



Coastal Breeding Bird Monitoring Protocol for Boston Harbor Islands National Recreation Area

Northeast Temperate Network

Natural Resource Report NPS/NETN/NRR—2010/176



ON THE COVER

Black-Crowned Night-Heron chick and eggs

Photo: Carol Lynn Trocki

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Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	New Version#
1.00	5/08	Carol Lynn Trocki	Update methods to reflect refinements during the 2007 field season, specifically adding methods for including a measure of detection probability to survey methods.	1.01
1.01	11/08	Carol Lynn Trocki	Update to reflect editorial comments and analysis recommendations of NETN Monitoring Coordinator. Minor refinements to methods based on 2008 field season experience.	1.02
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1 - Background and Introduction

In 1992, the National Park Service (NPS) developed a national policy “to better understand [the] dynamic nature and condition of natural resources, to detect or predict changes that may require intervention, and to serve as reference points for more altered parts of the environment. By integrating this information into NPS planning, management, and decision-making, scientific knowledge of natural resources will improve NPS stewardship of our heritage lands” (NPS 1992). The result was that NPS developed an Inventory & Monitoring Program which identified all parks in the NPS system with significant natural resources and in 1998 created 32 “networks,” or groupings, of parks linked by geography and shared natural resource characteristics. The goals of the networks are to work to develop common monitoring methodologies for data comparability, to reduce the level of effort required, and to share resources. Boston Harbor Islands National Recreation Area (BOHA) is one of thirteen park units included in the Northeast Temperate Network (NETN), which is one of four networks in the NPS Northeast Region.

BOHA includes 34 islands and peninsulas situated within the Greater Boston shoreline (Figure 1). It was established by Congress as a unit of the National Park System in 1996 (Public Law 104-333). The park has a threefold purpose of (1) preserving and protecting a drumlin island system within Boston Harbor, along with its associated natural, cultural, and historic resources, (2) telling the islands’ individual stories and enhancing public understanding and appreciation of the island system as a whole, and (3) providing public access, where appropriate, to the islands and surrounding waters for education, enjoyment, and scientific and scholarly research for this and future generations (BOHA General Management Plan 2002). In support of the park’s mission, volunteers will be used to implement the coastal breeding bird protocol. This will enhance community involvement with park islands, provide an opportunity for various stakeholders to participate in long-term monitoring within the park, and be a cost-effective means to implement this program.

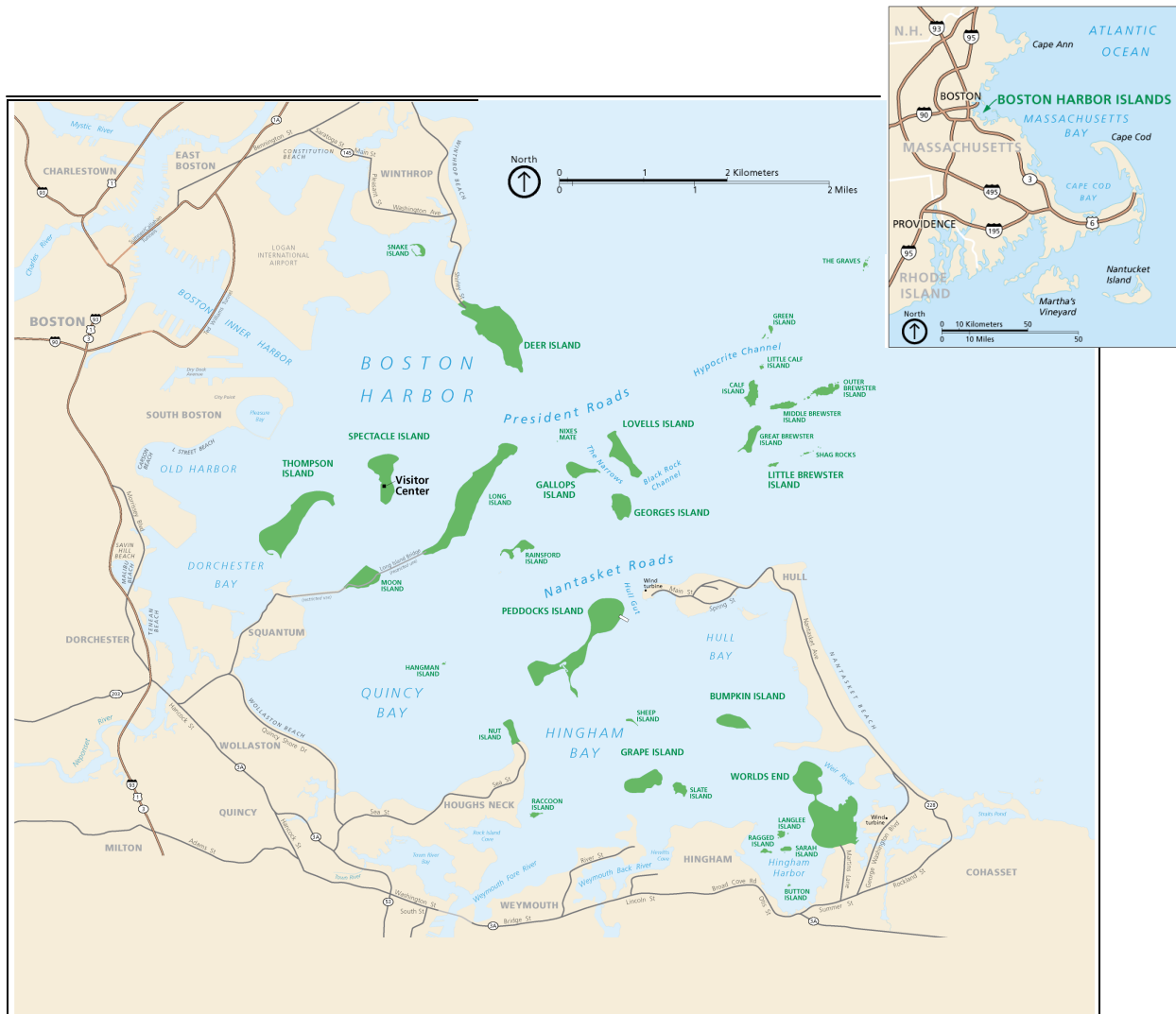


Figure 1. Map of Boston Harbor Islands National Recreation Area.

The Boston Harbor Islands are part of the only drumlin field in the United States that intersects a coastline. Located at 42° N latitude in the Northeastern Coastal Zone level III ecoregion (United States Environmental Protection Agency 2002), the islands have a humid maritime climate characterized by a moderate annual range of temperatures and definite summer and winter seasons. The park encompasses a total of 600 terrestrial ha, with islands and peninsulas ranging in size from 0.1 to 104.5 terrestrial ha (Roman et al. 2005). In addition, the park includes approximately 55 km of shoreline and 641 ha of intertidal habitat (Roman et al. 2005). BOHA is a unique unit of the national park system in that it is managed by a 13-member partnership which includes the National Park Service and other public and private stakeholders (Table 1). The NPS owns no land in the park.

Table 1. Members of the Boston Harbor Islands Partnership.

National Park Service
US Coast Guard
Massachusetts Department of Conservation and Recreation (2 seats)
Massachusetts Water Resources Authority
Massachusetts Port Authority
City of Boston, Environment Department
Boston Redevelopment Authority
Thompson Island Outward Bound Education Center
The Trustees of Reservations
Boston Harbor Island Alliance
Boston Harbor Islands Advisory Council (2 seats)

The islands vary in their geologic and ecologic composition, in addition to their degree of influence from human use over time. Available habitats include open water, rocky shores, tidal flats, beaches, dunes, cliffs, ledges, maritime shrub and deciduous forest communities, salt marshes, freshwater marshes, and a few examples of human-maintained fields and grasslands. The flora and fauna of the islands reflect their long history of human use and alteration; forty-four percent of the plant species documented in the park are classified as exotic (Elliman 2005).

1.1 Monitoring Rationale: Waterbirds as a Vital Sign

Vital signs, as defined by NPS, are a subset of physical, chemical, and biological elements and processes that represent the overall health or condition of park resources, known or hypothesized effects of stressors, or elements that have important human values. Birds are an important component of park ecosystems and sensitive to changes within them. They operate close to the limit of their ecological tolerance, and their high body temperature, rapid metabolism, and high ecological position in most food webs makes birds an important indicator of ecosystem change at the local and regional scale (Fancy and Sauer 2000). A shift in environmental conditions or a change in the abundance of lower trophic level food sources, may produce a change in condition, reproductive rate, or abundance. By comparison, fish and invertebrate species, although they do have their particular sensitivities (e.g., low oxygen for fish and certain pollutants for insects), are in general able to tolerate much broader swings in environmental conditions, while trees are long-lived enough that it may take longer to detect population changes. Moreover, among the public, birds are a high profile taxa and many parks provide information on the status and trends of the park's avian community through their interpretive materials and programs.

In developing comprehensive long-term monitoring plans, birds are among the best taxonomic groups to monitor because:

- they are easily and inexpensively detected and identified
- a single survey method is effective for many species
- accounting and managing for many species with different ecological requirements promotes conservation strategies at the landscape scale
- many reference datasets and standard methods are available
- response variability is fairly well understood

Breeding birds were identified as a high-priority vital sign for NETN parks during the network's vital signs selection process and are one component of an integrated monitoring program being developed for BOHA (Mitchell et al. 2006). While forest breeding birds are the community of interest at most NETN parks, at BOHA coastal breeding birds (waterbirds) are the more important avian community. Other monitoring at BOHA includes rocky intertidal and salt marsh communities, as well as phenology and invasive plant species surveillance. Additional details on NETN's monitoring strategy can be found in Mitchell et al. (2006).

In 2002, BOHA was designated as a Massachusetts Important Bird Area (IBA). IBA sites provide essential habitat to one or more species of breeding, wintering, or migrating birds and generally support high-priority species, large concentrations of birds, exceptional bird habitat, and/or have substantial research or educational value. The Boston Harbor Islands provide habitat for a significant number of colonial-nesting waterbirds, including Least Terns (*Sterna antillarum*) and Common Terns (*Sterna hirundo*), which are both listed as species of special concern in the State of Massachusetts (Massachusetts Natural Heritage and Endangered Species Program 2007). BOHA also provides habitat for breeding wading birds including Snowy Egrets (*Egretta thula*) and Black-crowned Night-Herons (*Nycticorax nycticorax*) which are, respectively, species of high and moderate continental conservation concern (Kushlan et al. 2002). American Oystercatchers (*Haematopus palliatus*) have expanded their range northward into Massachusetts and now have a substantial breeding population in the Boston Harbor Islands (Paton et al. 2005). The North American population of American Oystercatchers is listed as a high priority shorebird species with high conservation concern in the U.S. Shorebird conservation Plan (2004). In addition, eider, cormorants, several other wading and shorebird species, and gulls regularly nest on the islands.

1.2 History of Waterbirds in BOHA

Although much is known about the spatial distribution and abundance of breeding birds in Massachusetts (Veit and Petersen 1993), less has been published on the avifauna of the Boston Harbor Islands. One current comprehensive, long-term survey of birds in Boston Harbor is conducted by the Take A Second Look (TASL) program (see <http://www.gis.net/~szendeh/tasl.htm>), which has monitored waterbirds during winter months since 1980.

Although not part of a consistent monitoring program, periodic records of breeding waterbirds on the islands do exist. During 1984-85, the US Fish and Wildlife Service conducted a survey of all coastal waterbird colonies from Maine to Virginia (Andrews 1990), but this regional effort has not been repeated. The State of Massachusetts and Mass Audubon also conduct regular monitoring of coastal waterbirds in the state, but coverage and survey frequency varies and the Boston Harbor Islands have not been regularly included (Natural Heritage and Endangered Species Program, Scott Melvin, Senior Zoologist, pers. comm., 2007 and Mass Audubon, Rebecca Harris, Director, pers. comm., 2007). Although BOHA wading bird colonies were recently resurveyed in 2006 (Manomet Center for Conservation Sciences, Katherine Parsons, Wildlife & Energy Senior Scientist, pers. comm., 2007).

From 1972 to 1982, Hatch (1984) documented an increase in the number of Double-crested Cormorants (*Phalacrocorax auritus*) nesting on the outer islands. In 1994, Blodgett and

Livingston (1996) estimated the numbers of nesting pairs of coastal waterbirds (waterfowl, cormorants, wading birds, shorebirds, gulls and terns) throughout the state of Massachusetts, and included BOHA in their survey. The 1994 inventory also documented the presence of 13 Common Eiders (*Somateria mollissima*) nesting in BOHA and speculated that this population may have descended from 175 chicks translocated from Casco Bay, ME to Penikese Island in Gosnold, MA in the early 1970s (Blodget and Livingston 1996). The Boston Harbor Islands are located at the southernmost extent of this species' range.

In 1993 and 1994, Parsons et al. (2001) included wading bird colonies on Sarah Island and Middle Brewster Island in a study conducted on wading bird productivity in the northeastern US. At that time, 725 wading bird nests were documented on Sarah Island, but researchers found that egg viability was low, presumably due to the influence of embryotoxic contaminants (Parsons et al. 2001). Nove (2001) summarized some breeding records of waterbirds in BOHA, but this report focused on islands that were publicly accessible through the island ferry system, and thus did not provide complete information for the park.

In 2001-2003, Paton et al. (2005) conducted an avian inventory of BOHA, which in part established the need for a long-term coastal breeding bird protocol in the park. When compared with previous studies, the Paton et al. (2005) waterbird inventory suggested that:

- Common Eiders have a small, but established colony of approximately 70 nests on islands in the Outer Harbor, primarily Calf Island.
- Double-crested Cormorants have redistributed themselves among the islands of the Outer Harbor, but have maintained fairly stable numbers since the 1980s (Andrews 1990, Hatch 1984).
- Wading birds have experienced a significant decline on Sarah Island where the population declined from 725 nests in 1994 (Parsons et al. 2001) to 112 nests in 2003. The number of nesting wading birds on Middle Brewster Island has varied from 124 nests in 1984-5 (Andrews 1990), to 207 nests in 1994 (Blodget and Livingston 1996), to only 14 pairs present in 2003. Wading birds are no longer present on Spectacle, Peddocks, or Gallops (Nove 2001).
- American Oystercatchers have increased from only several pairs in the early 1990s (Veit and Petersen 1993, Nove 2001) to approximately 16 pairs on 14 islands in 2003.
- Herring Gulls (*Larus argentatus*) have declined in BOHA (Andrews 1990), as they have regionally (Rome and Ellis 2004), which may be due in part to the restoration of Spectacle Island, a former land fill and gull nesting site.
- Great Black-backed Gulls (*Larus marinus*) have maintained a stable population in BOHA (Andrews 1990), though regional data suggests they may be increasing (Rome and Ellis 2004).
- Least Terns have a small but relatively stable population (<100 pairs), usually on Rainsford or Lovell's Islands (Hatch 2001, Nove 2001).
- Common Terns have declined from a peak of 100 pairs in 1993 (Hatch 2001) to approximately a dozen pairs on Snake Island in 2003.

Additional waterbird surveys conducted in BOHA in 2005 and 2006 used similar techniques and provided generally similar results (Trocki et al. 2007). However, because waterbird populations

can fluctuate widely, it is necessary to establish a consistent and comprehensive long-term monitoring protocol in order to accurately measure population trends over time. In 2007, and again in 2008, waterbird surveys were conducted in BOHA as part of the development of this long-term monitoring protocol for coastal breeding birds in the park (Trocki and Paton 2007, Trocki 2008).

1.3 Measurable Objectives

The following objectives provide the basis for this coastal breeding bird monitoring protocol for Boston Harbor Islands National Recreation Area:

- 1) Determine annual changes and long-term trends in abundance of high priority coastal breeding bird species (Least Terns, Common Terns, and American Oystercatchers)
- 2) Conduct an annual surveillance program within the park to identify future use by threatened or endangered coastal breeding bird species, such as Piping Plover (*Charadrius melodus*) or Roseate Tern (*Sterna dougallii*).
- 3) Determine long-term trends in species composition and abundance of priority coastal breeding bird species (eider, cormorants, wading birds, shorebirds, and gulls)

In addition to these measurable objectives, we also seek to improve our understanding of breeding waterbird – habitat relationships in BOHA and the effects of habitat changes and management actions (such as invasive plant control or predator control) on waterbird species composition and abundance. Waterbird monitoring data can be correlated with ancillary data on park management actions, rocky intertidal communities, water quality, climate, and other available data to assist park managers in their efforts to protect and, in some cases, encourage the recovery of coastal breeding birds in the park.

1.4 Populations Being Monitored

This monitoring protocol focuses on populations of coastal bird species that breed on islands in BOHA. Many of these species nest colonially, some in mixed-species colonies. Required breeding habitat varies by species, but includes beaches, rocky shores, cliffs, open ground, shrub and tree communities. The focal species for this protocol have been arranged into groups that correspond to their predominant nesting habits:

Common Eider – Vegetated Ground Habitats

- Common Eider (*Somateria mollissima*)

Cormorants & Gulls – Rocky Shore / Cliff Habitats

- Double-crested Cormorant (*Phalacrocorax auritus*)*
- Herring Gull (*Larus argentatus*)
- Great Black-backed Gull (*Larus marinus*)

Wading Birds – Shrub / Woodland Habitats

- Great Egret (*Ardea alba*)
- Snowy Egret (*Egretta thula*)
- Black-crowned Night-Heron (*Nycticorax nycticorax*)

- Glossy Ibis (*Plegadis falcinellus*)

Large Shorebirds - Beach / Shore Habitats

- American Oystercatcher (*Haematopus palliatus*)
- Willet (*Catoptrophorus semipalmatus*)

Small Shorebirds – Nearshore Vegetated Ground Habitats

- Spotted Sandpiper (*Actitis macularia*)

Terns - Beach / Shore Habitats

- Least Tern (*Sterna antillarum*)
- Common Tern (*Sterna hirundo*)
- surveillance for possible future populations of Piping Plover (*Charadrius melodus*) and Roseate Tern (*Sterna dougallii*)

*Double-crested Cormorants also nest in trees on Sarah Island.

A summary of the survey techniques and survey metrics for each group of species using shared habitat is provided in Table 2 below. Because islands in BOHA are limited in number and size, a complete census of all nesting activity occurring in the park is reasonable on a 3-year survey rotation. Additional information on survey techniques and implementation can be found in corresponding SOPs in Appendix D.

Table 2. Summary of survey techniques and survey metrics for each group of waterbird species nesting on islands in BOHA.

Species Groups	Nesting Habitat	Survey Techniques & Metrics
Common Eider	Vegetated Ground	Complete ground-based nest counts, followed by boat-based crèche counts several weeks after hatching (count females and chicks on the water)
Cormorants & Gulls	Rocky Shore / Cliffs	Boat-based nest estimate; some ground-based nest counts in accessible locations
Wading Birds	Shrubs & Woodlands	Complete ground-based nest counts; estimates of nesting pairs based on counts of adults flushing from the colony may be necessary in inaccessible locations
Large Shorebirds	Beach / Shore Habitats	Boat-based counts of nesting pairs; ground based counts of nesting pairs or actual nests where possible
Small Shorebirds	Nearshore Vegetated Ground Habitats	Estimates of nesting pairs based on counts of flushing adults presumed to be incubating; ground-based nest counts wherever possible
Terns	Beach / Shore Habitats	Complete ground-based nest counts; estimates of nesting pairs based on counts of adults flushing from the colony may be necessary in inaccessible locations

2 - Sampling Design

2.1 Rationale for Sampling Design Selection

Focal species for this protocol are all highly visible and most nest in colonies, making them relatively easy to locate. Given the limited number and size of islands in BOHA (28 islands, 21 of which are < 10 ha), completing a census of the entire park area for nesting waterbirds within a 3-year rotation is a reasonable goal. For this protocol, the sampling unit is the area comprising the colony or individual nest site, with the primary objective being to estimate the total number of nests and/or nesting pairs for each species.

2.2 Site Selection

Coastal waterbirds nest in a variety of habitats, and the specific requirements of each individual species are well understood and fairly predictable (see species descriptions included in volunteer training materials and in SOPs [Appendix D]). Colonial-nesting waterbirds also exhibit a high degree of site fidelity, so colony locations are likely to remain similar from year-to-year. However, to accurately understand long-term trends, it is critical to have periodic and comprehensive surveys of all islands in the park to avoid a sampling bias for known locations. A regular surveillance program will ensure that all nesting species are detected and that shifts in colony locations are not incorrectly recorded as losses. A comprehensive approach to sampling will also allow for the detection of new colony sites or nesting by new species (such as Piping Plover or Roseate Tern).

2.3 Sampling Frequency, Replication and Timing

Surveys will be conducted annually for high priority species (oystercatchers and terns). A complete survey rotation including all focal species will be conducted over a 3-year period. (Table 3). Surveillance surveys for new species and new colony sites will be ongoing in conjunction with all coastal breeding bird monitoring efforts.

Sampling will be conducted from mid-May through mid-July each year. It is critical that surveys take place during the same stage of the nesting cycle for all species or groups each year. It is recognized however, that even during the peak nesting season counts will likely underestimate the true nesting effort of the population, given the likelihood that some nests will be missed.

Surveys will coincide as closely as possible with peak incubation for each species to accurately assess peak nesting effort and minimize disturbance.

Table 3. Proposed schedule for 3-year survey rotation, based on annual effort and park priorities.

Survey Tasks ¹	Year 1			Year 2			Year 3		
	May 15-31	June 1-15	June 15 – July 15	May 15-31	June 1-15	June 15 – July 15	May 15-31	June 1-15	June 15 – July 15
Common Eiders	x		x			x			x
Cormorants & Gulls	x								
Wading Birds				x	x				
Large Shorebirds	x	x	x	x	x	x	x	x	x
Small Shorebirds / surveillance							x	x	x
Terns		x	x		x	x		x	x

¹ See corresponding SOPs for detailed information on methods and target dates

The effect of observer disturbance on the breeding success of colonial waterbirds remains a controversial topic (see Carney and Sydeman 1999, Nisbet 2000). If surveys are conducted too early in the season, disturbance may cause nesting individuals to relocate or abandon their efforts. Carefully designed survey protocols and thorough volunteer training will reduce the potential negative effects of disturbance.

In addition, several of the survey protocols include an element of replication. Repeated surveys of American oystercatchers, terns, and common eider chicks may occur several times during a single breeding season. In an effort to quantify variability, boat-based gull and cormorant surveys may include simultaneous surveys by multiple observers in addition to multiple surveys during a single breeding season. Data generated during replicated surveys must be treated appropriately, so as not to introduce bias into survey results.

2.4 Recommended Number and Location of Sites

A census is an appropriate and efficient technique for surveying waterbirds in BOHA. Islands in the park are limited in number and size (28 islands, 21 of which are < 10 ha). Many of the focal species are conspicuous, nest colonially, and return to known locations repeatedly. In addition, most species use relatively restricted habitats, making it possible to thoroughly survey all potential nest sites (whether previously used or unused) on a 3-year rotation.

2.5 Minimum Detectable Level of Change

This coastal breeding bird protocol is conducted as a census, so a power analysis (which assumes a sampled population rather than a census) is not strictly appropriate. Nevertheless, there will be some minimum level of change that can be statistically detected as data are collected over the long term. In this case, major factors that will affect the ability to detect change are annual variation and observer error in census counts. The methods used in this protocol have not been used long enough at BOHA or similar areas to allow us to estimate the minimum level of detectable change, but we should be able to examine this after approximately six years of data collection for those species for which annual data has been collected. In developing this protocol, our intent has been to design methods that produce a reliable index of population size with repeatable counts that have less than 10% variability due to observer error when conducted simultaneously or consecutively. Over time, these methods will produce a dataset that can be used to better determine population trends.

3 - Field Methods

3.1 Sampling Protocol and Field Methods

The coastal breeding bird monitoring protocol recommended here is derived from several standardized sources, with appropriate modifications to suit a volunteer effort at BOHA. To address the monitoring needs identified within the North American Waterbird Conservation Plan (Kushlan et al. 2002), the USGS Waterbird Monitoring Partnership has produced a Draft Manual of Recommended Breeding Season Population Census Techniques for Seabirds and Colonial Waterbirds (<http://www.pwrc.usgs.gov/cwb/manual/>; Steinkamp et al. 2003). In addition, Erwin et al (2003) recently completed a long-term waterbird monitoring protocol for Cape Cod National Seashore that includes information relevant to BOHA. However, both documents target larger colonies, where sampling is necessary based on time, effort, and disturbance constraints. The detailed methods employed at BOHA are appropriate for the small colonies found there, and for implementation by volunteers.

The survey methods recommended in this protocol focus on obtaining information on the relative abundance of coastal breeding species by estimating or directly counting all nests, incubating adults, or territorial nesting pairs (methods vary by species, see Table 2 and SOPs for details). These methods were selected based on their ability to:

- accurately detect changes in species richness, relative abundance of nesting pairs, and nesting location for each focal species.
- create minimal disturbance to nesting colonies and/or nesting pairs.
- be implemented by trained volunteers working with a lead scientist and park staff.
- be carried out with an annual budget of approximately \$15,000.

3.2 Summary of Survey Techniques

Surveys will not be conducted when winds are greater than 25 km/h, precipitation reduces visibility, or when boating conditions are deemed unsafe by the boat captain. Surveys will generally be conducted between 0730h and 1230h each day and restricted to a temperature range of 10 to 35° C. Ground-based nest surveys will only be conducted when winds are below 20 km/hour, temperatures are 16 to 27° C, and there is no precipitation. A coordinated field schedule that specifies dates, target species, and islands to be surveyed will be compiled in advance of each field season. A small boat is required for all surveys, and a landing craft is critical for accessing many islands. It is also important to note that some islands are only accessible at high tide; therefore the annual field schedule must be coordinated with local tides (see Appendix D.1, Field Season Preparation SOP). Detailed descriptions of survey techniques are described in the SOPs (Appendix D); brief descriptions are provided below. Whenever possible, efforts will be made to limit disturbance during the nesting season while meeting protocol objectives. In some cases, islands with dense waterbird breeding sites (such as Sarah) may only be surveyed intensively using ground-based methods once every 3 years for all species.

Common Eider

Common Eiders nesting on the Outer Islands will be surveyed with a complete, ground-based nest count on a 3-year rotation. Common Eiders nest semi-colonially in BOHA and have generally been found nesting under overhanging vegetation, primarily sumac. Surveys will focus on known nesting areas on Calf, Little Calf, Green, Middle Brewster, Outer Brewster, and Great

Brewster Islands, but regular reconnaissance will be undertaken to record shifts in nesting locations. During surveys, four to five observers will spread out in a line (approximately 3-4 m apart) and proceed through vegetation to flush incubating females and locate nests. Ground-based nest counts will target peak incubation, which may vary based on spring weather conditions, but should generally be timed for 15 May to 1 June.

Approximately 2-3 weeks following peak incubation, chicks can be observed rafting in crèches offshore near nesting islands. Water-based counts of chicks from 15 June to 15 July will provide supplementary data on Common Eider reproductive success for the year. Boat-based crèche surveys will be conducted in years following ground-based nest counts, but could also be conducted annually in conjunction with tern and oystercatcher surveys for very little additional effort.

Cormorants and Gulls

Double-crested Cormorants, Herring Gulls, and Great Black-backed Gulls all nest together on the rocky fringes of islands in the Outer Harbor, as well as on Sarah and Sheep Islands. Gulls also nest currently on George's, Gallops, Hangman, and on the steep drumlin bluff faces of Greater Brewster. Visible active nests (as evidenced by the presence of an incubating adult or visible chicks) will be counted by surveyors circling the island by boat at approximately 5 km/h from a distance of approximately 10-45 m offshore (or as close as the boat captain feels safe boat operation is feasible). All islands will be surveyed on a 3-year rotation between 15 May and 1 June. Although these surveys will likely underestimate the actual number of nesting pairs (not every nest will be visible from the water), they will provide a consistent index of relative abundance and a reasonable compromise for these focal species given their stable populations and abundance in the park. Boat-based surveys reduce sampling effort, disturbance to nesting birds, and safety risks to volunteers. Landing boats and negotiating terrain on many of the Outer Islands is difficult and can be dangerous. In some locations (Sheep, Great Brewster) boat-based nest counts are not possible and periodic ground-based counts will be conducted. Beginning in 2009, researchers will explore the use of high-resolution digital photography to document colony sites and quantify nesting individuals.

Wading Birds

There are currently five mixed-species wading bird colonies in BOHA, located on Calf, Middle Brewster, Outer Brewster, Sheep, and Sarah Islands. Black-crowned Night-Herons are the most common and widely distributed nesting species, but Snowy Egrets, Glossy Ibis, and Great Egrets regularly nest in the park as well. All active nests of wading bird species will be counted through a complete ground-based survey of each colony on a 3-year rotation. Surveys will target peak incubation and take place between 15 May and 5 June. In areas that are inaccessible due to especially dense vegetation, the number of nesting pairs will be estimated based on a count of adults flushed from the colony site by the research team.

Large Shorebirds

American Oystercatchers and Willets will be surveyed annually with boat-based surveys designed to estimate the number of nesting pairs on each island. Pairs of American Oystercatchers now nest on many islands in the park, whereas Willets have only been detected nesting on Snake Island. Both species nest near shore and are highly visible and vocal. Because

of this, surveyors will be able to slowly circle each island by boat and accurately detect nesting pairs without causing undue disturbance at nest sites. Surveys will be conducted between 15 May and 15 July each year. Additional information on nest locations from ground-based nest counts and ground-based observations of territorial pairs will be collected when possible.

Small Shorebirds

Spotted Sandpipers have been documented nesting on nine islands in the park. Piping Plovers have not been documented nesting in the park, but nest elsewhere in Massachusetts and may colonize available habitat in BOHA in the future (such as beaches on Lovell's or Spectacle Island). Piping Plovers are a federally threatened species on the Atlantic Coast; if they are discovered nesting in the park in the future, the Piping Plover Atlantic Coast Population Recovery Plan (U. S. Fish and Wildlife Service 1996) should be consulted for monitoring and management guidelines. Walking surveys of suitable habitat (i.e., gently sloped pebble beaches with adjacent grassy areas) on island shorelines will be undertaken to estimate the number of nesting pairs of Spotted Sandpipers on a 3-year rotation. These walking surveys can also be used to gather additional information on American Oystercatchers (see Appendix D.6, Survey Techniques – Large Shorebirds SOP). Surveys will be conducted between 15 May and 15 July.

Tern Colonies

Least and Common Terns will be surveyed annually through a complete, ground-based nest count. Target islands (where nesting has occurred in the past) include Rainsford and Lovell's for Least Terns and Snake Island for Common Terns, but regular surveillance will be undertaken to identify all active colony sites each year. Roseate Terns have not been documented breeding in BOHA, but do nest at other sites in Massachusetts, generally in conjunction with Common Terns. Peak incubation (2-3 eggs in most nests) generally occurs between 10 June and 25 June, though Least Terns are known to be especially asynchronous. Therefore, Least Tern colony counts will be repeated 2-3 times during the month of June and into early July. Common Terns are also currently known to nest on a raised platform off Spinnaker Island. The platform itself is inaccessible, but the area will be surveyed annually by boat, though it is outside park boundaries, and the number of nesting pairs will be estimated based on a count of adults flushed from the colony site by the research team.

3.4 Volunteer Recruitment and Training

Volunteers interested in participating in the long-term monitoring of coastal breeding birds in BOHA will be recruited by park staff each year. Efforts will be made to involve all stakeholders (Table 4; see Appendix D.2, Volunteer Recruitment & Training SOP and Appendix A for additional information).

Table 4. Boston Harbor Islands (BOHA) coastal breeding bird stakeholder groups.

Organization
BOHA Staff
NPS Inventory and Monitoring Program Staff
Massachusetts Dept. of Conservation and Recreation
Thompson Island Outward Bound Education Center
New England Aquarium
Mass Audubon
Harvard Museum of Comparative Zoology
Massachusetts Fish and Wildlife
Manomet Center for Conservation Science
Take a Second Look
Conservation Commissions for Boston, Hingham, Hull, and Winthrop
The Trustees of Reservations
Local birding clubs
Cornell Lab of Ornithology, citizen science contact
All other Island Partnership Members / Island Alliance
Participating community volunteers

Volunteers will be required to attend a training session lead by the lead scientist and park staff prior to the start of the field season. Although volunteers of all skill levels will be welcome to participate, training efforts will focus on developing and assessing volunteer capabilities to ensure accurate, efficient, and safe data collection in the field.

3.5 Accounting for Observer Error / Bias

Whenever feasible, supplementary survey methods will be used to quantify detection probabilities and observer bias (see Mackenzie and Kendall 2002). Counts of actual nests or incubating adults will always underestimate the true nesting effort of a population, since some nests are likely to go undetected by even the most vigilant observer. Population estimates can be improved by incorporating a measure of error (i.e., accounting for a probability of detection that is less than one).

In its simplest form, this technique requires repeat visits to a colony site using a ‘mark-and-recapture’ method or a double observer method of nest censusing to evaluate the portion of nests that are missed during a given visit. This measure of error (detection probability) can then be applied to population estimates to produce more accurate results.

Suggestions for including measures of detection probability are offered for each survey technique, where applicable (see Appendix D for detailed SOPs for Common Eider, Cormorants & Gulls, Wading Birds, and American Oystercatchers). Although every effort has been made to develop techniques that minimize disturbance and maximize efficiency, measuring detection probability requires repeat visits to colony sites and the temporary marking of nests (for eiders and wading birds). To offset these additional costs, these methods may be applied to only a subset of the areas to be surveyed and then extrapolated to the entire population, provided fairly consistent error rates are obtained.

4 - Data Management, Analysis, and Reporting

4.1 Data Management

In order for this monitoring program to meet I&M Program goals, data management procedures will adhere to the guidelines established in the NETN data management plan (<http://science.nature.nps.gov/im/units/NETN/monitor/monitor.cfm>). A detailed data management plan is needed to ensure data quality, interpretability, security, longevity, and availability. The data collected on coastal breeding birds at BOHA will be entered into a MS Access database created with input from the NETN Data Manager to meet all I&M program standards. A metadata record and data dictionary for this database will be created.

Raw Data Collection

The field data specified in the survey methods section will be collected for focal species on standard data sheets (Appendix B). Volunteers involved in data collection will be trained in advance to accurately complete the required information. Field records will be reviewed for discrepancies at the end of each day. Field data sheets will be copied and stored at both park and network offices.

Data Entry / Error Checking

Data will be entered from field data sheets into the MS Access database as soon as possible after data collection, usually by someone directly involved in the data collection effort. After data entry is complete, the year's database entries will be reviewed for discrepancies internally, and then by someone not involved in the data collection effort, such as the NETN Data Manager. Dated copies of the MS Access database will reside in multiple locations for archival and security purposes.

Data Availability

NETN is committed to making monitoring data as widely available as possible. Any individuals interested in accessing the data set should contact the NETN Data Manager (contact information is at <http://science.nature.nps.gov/im/units/NETN/about/aboutus.cfm>). Data on sensitive species can only be released with the approval of the natural resources manager for Boston Harbor Islands.

4.2 Data Analysis

Analysis will be conducted by the lead scientist coordinating this program or by NETN staff. A summary of results will be compiled on an annual basis. As the data set for this program grows, a variety of statistical methods will become feasible for analyzing trends in coastal bird populations. A detailed discussion of the statistical methods that may be most appropriate for data analysis is being developed.

Periodically, the NETN will conduct an analysis of the correlations between waterbird monitoring data and ancillary data, describing habitats, management activities, and conditions. Park datasets and records that may be of interest include: invasive species management activities (timing, methods, and locations), prey availability, training and recreational activities (or any other indications of human disturbance), and weather data (precipitation, temperature, wind) particularly early in the nesting season (April – June).

4.3 Reporting

The two major reports developed for this program will be an Annual Report (e.g., Trocki and Paton 2007) and an Analysis and Synthesis Report completed every three years beginning in 2010. Templates and formatting instructions are available at the NPS Northeast Region website: <http://www.nps.gov/nero/science/Guidelines/Guidelines.htm>.

In addition, weekly updates during the field season are shared by the lead scientist online with participating community volunteers and other interested stakeholders. This effort adds value for the park community and helps island managers keep track of the timing of nesting activities.

Annual Reports

Annual Reports will provide a general overview of activities and a summary of results from each year's field season and will be due to the NETN office by December 15 of each year. The annual report and responsibilities include:

- Document monitoring activities
- Summarize findings
- Document changes in the monitoring protocol
- Public interest highlights

Annual Reports will be shared with all interested stakeholders (see Table 4). In addition, contributing information to regional working groups on an annual basis will provide an opportunity for the detection of regional changes and the implementation of more comprehensive management strategies.

Analysis and Synthesis Reports

Analysis and Synthesis Reports will be completed every three years (beginning in 2010) and will provide more detailed analyses of population trends. Results will be interpreted to provide specific information related to the measurable monitoring objectives. In general these reports will estimate patterns and trends in abundance and community composition and evaluate the efficacy of the current monitoring protocol to achieve the stated objectives. In addition, Analysis and Synthesis Reports will recommend changes to monitoring and management practices within the park.

4.4 Program and Protocol Reviews

The protocol will be internally reviewed after every field season. This review (by NETN staff and cooperators) will focus on discussing any difficulties with protocol implementation and developing and documenting improved methods for future years. External peer reviews will be conducted every 5 to 10 years in order to ensure that the protocol is meeting stated objectives. The reviews will be conducted by scientists who are not directly involved with the implementation of the protocol. The reviewers may be associated with the NPS, other government agencies (e.g. USGS) or educational and non-profit organizations.

The protocol reviews include the following:

- Formal reviews of operations and results
- Review of protocol design and products to determine if changes are needed
- Evaluation of methods and objectives.

5 - Personnel and Training

5.1 Roles and Responsibilities

Initial protocol development was completed through a cooperative agreement with researchers Peter W. C. Paton and Carol Lynn Trocki at the University of Rhode Island. A full-scale pilot of the monitoring program was undertaken in May and June 2007 and 2008, and a draft monitoring protocol was submitted to NETN in early 2008.

Key roles for implementing the BOHA Coastal Breeding Bird Monitoring program are:

Lead Scientist: Plans and schedules all monitoring activities. Works with BOHA staff to plan volunteer training session. Trains and supervises volunteers. Participates in all data collection, oversees data entry, manages and archives data, performs initial data QA/QC checks. Develops annual report.

BOHA Volunteer Manager: Recruits and coordinates volunteers. Provides logistical support for volunteer training and schedules volunteers for monitoring trips. Communicates public interest highlights. Organizes BOHA staff participation.

BOHA Staff Participant: Ensures safety and provides logistical support during monitoring trips. Assists with data collection as needed.

NETN Network Program Manager (or other designated NETN staff member): Oversees the contract / cooperative agreement. Acts as key liaison between the Lead Scientist and BOHA park staff.

NETN Data Manager: Provides assistance in creating and maintaining a MS Access database for the protocol. Responsible for certifying that QA/QC procedures have been followed.

Volunteers: Collect data during trips overseen by the cooperating / contracting researcher.

5.2 Qualifications

The Lead Scientist responsible for implementing the Coastal Breeding Bird Monitoring Protocol in BOHA should have demonstrated experience conducting research on coastal breeding birds and a working knowledge of the logistical challenges inherent in conducting both land and boat-based surveys on remote islands with limited access. Experience working with volunteers is essential.

Volunteers participating in the protocol must have an interest in learning about coastal breeding birds and be willing to engage in scientifically rigorous monitoring techniques. Previous experience with bird identification or waterbird monitoring is helpful, but not required. Field work is physically demanding with limited access to emergency services; volunteers must be in good health and able to negotiate uneven, ungroomed paths with heavy vegetation. A volunteer job description can be found in Appendix A.

5.3 Training

New volunteers will be required to attend a training session prior to the start of the field season. Recurring review of species identification and survey methods will also be provided throughout the field season. More detailed information about volunteer training can be found in the SOPS in Appendix D, and in Appendix A.

5.4 Safety Considerations

Field work is physically demanding and involves small boat travel and hiking over rough terrain. Some of the islands are remote and access to emergency services may be limited. The Volunteer Recruitment & Training SOP in Appendix D provides more detailed information on volunteer training and safety considerations.

6 - Operations

6.1 Research Permits

All researchers are required to file for permits and have copies on hand when in the field. Details for the permit application process can be found at

<http://science.nature.nps.gov/research/ac/ResearchIndex>. It is permissible to apply for a multi-year (e.g., 5 or 10 years) permit for an ongoing monitoring project. Regardless of the length of the permit period, researchers are required to file an Investigator's Annual Report (IAR) online every year. For the coastal breeding bird monitoring program, the IAR can be brief, and will probably cite the annual report submitted separately to the park and NETN, as well as any recent trend analyses.

6.2 Scheduling Site Visits

A field schedule will be created in advance of each field season, taking into account a variety of components (see Appendix D.1, Field Season Preparation SOP). This field schedule will be circulated among the lead scientist, park staff, NETN staff, and the contracting boat captain (currently UMASS Boston) before being made final. This schedule, though subject to change, will be shared with volunteers and island managers in advance of the field season.

Every effort will be made by researchers to obtain permission for access from individual island contacts in advance of each field season. This will ensure appropriate access to sampling sites and inform researchers of possible closures or other necessary safety information (see Appendix D.1, Field Season Preparation SOP).

6.3 Equipment

A list of the supplies required to carry out this protocol can be found in Appendix D.1, Field Season Preparation SOP.

6.4 Budget

The estimated annual budget covers costs for personnel, travel, boat transportation, equipment, and volunteer training.

The funds needed to implement this program are contributed by the Northeast Temperate Network of the NPS Inventory and Monitoring Program. The annual estimated cost for fieldwork, annual reporting, and protocol revision in 2009 is \$16,000.00. The budget from 2009 is provided in Table 5.

Table 5. BOHA Coastal Breeding Bird Monitoring Protocol, 2009 budget for volunteer training, field work, data entry & analyses, annual reporting, and protocol revision (does not include the cost of park staff to recruit & coordinate volunteers and provide basic administrative support).

Category	Cost
Contracting Researcher Salary	\$10,815.00
volunteer training session, planning, and implementation (24hrs)	
field work (10 days x 9hrs = 90hrs)	
data entry & annual analyses (48hrs)	
dissemination of results, preparation and attendance at regional working groups, park and/or network meetings (4 days x 8hrs = 32hrs)	
draft annual report (48hrs)	
protocol update and revisions (48hrs)	
Mileage & Travel	\$1,231.25
BOHA round trip travel (11 trips x 150 miles x \$0.585)	
BOHA parking (11 days x \$6.00)	
waterbird meetings	
Field Transportation Expenses	\$2,500.00
contract landing craft from UMASS Boston (10 field days x 5hrs = 50hrs)	
Room Fees / Transportation for Volunteer Training	\$500.00
Supplies & Equipment	\$850.00
miscellaneous field supplies (pens, paper, field and datasheet printing, calipers, sheet protectors, batteries, etc.)	
volunteer Guide printing and binding	
annual supply addition and replacement, 1 item per yr (gps unit, telescoping mirror, weather station)	
volunteer appreciation gifts	
Grand Total	\$15,896.25

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Appendix A: Boston Harbor Islands Coastal Breeding Bird Protocol – Available Volunteer Materials
Version 1.01

The following sample materials from 2008 are available upon request or for downloading from NETN's website at: <http://science.nature.nps.gov/im/units/NETN/monitor/monitor.cfm> in the Coastal Birds row.

