National Park Service
U.S. Department of the Interior

Southeast Coast Network
Atlanta, Georgia

Migratory, Wintering, and Beached Shorebird Monitoring at Southeast Coast Network Parks

Recommended Citation:

Byrne, M.W. and J.C. DeVivo. 2005. Migratory, Wintering, and Beached Shorebird Monitoring at Southeast Coast Network Parks. National Park Service, Southeast Coast Network, Atlanta, Georgia.

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Executive Summary

1. This protocol was developed to provide information to managers at Cape Hatteras National Seashore (CAHA) to allow for science-based management of both federally threatened Piping Plover (*Charadrius melodus*) populations and ongoing recreational activities.
2. The field methods described herein are loosely based on the conceptual framework described in protocols developed by Cape Cod National Seashore (Erwin et al. 2003). Information related to the justification and need for monitoring of Piping Plovers and other shorebirds were developed for conservation protocols currently being written for Cape Hatteras National Seashore (Cohen 2005).
3. The overall strategy of the protocol is to identify the types of habitats being used by focal species and the seasons and times (of day) those habitats are used. Ultimately, field-monitoring data will be combined with data collected from other monitoring techniques (e.g., remote sensing) to develop models that predict habitat use across the entire sampling area. After initial models have been developed, monitoring intensity is reevaluated (likely reduced) to continuously refine and calibrate the predictive models.
4. Although developed for monitoring wintering and migratory Piping Plover populations, this protocol is applicable to any shorebirds of interest. Other species of interest include Wilson Plover (*Charadrius wilsonia*), Red Knot (*Calidris canutus*), and American Oystercatcher (*Haematopus palliatus*); considered "focal shorebirds" of this monitoring protocol.
5. The protocol can be adapted for use at other coastal parks within the Southeast Coast Network; sampling schedules can be developed following methods described below.
6. This protocol addresses issues only to migratory and wintering populations of Piping Plovers and other shorebirds. Monitoring of nesting populations of shorebirds will be addressed in other monitoring protocols currently in development.

Background and Objectives

Focal Shorebirds Identified in this Protocol

The migratory / wintering component of this protocol is designed with specific emphasis on Piping Plover, Wilson's Plover (*Charadrius wilsonia*), Red Knot (*Calidris canutus*), and American Oystercatcher (*Haematopus palliatus*), henceforth referred to as "focal shorebirds".

Piping Plovers are found in several coastal SECN parks which provide key wintering and nesting habitat for this federally-endangered species. Piping plovers use CAHA and Cape Lookout National Seashore (CALO) year-round and winter at Canaveral National Seashore (CANA) and Cumberland Island National Seashore (CUIS). Human disturbance has been attributed low Snowy Plover chick survival (Ruhlen et al. 2003), and Piping Plover chick survival is likely affected similarly. Chick survival is also related to brood access to quality foraging habitats (Loegering and Fraser 1995). Piping plovers will use a variety of habitats during the breeding-season or winter for foraging (e.g., wash zone, intertidal ocean beach, wrack lines, washover passes, mud, sand and algal flats, and shorelines of streams, ephemeral ponds) (Loegering 1992, Hoopes 1994), however these habitats must be available free from disturbance (Lafferty 2001). In 2003 Piping Plovers nested on nine different islands in North Carolina (Cordes and Rikard 2003). Each of the nine nesting islands had a different combination of predators, susceptibility to flooding and amount of disturbance from people. Productivity continued to be poor throughout the state (0.46 chicks fledged per nesting pair) despite the use of predator exclosures.

Wilson's Plover occurrences are verified for CUIS, although it is likely to occur at all SECN coastal parks as they all fall within the breeding season range for Wilson's plover (Sibley 2000). A small breeding population exists at

Merritt Island National Wildlife Refuge, adjacent to CANA (Epstein 1999). Habitat requirements for Wilson's Plover are similar to the Piping Plover.

The Red Knot undergoes one of the longest migrations of any bird; from their nesting grounds in the northern Arctic to their wintering grounds in southern Chile (Harrington 2001). Birds with long migrations are more dependent on adequate habitat than birds that undertake shorter migrations and can be more susceptible to compromised habitat (Piersma and Baker 2000). They tend to be gregarious as migrants, thus increasing the likelihood of local-scale disturbances (e.g., hunting, disease, harassment) having a more substantial impact of the migrating flock. Population abundance is estimate to have decreased 30% since 1980 (Donaldson et al. 2000).

American Oystercatcher is a year-round resident at all SECN coastal parks in Florida and Georgia. Data suggest abundance is declining throughout the southeast (Davis et al. 2001). Nesting habitat requirements are generally open areas in beach/dune (Davis et al. 2001). The effects of human-induced disturbance on American Oystercatchers remains unknown (Davis et al. 2001).

Piping Plover and Shorebird Conservation in Southeast Coast Network Parks

Modified from (Cohen 2005)

The Atlantic Coast population of the piping plover (*Charadrius melodus*) was federally listed in 1986 as threatened (Federal Register 1985). At that time approximately 790 pairs remained and the species was in decline (U.S. