Street and is less than four acres in area. It was created by the joining of Great Mill Rock and Little Mill Rock in 1885. Groves of Norway maple trees provide nesting habitat for wading birds.
UThant Island is a manmade island, less than an acre in area. Vegetation is mainly grasses and herbaceous plants. A steel arch structure stands in the middle of the island.

4. Hutchinson River and Long Island Sound
Goose Island is a forested rocky islet, approximately one acre in area, and densely covered with poison ivy. Most heron nests are in Macki's honeysuckle, a non-native shrub. Other nests are in mulberry and other non-native trees.
Huckleberry Island is a twelve-acre rocky island. Privately owned, the southeastern part of the island is used by the NY Athletic Club. The island is mostly covered with deciduous forest composed of sassafras, white oak, Norway maple, chestnut oak, and black locust. There are virtually no shrubs under the forest canopy

Foraging Habitat

Long-legged wading birds, such as herons and egrets, forage in both tidal wetlands and fresh water wetlands in the NY/NJ region. Depending on the availability of appropriate prey, species will fly on average distances of 2.8 km (Snowy Egret) to 24 km (Black-crowned Night-Heron) from their nesting colonies to foraging sites (Davis 1993, Parsons and Master 2000). Great Egrets have been observed on foraging grounds that are 3.0 to 12.0 km from their nests (McCrimmon et al. 2001). White Ibis will shift their prey base and their foraging sites as their nestlings grow; newly hatched nestlings need freshwater prey; birds approaching fledging can process salt water prey (Bildstein et al. 1990).

Coastal development and usage pressures not only affect nesting islands but foraging areas as well (Erwin 1996). Foraging habitat may be a limiting factor in supporting Harbor Heron nesting colonies. Theoretically, foraging site preferences are a trade-off between the quantity and quality of the prey available at a site and the time/energy costs of getting there. The distance between the foraging site and the colony is important. High quality foraging sites that are far from a colony require prolonged absence from the nest and energy output to fly to the site, reducing the benefit to the developing young of high quality food.

Studies conducted by NY City Audubon and associates, have identified probable foraging

sites using flight-line analyses methodology (Erwin 1981). Each island is sectioned into eight 45º sectors with the colony being the center of the pie. Observers, positioned so that they can observe the island from all directions, record heron and egret arrivals and departures, direction in which birds leave or return to the colony, time of day, and weather condition (Maccarone and Brzorad 2000, Bernick 2005). Biologists then evaluate available foraging habitat that lie in the direction of those average vector angles. Results from these studies suggest that birds from North and South Brother Islands most likely forage in the tidal mudflats of New Jersey‘s Meadowlands (Figure 4). Other birds were observed flying from Hoffman Island across Staten Island to forage in the Arthur Kill and the Raritan River Basin (Figure 4; Maccarone and Brzorad 2000). Ideally, researchers would follow individuals from the colony to the foraging grounds. In 2005, NY City Audubon staff had the opportunity to board a blimp and follow individual birds flying from Hoffman Island for distances up to 13 miles away to foraging sites south of Sandy Hook in New Jersey (ref).

Figure 4: Current and historical wetlands of the NY/NJ Harbor estuary. Map courtesy of the Regional Plan Association. Tracking the movements of the Harbor Herons from Colonies to foraging areas, observed and predicted flight lines used (Gelb 2004). Solid lines represent observed flight lines. The longer solid lines were confirmed using the Fuji Film blimps; dashed lines represent predicted flight lines. Flight lines superimposed on a map showing the current (green) and historic (purple) wetlands of the NY – NJ Estuary.

Restored habitat may provide higher quality foraging sites than degraded wetlands. Black-crowns have used urban and industrial areas, possibly because lights attract fish to the water‘s surface (Erwin 1991). A recent comprehensive two-year survey of avifauna in the NJ Meadowlands District undertaken by New Jersey Audubon Society (NJAS) recorded over 500 sightings of Great and Snowy Egret and over 100 sightings of the state

listed Great Blue Heron and Black-crowned Night-Heron (Mizrahi et al. 2007). While this survey was not designed specifically for monitoring herons and egrets, it provides strong evidence of the importance of the New Jersey Meadowlands' wetlands to these birds. Only the Yellow-crowned Night-Heron is known to breed in the District, therefore the birds observed during the survey are ones that travel daily from their nesting rookeries in the NY/NJ Harbor to feed and loaf in the Meadowlands' wetlands.

New Jersey Audubon Society (NJAS) and NY City Audubon (NYCA) recently launched a joint project with funding from the NJ Meadowlands Commission, The Education Foundation of America, and NJ DEP's Conserve Wildlife Matching Grants to study the connections between Harbor Heron breeding and foraging areas. Building on the strengths of past citizen science activities, the two groups developed methods and training materials, recruited and trained volunteers and have been conducting surveys during the breeding season since 2008 to determine foraging site use by colonial waterbirds nesting in the Harbor colonies. Specific objectives of this project are (1) to determine the abundance and distribution of long-legged colonial waterbirds at various sites and habitats and identify areas used as foraging grounds; and (2) to engage the public, especially citizen scientists, in nature study thereby creating stewards of the birds and their habitats.

Surveys of foraging Harbor Herons in New Jersey have focused on the Meadowlands and Raritan Bay with some sites in Northern New Jersey and Staten Island also included. Survey sites include Harrier Meadow, Richard P. Kane Natural Area (Empire Tract), Kearny Brackish and Freshwater Marsh**,** Kingsland Impoundment (DeKorte Park)**,** Mill Creek Marsh/Secaucus High School Wetlands, Marsh Resources Meadowlands Mitigation Bank in the Meadowlands and Cheesequake, Comptons Creek, Conaskonk Point, Matawan Marsh, Natco Lake, Raritan Center, Sandy Hook and South Amboy in the Raritan River and Bay and the Arthur Kill (Table 4, 5).

These focal areas were chosen based on flight line observations suggesting that birds from North and South Brother Islands fly over Manhattan and the Hudson River to forage in the tidal mudflats of New Jersey's Meadowlands, while birds from Hoffman Island cross Staten Island to forage in Arthur Kill and the Raritan River basin (Figure 4; NYCA unpublished data 2005). In 2009, NYC area survey sites were added and surveyed including Queens: Alley Pond Park, Jamaica Bay; Staten Island: Goethals Bridge Pond, Clay Pit Pond Park Preserve, Lemon Creek, Clove Lake; Brooklyn: Drier-Offerman Park, Gerritsen Beach; Bronx: Pelham Bay Park; Manhattan: Inwood Hill, Randalls Island.

Survey points were established at these sites based on the presence of suitable habitat and accessibility, and located to cover as much of the site as possible while maintaining sufficient distance to minimize overlap in viewing area between points. Volunteer citizen scientists were assigned specific sites, which they visited twice per month during the breeding and post-breeding season. During each site visit these citizens recorded the total number of herons, egrets and ibises and collected additional information on tidal cycle, habitat, and behavior (Table 4).

Table 4. Total number of observations of colonial waterbirds during 2008 surveys in the Meadowlands, based on 142 site visits. In the table below, the following acronyms are used: BCNH – Black-crowned Night-Heron; SNEG – Snowy Egret; GREG – Great Egret; GLIB – Glossy Ibis; LBHE- Little Blue Heron; YCNH – Yellow-crowned Night-Heron (Tsipoura et al 2009).

Site	Total Number Observed					
	BCNH	GBHE	GLIB	GREG	SNEG	YCNH
Anderson Creek	0	5	0	10	29	5
Harrier Meadow	28	23	0	143	137	0
Kane Natural Area (Empire Tract)	0	1	0	1	24	0
Kearny Brackish Marsh	0	6	0	283	7	0
Kearny Freshwater Marsh	0	8	0	27	0	0
Kingsland Impoundment (DeKorte)	5	13	0	421	50	0
Mill Creek Marsh	0	7	0	23	185	0
Marsh Resources (MRI)	0	37	6	112	265	0
Riverbend Wetland Preserve						
Sawmill Creek	7	19	1	305	149	0
Sawmill WMA	5	17	0	62	39	1
Secaucus High School	0	13	0	31	117	0
Skeetkill	0	6	0	3	25	0
All Meadowlands Sites	**45**	**155**	**7**	**1421**	**1027**	**6**

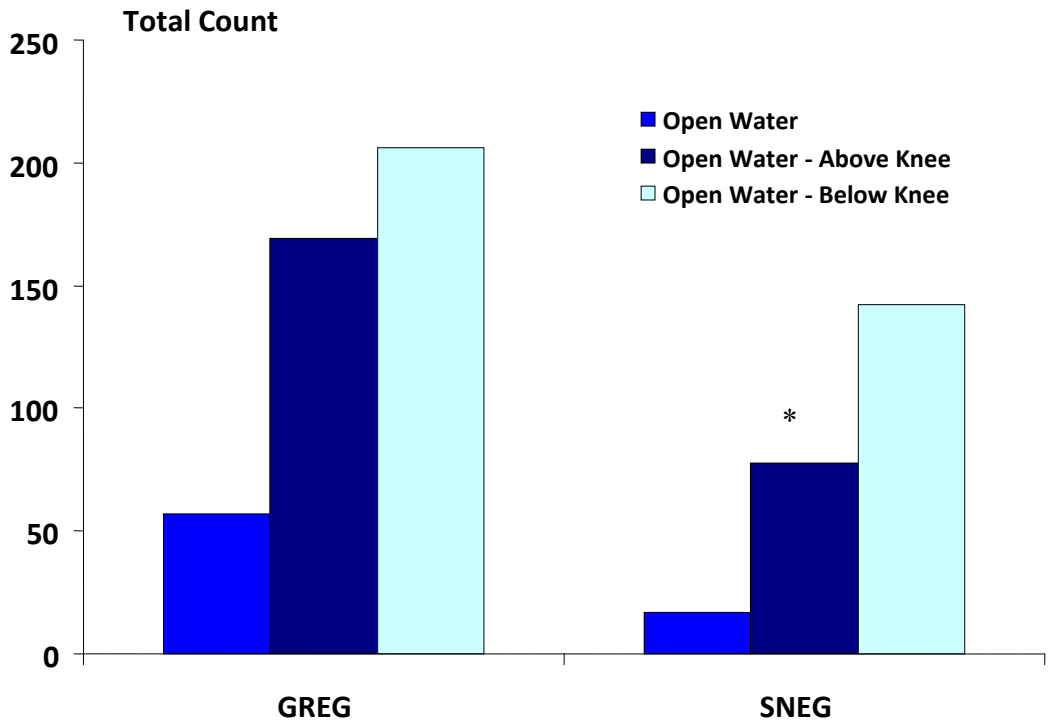
Over 50 volunteers participated and over 400 site visits we completed in 2008. Field reports from 2009 have not been tallied yet. In the Meadowlands in 2008, observers made 2,684 observations of colonial waterbirds. The two most common species observed were Great Egret (1,421 observations) and Snowy Egret (1,027 observations). Preliminary results suggest that more waterbirds were observed per visit in the Meadowlands than any other survey area. An average of 18.9 birds was observed per site during each visit compared to 5.4 in Raritan Bay and 6.0 in the Arthur Kill. On average, 10.0 Great Egrets and 7.2 Snowy Egrets were observed per site visit to Meadowlands sites. By comparison, an average of 3.7 Great Egrets and 0.5 Snowy Egrets were observed per visit in the Raritan Bay area. Great Egrets were observed at 100% of all sites and 91% of points surveyed in the Meadowlands, compared to 90% of sites and 72% of points in the Raritan Bay region. Snowy Egrets were observed at 92% of sites and 86% of points in the Meadowlands, compared to only 50% of sites and 19% of points in the Raritan Bay area. See Table 5.

Table 5. Relative frequency of birds seen during 2008 surveys, by general area. Frequency was calculated as the number of points in which a species was observed divided by the total number of points surveyed (Tsipoura et al. 2009).

Site	# of Points	Freq (# sites observed/total # of sites)						
		BCNH	GBHE	GLIB	GREG	GRHE	SNEG	YCNH
Meadowlands	66	0.27	0.71	0.06	0.91	0.06	0.86	0.05
Staten Island / Arthur Kill	7	0.43	0.29	0.57	0.57	0.14	0.71	0.14
Raritan	36	0.08	0.22	0.00	0.72	0.03	0.19	0.11

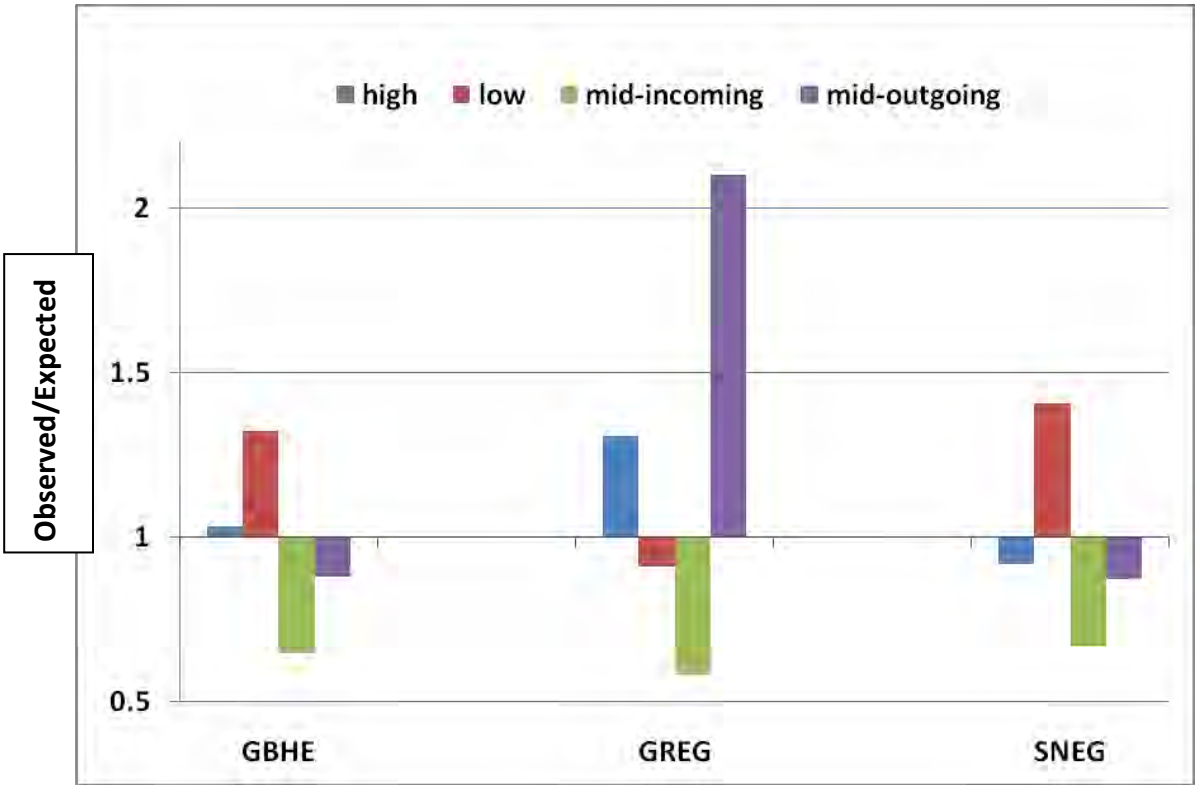
The largest numbers of colonial wading birds were observed in open water habitats, both in the Meadowlands and outside the Meadowlands region. Great Egrets were found foraging in deeper water than Snowy Egrets (Figure 5). These differences can be explained by their foraging behavior patterns. Great Egrets generally forage by standing in open water and waiting for prey or by walking slowly through an area (McCrimmon et al 2001), while Snowy Egrets are more visual foragers, typically preferring the edges of open water where they use a variety of strategies to get their prey, including running, hopping, and foot-stirring (Parsons and Master 2000). Strategies for improving waterbird habitat through water level management, must take these interspecific differences into consideration when attempting to manage for a variety of species. For example, it is possible that the abundance of Snowy Egrets at Meadowlands sites was higher because of the existence of wetlands of various (and varying with the tides) depths in the District.

Figure 5. Number of Great Egrets (GREG) and Snowy Egrets (SNEG) observed in open water habitats during 2008 surveys in the Meadowlands. The ‗Open Water' category is undetermined depth. * indicates Snowy Egrets were seen significantly more often in water depth below the knee than water above the knee (Tsipoura et al. 2009).



Preliminary analyses also suggest that habitat and tide cycle are important factors in determining use by Harbor Herons as has been reported for these species in the literature (e.g. Burger 1983, Maccarone and Parsons 1994, Maccarone and Brzorad 2002). More birds than expected were seen during mid-incoming tides in the Meadowlands and during mid-outgoing tides in the Raritan Bay area, suggesting the importance of tidal cycle in determining Harbor Heron use of non-breeding sites (Figure 6).

Figure 6. Number of birds observed/number expected at different tides in the Meadowlands District. We corrected for the total number one would expect to see based on the total number of surveys by tide since more surveys were conducted during certain tides. Values >1 reflect that more birds than expected were seen during that tide for Great-blue Heron (GBHE), Great Egret (GREG), and Snowy Egret (SNEG). Tsipoura et al. 2009.



NYC Audubon initiated a banding and radio-tracking project in conjunction with volunteer observations of tagged birds. During June and July 2008, 11 nestling Glossy Ibises and 17 nearly fledged Great Egrets were color banded (Pro-touch and Haggie, respectively and USFWS aluminum bands). Great Egrets also received VHF transmitters (Sir Track), attached to their color bands. We tracked birds with both stationary (data loggers) and mobile units (ATS). From June through October 2008, NYC Audubon staff surveyed approximately 45 sites in NY and New Jersey during a total of 82 observation hours. Three of these surveys were made at nesting colonies. Positive identifications were made for seven individuals during four separate surveys. One bird was identified foraging in the NJ Meadowlands from Erie Landfill (K. Ruskin, pers. comm.).

III. STATUS OF HABITAT CONSERVATION FOR HARBOR HERONS; MANAGEMENT, ACQUISITION, RESTORATION, AND ENFORCEMENT

NY/NJ Harbor has a long history of wetland loss through filling and draining of marshes; by current estimates, only 20 percent of the area‘s original tidal wetlands and an even smaller percentage of its freshwater wetlands remain (Hudson River Foundation 2004,

NY/NJ Harbor Estuary Program 1996). (Figure 4).

Central to the conservation approach in the Harbor region is the need to conserve both the breeding, and loafing and foraging sites of the Harbor Herons. It is only by conserving both of these types of habitat that the Harbor region can continue to provide viable breeding opportunities for these birds. This approach is reflected as the Target Ecosystem Characteristic (TEC) _Islands for Waterbirds‘ in the Hudson Raritan Estuary Comprehensive Conservation Management Plan (CRP) that focuses on restoring and protecting roosting, nesting and foraging habitat for long-legged wading birds (Bain et al. 2007, USACE and PA NY/ NJ, 2009).

Many of the colonies in the NY/NJ Harbor are located on nesting islands that owe their origins either entirely or partly to human activity. For example, Hoffman Island is an entirely man-made island. At North Brother Island, the Harbor Herons currently nest in an area that was added to the island by NY City. The human desertion of the Harbor‘s many islands after years of use has been crucial in enabling the Harbor Herons to return to the this region.

Destruction and filling of wetlands has taken place over the past 400 years and continues today. Tidal wetlands representing key foraging habitat in the region have been better preserved than fresh water wetlands, which are virtually extirpated. In New York, for example, except for the few protected marshes around Pelham Bay Park, the conversion from wetland to upland is nearly complete. Cement and rock-lined river channels, manmade impoundments, and reservoirs are the remains of fresh water wetlands in the region. These habitats have only recently begun to receive adequate protections largely through grass roots efforts of lobbying groups. In Jamaica Bay, with the creation of Gateway National Park in 1972 and with the consortium of advocates that has developed, marshes have received more political support and attention even as they continue to recede. In the NJ Meadowlands, an area designated by U.S. Fish and Wildlife Service as part of New Jersey's North Atlantic Coast Waterfowl Focus Area, the NJ Meadowlands Commission‘s Master Plan has made the preservation and restoration of open space a high priority. However, controversies regarding wetland enhancement and site remediation continue to exist in the Meadowlands District. Similarly, the once vast marshes of the Arthur Kill have been attracting political support but controversy surrounds proposed restoration and development continues. Finally, the Raritan River watershed and Raritan Bay remain the least studied and protected.

Restoration and enhancement of some of breeding islands and foraging grounds is also a concern as many areas are encroached upon by invasive species, such as *Phragmites*, oriental bittersweet and purple loosestrife. However some invasive species of plant may provide appropriate substrate for breeding herons, for example Black-crowned Night-Herons nested in oriental bittersweet vines on North Brother Island. They will also nest in *Phragmites*, as will Yellow-crowned Night-Herons, Little Blue Herons and Glossy Ibises (Burger 1979, Kane 2001, Parsons 2003). Reduction of pollutants remains a concern in the entire region as these pollutants threaten to degrade habitat. Costal wetland restoration, in addition to improving habitat for the Harbor Herons and their

prey, will improve ecosystem function through nutrient and carbon retention and sediment stabilization (USACE and PA NY/ NJ, 2009). The coastal wetlands TEC of the HRE CRP is to address acreage and ecosystem function. Target restoration sites could include Hackensack River and its tributaries, the Arthur Kill and its tributaries, Jamaica Bay, and along the Raritan River and its tributaries. Shoreline restoration can target areas within the Lower Hudson, Upper Bay, and Harlem/East River/Long Island Sound which have high percentages of hardened shoreline. Especially desirable is shoreline restoration that creates continuous natural shoreline with associated upland buffer (USACE and PA NY/ NJ, 2009).

Since 1997 the Harbor Estuary Program Habitat Workgroup has supported a stakeholder-based nomination process for parcels of undeveloped land in the area that might be good targets for conservation purchases, as well as for publicly owned parcels that would benefit from ecological restoration efforts. The HEP Habitat Workgroup, a Committee of the NY/NJ Harbor Estuary Program (HEP) charged with delineating critical habitat areas in the estuary, developed watershed-based priorities for acquisition, protection, and restoration. The criteria used to rate the project sites included: existence of species or communities which are rare, endangered or threatened at the federal, state or local level; existing and potential ecological value and size; imminence of development; and economic considerations. The Acquisition and Restoration Priority Sites map employs an ecosystem approach to watershed management and protection consistent with the HEP Comprehensive Conservation and Management Plans Action Priorities (CCMP H-11.3, 12.5, 12.8, and 4.4) and has resulted in the HEP Priority Restoration Lists. These were created to guide acquisition and restoration in the NY/NJ Harbor Estuary. All sites listed have been ratified by the HEP Policy Committee.

These lists make up the HEP Priority Acquisition List and the HEP Priority Restoration List, respectively. Since 1997, nearly 60 parcels have been placed on the Acquisition List and over 100 on the Restoration List (Figures 7, 8). These lists are shared with public agencies and nonprofits and help direct conservation funds toward parcels that will add the most value to the portfolio of conservation land in the region. Recommendations for acquisition and restoration of sites critical to Harbor Herons have been made by scientists, environmental groups and policy makers and are presented below. Furthermore, a GIS-based analysis was conducted to quantify key differences between the stakeholder-nominated sites and to rank them according to their potential benefits for wading birds (Lynch 2006). The analysis ranked the Priority Acquisition and Priority Restoration sites separately and the results are also presented below.

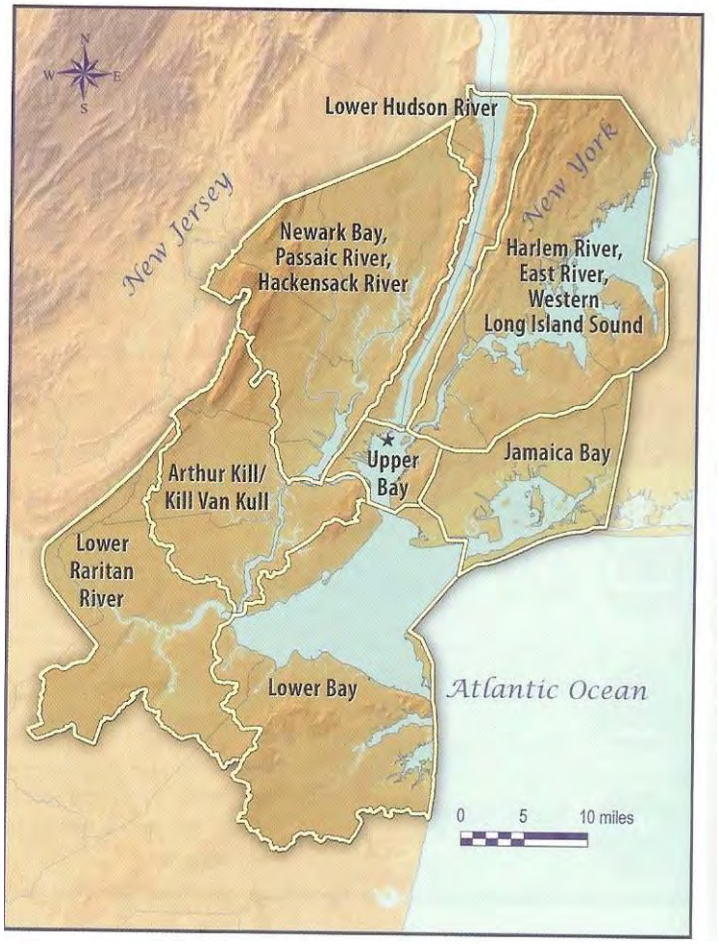
Figure 7. HEP Priority Acquisition sites. Labels refer to HEP coding. Some labels have been omitted because of space limitation. Figure is reprinted from Lynch 2006

Figure 8. HEP Priority Restoration Sites. Several labels are omitted due to space limitation. Figure is reprinted from Lynch 2006.

Acquisition and Restoration of Nesting Islands

In the HRE CRP, the TEC for waterbirds outlines restoration opportunities within the eight identified planning regions of the Hudson-Raritan Estuary (Figure 9).

Figure 9. The eight planning regions of the Hudson-Raritan Estuary study area. The Statue of Liberty is represented by a star. Map courtesy of the CRP.



In 2004-2005, the Habitat Workgroup identified acquisition of South Brother and Huckleberry Islands as a top priority, since those were the only two privately owned islands. In 2007, South Brother was transferred from private hands to NYC Parks and Recreation when it was purchased as a result of NOAA funding to The Trust for Public Land, The Wildlife Conservation Society, and The Point Community Development Corporation. Other accomplishments that have contributed to improved nesting habitat for waterbirds in the region include: incorporation of island habitat protection under the NY State Wildlife Action Plan; the TEC designation in the Comprehensive Restoration Plan (CRP); and the designation of these islands as Audubon NY Important Bird Area regions.

Many of the colonies in the NY - NJ Harbor are located on nesting islands that owe their origins either entirely or partly to human activity. Abandonment of the Harbor‘s islands after many years of use by humans has played a critical role in enabling the Harbor Herons to return to the this region.

Foraging Habitat Acquisition and Restoration

To survive, herons, egrets, and ibises in addition to needing breeding islands require appropriate foraging habitat, which varies seasonally, daily, and with the tides (Burger 1983). While nesting habitat is included in CRP as part of the Waterbird TEC as well as indirectly under coastal wetlands and under habitat complexes, foraging habitats have generally been understudied and are not as well represented in restoration and acquisition efforts. Nonetheless, recent advances to improve foraging habitat for waterbirds in the region include the following:

- HEP partnership completed a Comprehensive Conservation and Management Plan (CCMP) in 1997 that was then signed by the governors of New York and New Jersey. Focusing on air and water quality, habitat acquisition and restoration, and sediment issues, in essence the plan calls for a ―swimmable and fishable" estuary by 2009.

- While foraging habitat is not included explicitly in the CRP Waterbird TEC, TEC guidelines for habitat complexes include recommendations that will increase and improve heron foraging areas in the harbor.

- The New Jersey Wildlife Action Plan (WAP) lists colonial waterbirds as one of the suites of species of greatest conservation concern for coastal areas in the northern and the Raritan Bay conservation zones of the Piedmont Plains, including foraging habitat, and describes bird surveys with the purpose of populating the biotics database as one of the priority conservation actions in this landscape (NJ DEP 2008).

- The New York State Department of Environmental Conservation has identified the foraging landscape for long-legged wading birds as one of the major focal areas for State Wildlife Implementation Grants in the Atlantic Ocean Basin region.

- Passage of the 2004 Meadowlands Master Plan and its resultant re-zoning of all 8,400 acres of existing wetlands & waterways within the 32 square-mile Hackensack Meadowlands District for conservation.

- Creation and empowerment of the Meadowlands Conservation Trust (MCT) as a funded, state-chartered entity to acquire, hold and manage conservation lands within the Hackensack River watershed.

- In the recently established Sustainable Raritan River Initiative, Rutgers University and over 30 partner organizations and businesses are collaborating to restore and revitalize the Raritan River (Shaw et al. 2009).

Additionally, the Arthur Kill Marshes now show a net increase in habitat over two decades. That comes despite the historic low regard for this part of the estuary. The net

gain may be attributed to the active approach taken by New York City Parks that led to the enhancement of 16 acres of marsh from 1992-2004. Three active projects in the Arthur Kill watershed will enhance 34 additional acres while another in Newark Bay will restore another 32 (Blanchard et al. 2001).

Specific recommendations for Harbor Heron Acquisition and Restoration Priority Sites in New Jersey

Several sites in New Jersey were recommended to receive acquisition and/or restoration attention by members of the Harbor Heron committee (Hugh Carola, Greg Remaud, Fred Virrazzi, pers comm.). The New Jersey sites recommended have commonality with the sites picked by the HEP Habitat Workgroup and, therefore these sites were chosen for similar reasons. However, these sites are picked for their importance to Harbor Herons rather than the broader faunal range that the Workgroup considered. The site list is dynamic and sites can be added or modified in the Harbor Heron Plan in the future. The sites are within three broader watersheds: Hackensack River, Raritan, and Arthur Kill.

Hackensack River Watershed

The Hackensack Meadowlands is a large wetland complex dominated by intertidal and intermittently flooded common reed (*Phragmites australis*) marshes with smaller areas of the following wetland types: shallow tidal bay/mudflat; low salt marsh dominated by low marsh cordgrass (*Spartina alterniflora*); remnant high salt marsh dominated by high marsh cordgrass (*Spartina patens*); brackish impoundments; freshwater impoundments; and remnant palustrine forest dominated by pin oak (*Quercus palustris*), red maple (*Acer rubrum*), and swamp white oak (*Quercus bicolor*). Grassland, shrubland, and early successional forest are the upland habitat types on the landfills, with small, undeveloped uplands scattered around the edge of the Meadowlands.

- Priority site: HR2C Hackensack Meadowlands/Empire Tract/Moonachie Creek (NJ) (*) (c) -- wetland Acquisition; Northern Harrier & Yellow Crowned Night Heron Foraging Area. Has been acquired as the Richard P. Kane Natural Area.

- Priority site: Hackensack Meadowlands/Secaucus High School Marsh, Secaucus -- NJ Wetland and tidal enhancement. Enhancement done.

- Priority site: HR2E Hackensack Meadowlands/Kearny Marsh (NJ) -- permanent Open Space Designations. Should be a designated restoration site, in addition to its current ―Permanent Open Space" designation. New Jersey Meadowlands Commission is designing plans for the natural restoration of this site, although there are serious concerns about contaminants onsite.

- Priority site: HR2E Hackensack Meadowlands/Kearny Marsh, Kearny, NJ -- Freshwater wetland enhancement. This area is heavily impacted by outdoor recreational vehicle use and carries some contaminant concerns, but pilot projects are being conducted to determine how enhancement can proceed without spreading contamination.

- HR1 Lincoln Park West—the restoration of 40 acres of wading bird habitat is planned for an area of impacted marshlands within Hudson County's Lincoln Park. The west side of the park is a well-vegetated natural area along the lower Hackensack River, near the confluence with the Passaic River. Its natural cover and location between the Arthur Kill and the Hackensack Meadowlands has made it an important foraging and stop over area for herons, wading birds and a variety of waterfowl species. Restoration should begin in 2010 thanks to federal stimulus money.

Raritan Bay River and Watershed

Areas to the southeast of the mouth of the Raritan River include a narrow strip of bayshore marshes, creeks, beaches, dunes, and remnant forests. Intertidal and shallow subtidal mudflats and sandflats extend out an average of 1/4 mile offshore of these habitats. A total of 1,460 hectares (3,600 acres or 1457 ha) of flats was mapped in the National Wetlands Inventory for the entire watershed. The salt marshes along this shoreline consist of high and low marsh cordgrass with lesser amounts of black grass (*Juncus gerardii*), marsh elder (*Iva frutescens*), and groundsel bush (*Baccharis halimifolia*) in the high tide zone, and *Phragmites,* an invasive in many places. The upland forests are composed primarily of oaks, black cherry (*Prunus serotina*), and tree-of-heaven (*Ailianthus altisima*), with an understory of mountain laurel (*Kalmia latifolia*) and arrowwood (*Viburnum spp*.) and lowland forests composed of cottonwood (*Populus heterophylla*) and sweet gum (*Liquidambar styraciflua*). These wetlands, uplands, and nearshore waters form a bayshore complex which is critical for migratory and resident birds and fish.

In addition, acquisition of unprotected parcels and the natural restoration of select areas along stream corridors would have tremendous benefits to herons and other wading birds of the Estuary. This area should be considered among the highest priorities given its ecological significance, great potential for restoration and high risk of development in key natural areas, especially along Waackaack Creek.

- Priority site: RB5 Natco Lake/Thorn's Creek (NJ) -- Permanent Protection & Possible Stream/Lake Enhancement.

- Priority site: RB8 Conaskonk Point (NJ) (*) -- Permanent Protection; Wetland & Upland Restoration. NJDEP Office of Natural Resources, USFWS and knowledgeable conservationists view the acquisition of this site a high priority. However, the site of 200-acres of wetlands is in excellent ecological condition as is, and therefore should not be considered for restoration.

- Priority site: RB13 Cheesequake Marsh (NJ) (*) -- Permanent protection and restoration. The remaining unprotected parcels of this over 1,000 acre expanse of coastal wetland should continue to be acquired and preserved as part of Cheesequake Park. Additionally, there may be several opportunities for beneficial natural restoration on existing and soon to be acquired areas of Cheesequake Marsh.

- Priority site: RB5 Natco Lake/Thorn‘s Creek -- Includes the Waackaack Stream Corridor, (which is much longer, greater in volume and covers a much larger watershed than Thorn‘s Creek). Thorn‘s Creek joins Waackaack at its mouth just before emptying into Raritan Bay. Together these streams along with the adjacent freshwater Natco Lake provide significant habitat for herons, which can be found there in abundance.

- (Approved on updated HEP list) RR#-- One of the most significant opportunities to preserve heron habitat hinges on the ability to acquire and preserve the Dismal Swamp. The Dismal Swamp is most likely to be the largest remaining unprotected freshwater wetlands in the Estuary. It is located along the lower Raritan River within close proximity to the Arthur Kill Herons complex. Unfortunately some residential development has occurred amidst these thriving wetlands and more residences and a large connecting roadway have been proposed within the Dismal Swam area.

Arthur Kill Watershed

The Arthur Kill sites include a diversity of wetland habitat types, primarily tidal and nontidal emergent salt, brackish, and fresh marshes, mudflats, ponds, and creeks, dominated by cordgrasses, spike grass (*Distichlis spicata*), marsh elder, *Phragmites*, and cattail (*Typha latifolia*). In addition to vegetated wetland areas, this complex contains extensive interspersed areas of human-made structures, including railroad yards, oil tank farms, bulkheads, docks, road systems, landfills, and numerous industrial and residential buildings, both occupied and abandoned.

- Priority site: AK2 Piles Creek (NJ) (*) -- Tidal Wetland Acquisition, Preservation, & Enhancement

- Priority site: AK1 Arthur Kill, Multiple Sites (NJ) (a) -- Salt Marsh Restoration (Harbor Herons recommends that the lower Rahway River marshes from the Route 1 overpass in Rahway to the river mouth be prioritized).

- Priority site: AK3F Rahway River/Potter‘s Island (NJ) -- Habitat Enhancement for Heron/Egret Rookery

- Priority site: AK4 Woodbridge River Restoration (NJ) (*) (5, 7, 10) -- Wetland Enhancement & Wildlife Sanctuary

- (Approved on updated HEP list) AK# --, Weequahic Park, natural shoreline restoration along Lake Weequahic offers one of the more exciting and educational opportunities to restore heron habitat in the Estuary. Located in the popular Olmstead-designed park landscape in Newark, this oasis would not only increase habitat to existing herons who forage at the park, but would give maximum public exposure to an urban population that may otherwise never encounter such natural wonders.

Key to HEP and HH Acquisition Priorities
*** -** Highest Priority Site, as selected by HEP Habitat Workgroup (NY sites ratified by HEP Policy Committee, 11
December 1997, unless otherwise noted; NJ sites ratified by HEP Policy Committee July 1997, unless otherwise noted)
a - Does not appear on map
b - Needs more information
c - These sites have actions pending by the US EPA, US ACE, NJDEP, or NYC DEP. Please see addenda to HEP
Acquisition and Restoration Priorities sites list.
d - Pending ratification by HEP Policy Committee
1 - Funded by the Garden State Preserve Trust (in progress)
2 - Funded by the 1995 NJ Green Acres Bond Act
3 - Funded by the FY 1998-1999 NJ DEP (in progress)
4 - Funded by the 1996 NJ Blue Acres Bond Act

Key to HEP and HH Restoration Priorities
*** -** Highest Priority Site, as selected by HEP Habitat Workgroup (NY sites ratified by HEP Policy Committee, 11
December 1997, unless otherwise noted; NJ sites ratified by HEP Policy Committee July 1997, unless otherwise
noted)
a - Does not appear on map
1 - Funded by NYS Clean Water/Clean Air Bond Act & City of New York
2 - Partial funding by NYS Clean Water Bond Act & City of New York
3 - Funded by Jamaica Bay Damages Account (NYS DEC)
4 - US ACE Feasibility Study site
5 - US ACE proposed Reconnaissance site
6 - US ACE 1135 proposed stream restoration site
7 - Funded by the 1991 Exxon Bayway Oil Spill Damage Recovery (design in progress)
8 - Partial funding by the 1999 Montauk Oil Damage Recovery (in progress)
9 - Partial funding by EPF grant (NYS DOS)
10 - Partial funding by the NY/NJ Oil Spill Trustees
11 - Partial funding by the National Fish and Wildlife Foundation
12 - Public works mitigation

Staten Island

Arthur Kill Watershed

AK 9. Arlington Marsh was transferred to City of New York Parks & Recreation in 20TK. The Staten Island Container Terminal (SICT) is proposing a facility expansion that would fill in 19 acres of Arlington Marsh and perform compensatory mitigation off-site. Salt marsh restoration opportunities exist at Arlington marsh but feasibility studies performed by SICT indicate that off-site disposal of polluted sediments would result in a great expense. This raises two questions: 1) Is Arlington marsh a toxic sink that is a liability to the wading birds and others that forage there; and 2) Would salt marsh restoration ameliorate or exacerbate this situation?

AK 15. Neck Creek, Salt marsh Restoration

This 60 acre site includes freshwater and tidal wetlands drained by Neck Creek and forested headwater that surrounds the intersection of Meredith Avenue and the West Shore Expressway. The site is a critical habitat link between the Fresh Kills wetland

complex to the south – including Isle of Meadows – and the Saw Mill Creek and Bridge Creek wetland complexes to the north, ultimately integrating the Arthur Kill and Kill Van Kull. In 2006 the Trust for Public Land acquired and donated to the City of New York Parks & Recreation 15 acres containing primarily high quality tidal wetland. Residue and ecological constraints related to the site's former industrial land use remain as opportunities for salt marsh restoration.

AK08. Prall's Island, Heron Rookery Enhancement

Pralls Island was the first site where Staten Island resident Scotty Jenkins observed breeding wading birds after their return to the region in the early 1970s. Breeding ceased abruptly in about 1993 or 1994. The following are possible reasons, either singly or in combination, for the colony collapse:

- Pralls Island was the epicenter of the 1990/1991 Exxon Bayway oil spill resulting in heavy shoreline pollution by number 2 heating oil.

- Grey birch, the preferred nesting tree on the island exhibited a precipitous die-back. Leaf miner damage to foliage was heavy, but probably represented a symptom of a more significant underlying stress. A probable cause is six foot higher than normal high tides accompanying the four day nor'easter in October 1992. The amplitude and duration of this storm surge could have resulted in salt water intrusion and overwash of Prall's Island.

- Coincidental with the abandonment of Prall's Island and Shooters Island colonies was the dramatic change in water level (and possibly salinity) in Goethals Bridge Pond. Previously the pond was visited by large numbers of mixed wading bird species during nesting season and fall migration. The construction of a "big box store" and a self-storage facility adjacent to the pond appeared to substantially decrease fresh water flows to the pond.

- At 50 acres Prall's Island offers abundant habitat for predators including raccoon, boat tailed grackle, and common and fish crows.

  NRG received New York State Clean Air/Clean Water Bond Act funds to remove the non-native Ailanthus trees that survived on the island's high rocky spine and replace these trees – too open-branched and week-wooded to support heron nests – with small statured, slow growing native hardwoods. As NRG performed analysis and drafted plans for this restoration gray birch was regenerating but herons were not recolonizing. Then in 2007 the United States Department of Agriculture Animal and Plant Health Inspection Service (APHIS) discovered that the island was a new locus of Asian long-horned beetle (ALB) infestation. In response the state removed approximately 3,000 potential ALB host trees, mostly gray birch and Norway maple. Gray birch is re-sprouting vigorously and NRG is planting thousands of new trees, butnew challenges include deer, rabbit, and vole herbivory and burgeoning populations of invasive shrubs and vines – most notable glossy buckthorn (*Rhamnus frangula*) and mile-a-minute weed (*Persicaria perfoliata*).

Jamaica Bay Watershed
Priority Site: JB 7, Dubos Point Park Preserve, Salt Marsh Restoration
The largest salt marsh on the Rockaway peninsula north shore Dubos Point supports confirmed breeding sharp-tailed sparrow and willet, and possible Black-crowned Night-Heron. The preserve is a mosaic of low and high salt marsh, maritime grassland and shrubland, early successional woodland, and vine land thicket dominated by invasive non-native plants including Asiatic bittersweet (*Celeastrus orbiculatus*) and multiflora rose (*Rosa multiflora*). Restoration opportunities include augmenting salt marsh via debris and fill removal and creating maritime forest via invasive plant species removal and replanting. The former would result in enhanced wading bird feeding opportunities; the latter would result in possible enhanced night heron nesting opportunities.

Priority Site JB 8, Four Sparrow Marsh Park Preserve, Salt Marsh Restoration and Upland Forest Buffer Enhancement.
This 40 acre preserve is composed of a large expanse of high and low salt marsh – perhaps the second largest Jamaica Bay tributary wetland – flanking a smaller maritime shrubland and early successional forest. The site derives its name from Sharp-tailed, Seaside, Swamp, and Song sparrows that breed there. Additional breeding birds include Willet, Clapper Rail, and possible Green-backed Heron. City of New York Parks & Recreation Natural Resources Group (NRG) restored two acres of salt marsh at the site in 2000. Additional salt marsh restoration opportunities exist, including via the removal of decades of accumulated marine debris. Adjacent to the preserve is an additional 30 acres of undeveloped upland under the jurisdiction of the Economic Development Corporation (EDC). EDC completed an Environmental Impact Statement (EIS) but has not to date received a viable proposal for commercial development. The EIS included as part of the ultimate development design the inclusion of a vegetated buffer between the future development and the preserve.

Site Evaluation: a GIS modeling approach
In the NY/NJ Harbor Estuary, with its ubiquitous buildings, massive transportation networks, and huge extent of impervious surface, it would be desirable to preserve all remaining wetland habitat through acquisition by public agencies or nongovernmental conservation organizations. But the realities of real estate expense, limited conservation funding, and continuing development in the Harbor area make it advisable to buy the best parcels first before they are lost forever.

Similarly, restoration is an integral component of habitat considerations for the Harbor Herons Conservation Plan. In the area surrounding NY/NJ Harbor, natural areas are beset by the many stresses discussed above that lower their value as wildlife habitat. These stresses can impede wildlife use of the wetlands and lead to their conversion to upland habitat. Restoration of habitat is essential to maximize wildlife use of the available natural areas in the region.

The HEP Priority Restoration Lists were created to guide acquisition and restoration in the NY/NJ Harbor Estuary. Because the HEP Priority lists are so long, and because not

all of the sites are wading bird habitat, a prioritization process was undertaken to assess the acquisition and restoration projects that can be expected to be most important to the wading birds that nest in the Harbor. This assessment is based on ecological principles and employs a geographic information system (GIS) analysis to identify the most appropriate of the HEP Priority List parcels that should be acquired or restored to optimize the quality and quantity of foraging area for resident wading birds. The final result is an ordered ranking of parcels on each of the two HEP Priority Lists, indicating the top 15 parcels that should be acquired for protection and the top 15 parcels that should have restoration work undertaken in them.

Potential foraging habitat includes tidal and nontidal wetlands within a 28-kilometer radius of the target species' nesting islands. The 28-kilometer radius is informed by distances reported in the scientific literature and data gathered by New York City Audubon's Harbor Herons Monitoring Program (Custer and Osborn 1978, Nagy 2005). While the analysis considers all wetlands within this radius, it favors foraging grounds that are closer to the nesting islands over foraging grounds that are farther away. (Research on Harbor Heron foraging ecology is needed to determine the distance birds will fly to find appropriate foraging habitat and help rank the value of individual parcels.) The 28-kilometer foraging distance is a high estimate, but Great Egrets have been recorded traveling as far as 40 kilometers to foraging grounds (Bancroft et al. 1994), and the Harbor Herons are known to use foraging grounds up to 23 kilometers away from their islands (Nagy 2005). It is not clear whether a shorter flight distance is due to an inability to fly farther or due to adequate nourishment being found closer to the nest; an increase in flight distance may indicate decreased quality of foraging conditions (Bancroft et al. 1994). This would be consistent with the problems in the Harbor Estuary. All parcels on the HEP Priority Lists are within the 28-kilometer radius of the islands, and most are within the 23-kilometer radius.

The study area includes about 8,200 hectares (20,200 acres) of tidal wetlands and 22,900 hectares (56,600 acres) of non-tidal wetlands. The wetland patches in the study area range in size from scattered patches as small as .06 hectares (.15 acres) to the largest patch, of about 2,200 hectares (5,400 acres), at Great Swamp National Wildlife Refuge in Morris County, New Jersey. About 48 percent of the tidal wetlands and 28 percent of the nontidal wetlands are currently under management by public authorities or under conservation easement.

The analysis was done in several steps. First, all wetlands in the study area were scored based on criteria believed to affect their value to colonial waders. Next, the stakeholder-nominated HEP Priority List parcels were overlaid on the scored wetland areas, and parcels were ranked according to total area of wetland they contained, weighted by the score given to that wetland in the first part of the analysis. (Note: The entire selection process is presented in Jean Lynch's master's project, completed in 2006 through Duke University (Lynch 2006). In this analysis, scores are given to units of habitat that reflect the expanse of wetland and wetland quality, so recommendations are strongly influenced by the amount of wetland in a parcel; they are modified by the quality of the wetland. No parcel with a quality score of less than 0.60 is recommended for purchase. Establishment

of this quality score cutoff is explained in the full report of the study (Lynch 2006). There was no quality cutoff for restoration priorities, as these parcels are already publicly owned.

Ultimately the recommendations rest on two guiding principles. First, that in the highly urbanized setting of NY/NJ Harbor, total acreage available for wildlife is the most important factor to go into conservation decisions. Second, that some consideration should be given to setting a minimum quality standard for land dedicated to wildlife use.

Acquisitions

The top 15 parcels that are recommended for conservation acquisition include close to 1,000 hectares (approximately 2,500 acres) of wetlands (Figure 10).

Figure 7. Map and Ranking of Top 15 HEP Priority Acquisition List Sites. Recommendations are based on GIS analysis of proximity of wetland to nestling islands; proportion of the surrounding landscape that is wetland or protected land; development impacts on the wetland; known contamination and toxicity studies in the vicinity of the wetland.

Several parcels of land were removed from the list of acquisition recommendations because their purchase has recently been completed or because they did not meet the quality score cutoff. Sites that were removed because of the quality score cutoff include Penhorn Creek (HR02B) in the New Jersey Meadowlands, Range Road Forest (AK04), Udalls Cove Ravine (LI03), and Arlington Marsh (AK09). Most of these parcels are in close proximity to the Harbor Herons nesting islands, and with the exception of Udalls Cove, all of them received low scores largely because of contamination threats. The decision to remove these parcels reflects a reluctance to recommend the purchase of low-quality habitat. It also points to the importance of solving contamination problems that afflict otherwise extremely valuable wildlife habitat.

Restoration

The top 15 parcels recommended for restoration are presented in Figure 11. The restorations desired in the recommended sites are varied and may include restoring tidal circulation, removal of fill, and removal of invasive species. A small restoration project, such as removal of a berm or enlargement of a culvert to increase tidal circulation, can benefit a much larger area than the immediate work area in which the restoration is performed. Some of these parcels require modest restoration efforts, but the parcels themselves encompass over 400 hectares (about 1,000 acres) of wetlands (Fig.11).

Figure 8. Map of Top 15 HEP Priority Restoration List Sites. Recommendations are based on GIS analysis (Lynch 2006) of proximity of wetland to nesting islands; proportion of the surrounding landscape that is wetland or protected land; development impacts on the wetland; known contamination and toxicity studies in the vicinity of the wetland.

IV. CONSERVATION THREATS

Waterbirds in the NY/NJ Harbor face a number of threats to their nesting and foraging habitats: human disturbance, habitat degradation or alteration, and mammalian predators (Parnell et al. 1988, Erwin 1989, Rounds et al. 2004). Global climate change, sea level rise and pollution are issues facing birds on a larger scale (Erwin et al. 2006). According to the Waterbird Working Group of Partners in Flight (ref), shortage of colony sites, predation and disturbance at nesting colonies, reduction in nesting and foraging areas, and impacts of pesticide/chemical contamination are the most pressing threats to wading birds in the Mid-Atlantic/New England Maritime region. Issues can be addressed on a threat-by-threat basis, but often several threats operating on different points of the system that can set the tipping point for sustaining a healthy heron colony.

Species Conservation Issues and Threats

Human Disturbance

Harbor Herons breed and forage in an urban environment, and are thus continually subjected to high levels of disturbance. The impact of disturbance on waterbirds is dependent on the type of disturbance (Burger et al. 1995, Carney and Sydeman 1999, Schmidt and Parsons 2007). Scientific investigators and ecotourists often introduce high levels of disturbance. People who use sites for other types of recreation can also disturb these birds as they come across them incidentally, but often to a lesser extent (Carney and Sydeman 1999). In some cases, however, recreation/tourism can even enhance the conservation of land on a landscape scale, leading to habitat protection and biodiversity preservation (Burger 2000). With increased scientific and educational activities, both at or near the colonies and at the foraging grounds, efforts should be made to minimize disturbance to the birds. To minimize disturbance to the nesting birds, the frequency of the surveys should be weighed against the knowledge gained from such surveys (Schmidt and Parsons 2007).

Several studies have demonstrated habituation to human presence, wherein birds may exhibit a reduction in behavioral or physiological response to disturbance (Peters and Otis 2006, Fowler 1999, Keller 1989). In addition, bird species may show a differential response to disturbance (Burger and Gochfeld 1998). These potential interspecific and inter-populations differences in the waterbirds‘ response to disturbance should be explored and taken into consideration when attempting to address the threats.

Disturbance at Nesting Sites

Human intrusion at waterbird nesting areas can result in desertion of nest sites (Tremblay and Ellison 1979, Burger 1981a, Burger and Gochfeld 1990), decreased hatching success (Hunt 1972, Schreiber 1979), increased loss of chicks wandering from their nests (Veen 1977), increased predation (Kury and Gochfeld 1975, Robert and Ralph 1975, Desgranges and Reed 1981), and decreased parental attendance (Safina and Burger 1983). When adults are flushed from their nests, they leave their nests and young unprotected from predation by crows or gulls (Burger 1981) and exposed to inhospitable

weather conditions (Carney and Sydeman 1999). In addition, industrial traffic, in the form of large barges and other off shore vessels in addition to motorboats and personal watercraft operated near a nesting colony can cause wake damage as well as physical disturbance from the vessel. Some species of waterbirds may be more tolerant of the industrial disturbance than others (Mueller and Glass 1988).

Human disturbance can cause high mortality in a colony especially when birds have not been habituated to groups of humans near the colony. Critical periods of heron nesting occur during the courtship and early incubation phase and the pre-fledgling period (Hunt 1972, Conover and Miller 1979, Tremblay and Ellison 1979, Cairns 1980, Parsons and Burger 1982). Disturbance during these times can lead to colony abandonment. Young birds of four to six weeks of age, may be startled by people in the colony and actually try to leave their nests prematurely, falling to the ground or getting disoriented (Parsons and Burger 1982; Stephanie Schmidt, K. Parsons, pers comm). Adult herons and egrets will not feed their young on the ground or locate them if they are lost, so those young are then lost to the population.

Buffer zones of 100 to 300 meters have been suggested around breeding areas (Rodgers and Smith 1995, Butler 1993). Birds are easily disturbed before and during the egg-laying period (Butler 1993). Wading birds have been shown to be very sensitive to disturbance, especially before and during the egg-laying period (Kushlan and Bildstein 1992, Butler 1992, Tremblay and Ellison 1979). Vos et al. (1985) reported that in March, during the egg-laying period, birds responded when an approaching person was 135 meters away, but from April through July showed no response when an approaching person was as near as 50 meters away. Burger et al. (2010) report that the distance at which Black Skimmers (*Rynchops niger*) first flew when a boat approached decreased from the pre–egg-laying period to hatching, and then increased slightly later in the season.

Many heronries are located within urban estuaries and are presumably exposed to commercial ship traffic and other industrial activities. For example, one mixed-species heronry, situated on an island 2.5 miles from St. Paul, Minnesota lies within a highly urban and industrial setting that offers the constant potential for mechanical disturbance. Noise levels from a stockyard, railroad, barges, aircraft, and car traffic have been measured at 61 decibels. Despite the substantial noise, this type of disturbance had no apparent effect on reproductive success in this environment (Grubb 1979).

In addition to those disturbances at colony nesting sites, mainland sites offer easier access to ground predators and human encroachment. Most studies have shown that foot traffic elicits a greater response in wading birds than mechanical disturbance and will result in a reduction in fledged young (Carlson and McLean 1996). As the adult flushes from the nest, they may dislodge eggs or young. Young remaining unattended in the nest are also at increased risk of predation (Vos et al. 1985). Nest and colony abandonment can also result from human disturbance at nesting colonies (Butler 1993). Birds have been reported to acclimate to pedestrian and boat traffic if a buffer zone is maintained (Rodgers and Smith 1995, Vos et al. 1985, Watts and Bradshaw 1994). In addition, birds may tolerate slower, repeated activities such as recreational fishing, but react strongly to

unexpected motions such as individuals walking in and around colony sites (Vos et al.1985).

Disturbance at Foraging Sites

Disturbance to foraging birds can affect their ability to feed and rest. During the breeding season, birds have increased nutritional requirements due to the high energy demands of breeding and providing for their young (Frederick 1997, Rodgers and Schwikert 2003, Stolen 2003). It has been recommended that refugia be designated for birds to rest or feed without disturbance by boat, car, bicycle, or walking humans (Erwin 1996, Burger et al. 1995). Disturbed birds may flush, but even in situations where they remain, they may decrease their foraging rate thereby decreasing their energy intake. Herons and egrets have been shown to alter their behavior while people are nearby, decreasing foraging time and increasing vigilance. These changes in behavior were correlated with noise levels (Burger 1998). In the case of vehicles, foraging wading birds are more likely to be disturbed when vehicles slow or stop adjacent to them, than when vehicles continue driving by (Stolen 2003). A buffer of 100 m has been suggested to be effective in limiting disturbance at foraging sites for several species of herons and egrets (Rogers and Smith 1997). On the other hand, birds are able to habituate to disturbance (Stolen 2003), and the effects of disturbance in terms of decreases in foraging time may differ among species (Burger and Gochfeld 1998).

Small powerboats, jet skis, kayaks, and canoes can disturb birds feeding in shallow coastal waters (Burger 1998). In a study of boat disturbance, flushing and local site use in tidal creeks on the Cape Romain National Wildlife Refuge, South Carolina, experimental, cumulative boat intrusion caused approximately one-half of individuals of all species except Snowy Egrets to immediately abandon a tidal creek. However, based on species counts across the refuge, only two species, Yellow-crowned Night-Heron and Great Egret showed an aversion to high-traffic creeks (Peters and Otis 2006).

Buffer zones of 180 m for wading birds, have been recommended to minimize their disturbance by small power boats at foraging and loafing sites in Florida (Rodgers and Schwikert 2002).

Predators

Nest predation on eggs and on chicks has influenced the evolution of many aspects of avian nesting behavior (Lack 1968, Burger 1982) and a main advantage of colonial nesting is the avoidance of nest predation via early warning, predator swamping, and group defense (Burger 1982, Wittenberger and Hunt 1985). However, this group of species doesn‘t exhibit strong nest-defense behavior and a small number of predators can destroy even large colonies (Rodgers 1987). Within a colony, different species may be more susceptible to predation than others. For example, higher levels of predation were reported on Great Egret than Great Blue Herons chicks at the Audubon Canyon Ranch colony in California, resulting in higher mortality impacts in the egrets (Pratt and Winkler 1985). In addition to reduction of the colony through predation on eggs, young, or adult, the presence of ground predators can cause colony disturbance resulting in colony

abandonment.

Nesting colonial waterbirds can avoid mammalian predators by selecting inaccessible nesting sites, such as islands surrounded by water. Raccoons, (*Procyon lotor*), particularly, appear to be limited by the presence of water and even shallow water can have an important dampening effect on nest predation (Frederick and Collopy 1989). Inland colonies, such as the ones in northern New Jersey are therefore more likely to be impacted by raccoons and cats. However, there is evidence that raccoons and rats are present on some of the islands colonies, such as Goose, Swinburne and Hoffman Islands and Canarsie Pol. The arrival and proliferation of mammalian predators along the Virginia barrier islands has had dramatic negative effects on colonial-nesting birds (Erwin et al. 2001; Keiss 2001). The number of mixed-species heronries in Virginia's immediate coastal barrier islands declined from eight in 1975 to only three by 2002 and only those islands which lacked mammalian predators retained mixed-species heronries (Keiss 2001, Williams et al.2007).

Avian predators are not limited by water barriers. Fish Crows (*Corvus ossifragus*), American Crows (*Corvus brachyrhynchos*, Black-crowned Night-Herons (*Nycticorax nycticorax*), Herring (*Larus argentatus*) and other gulls, and Great Horned Owls (*Bubo virginianus*) are the most frequently reported avian nest predators in waterbird colonies in the United States (Nisbet 1975, Burger and Hahn 1977, Burger 1982, Pratt and Winckler 1985, Frederick and Collopy 1989, Lauro and Tanacredi 2002).

Predator removal is a controversial topic that elicits diverse reactions from wildlife managers and the public. The need for animal control and the methods used must be carefully considered (Messmer 1996). Removal options may include physical, chemical, and biological control (Garrettson et al. 1996). Efforts to improve the nesting of Least Terns in coastal southern California included trapping mammalian predators with cage, leghold, and Conibear traps, as well as lethal removal (Shwiff et al.2005). Leghold traps however are not legal in New Jersey.

Avian predators such as crows and ravens have been controlled successfully with avian toxicants such as DRC-1339 (federal and state permits required). In addition, non-lethal methods, such as bird repellent products containing methiocarb have been widely used in the USA and Europe and have been shown to be highly efficient as feeding deterrents (Avery et al 1995, Neves et al 2006). Methiocarb's effectiveness is due to its ability to produce severe, reversible illness after ingestion, which causes birds to learn and avoid the eggs in the future. Avery et al. (1995) suggested that conditioning of birds will be effective if repellent eggs are deployed 2–3 weeks before egg laying, so that the avian predators are conditioned before the waterbird eggs are available to them.

Predator removal can improve hatching and fledging success and produce significant increases in breeding population numbers and is an effective conservation strategy for enhancing bird populations (Côté and Sutherland 1997, Smith et al. 2010). This type of management can have long-lasting benefits to prey populations, particularly following the eradication of predators from islands that cannot easily be reinvaded by predators

(Veitch 2002, Smith et al. 2010). These efforts can effectively increase fledgling success (Witmer et al. 1996), although they are expensive, as long-term management is essential for effective predator control.