1. Boston Harbor Islands Volunteer Guide
2. Volunteer Training Session Agenda
3. Volunteer Training Session PowerPoint Presentation
4. Volunteer Job Description
5. Volunteer Agreement
6. Hazard Fact Sheets
 - 6a - Poison Ivy
 - 6b - Lyme Disease
 - 6c - Exposure to Airborne Pathogens in Wading Bird Colonies
 - 6d - West Nile Virus
 - 6e - Histoplasmosis

REVISION HISTORY LOG

Previous Revision #	Revision Date	Author	Changes Made	New Version #
1.00	4/09	Carol Lynn Trocki	Updated to include volunteer agreement and hazard fact sheets.	1.01

Version 1.00

Sample data sheets from the 2008 field season are provided for reference.

2008 BOHA Waterbird Monitoring Program

Boat-based Survey Data Form	
GPS Unit:	ENVIRONMENTAL CONDITIONS Temperature: Tide: % Cloud Cover: High Wind Speed: Mid Wind Direction: Low
Date:	
Start Time:	
End Time:	
Observer:	
Recorder:	

[illegible]

Appendix B: Field Data Sheets (continued)

2008 BOHA Waterbird Monitoring Program

Complete Colony Nest Survey Data Form

Island:	GPS Unit:	
Date:	ENVIRONMENTAL CONDITIONS	
Start Time:	Temperature:	Tide:
End Time:	% Cloud Cover:	High
Observer:	Wind Speed:	Mid
Recorder:	Wind Direction:	Low

Number	Species	# Eggs	# Chicks	X (UTMs)	Y (UTMs)	Acc (m)
1						
2						
3						
4						
5						
6						
7						
8						
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****Be sure to complete a field map form with every datasheet.****

Appendix B: Field Data Sheets (continued)

2008 BOHA Waterbird Monitoring Program

Field Survey Data Form

Complete instructions for completing this form can be found on the back. Please see the Boston Harbor Island National Park Area: Coastal Breeding Bird Monitoring Protocol for more detailed information.

Date: _____ Start Time: _____ End Time: _____ Observer 1: _____ Observer 2: _____ Recorder: _____	ENVIRONMENTAL CONDITIONS Temperature: _____ % Cloud Cover: _____ Wind Speed: _____ Wind Direction: _____ Tide: High Mid Low
---	---

Survey Type: Boat-based Ground-based Target Species: _____ Island(s) Surveyed: _____ Habitat Type: _____	ADDITIONAL NOTES
--	--

COLONY LOCATION INFORMATION Island: _____ GPS Location X: _____ Y: _____ Accuracy: _____	
---	--

Nest Stage of Most Individuals: _____

	<u>COUNT RESULTS</u>
Survey Method 1: Estimate of Adults Flushed Method 1 / Observer 1: _____ Estimate of Nesting Pairs _____ Estimate of Incubating Adults Method 1 / Observer 2: _____ Direct Nest Count _____	
Survey Method 2: Estimate of Adults Flushed Method 2 / Observer 1: _____ Estimate of Nesting Pairs _____ Estimate of Incubating Adults Method 2 / Observer 2: _____ Direct Nest Count _____	

*****Be sure to complete a field map form with every datasheet.*****

Appendix B: Field Data Sheets (continued)

2008 BOHA Waterbird Monitoring Program

Field Survey Data Form

BOHA Waterbird Monitoring Program - Datasheet Instructions

Record the date (mm/dd/yyyy)

Record the starting and ending times for the survey using a 24 hour clock.

Record the names of observers (doing the counting) and the recorder completing this sheet.

Record the temperature in degrees C, % cloud cover (0-100%), the wind speed and direction.

Circle the tidal stage that best describes conditions at the time of the survey (mid tide is slack).

Circle the appropriate survey type.

List the target species using the standard 4-letter codes provided:

Double-crested Cormorants = DCCO	American Oystercatcher: AMOY
Great Back-backed Gull = GBBG	Spotted Sandpiper: SPSA
Herring Gull = HERG	Black-crowned Night-Heron: BCNH
Common Eider = COEI	Snowy Egret: SNEG
Least Tern = LETE	Great Egret: GREG
Common Tern = COTE	Glossy Ibis: GLIB
Willet = WILL	

List the island or islands surveyed, for which data appears on this sheet only.

List the habitat type below that best describes the location of the colony or nesting individuals:

mixed maritime forest	Phragmites marsh	maritime dune
red cedar woodland	cattail marsh	beach strand
maritime shrub	maritime erosional cliff	salt marsh
old field	maritime rock cliff	

Under the heading 'COLONY LOCATION INFORMATION', complete the information requested for ground-based surveys only. Use the gps provided to obtain coordinates and accuracy information.

List the nest stage below that best describes the majority of individuals/nests being surveyed:

nest building	hatching	fledging
incubation	chick rearing	fledged juveniles

In many cases, a combination of two survey methods will be used during a single colony visit (for example, protocols suggest recording the number of adults flushed from a colony before conducting a complete nest count). Circle the choice of survey method that best describes the approach used. When double-observer methods are being employed, record counts for each observer separately.

Use the space provided to record any additional notes, or additional gps coordinates, information on nest contents, etc.

*****Be sure to complete a field map form with every datasheet.*****

Appendix C: Boston Harbor Islands Coastal Breeding Bird Protocol Review – Responses to Peer and Park Review Comments.

Version 1.00

Review comments are available upon request or for download on NETN's website at: <http://science.nature.nps.gov/im/units/NETN/monitor/monitor.cfm>) in the Coastal Birds row.

We sincerely appreciate the comments and suggestions made by five peer reviewers and BOHA park staff.

Peer Reviewer #1: Sam Droege, USGS

Peer Reviewer #2: Wayne Petersen, Mass Audubon

Peer Reviewer #3: Greg Shriver, University of Delaware

Park Staff Review: Marc Albert & Mary Raczko, BOHA

External Peer Review: Dr. Curtice Griffin, University of Massachusetts 4/09

External Peer Review: Kathy Parsons, Manomet Center for Conservation Sciences 4/09

Appendix D: Boston Harbor Islands Coastal Breeding Bird Protocol – Standard Operating Procedures.

Standard Operating Procedures

D.1 Field Season Preparation

D.2 Volunteer Recruitment & Training

D.3 Survey Techniques – Common Eider

D.4 Survey Techniques – Cormorants & Gulls

D.5 Survey Techniques – Wading Birds

D.6 Survey Techniques – Large Shorebirds

D.7 Survey Techniques – Small Shorebirds

D.8 Survey Techniques – Tern Colonies

D.9 Data Management

D.10 Data Analysis

D.11 Reporting

D.1 Field Season Preparation

Northeast Temperate Network

Version 1.04

1. Draft Field Schedule

Based on the previous year's accomplishments, draft a schedule for the coming year by 15 March. The schedule should include a matrix of dates, islands to be visited, and target species (Table 1). Dates must take into account the estimated peak of incubation (or other necessary phenology) for the target species. Some islands (Snake, Sheep, Rainsford, Middle Brewster, Outer Brewster) require high tide for landing; coordinate your draft schedule with the transportation provider to insure its feasibility.

It is advisable to include make-up / weather days during each week of the schedule. This allows the volunteer manager to plan accordingly for volunteers, and allows easy re-scheduling within a tight timeframe should an extra day be needed. Currently, the capacity of the survey boat is limited to six people, and monitoring tasks have been structured accordingly. No more than six people (including lead scientist and participating park staff) should be assigned for each field day.

2. Schedule Transportation, Volunteers, Access

Once the field schedule has been finalized, schedule marine transportation by 31 March. Currently, Marine Operations at UMASS Boston (<http://www.umb.edu/umb/marineops/>) is able to provide a landing craft and licensed captain for \$55 per hour. Although a landing craft may not be necessary for all field work, the scheduled use of a landing craft maximizes the flexibility of field work on the islands.

Share the final field schedule with the BOHA volunteer manager, responsible for recruiting and coordinating volunteers, by 31 March. Circulate the final field schedule among island managers and partners by 7 April to ensure that access is permitted. Communicate with BOHA staff to obtain updated contact information for the appropriate list of partners in advance of each season. Obtain a valid research permit from the park (multi-year permits may be available).

3. Organizing Supplies

Supplies required for this protocol include:

- clipboards
- waterproof pens
- waterproof paper
- field data sheets
- park maps
- long-handled mirror for nest-checking
- first aid kit
- film (if using 35mm)
- calipers
- flagging
- batteries
- (digital) camera
- portable weather station
- GPS units (ideally 3-4)
- binoculars (most volunteers will come with their own, but extras are helpful)

Review available supplies and order any materials needed well in advance of the field season.

Appendix D: Boston Harbor Islands Coastal Breeding Bird Protocol – Standard Operating Procedures (continued).

Table 1. BOHA Waterbird Monitoring, Draft 2008 Field Schedule.

Date	Day	Target Area	Target Species	Islands - Boat Survey Only	Islands - Landing Needed	Notes
12-May	Mon	Outer Islands	DCCO & gulls, COEI, waders, AMOY	Little Brewster, Great Brewster, Little Calf, Green, Shag Rocks	Middle Brewster, Outer Brewster, Calf	Morning High Tide
13-May	Tues	Outer Islands	DCCO & gulls, COEI, waders, AMOY	Little Brewster, Great Brewster, Little Calf, Green, Shag Rocks	Middle Brewster, Outer Brewster, Calf	Morning High Tide
14-May	Wed	Outer Islands				<i>Weather Make-up; Extra Field Day</i>
19-May	Mon	Hingham Harbor	DCCO & gulls, AMOY	Ragged, Langlee, Button, Grape, Slate, Bumpkin	Sarah, Sheep	
23-May	Fri	Hingham Harbor	DCCO & gulls, AMOY	Ragged, Langlee, Button, Grape, Slate, Bumpkin	Sarah, Sheep	
26-May	Mon	Hingham Harbor				<i>Weather Make-up; Extra Field Day</i>
29-May	Thurs	Inner Harbor, Hingham, Dorchester	AMOY, gulls	Hangman, Rainsford, Georges, Gallops, Lovells, Thompson, Spectacle		Early Morning High Tide
30-May	Fri	Outer Harbor, Hingham	as needed to complete DCCO & gulls	Peddocks; Inner Harbor as time permits	Outer Islands as Needed	Morning High Tide
2-Jun	Mon	Inner Harbor, Hingham, Dorchester				
4-Jun	Wed	Snake, Lovells, Rainsford	terns, AMOY	Inner Harbor as needed	Rainsford, Lovells, Snake	
5-Jun	Thurs	Snake, Lovells, Rainsford				<i>Weather Make-up; Extra Field Day</i>
12-Jun	Thurs	Snake, Lovells, Rainsford				<i>Weather Make-up; Extra Field Day</i>
13-Jun	Fri	Snake, Lovells, Rainsford	terns, AMOY, COEI chicks	Outer Islands, Inner Harbor as needed	Rainsford, Lovells, Snake	Morning High Tide
24-Jun	Tues	Outer Islands; Terns as needed	COEI chicks, terns	Outer Islands	Rainsford, Lovells, Snake	Morning High Tide
1-Jul	Wed	Outer Islands; Terns as needed	COEI chicks, terns	Outer Islands	Rainsford, Lovells, Snake	
15-Jul	Tues	Outer Islands; Terns as needed	COEI chicks, terns	Outer Islands	Rainsford, Lovells, Snake	Morning High Tide

Appendix D: Boston Harbor Islands Coastal Breeding Bird Protocol – Standard Operating Procedures (continued).

4. Volunteer Recruitment, Training Session

Communicate with the BOHA volunteer manager responsible for coordinating and recruiting volunteers. By 31 March, agree to a date and location for an early May volunteer training session. Update volunteer materials accordingly.

5. Prepare Field Data Sheets and Field Maps

Update field data sheets and field maps as needed. Print in advance. Use waterproof paper to improve ease of use in damp situations.

REVISION HISTORY LOG

Previous Revision #	Revision Date	Author	Changes Made	New Version #
1.00	5/08	Carol Lynn Trocki	Update to clarify timing of steps. Provide UMASS website and update of field schedule.	1.01
1.01	11/08	Carol Lynn Trocki	Update to clarify methods based on comments provided by the NETN Network Coordinator.	1.02
1.02	1/09	Carol Lynn Trocki	Minor editorial changes.	1.03
1.03	4/09	Carol Lynn Trocki	Minor editorial changes in response to comments during peer review; see Appendix C.	1.04

D.2 Volunteer Recruitment & Training

Northeast Temperate Network

Version 1.03

1. Volunteer Recruitment

A BOHA staff member (currently Volunteer Manager, Mary Raczko) will assume the primary responsibility of volunteer recruitment and management. However, the lead scientist coordinating the project should work closely with the designated BOHA volunteer manager to develop and update volunteer recruitment materials in advance of each field season (by 1 March). See Appendix A for a sample volunteer job description.

2. Volunteer Training

The lead scientist and the designated BOHA volunteer manager will work together to agree on a draft field schedule (by 15 March) and volunteer training session date and location (by 31 March) each year. Volunteers should have some experience with general bird identification and monitoring techniques, and must be approved by the BOHA volunteer manager and lead scientist to participate. Ideally, a consistent core group of volunteers will return to work on this project each year. See Appendix A for sample volunteer training materials.

3. Managing Volunteers in the Field

The BOHA volunteer manager will work with the lead scientist to assign volunteers and park staff for field work according to the draft field schedule and with input from the lead scientist. The BOHA volunteer manager will be the primary point of contact for volunteers during the field season and will assist in informing participants of changes in the field schedule due to weather, etc.

The lead scientist will bear the primary responsibility for volunteer management while in the field. A BOHA staff person will participate in field work daily and will be available to assist and represent the park in an emergency situation.

Tasks will be assigned in the field based on individual volunteers' comfort level and skills. Clear and precise communication with volunteers and the BOHA volunteer manager will be necessary at all times to ensure a positive experience and quality data.

4. Volunteer Appreciation

Volunteers should receive a copy of the annual summary report each year. Distribution of this report and appropriate volunteer appreciation material (thank you cards, small gifts, etc.) should be coordinated with the BOHA volunteer manager.

Appendix D: Boston Harbor Islands Coastal Breeding Bird Protocol – Standard Operating Procedures (continued).

REVISION HISTORY LOG

Previous Revision #	Revision Date	Author	Changes Made	New Version #
1.00	11/08	Carol Lynn Trocki	Update to clarify methods based on comments provided by the NETN Network Coordinator.	1.01
1.01	1/09	Carol Lynn Trocki	Minor editorial changes and change to reflect Appendix A including all training materials.	1.02
1.02	4/09	Carol Lynn Trocki	Minor editorial changes based on input received during peer review process; see Appendix C.	1.03

D.3 Survey Techniques – Common Eider

Northeast Temperate Network

Version 1.05

1. Survey Parameters

These methods target incubating female Common Eider (*Somateria mollissima*). Complete ground-based nest censuses will be conducted every 3 years from 15 May to 1 June. Nest counts will be followed by boat-based surveys of chicks on the water from 15 June to 15 July. Ground-based nest surveys will only be conducted when winds are below 20 km/h, temperatures are 16 to 27° C, and there is no precipitation. Boat-based surveys will not be conducted when winds are greater than 25 km/h, precipitation reduces visibility, or when boating conditions are deemed unsafe by the boat captain.

Currently, Common Eider are known to nest throughout the Outer Islands, but are most concentrated on the northern side of Calf Island.

2. Survey Methods

In BOHA, eider usually nest under overhanging vegetation (primarily sumac) on the Outer Islands. With four to five observers, spread 3-4.5 m (10-15 feet) apart should-to-shoulder, walk in a line and progress through suitable vegetation on each island, watching for flushing females. Be sure to record the start and end time for all survey efforts, as well as making note of the survey route followed (GPS unit set to track). Record environmental conditions (temperature, wind speed, wind direction, cloud cover) prior to beginning surveys.

When a female eider is flushed, search the immediate area to locate the nest. Record the nest's contents (number of eggs and/or chicks) and record the nest location using a GPS. Maintain constant vocal communication with other observers as you search to assure complete coverage of each island and reduce the chances of double-counting nests. To minimize disturbance and increase the likelihood of finding nests, time surveys appropriately for the peak incubation period.

Approximately two to three weeks following ground-based surveys, return to the Outer Harbor to record the numbers of chicks observed. Crèche surveys follow a similar route and method as boat-based gull and cormorant surveys. Circle the entire perimeter of each island in the Outer Harbor in a small boat traveling at approximately 5 km/h (3 mph) as close to shore as the boat Captain will allow (between 9-46 m [30-150 feet] offshore). Record the number of female common eider and chicks on the water rafting in crèches. Beginning in 2009, NETN will explore whether it is feasible to use a high-resolution digital camera to photograph creche observations so that counts can be verified in the office. Surveys should be repeated several times during the latter half of the breeding season, from 15 June to 15 July.

3. Quantifying Detection Probabilities

To quantify a measure of error in nest counting, a sub-sample of nests could be counted using a mark-and-recapture technique, which requires two visits to a nesting colony, ideally on successive days. On the first site visit, for each nest found, contents and GPS location should be recorded and the nest should be marked with a uniquely numbered popsicle stick or other unobtrusive,

Appendix D: Boston Harbor Islands Coastal Breeding Bird Protocol – Standard Operating Procedures (continued).

biodegradable identifier placed on the ground next to the nest. On the second visit (ideally the next morning) a thorough nest search should be undertaken. All previously marked nests should be identified by popsicle stick number and contents recorded. All ‘new’ nests should have both contents and GPS location recorded. This information can then be used to calculate an estimate of the actual number of nests present based on the detection probability, or percentage of nests likely to be found during a single search effort.

Example from 2008 field season:

On May 14, 77 nests were located on the north end of Calf Island by a team of six trained observers. On May 15, 60 nests were located on the north end of Calf Island by a team of six trained observers, 43 of which had been marked on the previous visit. Given this information, the following ratio can be constructed:

nests marked on first visit / total number of nests = number of nests found marked on second visit / total number of nests found on second visit

$77 / X = 43 / 60$ where X = the total number of nests on the north end of Calf Island

X = 107 estimated number of nests

detection probability = $43 / 60 = 72\%$

Further research is needed to determine the effects of repeated disturbance on incubating females.

Appendix D: Boston Harbor Islands Coastal Breeding Bird Protocol – Standard Operating Procedures (continued).

REVISION HISTORY LOG

Previous Revision #	Revision Date	Author	Changes Made	New Version #
1.00	5/08	Carol Lynn Trocki	Update to include recording start and stop times and environmental conditions. Update section on detection probability to reflect unknown effects of repeated surveys on incubating females.	1.01
1.01	11/08	Carol Lynn Trocki	Update to clarify methods based on comments provided by the NETN Network Coordinator.	1.02
1.02	1/09	Carol Lynn Trocki	Minor editorial changes. Add information about pending test of digital photographic methods and better describe mark-and-recapture techniques for determining detection probability.	1.03
1.03	4/09	Carol Lynn Trocki	Minor editorial changes based on input from peer review; see Appendix C.	1.04
1.04	11/09	Carol Lynn Trocki	Updated to reflect the addition of environmental parameters.	1.05

D.4 Survey Techniques – Cormorants & Gulls

Northeast Temperate Network

Version 1.05

1. Survey Parameters

These methods target incubating Double-crested Cormorants (*Phalacrocorax auritus*), Herring Gulls (*Larus argentatus*), and Great Black-backed Gulls (*Larus marinus*). These species will be surveyed using a boat-based census of all appropriate and visible nesting habitats every 3 years. Surveys will estimate the number of nesting pairs by recording the number of visible, actively nesting adults.

Although boat-based methods will likely underestimate the actual number of nesting adults, information gathered should provide a reliable index of relative abundance and spatial distribution. Surveys will be conducted from 10 May to 5 June. Surveys should be conducted once per week for three consecutive weeks during the peak of the breeding season to reduce interannual variation.

Surveys will not be conducted when winds are greater than 25 km/h, precipitation reduces visibility, or when boating conditions are deemed unsafe by the boat captain. Surveys will generally be conducted between 0730 and 1230 each day and restricted to a temperature range of 10 to 35° C. Ground-based nest surveys will only be conducted when winds are below 20 km/h, temperatures are 16 to 27° C, and there is no precipitation. Surveys will be discontinued if signs of unnecessary stress or predation are observed.

If a survey is discontinued due to birds appearing stressed or from high predation rates, the survey will not be repeated that week and the data will be marked as incomplete in the database, along with the approximate percentage of the island that was surveyed. The lead scientist will then review the field methods and environmental conditions on the survey date, and work with local experts to determine whether the field methods can be altered to reduce stress or predation.

Double-crested Cormorants, Herring Gulls, and Great Black-backed Gulls all nest together on the rocky fringes of islands in the Outer Harbor, as well as on Sarah and Sheep Islands. Gulls also nest currently on George's, Gallops, Hangman, and on the steep drumlin bluff faces of Greater Brewster.

2. Survey Methods

Circle the entire perimeter of each island, where gulls or cormorants are present, in a small boat traveling at approximately 5 km/h (3 mph) as close to shore as the boat Captain will allow (between 9-46 m [30-150 feet] offshore). Be sure to record the start and end times of each survey effort, as well as making note of the survey route (GPS unit set to track). Record environmental conditions (temperature, wind speed and direction, cloud cover) prior to beginning surveys.