Habitat Conservation Issues and Threats

Habitat Loss

More than half of the U.S. population now lives along coasts including the NY/NJ Harbor Bight Region. These coastal areas are under constant and continuing pressure from residential and industrial development (NOAA 2004).

Much of the Harbor Herons' habitat is highly threatened with development and degradation. Between 1970 and 1975, federal laws (Clean Water Act 1972) and state laws (NY 1973, New Jersey 1970) created buffers around wetlands and legislated limits to filling in and building on wetlands. Despite the legislative protection, destruction and degradation of wetlands continues. Permitted development, road building, port expansion, and navigation maintenance using dredging and shoreline hardening are current practices that lead to degraded heron habitat.

The presence of the Harbor Herons in the NY/NJ Harbor Estuary is dependent on a complex of habitat types: upland islands for nesting colonies and productive wetlands within range of those islands for foraging. Without adequate quantity and quality of both types of habitat, the NY/NJ Harbor will not be able to support significant colonies of herons. Wildlife habitat is scarce in NY/NJ Harbor, but the agencies making up the Habitat Workgroup are dedicated to improving the situation. This analysis is a step in a process that began years ago and that gained momentum when the Habitat Workgroup asked the community to nominate parcels to be preserved for conservation or restored. The existence of a stakeholder-nominated list that is actively being used shows that the natural environment is valued, even in this highly urbanized place.

Some species have specific preferences for types of nest trees. Great Egret and the smaller herons and egrets nest in trees that provide stability, height (from the ground), cover, and open space above the nest structure. All of the harbor herons, with the exclusion of the Great Egrets, nest in trees or shrubs that provide enough branching for nest stability and hest clustering, height above the ground, dense leafy cover obscuring the nest from view, and openness at the nest for adult birds to access them (Davis 1993, Parsons and Master 2000, McCrimmon, Ogden, and Bancroft 2001).

Quality of foraging grounds is compromised by toxic contamination of water and wetland sediments, a result of the area's heavy industrial presence (NY/NJ Harbor Estuary Program 1996, Hudson River Foundation 2004). And while the Harbor Herons' marsh habitat continues to be altered, pockets of wetlands and waterbird habitat will be lost to marsh subsidence and rising sea level. In Jamaica Bay National Wildlife Refuge, a globally important area for birds and key foraging areas for the Harbor Herons, salt marsh is subsiding into the bay at the rate of 40 acres per year (D. Riepe, pers. comm.

2006).

Invasive or Over-abundant Species

Plants

Non-native, invasive plants exist on all of the harbor islands. Norway maple (*Acer platanoides*), tree-of-heaven (*Ailanthus altissima*), honeysuckle (*Lonicera* spp.), multiflora rose (*Rosa multiflora*), oriental bittersweet (*Celastrus orbiculatus*), common reed (*Phragmites australis*), Kudzu (*Pueraria lobata*) and climbing nightshade (*Solanum* sp.) are present on the islands.

Black-crowned Night-Herons, Glossy Ibises, and Snowy Egrets nest in the dense under story created by the vine-like non-natives such as oriental bittersweet and multiflora rose. Great Egrets nest in the canopy on the tops of trees. Birds also nest in white mulberry (*Morus alba*). Several native species also occur on the islands: poison ivy (*Rhus radicans*), staghorn sumac (*Rhus typhina*), black locust (*Robinia pseudoacacia*), Virginia creeper (*Parthenocissus quinquefolia*), and roundleaf greenbrier (*Smilax rotundifolia*) These species are known to be of value to wildlife as food or cover. Although wading birds nest in invasive species (Norway maple, oriental bittersweet, Tree-of-heaven, black locust), nests may become unstable and unable to sustain weather effects and thus reduce bird productivity.

Phragmites australis is not native to the Hudson River wetlands (Winogrond and Kiviat 1997) and recent range expansions in the Hudson Valley are attributed to a non-native haplotype of *Phragmites* from Europe (Saltonstall 2002, 2003). Invasive *Phragmites* affects species abundance in invaded areas, but factors such as flood regime, appear to have a stronger influence on species richness and composition (McGlynn 2009).

The invasion of *Spartina* marshes by *Phragmites* appears to cause changes in marshes that detrimentally influence fish populations. While *Phargmites* contributes nutrients (Carbon, Nitrogen, and Sulfur) to the trophic chain, overall it appears to be inferior habitat for fish (Currin et al. *2003* Weinstein et al. *2009*). Replacing *Phragmites* with *Spartina*, during restoration resulted in improved habitats for young of the year mummichog (*Fundulus heteroclitus*) in the Delaware Bay Able et al. 2003). Similarly, Weinstein et al. (2009) found that *Phragmites* dominated marsh was an inferior habitat for these fish, resulting in lower lipid reserves. Since many of the Harbor Heron species are piscivorous, negative effects on the fish that they prey upon can also negatively influence their populations.

However, *Phragmites* marshes are important for certain endangered and threatened species in the region such as the night-herons and also provide valuable habitat for glossy ibises and egrets. Obviously, phragmites marshes that are ponded or flowed with creeks and that have mud flats will be more productive, as they are for example in the Hackensack Meadowlands.

Insects

Asian Longhorned Beetle (ALB, *Anoplophora glabripennis*) was discovered on Prall's Island in the Arthur Kill in 2001. These insects ultimately kill the host tree. The response was to fell all infected trees and any potential host trees located on the island in an attempt to prevent the insect from reaching the shores of Staten Island. Felled trees were chipped, and the chips were left in piles on the island. Unfortunately, the ALB had already spread. Eradication strategies by the United States Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS) include treatment of infected area with pesticide and removal and replanting of infested trees (USDA-APHIS 2005).

Birds

Once a declining and protected species, Double-crested Cormorants (*Phalacrocorax auritus*) are currently considered to be over-abundant and directly impacting habitat and co-occurring species on six of the island colonies. Cormorants have been observed competing directly with Black-crowned Night-Herons for nests (Bèdard et al. 1995, C. Weseloh personal communication). In 2009 cormorants were the only nesting species on Huckleberry Island, an island previously supporting a mixed-species heronry (in addition to cormorants). Data supporting habitat destruction as a result of cormorant occupation are plentiful: cormorants strip trees for nest materials and excrete highly acidic and ample guano that acts like a super fertilizer on leaves and underlying vegetation, ultimately resulting in dead trees and bald islands. Cormorant diet has been studied as it pertains to fisheries management in the Great Lakes, Upstate New York, and the southern USA. In some instances (Rudstam et al. 2004), fish populations are negatively impacted. In other cases (Withers and Brooks 2004), there is little supporting data.

Broad Environmental Issues and Threats

Environmental Contaminants

Habitat quality is directly impacted by the presence of environmental contaminants in the sediments and water column in the NY/NJ Harbor. Studies have shown that contaminants can impact birds physically, behaviorally, or physiologically. Research has shown that mercury can cause reduced survival, impaired reproduction, and altered behavior in Great Egret (McCrimmon et al. 2001, Spalding et al. 2000a, 2000b). Wading birds have been used as bioindicators of mercury contamination in Florida (Frederick et al. 2002). Sub-lethal lead levels have negative behavioral and physiological effects on birds including depressed or impaired feeding behavior and deficits in neurobehavioral development of young (Burger 1995, Burger et al 2002, Burger and Gochfeld 2000). Compounds like dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenols (PCBs), chlordane, and dioxin often act as endocrine disruptors, causing reproductive impairment. According to the Hudson River Foundation's 2004 *Health of the Harbor* report (Steinberg et al. 2004), ~~t~~oxic materials are no longer discharged to the estuary to the extent they used to be. As a result levels of contaminants in sediments and fish […] have decreased over time. However, there is still room for much improvement." Contaminants still reside in sediment and animal tissue in the harbor.

Contaminated sediments are a problem throughout the estuary and are a TEC in the HRE CRP (USACE and PA NY/ NJ, 2009). Historical industrial discharges, point and non-point source pollution from the harbor and from upstream discharge have been documented. Sediments include PCBs, dioxins, mercury, lead, cadmium, chromium and copper, pesticides and PAHs. The challenge is to remove them from the habitat before they become mobilized in the system and incorporated into the food chain. Data indicate that this has already occurred, resulting in decreased productivity in wading birds.

The Hudson River Foundation's *Health of the Harbor* suggests that toxicity varies both by area within the region as well as by toxin (Steinberg 2004). Chemical residues continue to exist in fish, shellfish, and crustaceans in the NY/NJ Estuary. PCBs and chlordane are a pervasive and serious concern throughout the entire region, while dioxin levels were a serious concern only in certain areas. DDT and mercury, on the other hand, were no longer found to be a serious concern in the area. Arthur Kill/Newark Bay was identified as having the highest concentrations of contaminants compared to other areas in the Harbor.

Oil Spills and Leaks

In 1990, a series of large oil spills occurred in the NY/NJ Harbor Region. Oil sinks to the sediment level in the waterways, smothering prey items and reducing food availability (Parsons 1994). Oil preened off feathers is ingested and causes toxic death. The largest spill occurred in the Arthur Kill, near the Harbor Heron Islands, off the western shores of Staten Island. Research showed that after the oil spill, there was increased mortality in fiddler crabs (*Uca pugnax*), one of the main prey items of the Yellow-crowned Night-Heron (Burger et al 1992, Burger 1994). The oil had immediate harmful effects on behaviors such as righting response, locomotion, and aggressive or defensive behaviors of the crabs (Burger et al 1991). Other research has revealed that oiled shorebirds spend significantly less time resting and more time bathing and preening, which results in weight loss (Burger and Tsipoura 1998).

Research comparing prey items pre- and post- oil spill (Parsons 1994) showed that Black-crowned Night-Herons and Cattle Egrets consumed a wide range of items including garbage presumably from the Great Kills land fill in addition to aquatic and terrestrial prey. Snowy Egrets and Glossy Ibises were more specialized in their diet and foraged in marshlands for their food. Snowy Egrets and Glossy Ibises showed dramatic decreases in productivity and reproductive success for years after the spill. Nestling growth was lower and egg contaminant load (i.e., PCBs, DDE, oxychlordane, heptachlor epoxide, and transnonachlor) were higher for waterbirds in the Arthur Kill than in most other estuaries in the northeastern United States, including Delaware Bay, Nantucket Sound, and Boston Harbor (Parsons 2001).

Proximity to Airports

The flight paths of the Harbor Herons occasionally intersect with those of aircraft arriving and departing New York, the busiest metropolitan airspace in the world. Several of the Harbor Heron breeding colonies and foraging locations are located within five miles of John F. Kennedy International (JFK), LaGuardia (LGA), or Newark Liberty

International (EWR) Airports, including Canarsie Pol, South and North Brother Islands, Shooter‘s Island, Prall‘s Island, and Hoffman Island. In 2009, there were approximately six collisions with aircraft (“birdstrike”) per 10,000 aircraft operations at the three airports combined. While these strikes involve a variety of bird species, including long-legged wading birds, the birds that are most frequently struck at the airports are gulls and waterfowl. According to FAA statistics, there have been 850 strikes with herons and egrets in the United States from 1990-2008. Of those, only 14% of the strikes resulted in damage to the aircraft. In comparison, 45% of all waterfowl strikes, 16% of all gull strikes, and 36% of all cormorant strikes during the same period resulted in damage to aircraft. Waterfowl, cormorants, and gulls are also the most hazardous birds to aircraft at the New York metropolitan airports.

Airports are aware of the hazards that birds pose to aircraft safety and employ integrated wildlife management programs to address the issue. Habitat management plays an important role in deterring birds from feeding or nesting at the airport. Sources of food, cover, or fresh water are eliminated or minimized from the airport and the surrounding area. The Port Authority of New York and New Jersey airports have a zero-tolerance policy on the airfield for birds that are known to be the most hazardous to aircraft such as Canada geese. The airports also use insect control, water management and solid waste management strategies to further reduce the attractiveness of the airport environment to birds and other wildlife. The airports work with biologists and government officials to develop new strategies and policies to reduce the presence of birds hazardous to aircraft from the airport environment. Research at the airports on bird control techniques, populations, diet, and movements has benefited the larger birding community by contributing new scientific information and providing opportunities for partnerships.

Global Warming/Climate Change

Wetland ecosystems have been identified as particularly vulnerable to climate change (Van Ierland et al. 2001). Fluctuations of habitats and weather conditions could result in geographic shifts or changes in species composition and increased net productivity in wetland ecosystems (Opdam and Wascher 2004). While Great Blue Herons and Black-crowned Night-Herons were designated as low risk species in a study of the sensitivity of wetland bird communities to hydrologic change in the eastern Great Lakes region (Steen et al. 2006), waterbirds in urban intertidal and freshwater habitats are already facing threats that will be exacerbated by the effects of global warming (Wilby and Perry 2006)

A _Climate Change Adaptation Task Force‘ is one of the 127 initiatives proposed in PlanNYC, the City's long-term sustainability plan. This task force will create a coordinated plan to secure the City's critical infrastructure including roads, bridges, and tunnels, mass-transit network, and electric, gas, and steam production and distribution systems against the effects of climate change. The Climate Change Adaptation Task Force is taking inventory of existing infrastructure that may be at-risk from the effects of climate change and is developing coordinated strategies to secure these assets based on New York City-specific climate change projections.

Advising the task force is a panel of experts from academic institutions and the legal, engineering, and insurance industries. This technical advisory committee, the New York

City Panel on Climate Change developed and presented climate change projections for New York City in a recent report (Climate Risk Information, New York City Panel on Climate Change, 2009). This report predicts warmer temperatures in New York City and the surrounding region. Mean annual temperatures are projected by global climate models to increase by 1.5 – 3 ^{o}F by the 2020s, 3 – 5 ^{o}F by the 2050s, and 4 – 7.5 ^{o}F by the 2080s. Similarly, rising sea levels are extremely likely with projections of 2 – 5 inches by the 2020s, 7 – 12 inches by the 2050s and 12 – 23 inches by the 2080s. In addition, brief but intense weather hazards such as heavy precipitation events can cause inland flooding and storm-related coastal flooding due to sea level rise. Rising seas levels along with more frequent flooding will likely have the greatest impact on low lying wetland areas and estuarine habitats. Climate change will also influence land use patterns due to human response to flooding and temperature changes (Opdam and Wascher 2004).

As new areas flood, egrets and herons may be able to adapt and use new sites. However, projected impacts on wetland ecosystems and habitats may include increased salt water encroachment on freshwater sources, increased rates of beach and salt marsh erosion and increased pollution runoff from brownfields and waste storage facilities that will result in degradation or loss of habitat.

While the PlanNYC has incorporated some components relating to wetlands, most of the plan refers to infrastructure. In addition, climate change is a global issue that cannot be addressed or resolved within the metropolitan area alone. The Association of State Wetland Managers (2009) recommends a National Wetlands and Climate Change Initiative, to improve cooperation between climate change, watershed and coastal zone programs and enable coordinated planning and actions with organizations and agencies that work with upland issues. According to a report produced by this group of scientists, some of the first steps in achieving wetland protection in a changing climate within a broader scale include: compiling information on wetlands and climate change efforts including policies, programs, and publications; creating a national wetlands and climate change website; and producing a priority list of wetland and climate change research needs.