Use at least two independent observers to record the number of active nests determined by the presence of an incubating adult, an adult standing on or in a recognizable stick nest, or the presence of visible chicks within a stick nest. Be careful not to overestimate the number of active nests by counting nearby adults that are not on a nest. If it is helpful, observers may work in teams with one observer and one recorder each.

Appendix D: Boston Harbor Islands Coastal Breeding Bird Protocol – Standard Operating Procedures (continued).

Record the approximate location of each nesting colony on a field map, noting the date and species present. Note any available evidence indicating the breeding stage for each species (presence of eggs or chicks, adults engaged in nest building, feeding chicks, etc.).

Beginning in 2009, NETN will explore whether it is feasible to use a high-resolution digital camera to photograph the shoreline from the boat so that numbers of nesting individuals of each species can be counted in the office. It is also hoped that these photos can provide documentation of long-term changes in the spatial distribution of nest sites among islands.

REVISION HISTORY LOG

Previous Revision #	Revision Date	Author	Changes Made	New Version #
1.00	5/08	Carol Lynn Trocki	Update to reflect clarification including timing and survey route in data collection.	1.01
1.01	11/08	Carol Lynn Trocki	Update to clarify methods based on comments provided by the NETN Network Coordinator.	1.02
1.02	1/09	Carol Lynn Trocki	Minor editorial changes. Added information about pending test of digital photographic methods.	1.03
1.03	4/09	Carol Lynn Trocki	Minor editorial changes based on input from peer review; see Appendix C.	1.04
1.04	11/09	Carol Lynn Trocki	Updated to reflect the addition of environmental parameters.	1.05

D.5 Survey Techniques – Wading Birds

Northeast Temperate Network

Version 1.05

1. Survey Parameters

These methods target nesting Great Egrets (*Ardea alba*), Snowy Egrets (*Egretta thula*), Black-crowned Night-Herons (*Nycticorax nycticorax*), and Glossy Ibis (*Plegadis falcinellus*). Complete ground-based nest censuses will be conducted every 3 years between 15 May and 5 June. Ground-based nest surveys will only be conducted when winds are below 20 km/h, temperatures are 16 to 27° C, and there is no precipitation. Surveys will be discontinued if signs of stress are observed, such as hypothermic or overheated young, branching older young, or harassment by potential predators.

If a survey is discontinued due to birds appearing stressed, the survey will not be repeated that year and the data will be marked as incomplete in the database, along with the approximate percentage of the colony that was surveyed. The lead scientist will then review the field methods and environmental conditions on the survey date, and work with local experts to determine whether the field methods can be altered to reduce colony stress.

Wading bird colonies will not be unnecessarily disturbed during other survey efforts. All waterbird breeding information for islands with wading bird colonies will be gathered during wading bird surveys, even though this may result in data being gathered off-cycle. For example, Sarah Island currently has the largest wading bird colony in Boston Harbor. Ground-based surveys on Sarah targeting wading birds will be conducted every third year. Information on other waterbird species potentially using the island (such as Spotted Sandpipers or American Oystercatchers) will be collected during wading bird visits, or estimated through boat-based surveys that do not disturb the wading bird colony.

Currently, wading birds are known to have nesting colonies on Calf, Middle Brewster, Outer Brewster, Sheep, and Sarah Island. Sarah is the largest and densest colony location.

2. Survey Methods

Determine the location of active colonies by observing wading bird activity, such as adults landing in trees, carrying nesting material or carrying food. Record environmental conditions (temperature, wind speed and direction, cloud cover) prior to beginning surveys.

Record colony location using a GPS unit and field map notations. Also record the primary vegetation used for nesting. Carefully approach the colony site, noting the estimated number of adults present, by species, as they flush. Be sure to note the GPS location of the colony boundary as you enter. Add an observer outside the colony to identify and count flushing adults if the colony is large or densely vegetated. Record your starting time.

With four observers working in teams of two, work through the colony systematically, recording nests and nest contents as you go. Identify active nests by species whenever possible based on nest/egg characteristics, nestlings, or by the attending adult. When it is not possible to identify the nest to a particular species, simply list as Unknown Wading Bird (UNWB).

Appendix D: Boston Harbor Islands Coastal Breeding Bird Protocol – Standard Operating Procedures (continued).

Make sure to distinguish wading bird nests from those of other species (like cormorants or gulls), which may nest nearby, especially on Sarah and Sheep.

Upon exiting the colony, note your GPS location again. For irregularly shaped colonies, you will need to obtain additional GPS points along the edges sufficient to delineate the boundary of the colony. Record your ending time and any additional notes.

3. Quantifying Detection Probabilities

To quantify a measure of error in nest counting, a sub-sample of nests could be counted using a mark-and-recapture technique, but this would require at least two visits to a nesting colony, ideally on successive days. On the first site visit, for each nest found, record contents and GPS location and mark the nest tree with a unique number using water-based paint or some other unobtrusive, biodegradable identifier like biodegradable flagging. On the second visit (ideally the next morning) a thorough nest search should be undertaken again. All previously marked nests should be identified by number and contents recorded. All ‘new’ nests should have both contents and GPS location recorded. This information can then be used to calculate an estimate of the actual number of nests present based on the detection probability, or percentage of nests likely to be found during a single search effort.

Further research is needed to determine the effects of this repeated disturbance on incubating females and chick survival rates.

Appendix D: Boston Harbor Islands Coastal Breeding Bird Protocol – Standard Operating Procedures (continued).

REVISION HISTORY LOG

Previous Revision #	Revision Date	Author	Changes Made	New Version #
1.00	5/08	Carol Lynn Trocki	Update to include recording environmental conditions. Update section on detection probability to reflect unknown effects of repeated surveys on incubating females.	1.01
1.01	11/08	Carol Lynn Trocki	Update to clarify methods based on comments provided by the NETN Network Coordinator.	1.02
1.02	1/09	Carol Lynn Trocki	Minor editorial changes. Add information better describing mark-and-recapture techniques for determining detection probability.	1.03
1.03	4/09	Carol Lynn Trocki	Minor editorial changes based on comments received during peer review; see Appendix C.	1.04
1.04	12/09	Carol Lynn Trocki	Updated to reflect the addition of environmental parameters and disturbance avoidance.	1.05

D.6 Survey Techniques – Large Shorebirds

Northeast Temperate Network

Version 1.05

1. Survey Parameters

These methods target nesting American Oystercatchers (*Haematopus palliatus*) and Willets (*Catoptrophorus semipalmatus*) with a boat-based survey of nesting pairs on islands in BOHA. All islands within BOHA will be surveyed annually. Currently, American oystercatchers nest on 14 islands in the park, while nesting Willets have only been observed on Snake Island.

Because these species are large, visible, and generally vocal, survey efforts may be spread over the nesting season (15 May to 15 July) with observations focusing on individuals or pairs that appear to be defending or incubating a nest or brooding chicks.

Surveys will not be conducted when winds are greater than 25 km/h, precipitation reduces visibility, or when boating conditions are deemed unsafe by the boat captain. Surveys will generally be conducted between 0730 and 1230 each day and restricted to a temperature range of 10 to 35° C. Ground-based nest surveys will only be conducted when winds are below 20 km/h, temperatures are 16 to 27° C, and there is no precipitation.

2. Survey Methods

Circle the entire perimeter of each island in a small boat traveling at approximately 5 km/h (3 mph) as close to shore as the boat Captain will allow (between 9-46 m [30-150 feet] offshore).

While circling, scan the shoreline carefully for the presence of American Oystercatchers or Willets. Note evidence of breeding pairs, such as agitation and defensive maneuvers as you approach a particular location, the presence of an incubating adult, or the presence of unfledged chicks on the shore.

Record environmental conditions (temperature, wind speed and direction, cloud cover) prior to beginning surveys. Record the number of breeding pairs observed on each island by species. Also be sure to record the approximate location and date of your observations on a field map as well as survey start and end times. While you may wish to include records of presumed non-breeding adults, be sure to list these as such in the 'Notes' column.

Currently, there is a comprehensive banding program being implemented for American Oystercatchers along the Atlantic coast, including sites in Massachusetts, and banding of American Oystercatchers in BOHA may occur in 2009. During American Oystercatcher surveys, all sightings of banded birds will be reported. Information on band reading and the banding project can be found at: <http://www.ncsu.edu/project/grsmgis/AMOY/Banding.htm>
All volunteers will receive training to properly read and record American Oystercatcher bands.

While conducting shorebird surveys, be on the lookout for Piping Plovers, which are not currently known to nest in Boston Harbor, but may colonize the area in the future. Be sure to complete a data sheet for each island surveyed, even if no nesting birds are detected.

3. Quantifying Detection Probabilities

Although locating all individual nests is beyond the scope of this protocol, it is possible to estimate the detection probability of these techniques by conducting multiple surveys of nesting islands and counting the number and location of nesting pairs on repeated visits. Detection probability is likely very high (approximately 1.0) during ground-based surveys, but may be more variable during boat-based surveys. Efforts to quantify detection probabilities with periodic ground-based surveys will be incorporated into field work. The appearance of banded American Oystercatchers in BOHA will also aid in the quantification of detection probabilities.

REVISION HISTORY LOG

Previous Revision #	Revision Date	Author	Changes Made	New Version #
1.00	5/08	Carol Lynn Trocki	Clarification of techniques – add start and end date, null data entry.	1.01
1.01	11/08	Carol Lynn Trocki	Update to clarify methods based on comments provided by the NETN Network Coordinator.	1.02
1.02	1/09	Carol Lynn Trocki	Minor editorial changes. Clarification of need to determine detection probabilities for methods.	1.03
1.03	4/09	Carol Lynn Trocki	Minor editorial changes based on comments received during peer review; see Appendix C.	1.04
1.04	11/09	Carol Lynn Trocki	Updated to reflect the addition of environmental parameters.	1.05

D.7 Survey Techniques – Small Shorebirds

Northeast Temperate Network

Version 1.05

1. Survey Parameters

These methods target nesting Spotted Sandpipers (*Actitis macularis*), but can also be used to gather additional information on American Oystercatchers (*Haematopus palliatus*) and to detect possible future colonization by Piping Plovers (*Charadrius melodus*). These species will be surveyed by a walking census of all appropriate nesting habitats every 3 years. Surveys will estimate the number of nesting pairs by recording the number of incubating adults flushed from nests. Direct nest counts will be included whenever possible.

Spotted sandpiper nests are notoriously difficult to locate. In addition, this species may have two to three broods per season, making their nesting efforts extremely asynchronous. Surveys will be conducted from 15 May to 15 June with a second round of late season surveys (after 1 July) included whenever possible. Surveys will not be conducted when winds are greater than 25 km/h, precipitation reduces visibility, or when boating conditions are deemed unsafe by the boat captain. Surveys will generally be conducted between 0730 and 1230 each day and restricted to a temperature range of 10 to 35° C. Ground-based nest surveys will only be conducted when winds are below 20 km/h, temperatures are 16 to 27° C, and there is no precipitation.

On islands where Spotted Sandpipers may nest within close proximity to other sensitive waterbirds (wading birds or eiders), efforts will be made to census Spotted Sandpiper breeding activity while conducting ground-based nest counts for these other species, even though this may result in data being gathered off-cycle. For example, Sarah Island currently has the largest wading bird colony in Boston Harbor. Ground-based surveys on Sarah targeting wading birds will be conducted every third year. Information on Spotted Sandpipers activity on Sarah will be collected during wading bird visits, or estimated through boat-based surveys.

2. Survey Methods

Record environmental conditions (temperature, wind speed and direction, cloud cover) prior to beginning surveys. With 3-4 observers, spread out in a line no more than 9 m (30 feet) apart should-to-shoulder and progress through suitable vegetation on each island, watching for flushing male sandpipers. When an individual is flushed from a nest, search the immediate area to locate the nest. Record the nest's contents (number of eggs and/or chicks) and its GPS location, if found. Be sure to record the start and stop time of all survey efforts as well as the track of your survey route on a field map and, preferably, also with a GPS.

Maintain constant vocal communication with other observers as you search to assure complete coverage of each island and reduce the chances of double-counting nests. To reduce disturbance and increase the likelihood of finding nests, time surveys appropriately for the peak incubation period, which is difficult for this species because they generally double, or even triple, brood.

While conducting shorebird surveys, be on the lookout for Piping Plovers, which are not currently known to nest in Boston Harbor, but may colonize the area in the future.

3. Quantifying Detection Probabilities

Although locating all individual nests is beyond the scope of this protocol, it is possible to estimate detection probabilities for this species by conducting multiple surveys of known nesting islands and gathering information on individual nest abundance and location. We suggest surveying Rainsford Island (the largest known Spotted Sandpiper nesting colony) three times within one week during the height of the breeding season to establish some measure of detection probability for this species.

REVISION HISTORY LOG

Previous Revision #	Revision Date	Author	Changes Made	New Version #
1.00	5/08	Carol Lynn Trocki	Clarify survey techniques including adding start and stop times, survey location information, and improving description of detection probability estimate.	1.01
1.01	11/08	Carol Lynn Trocki	Update to clarify methods based on comments provided by the NETN Network Coordinator.	1.02
1.02	1/09	Carol Lynn Trocki	Minor editorial changes only.	1.03
1.03	4/09	Carol Lynn Trocki	Minor editorial changes based on comments received during peer review; see Appendix C.	1.04
1.04	12/09	Carol Lynn Trocki	Updated to reflect the addition of environmental parameters and to clarify disturbance avoidance efforts.	1.05

D.8 Survey Techniques – Tern Colonies

Northeast Temperate Network

Version 1.05

1. Survey Parameters

These methods target nesting tern species with a complete ground-based census of all nesting colonies within BOHA. Least Terns (*Sterna antillarum*) and Common Terns (*Sterna hirundo*) are currently known to nest in the park. In addition, there is the possibility that Roseate Terns (*Sterna dougallii*) may nest in BOHA in the future, most likely in a Common Tern colony. Each colony will be censused annually. Least Terns are known to be asynchronous in their nesting habits; therefore, Least Tern colonies and potential colony sites should be visited two to three times each season. Ground-based nest surveys will only be conducted when winds are below 20 km/h, temperatures are 16 to 27° C, and there is no precipitation.

Common Terns have recently nested on Snake Island, while Least Terns have oscillated between Rainsford and Lovells Islands. Spectacle and Peddocks Islands may also have appropriate habitat for nesting terns in the future. All islands should be surveyed for tern activity beginning in early June.

Survey efforts should target peak incubation, indicated by two or three eggs in most tern nests. Based on previous year's observations, peak incubation generally occurs between 10 June and 25 June for these species, but can vary based on both weather patterns and early-season colony disturbance.

2. Survey Methods

Determine the location of active colonies by observing tern activity from a distance (note incubating adults or adults delivering food).

Record colony location and site conditions. Record environmental conditions (temperature, wind speed and direction, cloud cover) prior to beginning surveys. Carefully approach the colony site, noting the estimated number of adults present as they flush. Be sure to note the GPS location of the colony boundary as you enter. Record your starting time.

Working in pairs (or groups for larger colonies), line up across the beach shoulder-to-shoulder, dividing the appropriate habitat from the wrack line to vegetation into swaths no more than 3 m (10 feet) wide. Designate a recorder. Working as a team, proceed slowly through the colony, calling out nest contents to a common recorder. Communicate with your partner(s) in identifying each sighted nest to avoid double-counting or under-counting nests.

CAUTION: Tern eggs and nests are extremely well-camouflaged and very easily stepped on. Carefully scan the ground below your foot with every single step, then scan the area around you for nests before stepping again.

Upon exiting the colony, note your GPS location again. For irregularly-shaped colonies, you will need to obtain additional GPS points along the edges, sufficient to accurately delineate the extent of the colony. Record your ending time and any additional notes.

Appendix D: Boston Harbor Islands Coastal Breeding Bird Protocol – Standard Operating Procedures (continued).

3. Quantifying Detection Probabilities

Because so few terns nest in the park, and because these species are particularly sensitive to disturbance, double counts and nest marking are not recommended. However, a measure of observer error could be calculated on a demonstration colony using well camouflaged wooden eggs. Methods for quantifying detection probabilities will be further explored during the 2010 field season; no terns were found nesting in BOHA in 2008 or 2009.

REVISION HISTORY LOG

Previous Revision #	Revision Date	Author	Changes Made	New Version #
1.00	5/08	Carol Lynn Trocki	minor clarification and grammatical changes.	1.01
1.01	11/08	Carol Lynn Trocki	Update to clarify methods based on comments provided by the NETN Network Coordinator.	1.02
1.02	1/09	Carol Lynn Trocki	Minor editorial changes; note lack of tern nesting in BOHA in 2008 limited refinement of methods.	1.03
1.03	4/09	Carol Lynn Trocki	Minor editorial changes based on comments received during peer review; see Appendix C.	1.04
1.04	11/09	Carol Lynn Trocki	Updated to reflect the addition of environmental parameters.	1.05

D.9 Data Management

Northeast Temperate Network

Version 1.03

1. Data Collection and Checking in the Field

Volunteers involved in data collection will be trained in advance to accurately complete the required information on datasheets in the field. Field records will be reviewed for discrepancies at the end of each day. Field data sheets will be copied and stored at both park and network offices. GPS units will be set to store track information, and this data will be collected for boat and island surveys, and downloaded and converted to ESRI shapefiles after each field day.

2. Data Entry

Data will be entered from field data sheets into the MS Access database as soon as possible after data collection by the lead scientist. This will allow for an additional review of the raw data while preliminary data entry is occurring.

3. Data Checking

After data entry is complete, the year's database entries will be reviewed for discrepancies by the lead scientist. This review will include spot checking 10% of the records for the year, and a general review of filtered fields for typographical and keystroke errors. In addition, the data will be provided to the NETN Data Manager by 15 November each year. The NETN Data Manager will conduct additional data review. Dated copies of the MS Access database will reside in multiple locations for archival and security purposes.

4. Additional Data

Additional data, such as photographs, field maps, and GPS tracks will be provided to the NETN Data Manager in the format requested for archival purposes. The cooperating / contracting researcher will be responsible for providing FGDC-compliant metadata for all data; the NETN Data Manager may be available to assist with this task.

Appendix D: Boston Harbor Islands Coastal Breeding Bird Protocol – Standard Operating Procedures (continued).

REVISION HISTORY LOG

Previous Revision #	Revision Date	Author	Changes Made	New Version #
1.00	11/08	Carol Lynn Trocki	Update to clarify methods based on comments provided by the NETN Network Coordinator.	1.01
1.01	1/09	Carol Lynn Trocki	Added information about recording and managing GPS track data and update date of submission requirement based on current contract.	1.02
1.02	4/09	Carol Lynn Trocki	Minor editorial changes based on comments received during peer review; see Appendix C.	1.03

D.10 Data Analysis

Northeast Temperate Network

Version 1.03

1. Data Analysis

A summary of results will be compiled on an annual basis (see Trocki 2008 for an example from the 2008 field season). In this annual summary, methods should be reviewed and any changes from previous years noted and explained. The annual summary should provide a detailed description of survey effort, including dates, times, and the individual islands visited. Results should include the counted or estimated number of nests/pairs for each species and each island surveyed. Maps and descriptions of the spatial distribution of survey efforts and nesting colonies should be included. Estimates of detection probability should be discussed wherever available, but raw (naïve) estimates should also be given. The discussion section should include recommendations for improvement to the monitoring protocol, as well as suggestions for management.

2. Future Trend Analysis

As the data set for this program grows, a variety of statistical methods will become feasible for analyzing trends in coastal bird populations. A detailed discussion of the statistical methods that may be most appropriate for data analysis is being developed. This SOP will be updated to discuss trend analyses as it becomes possible to conduct them.

REVISION HISTORY LOG

Previous Revision #	Revision Date	Author	Changes Made	New Version #
1.00	11/08	Carol Lynn Trocki	Updated to reflect change in appendices label.	1.01
1.01	1/09	Carol Lynn Trocki	Minor editorial changes only.	1.02
1.02	4/09	Carol Lynn Trocki	Minor editorial changes, clarification, and additional elaboration added based on comments received during peer review; see Appendix C for additional information.	1.03

D.11 Reporting

Northeast Temperate Network

Version 1.02

1. Annual Reports

Annual Reports will provide a general overview of activities and a summary of results from each year's field season and will be due to the NETN office by 15 December of each year (see Trocki 2008, SOP 10: Data Analysis for detailed information). The annual report responsibilities include:

- Document monitoring activities
- Summarize findings
- Document changes in the monitoring protocol
- Public interest highlights

Annual reports will be shared with all stakeholders and project participants. In addition, contributing information to regional working groups on an annual basis will provide an opportunity for the detection of regional changes and the implementation of more comprehensive management strategies. Templates and formatting instructions are available at Northeast Region website: <http://www.nps.gov/nero/science/Guidelines/Guidelines.htm>.

2. Analysis and Synthesis Reports

Analysis and Synthesis Reports will be completed every three years and will provide more detailed analyses of population trends. Detailed operating procedures for completing an Analysis and Synthesis Report will be developed with the first report in 2010.

3. Informal Field Season Reporting

Weekly updates during the field season will be shared by the lead scientist online with participating community volunteers and other interested stakeholders. This effort will add value for the park community and help island managers keep track of the timing of nesting activities.

REVISION HISTORY LOG

Previous Revision #	Revision Date	Author	Changes Made	New Version #
1.00	11/08	Carol Lynn Trocki	Minor editorial changes and update submission date to reflect current contract.	1.01
1.01	4/09	Carol Lynn Trocki	Minor editorial changes based on comments received during peer review; see Appendix C.	1.02

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
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