V. PLAN OF ACTION. ADDRESSING THREATS AND SETTING PRIORITIES

Mission Statement
To ensure that the New York – New Jersey Harbor region continues to serve as a viable breeding habitat for the Harbor Herons far into the future and that these birds remain an integral part of our region‘s ecosystem.

Vision
By identifying priorities and coordinating efforts with resource managers, legally authorized enforcement agencies operating in the harbor region, site owners, Waterbird Conservation Plan for the Mid-Atlantic/New England/Maritimes Region (MANEM), and other stakeholders, this Plan of Action aims to ensure that our precious wildlife and ecological resources are managed wisely to safeguard the health of the New York/New Jersey Harbor Estuary. Research, habitat conservation and restoration, and public outreach have been identified as the Plan's priorities. Through an integrated approach, the Plan aims to safeguard these precious resources. Partnerships among non-governmental organizations (NGOs), universities, and resource management agencies will ensure that research results are used to either implement new conservation strategies or to further develop existing management actions or policies. The Plan also fits within the context of the larger northeast Atlantic Waterbird Conservation Plan and focuses on issues germane to the urban-wildlife conflicts that arise in the New York metropolitan area

General recommendations
- Set target population size for wading birds, by species, in the greater NY/NJ Harbor
- Set target size for each nesting colony, by species in the greater NY/NJ Harbor
- Monitor breeding colonies annually to determine breeding population size
- Monitor wetland habitat availability and use by Harbor Herons in the greater NY/NJ Harbor

Species Conservation Issues and Threats: Approaches and Solutions

Threat: Human Disturbance
Colony Visitation Permits
In order to manage and control the number of people visiting the colonies during each breeding season, each visit to an active colony in the NY/NJ Region should require a permit. New York City Audubon, as stewards of the Harbor Herons on the nesting colony, needs to be part of the permitting process and consulted about any permits requesting access during the March-August time frame. A permit record will allow NY/NJ HEP‘s Harbor Herons Subcommittee to keep a formal count of the number of visitors each year. The number of people allowed entering the colonies each breeding season will be determined by the Review Committee. A system of enforcement needs to be in place.

A Review Committee to Authorize New and Existing Research Programs
A committee of experienced biologists and naturalists, as well as other informed individuals, will be created to review ongoing and proposed initiatives that require visitations to the Harbor Heron colonies. This Review Committee will pay special attention to research proposals that require visitations to the colonies during the breeding season, and will make any modifications necessary to minimize disturbance to the Harbor Herons.

Establish Guidelines for Colony Visitation
Although Harbor Herons are highly sensitive to human presence in the colony, they can acclimate to regular, predictable disturbance (Parsons and Burger 1982, Davis and Parsons 1991). To minimize disruption, maximize acclimation, and reduce midday and afternoon heat stress on the birds, colony visits for the purpose of obtaining survey data should be made in the morning by one or two teams of two to three people; visits for other research purposes should be limited to one team (Parsons 1995). The colony should not be visited or visits should be terminated during rain events, when wind speed is greater than 8 m/s (18 miles/hr), or when ambient temperatures are above 100°F or below 55°F.

To create patterns of behavior that are predictable to the birds, researchers should follow regular, established paths through the colonies. Bushwhacking should be avoided. Researchers should allow at least one hour to pass before revisiting any section of the colony they have passed through and should not disturb sections of the colony for more than 30 minutes at a time when small young are in the nest. Older nestlings (those two to three weeks old) are able to tolerate longer periods without brooding adults, but disturbance should be held to under an hour. Some evidence suggests that ―announcing" the arrival of research teams (i.e., calling out to the colony in a moderately loud voice) facilitates acclimation—by providing the birds with an early warning, it may prevent the panicky flights from the nest that are associated with the ejection of nest contents (Schmidt and Parsons 2007).

Set Limits on the Frequency and Timing of Nesting Surveys
As explained above, surveys are potentially highly disturbing to nesting wading birds. The information gained from annual surveys in terms of monitoring the resource outweighs the disturbance as long as surveys are conducted during the appropriate nesting phase and done in a calm, organized and scientific way. Single annual surveys should be timed to take place when all or nearly all nests contain late-stage eggs or nestlings. Adult birds who are late into the incubation period for their eggs exhibit a high degree of fidelity to the current year‘s nesting attempt, and they generally maintain a relative tolerance of short, controlled disturbances to the colony.

Surveys during early incubation are more likely to cause widespread abandonment. The presence of small young in the nest sometimes facilitates species identification, but researchers should be aware of the risks posed to hatchlings as a result of parents fleeing the nest. These risks include vulnerability to temperature stress, to opportunistic predators, and to accidental ejection from the nest as a result of parents‘ flushing.

Similarly, surveys should not be attempted when significant numbers of nests contain medium to large young because disturbance at this time causes premature fledging and nest failure. Birds are unlikely to re-nest after late-stage nest failure, and nest attempts made late in the season are unlikely to be successful. Researchers should be actively aware of the impact of their presence in the colony and modify their activities accordingly to minimize disturbance.

Disturbance at colony sites: buffer zones.
As recommended in the literature (Erwin 1989, Rodgers and Smith 1995, Carney and Sydeman 1999), buffers of no less than 100 meters should be created around all heron nesting islands to minimize the effects of disturbance. This distance is still fairly permissive, but politically realistic (D. McCrimmon, pers. comm.). In addition to creating buffer zones surrounding the heron nesting areas, visitor group size should be limited. While adult and nestling herons and egrets have been shown to adapt to regular disturbance by one to two researchers, larger, noisier groups tend to create a panic reaction. Panicked adults may topple their nests and accidentally kick out or crush eggs, while panicked nestlings may flee far from their nests or fall and be unable to return to their nests (Parsons and Burger 1982). These situations can cause an entire colony to abandon the site or cause poor colony productivity. A colony that experiences poor productivity may not return to the site in the subsequent years.

Foraging area disturbance
To reduce disturbance on foraging areas, sanctuaries should be established in area where surveys have identified high use by foraging Harbor Herons. Areas where the water depth ranges from 0.1m to 0.5m should be selected as these are depths most likely used by waders (Erwin 1996). Restricting access to important foraging areas from 1 April through 1 August may decrease disturbance stress to birds during the intensive nesting/egg-laying period through the juvenile stages of heron and egret breeding. To reduce the impact of ecotourism on foraging wading birds, managers should consider concentrating ecotourism in certain areas to allow wading birds to become habituated to disturbance there, and to help isolate sources of disturbance. Visitors should be educated about the effects of their behavior on wading birds, how to reduce their negative impacts, and how their activities influence management of species of conservation concern. Signs posted at marinas, boat ramps, and public coastal access areas can provide interpretive information on the uniqueness of the colony to the region and the importance of foraging areas to wading birds. Managers should also provide areas that are closed to ecotourism that can serve as refugia for wading birds (Parsons and Schmidt 2007).

Solutions

- Work with agencies and the public to patrol islands for trespassing
    - Decisions need to be made as to which agencies will be responsible for this, how the islands will be patrolled and how often, and what the penalties for trespassing will be.

- Minimize human disturbance
    - Restrict visitation dates to breeding colonies to after the birds have left: August 15 through March 15
    - For research access, ensure that research teams piggyback on colony visits and cooperate in data collection. The number of visits and number of people must be recorded.
    - Small research teams of up to four individuals regularly visiting a colony are permissible. We encourage researchers to visit frequently enough to habituate the birds to their presence. That is, two visits per week are better than one visit every two weeks.
    - Consider aquatic buffer zones around vulnerable colonies where birds nest near the edge of the colony
- Conduct surveys in small teams (no more than eight people in two teams) and during nestling phase so adults do not abandon the colony. People should be instructed to remain together as a group, speak quietly, and not clang or bang
- Prohibit recreational boat landing on islands from March 1-August 15
- Post signs on islands indicating bird sanctuary status. Post signs in the water where necessary
- Issue and enforce permits for access to harbor herons property
- If access is needed for research, combine trips with multiple researchers to reduce disturbance
- Large groups can view nesting herons and egrets by boat at a safe distance from the island.
- Install a visitor/researcher viewing blind on one of the islands. A screened walkway is the best way to approach the blind.
- Establish viewing areas at popular foraging sites, maintaining a buffer area between the viewers and the site.
- Limit access to foraging sites during preferred tides and/or seasonally from April 1 – August 1.
- Repair and maintain nest cameras prior to March 1. If repairs are needed during the breeding season (1 March – 15 August), this work needs to be done by someone already regularly visiting the sites (a researcher or resource manager).

<u>Predators: Approaches and Solutions.</u>

Nesting colonies should be closely monitored for avian and mammalian predator impacts. Where the potential for colony disruption from predators is high or is observed, the threat must be curtailed as quickly as possible through appropriate predator control means.

The following predators have been detected at Harbor Heron colonies:
Raccoon: Goose Island, Jamaica Bay, Secaucus, NJ
Rats: Hoffman and Swinburne Island
Crows: Hoffman and Swinburne Island
Great Horned Owl: North and South Brother Island
Great Black-backed and Herring Gulls: all islands

Subsidized feral cat (*Felix domesticus*) colony: Secaucus, NJ

Predator control is critically important and removal options must be carefully considered Any such type of predator removal in our area needs to be done without causing harm to the Harbor Herons. In addition, effectiveness of predator removal should be monitored to determine the success of these types of programs.

Solutions

- Survey islands for signs of predators
- Assess how extensive predator impacts are and define areas where predators need to be controlled
- Gain stakeholder approval for predator control activities
- Design and Implement predator control program
- Monitor effectiveness of the program

Habitat Issues and Threats: Approaches and Solutions:

Nesting Habitat Loss

Nest sites, or colony sites, are particularly vulnerable. First and foremost colonies contain an aggregation of birds, and thus they inevitably draw unwanted attention to themselves from both humans and natural predators. Harbor Herons return to the same nesting sites year after year barring any disturbance. Finding new nesting sites is a risky business, and birds are reluctant to experiment with new sites, and certainly not by themselves. Restoration projects should focus on limiting the expansion of invasive, non-native species such as Norway maple on the Harbor Heron islands. The usefulness of certain invasive species such as *Phragmites* and *Ailanthus* should not be discounted.

Special attention should also be given to the protection of mainland colonies, specifically those of Yellow-crowned Night-Herons, which are found in mainland areas of New York and New Jersey. More research should be conducted to assess the value and impact of various restoration projects carried out on nesting habitat.

Foraging Area Protection

As development pressures increase, efforts should focus on preserving, protecting, and restoring the foraging habitat of the Harbor Herons. Various scheduled projects, such as port expansion, harbor deepening, and the Goethals Bridge expansion will contribute to a loss of open, shallow water and marsh habitat measured in the tens of acres. Mitigation for those losses will likely enhance existing degraded salt marshes of a similar acreage but will not replace the loss of open, shallow water habitat. Proposals for future port expansion, both private and public, may yet result in cumulative loss of more than another hundred acres of habitat. Even small wetland losses due to road widening or bridge replacement can result in serious cumulative impact. The proposed rebuilding of Pelham Bridge and City Island Bridge in Pelham Bay Park will contribute to the loss of wetlands. Additional development pressure may come from recent requests for zoning changes. One such request, which has been discussed and debated by New York City‘s Department of City Planning, indicates a drive by certain business and political sectors to

free the Arthur Kill complex from its restrictive Manufacturing Districting classification and reassign it to the more flexible Commercial and Residential categories. If approved, these changes will spur a drive to develop the remaining land, wetland buffers, and perhaps some amount of wetlands.

Since funds are limited, preference should be given to purchasing new habitat rather than restoring habitat that is already protected. This being said, habitat restoration can be an important tool for creating additional foraging habitats. Such restoration efforts still require monitoring and, in certain cases, additional research. The quality of the foraging habitat is also an important topic to be researched.

Satellite telemetry, diet sampling, ecotoxicology assessments of prey, bird health assessments, stable isotope analysis, video surveillance of nest sites, and coordinated telemetry-behavioral ecology studies are necessary to establish direct connections among foraging ecology, productivity, and health. Of course, these studies will have to be limited so as not to cause needless disturbance to the birds.

Solutions

- Review and updates HEP Priority Acquisition Sites List
- Pursue habitat acquisition
- Pursue habitat restoration
- Conduct foraging ecology study with individually marked birds to locate areas of preferred foraging habitat for restoration or acquisition.

<u>Invasive or Over-abundant Species:</u>
Invasive and over-abundant species range from plants, to insects, to birds. Each has the potential to impact colony structure. Invasive vines may provide a labyrinth of support for nests. However, over time, these very vines may crush the structures that support them and result in a loss of nesting habitat. This has occurred on North Brother Island (Andrew Bernick, personal communication). An Asian Longhorned Beetle (ALB) invasion resulted in the immediate razing of half the trees on Pralls Island and loss of critical nesting habitat. A plan needs to be in place to monitor occurrence of and prioritize action against invasive species.

Intense development in the NY/NJ Harbor estuary that includes roads, dikes, berms, fills and secondary impacts probably favors the proliferation of *Phragmites* in marshes and waterways. However, eradication of reed for whatever purpose (mitigation, management of wetlands) should not be an automatic reflex decision, and should never occur without an on-site inventory of the resources present.

Solutions

- Invasives: Plants
    - Mapping and identifying all tree and shrub species on the islands
    - Identification of non-native, invasive, introduced plants
    - Removal of invasive plants and replacement with native plants
    - Remediation measures for plant invasions in tidal marshes should be based

upon knowledge of the species of plant that is invading and what zone it inhabits. Changes in tidal regimes may be just as effective as removal.
    - More research needs to be done on *Phragmites*, especially with a view to management strategies that maintain productivity.

- Invasives: Insects
    - Monitor trees for evidence of ALB.
    - Prepare a response plan for dealing with infected trees.

- Over-abundant Species: Cormorants
    - Set target sustainable population number
    - Monitor the population annually
    - Remove cormorant nests from wader portions of the colony and encourage nesting on select islands
    - Measure colony productivity and reproductive success of a subset of adults
    - Map nest locations of cormorants within mixed heronries on Harbor Heron islands
    - Periodically evaluate tree health at cormorant and non-cormorant nest sites

Broad Environmental Issues: Approaches and Solutions

Environmental Toxins

Because the Harbor Herons serve as an important indicator for overall ecosystem health, health analyses and blood analyses must be conducted. Measurement of contaminant levels in blood across colonies can provide insight on the quality of different foraging areas. In addition, contaminants should be monitored during wetland restorations and remediation to ensure that levels are not increasing even temporarily to the point where they will be impacting Harbor Herons. Finally, since these birds are higher level consumers, specific effects of pollutants on their breeding success and populations should be taken into consideration in plans and in the implementation of projects to decrease levels of pollutants in the NY/NJ Harbor.

Regular monitoring for key contaminants, such as mercury, which is a problem in terms of atmospheric deposition is essential. Bird tissues, especially feathers, can be used to monitor the contaminant concentrations that are being bioaccumulated in the birds, while contaminant levels in sediment, water, and prey items can provide information on trophic chain effects and inform decisions on habitat and restoration management and clean-ups.

A health assessment focused on waterbirds is of particular interest and value due to their capacity as sentinels of environmental health in the NY/NJ Harbor Estuary system. Herons and egrets in particular are excellent and widely used organisms for biomonitoring (Burger and Gochfeld 1993 Frederick et al. 2002). As top predators, they tend to accumulate toxins from their prey and the environment in their blood and tissues. Birds show sub-lethal effects of low levels of exposure with great sensitivity. Thus, they serve as both quantitative and qualitative monitors for a number of environmental toxins,

including organochlorines, organophosphates, heavy metals, and PCBs.

Incorporating satellite studies, diet sampling, ecotoxicology assessments of prey, bird health assessments, stable isotope analysis, video surveillance of nest sites, and coordinated telemetry-behavioral ecology studies are necessary to establish direct connections among foraging ecology, productivity and health. Of course, these studies will have to be limited so as not to cause needless disturbance to the birds.

Solutions

- Conduct research to assess the impacts of various toxins on the health of Harbor Herons.
    - Monitor productivity and individual reproductive success to see if birds are producing viable eggs and offspring
    - Monitor bird behavior for adverse effects from contaminants
    - Sample birds blood, feathers, and eggs and test for presence and level of contaminants in tissue
    - Monitor colony size for return of birds to the site

- Continued attention should also be focused on limiting the quantities of pollutants and toxins released into the NY/NJ Estuary.
- Remove contaminants from system by dredging and disposing of contaminated sediments
- Establish rapid response team to deal with oil spills and leaks
- Given the broad scope of this issue, collaboration with other entities is crucial to realizing this goal.

Proximity to Airports: Approaches and Solutions
The Federal Aviation Administration (FAA) requires airports be responsible for identifying hazardous wildlife attractants within a 5-mile radius (per FAA Advisory Circular 150/5200-33B). Each specific breeding colony, therefore, needs to be approached based on its connections to each airport.

- Conduct studies on flight lines and flight altitude of birds with respect to colony sites, foraging sites, and airport air space
- Control vegetation so it does not attract large-bodied birds in the immediate vicinity of the airport
- Making sure food resources (such as garbage dumps) are not situated so that birds have to cross the runways to reach them.
- Set up radar to detect birds approaching aircraft
- Research to explore habitat management at airports for decreasing populations of high risk collision species and increasing population of low risk species

Global Warming/Climate Change: Approaches and Solutions.
A list of strategies for reducing or mitigating the impact of climate change on coastal/estuarine wetlands was developed by the Association of State Wetland Managers (2009). A very basic component of these strategies is to implement ―low risk" impact

reduction options; that is actions which are justified whether or not climate change occurs and can serve a broad range of objectives. For example, these options can include building setbacks for coastal/estuarine wetlands, more stringent control of drainage, the attachment of conditions to permits to help protect carbon stores, and acquisition of wetlands with the largest carbon stores to protect them from drainage and filling. None of these strategies are specific to waterbird populations, however, they all impact the wetlands habitats that the birds use and it is important to incorporate into a management action plan.

Solutions relevant to our region and waterbird populations from the Association of Wetland Mangers are to:

- Incorporate wetland ecosystem protection and adaptation goals into coastal zone regulatory, infrastructure development, watershed management and land planning management programs.

- Work with coastal planning and management entities using agreed-on protocols to consolidate their wetland, sea level rise, subsidence, flooding and other types of maps (using GIS and other methods) to identify coastal and estuarine wetlands and wetland species most at risk from climate change within a locality, state, or particular region. This will require identification of plant and animal species with greatest vulnerability such as species with poor distribution and limited range.

- Establish on the ground priorities for protection and adaptation. For example wetlands best able to keep up with sea level rise could be identified and targeted for acquisition or more stringent regulations. Similarly, wetland types with strong restoration potential despite sea level rise should be identified.

- Strengthen control of draining of wetlands. Control of drainage of wetlands is a particularly high priority to protect carbon stores and carbon sequestering. It is also a high priority to better protect wetland functions and values since drainage is only partially regulated at federal, state and local levels.

- Establish buffers for coastal/estuarine and freshwater wetlands. Buffers will allow coastal/estuarine wetlands to migrate as sea level rises, if the landward slope is not too steep. Buffers will also reduce pollutant loads.

In addition, specific strategies for adapting coastal/estuarine wetlands to climate change (and thereby reducing impacts to wetland functions and wildlife populations) include:

- Control invasive species in climate-stressed wetlands. This will require the ability to distinguish between climate change induced range shifts and species invasion

- Study and better understand species that are expected to migrate north and up-slope in order to determine which ones are most likely to support wetland functions and values given climate change.

- Acquire upland buffers to permit coastal/estuarine wetlands to migrate when sea level rise occurs, where slopes are sufficiently shallow to allow for migration.

- Divert sediments to nourish wetlands that are subsiding. Study different methods of wetlands nourishment to determine which methods work best in different regions and under different conditions.

- Undertake restoration, creation, and enhancement for wetland types most threatened by climate change in contexts where restored, created, or enhanced wetlands may also be sustainable. Wetland restoration, creation and enhancement including the establishment of mitigation banks or more specific, multi-objective ~~–~~wetland carbon banks" may, in some instances, help reduce the impact of climate change on wetlands, protect existing carbon stores and carbon sequestering, and reduce methane emissions.

- Establish wetland reference sites to monitor the impact of climate change and determine the effectiveness of management and adjustment strategies.

V. OUTREACH, EDUCATION, AND ADVOCACY NEEDS

To be a successful plan, the HHCP must find outlets for communicating critical messages about the value of the resource and the ways to ensure its persistence in the harbor. There is a need to reach legislators, environmental advocacy groups, local citizens living in close proximity to the Harbor Herons, and citizens of the greater NY/NJ Metropolitan region need to be made aware of their existence.

Outreach to stakeholders is critical component of any Conservation Plan. The Harbor Herons Subcommittee needs to compile shared messages about Harbor Herons Conservation to be used by each member organization of the group. A media plan should be developed to identify a contact person for press releases at targeted newspapers, radio and television stations. A white paper, developed from this plan, needs to be presented to local legislators, informing them of the critical importance of the HHCP and of funding needs.

Education

To further educate the general public about Harbor Herons, the Plan calls for the expansion of ecotourism programs that focus on the breeding islands as well as the birds' foraging grounds. This can be done both through existing programs conducted by organizations such as New York City Audubon, Hackensack Riverkeeper, NJ Meadowlands Commission, and American Littoral Society, as well as through special programs designed to focus specifically on the Harbor Herons during the months of prime activity. Some of these programs could have a more local focus, similar to Future City Inc.'s proposed program to educate residents of the Elizabeth River/Arthur Kill Watershed to the importance of the Harbor Herons.

There is also a need to expand educational programs to include more students from preschool to college level. Educational efforts should emphasize the inclusion of all communities in the NY/NJ metropolitan area and should include bilingual education whenever possible.

As we try to educate more citizens in the NY metropolitan area about the interconnectedness of ecological, wildlife, and human health, an effort should be made, by working with the school systems, federal, state, county, municipal parks agencies, appropriate public agencies, and New York City Audubon, to enhance wildlife experiences and education. This could be in the form of additional classroom activities and lesson plans, or through additional boat trips around the islands, but may also take on opportunities to establish live video cameras, or ~~"n~~est cams" at or close to the colonies. These nest cams would send images of the birds directly from the islands (ideally via streaming video) to schools and other interested people. A simple but effective curriculum could be created to help teachers use the images in their classrooms. The Harbor Herons Subcommittee should also consider shopping the idea of a documentary film about the Harbor Herons to PBS and/or other outlets (e.g., National Geographic, Animal Planet, etc.) These initiatives would aid in providing the public with everlasting impressions that can foster citizen stewardship to ensure the conservation of this resource.

Advocacy

The Plan identifies the Harbor Herons Subcommittee as the principal body responsible for addressing important policy issues relating to the Harbor Herons. The advocacy potential of the Harbor Herons Subcommittee is greatly strengthened by the combined talents and expertise of its members and the organizations and agencies they represent. These include representatives from the non-profit sector, universities, and all levels of government. The strong scientific make-up of the Harbor Herons Subcommittee will provide invaluable support to any and all advocacy initiatives designed to protect the birds and their nesting and foraging habitats.

The Plan emphasizes the need to continue to protect the breeding colonies by limiting human access as well as promoting the conservation and acquisition of new habitat. In this regard, the bi-state makeup of the Harbor Herons Subcommittee should serve as a means to engage city, state and federal and nonprofit agencies in what must be a cooperative venture on behalf of the colonies.

Outreach

Improvement is needed for existing initiatives such as providing more information about Harbor Herons on NY/NJ Region HEP website. Hot links to the expanded Harbor Herons site will be included on all members' websites. The Plan also calls for developing new and creative public outreach methods and for utilizing such proven methods as tabling at community events, presentations before interested parties/organizations, and ~~"t~~elling the birds' story" through members' newsletters and other publications.

Many ongoing projects in the region, both in New York and New Jersey, focus on education and informing the public about the Harbor Herons, with the hopes of fostering the next generation of ecological stewards who will advocate on their behalf. These projects run the gamut from nature centers and local eco-cruises in both New York and New Jersey to active volunteer participation in patroling and monitoring initiatives.

These projects involve many different organizations and partners.

Below is a list of some recent accomplishments:

- Increased participation in Eco-Programs conducted by Hackensack Riverkeeper. Over 5,000 people came out for the Riverkeeper's boat trips, paddlecraft, and walks in 2004.
- Launched New Jersey Meadowlands Commission's Community Education and Outreach Program
- Increased participation in Eco-Programs conducted by New York City Audubon in partnership with New York Water Taxi. These include Eco-cruises to see the nesting colonies of the Harbor Herons in both the Brother Islands and Hoffman Island. The cruises, initially offered to students, are now available to the public. Over 1,500 people came out on these tours in 2004.
- Production of an educational pamphlet, "Guide to Harbor Herons," by New York City Audubon and NY/NJ HEP, with ten thousand copies printed

Waterfront Access

Wildlife-related recreation has become one of the most popular outdoor activities. Over the past 20 years, participation in wildlife watching, particularly bird watching, has increased nationally by more than 266% and is the largest economic growth sector in outdoor recreation. (USFWS 2001). Of the nation's 66 million wildlife watchers, 45 million of them are bird watchers. In 2001, these bird watchers spent $36 billion in retail stores, which generated $82 billion in overall economic impact and created over 670,000 jobs (USFWS 2009).

Waterfront access presents a number of opportunities for ecotourism as well as public awareness about and activism for water birds. Shoreline areas where humans can view and learn about birds have been historically limited in most of New York City due to waterfront development and industry but this has been changing over the past decade as waterfront parks are developed and renovated. For example, two new parks adjacent to the Bronx River estuary and another on the East River in Hunts Point have been completed since 2007. These new parks, in addition to extensive improvements in Soundview Park that are currently underway, represent prime areas for viewing water birds.

In New Jersey there is better waterfront access and in recent years ecotourism has grown, especially in the Meadowlands. Within the Meadowlands there are over 1,168 acres of publicly accessible parks, viewing platforms, and walking and paddling trails. A Meadowlands trail guide was developed in a collaborative effort led by New Jersey Audubon Society with information on site access and birding activities within the New

Jersey Meadowlands District (NJAS 2007). Improved interpretive materials at these Meadowlands sites as well as similar guides for other wetlands areas (Arthur Kill, Raritan) and more educational programs should be developed.

On-water group programs have also been expanding. Through ferry, paddling and rowing tours around the city, humans can approach areas such as the Brother Islands or the mudflats of the Bronx River estuary to view birds without disturbance to the birds and/or their breeding and foraging grounds. Similarly, the Hackensack River Keeper and New Jersey Meadowlands Commission offer boat tours on the Hackensack.

Recreational and educational programs should be developed and/or advertised to encourage human buy-in to conservation for birds and the preservation of breeding and foraging areas. Products and programs could include:

Local waterfront access guides for each borough

- Waterfront programs for youth and families (shoreline explorations, bird watching and aquatic sampling, for example)
- Waterfront stewards programs for local citizens
- Organized tours (on-land and on-water) to areas where birds can be observed but not disturbed
- Continued development of public waterfront parks
- Development of viewing areas with bird blinds and informational kiosks near key habitats to deter possibly damaging human incursions while allowing access
- Consider outreach opportunities using Facebook, Twitter and other such media forms that appeal to younger people
- Ecological enhancement, landscaping and other techniques to attract birds

Appropriate waterfront access may also have other positive long-term effects. As humans recreate in waterfront areas, they may have the opportunity to learn about aquatic and riparian ecosystems and their importance to the overall health of our environment. The more time humans spend near and on the water, the more they will learn about waterfront ecosystems and organisms and, hopefully, the more they will advocate and care for them.

Outreach Needs

- Establish a bioregional approach to foraging area management
- Continue to host annual research and reporting meetings of the Harbor Herons Subcommittee
- Ensure appropriate waterfront access

VI. RESEARCH NEEDS

This section includes research tied to conservation threat solutions. In order to ensure that herons, egrets, and ibises forever remain a fixture in the NY/NJ region, the Plan highlights the following actions to be taken with relation to the Harbor Herons in the

fields of research, habitat conservation, and stewardship.

More research must be conducted to determine the cause of recent population declines. A first step towards this end could be the completion of a synthesis study that will analyze regional population dynamics. It is useful to continue studies that focus on reproductive success and chemical contamination. Further research might be able to determine the impact of cormorant populations on the wading bird populations in the different colonies.

The most recent studies measuring wading bird reproductive success in NY/NJ colonies were conducted in the mid-1990s (Parsons 1997, Parsons *et al*. 2001). Future research should focus in particular, on mean clutch size, hatching success, nestling growth rates, and fledging success for a variety of wader species (e.g. Great Egret, Snowy Egret, Black-crowned Night-Heron, Glossy Ibis). Establishing island maps of nest sites and individually marking nests would provide data on habitat use by different species within the colony, including non-wading bird use.

Contaminants and Toxic Sediments and Bird Health

The lower Hudson River Estuary System has a long history of contaminant problems including PCBs, heavy metals, pesticides, and other chemicals (Adams et al. 1998, Adams and Benyi 2003, Steinberg et al. 2004, USACE and PA NY/ NJ, 2009). Contaminant levels of PCBs detected in sediments, invertebrates and fish have declined over the past 20-30 years, but for other contaminants, and particularly for mercury, concentrations are still present at levels that are of public health concern. Under HEP the Sediment Work Group has led the Contamination Assessment and Reduction Project (CARP) study that has mapped contaminants throughout the NY/NJ Harbor. Water quality data have been compiled into the CD-ROM CARP Database, and have been used to develop the CARP Model of sediment and chemical transport and fate in NY-NJ Harbor (www.carpweb.org). Since ongoing contamination is postulated as one issue still affecting the herons' population dynamics, coordinated studies evaluating contamination levels of prey items and adult heron physiological health, chick growth rates, and fledging success would be of great value.

Historical studies conducted on wading bird eggs have demonstrated that contaminant loads can be monitored easily through this sampling technique. Other studies using feathers and blood have been used successfully to monitor heavy metal and organophosphate and carbamate levels in wading birds. What has not been evaluated, in conjunction with contaminant levels, is the physiological health of individual birds. It is well known that many chemicals can have sublethal effects, and that exposure to multiple chemicals can result in additive effects. In many cases, the liver, kidneys, and immune system are targets of chemical exposures. Other sublethal effects may result in poor growth rates, lower fledging success, or behavioral abnormalities.

Blood analysis is an important tool for assessing overall clinical health in both human and veterinary medicine. Blood contains remnants of digested prey items, including nutrients and contaminants, and can provide indicators for immunocompetence, liver and kidney function, and general physiological health. By establishing reference ranges for a species, analyses can be done to compare bird health on different geographic scales: across

breeding colonies, along the east coast, and within eastern USA. In addition to allowing baseline health assessments, blood analyses can also reveal disease prevalence in bird populations. Since environmental changes have been linked with the emergence and spread of infectious diseases in wildlife (e.g. Spalding et al. 2000b), infectious diseases may be an important indicator of environmental conditions, as well as potential red flags for active or potential health risks to bird and human populations. It is important to know the status of diseases in populations of free-ranging wading bird species.

Burger et al. (1992) found that feathers from young Cattle Egrets reflect concentration of pollutants in local areas surrounding breeding colonies and can provide a sensitive tool for monitoring metals, especially lead, in the northeastern U.S. Consumption by top predators such as Harbor Herons leads to compromised reproduction in the colonies. Feathers can be analyzed immediately, but also they can be archived for future use because they are a stable tissue and do not require refrigeration.

In the case of the wading birds of NY/NJ Harbor, we have a great opportunity to conduct concurrent research on the health of harbor heron chicks fed on diets solely from the NY Harbor during development. Newman et al. (2008) found evidence that environmental conditions of the habitat compromised the health of Black-crowned Night-Heron chicks on Hoffman Island in 2004. Studies that concurrently evaluate physiological health, chick growth rates, fledging success, and contaminant loads, can reveal how these variables are related and whether these factors place birds at a survival disadvantage.

Reproductive Biology

As local declines in wading bird productivity have suggested, it is imperative that we conduct intensive studies of nesting wading birds in this region for comparative purposes. To determine whether the NY/NJ Harbor is a source or a sink for wading bird populations, research should focus on productivity (mean clutch size, hatching success, nestling growth rates, and fledging success) for a variety of wader species (e.g. Great Egret, Snowy Egret, Black-crowned Night-Herons). Establishing island maps of nest sites, and individually marking nests would allow inter-annual comparisons to be conducted and would also provide information about nest reuse patterns among waders.

Colony Population Dynamics

Another area in need of further exploration is the intra-colony population dynamics. The extent to which adults may move between colonies either during a year or among years, or even if there is colony site fidelity in the Harbor, is unknown. Furthermore, for those birds that do move, or even returning young, there is the question of how far they will move among colonies and where they go to forage with respect to their natal colony. Such questions can help identify the value of the NY/NJ Harbor colonies with respect to sustaining the population of wading birds in BCR30 and beyond. Is the Harbor a population sink or source, and is there gene flow among colonies in the northeast? The extent of gene flow among wading bird colonies in the northeastern US is largely unknown. Banding records confirming natal philopatry or emigration to other breeding colonies are scarce, probably because of the numbers of birds that need to be banded and

the amount of time that needs to be committed, to re-sight banded birds (C. Weseloh, pers. com.). Color banding or wing tagging nestlings and adults has not been a priority in the Harbor until recently (S. Elbin, pers. com.), and only a few birds have been tagged for post-breeding telemetry or observation studies for these species in the Harbor. Genetic relatedness, e.g. among colonies in the NY/NJ Harbor, Long Island, Delaware Bay, Chesapeake Bay, Boston Harbor, etc., contaminant and heavy metal load, trophic level of prey seen with stable isotope analysis, growth, and stress can be studied from tissue samples, i.e. blood or feathers. A concerted banding program, coupled with color marking individuals, could contribute to information about movement patterns within the Harbor and among colonies in the northeast. Because of the number of observation hours required for band re-sightings and the problems with structural and electronic interference with VHF telemetry signals, the best method for determining movement patterns would be the use of marking adults with satellite telemetry units during the chick rearing phase, enabling researchers to learn about post-breeding dispersal, survival, and ultimately, whether birds return to the same colonies the following breeding season, or choose to nest at a nearby or different colony.

Foraging Ecology

Patterns of wading bird foraging behavior and ecology have been examined in NY/NJ Harbor through focal observation at foraging sites, flight line observations, and repeated site surveys quantifying habitat use (Maccarone and Brzorad 2000, Gelb 2004, Bernick 2005). Results suggest differences in habitat use and foraging methods by habitat type for some species of wading birds (e.g., Black-crowned Night-Herons, Great Egrets), and also the possibility that local colonies may sort by sub-region (e.g., Jamaica Bay, Staten Island, western Long Island Sound), with each suite of colonies using unique, non-overlapping foraging areas. These studies, however, have limitations because the exact foraging location of birds observed leaving certain islands has never been confirmed because flight line observations are conducted on non-marked birds that can not be followed to their exact foraging site. Furthermore, there has been little direct connection between different foraging methods (effort and efficiency) at specific foraging sites, and individual or colony reproductive success. This information would greatly enhance our understanding of factors that may be affecting local sub-regional colonies and population stability at each of these locations. In addition, preliminary ecotoxicological assessments of prey fish (S.Newman unpublished data) cannot be correlated to the location they were captured in the NY Harbor, because exact foraging sites for birds nesting at specific colonies remain unknown. Therefore, studies incorporating satellite or VHF radio telemetry, diet sampling, ecotoxicology assessments of prey, bird health assessments, stable isotope analysis, video surveillance of nest sites, and coordinated telemetry - behavioral ecology studies are necessary to establish a direct connection between foraging ecology, productivity and health.

Habita Use

Wading bird species in the NY/NJ region include tidal marsh specialists (e.g. Snowy Egret and Glossy Ibis) as well as opportunists (e.g. Black-crowned Night-Heron) who find prey in many freshwater, benthic, and terrestrial habitats. Undeveloped areas in the NY/NJ Harbor Bight Region are under constant pressure because of continuing

residential and industrial growth, as is most of coastal North America. However, many wetlands remain, both as remnants of the natural environment, and as the inadvertent result of human activities (for example, fringing wetlands on dredge spoil deposits). These wetlands continue to provide important ecological services. Yet, urbanization has numerous effects on hydrology, geomorphology, and ecology that make wetland habitats in urban regions function differently from those in non-urban lands (Ehrenfeld 2000).

Monitoring of Harbor Heron habitat and site use is essential. An understanding of Harbor Heron nesting and foraging habitat characteristics is critical to preserving these habitats, restoring degraded habitats in the region and maintaining the bird populations.

Building on previous studies (Alderson 2003, Parsons 2003, NYC-DPR unpub. data), baseline research on which nest substrates are used (e.g., specific plant species, ground), microhabitat differences around nests (e.g., buffering vegetation, soils), and the dynamics of nest site selection (e.g., use of habitat vs. availability of substrates) should be continued for a range of colonies. The use of native versus non-native species for nesting should also be examined. For instance, do Oriental Bittersweet (*Celastrus orbiculatus*), *Phragmites*, or other common wetland species provide favorable habitat from a functional viewpoint (i.e., productivity, health, fitness) or as a buffer against human intrusion or predation? Quantitative studies on changing vegetation in rookeries and the effects of these changes on given nest site preferences would also be prudent.

Similarly, foraging studies are needed to characterize habitats used by water birds in NY/NJ Harbor, especially the Meadowlands and Lower Raritan River and Bay. Research on what biotic and abiotic factors (e.g., tide, depth, vegetation, prey, predators, microclimate, and human intrusion) influence site use away from the nesting area can identify areas that need to be protected from development and can improve the outcome of restoration and enhancement projects for the Harbor Herons. Studies of native versus non-native species and the parts they play in foraging dynamics, such as one that examined the role of *Phragmites* as foraging habitat and buffer in the NY/NJ area, would be also be beneficial. Opportunities for creating new foraging habitat in coordination with development projects (e.g., golf courses, brownfield development) should also be explored.

Migration

A limited number of banding programs and telemetry studies have provided evidence of the direction and distance of post-breeding dispersal for juvenile and adult wading birds in the northeastern US. Important roosting and wintering sites, and patterns of juvenile dispersal from NY/NJ Harbor area colonies should be examined through the use of leg bands, wing tags, and satellite or radio telemetry. This information will allow resource managers to identify non-nesting habitat that should be protected in order to ensure that these species overwinter and return to breeding colonies the following season.

Predation

The impacts of both avian (e.g., great horned owl, fish crow) and mammalian (e.g., raccoon, rat) predators on the reproductive success of local wading bird populations has

not been fully identified in the NY/NJ Harbor area. Although such predators are commonly found in association with colonial birds, under certain conditions they may exploit wading bird eggs, nestlings, or adults to the point of colony abandonment (e.g., 2001 Isle of Meadows abandonment following closing of Fresh Kills Landfill). Monitoring and research of predator effects on wading bird reproductive success should be conducted.

Competition

Additionally, competition between wading birds and other waterbirds during nest selection and rearing of offspring may have profound effects on the reproductive success of wading bird species nesting in mixed species colonies. One critical issue is the nesting of Double-crested Cormorants within wading bird colonies (D.V. Weseloh and S. Elbin, pers. comm.). Double-crested Cormorants may have profound effects on wading bird reproduction, as nesting cormorants may directly compete with waders for nest sites or destroy trees and shrubs through deposition of guano (Bèdard et al 1995). Such patterns are apparent at various sites in the Great Lakes region (D.V. Weseloh, unpub. data). Additional investigation of nest competition among wading bird species, as well as of the frequency of gull predation on adult wading birds during the breeding season (Bernick *in prep*), is also warranted.

Disturbance

Formal studies of human disturbance (both public and research-related) on reproductive success have been conducted for other waterbird species (e.g., terns and gulls), though rarely for wading birds. Most important for conservation efforts would be to limit public access to the nesting islands and provide surveillance and patrolling of islands especially during heavy boat use times (Memorial Day to Labor Day) when island landings are most likely to occur.

A carefully designed investigation on the effects of human disturbance and habituation in wading birds would be helpful in assessing the any potential impact that research programs might have. However, with frequent island visits by Parson and colleagues in the late 1990s and intermittent visits to the islands in 2004, no observed abandonment or problems have been noted.

Multilevel Studies

A concerted effort should be made to collaborate with researchers investigating issues that impact wading bird populations within the NY/NJ Harbor estuaries, such as changes in aquatic vertebrate and invertebrate health and distribution, the effect of contaminants on aquatic vertebrate and invertebrate reproductive success and foraging efficiency, ecosystem-level food web studies, and microscale habitat shifts influencing the persistence, absence, or future development of wading bird colonies. Large-scale, collaborative studies of this type would focus attention on a core issue in urban wading bird conservation—that wading birds are but one facet of this broad, complex urban ecosystem.

Archiving Data and Creating Formal, Available Reports

As with all research, it is important that the lessons learned not be lost over the course of

time. Ideally, all research ought to be published in peer-reviewed and widely read journals, however, as much of the body of work undertaken with respect to the Harbor Herons has been done by local amateurs, undergraduates, volunteers and others, not all of it is inevitably headed for publication. Therefore an effort ought to be made to collect, catalog and maintain in one location all existing datasets, including those belonging to NYC Audubon, HEP, NYC Department of Parks & Recreation, and others. In particular, using GIS to map spatial and temporal shifts in wading bird nesting activity, colony size, and foraging-habitat composition and availability would aid in describing trends in nesting and foraging habitat use over the past 30 years. It would also allow ready comparison to other regional wading bird populations.

Collaboration and Sharing Knowledge

There should be a concerted effort for researchers to gather on a regular basis to share their knowledge, interests, and lessons learned about the Harbor Herons. There are at least three current opportunities for such exchanges: 1) meetings of the HEP Harbor Heron Subcommittee, 2) the annual Harbor Heron Research Conference, and 3) regional Colonial Waterbird meetings. Upon gathering, researchers ought to be encouraged to share their views on a wide range of topics related to the Harbor Herons. For example, research scientists, citizen scientists, and others should share their insights on researching techniques, observations in the field, comparative analyses with respect to other colonies or species, and certainly means by which they may synergize their efforts.

VIII. MEASURING SUCCESS—EVALUATING THE CONSERVATION PLAN

The success of the Conservation Plan for Harbor Herons will ultimately be measured by how well it meets its goal: to ensure that the New York Harbor region continues to serve as viable breeding habitat for the Harbor Herons far into the future and that these birds remain an integral part of the NY Harbor region. Overall success of the Plan‘s implementation, as well as the success of each of its strategic goals, will be evaluated against specific benchmarks as outlined below. We recognize the importance of having an on-going evaluation progress that can adapt or change to better reflect lessons learned about which actions do and do not work.

The implementation of the Plan will be evaluated based on its ability to meet specific objectives and its overall contribution to the conservation of the Harbor Herons. A successful implementation of this conservation plan will influence regional environmental policies, ecosystem management, and citizen behavior in ensuring the health of the harbor herons breeding colonies.

Indicators of success for the Conservation Plan and its strategic goals for the Harbor Herons will include:

Indicator 1: breeding populations of harbor heron species on the harbor islands

Metrics:

- Number and diversity of mixed colonies of herons, ibises, egrets breeding on the islands

- High number of individuals of each species breeding
- Increased number of active nests for each species (GREG, SNEG, BCNH, GLIB)
- Increased reproductive success „Normal‘ species-specific clutch size, high hatchability (70-80%), healthy nestling growth, and high fledging success (50-67%) for each species

Indicator 2: land acquired for heron conservation

Metrics:

- Number of acres of important habitat (HEP priority sites) acquired by state and municipal agencies
- Number of acres of important habitat (HEP priority sites) placed under protection from development
- Percent of harbor islands on which harbor herons are nesting
- Percent of foraging habitat that is protected

Indicator 3: improvement of habitat quality

Metrics:

- Number of acres of restored foraging habitat from the identified list
- Number of acres of restored nesting habitat from the identified list
- Decreased level of toxins including polychlorinated biphenyls (PCBs), Chlorodane, DDT, heavy metals, dioxin, and organophosphates in bird tissue
- Decreased level of toxins such as polychlorinated biphenyls (PCBs), Chlorodane, DDT, heavy metals, dioxin, and organophosphates in critical foraging habitat
- Normal range of white cells in bird blood samples
- Improved water quality
- Decreased contaminant residues in fish, shellfish, and crustaceans

Indicator 4: knowledge produced

Metrics:

- Creation of a scientific review committee
- Creation of a research program that addresses the main questions while minimizing disturbance at the nesting colonies
- Number of relevant research projects completed
- For each project, develop a project-based criterion with measurable objectives

Indicator 5: knowledge disseminated

Metrics:

- Incidences of use of knowledge by decision makers in land planning and acquisition
- Number of new and improved advocacy efforts on behalf of the harbor heron birds and habitat
- Number of bilingual educational materials produced
- Increased visitor numbers in ecotourism programs focusing on harbor herons
- Increased number of citizen scientists involved in harbor herons projects
- Use of harbor herons curriculum in schools K-12

- Increased access to harbor herons through unique projects such as video cams and website development

Indicator 6: Advancement in all conservation priority areas of research, habitat conservation, education, and advocacy

Metrics:

- Collaboration with other researchers from other stakeholder organizations on research and grants
- Regional cooperation among non-governmental organizations, government agencies, and private entities to protect the Harbor Herons

Indicator 7: continued adaptive management process used to implement plan

Metrics:

- Establish a taskforce for yearly evaluation of Plan implementation
- Practice adaptive management in implementation of the goals
- Provide feedback to researchers, educators, funders, and managers about successes and failures

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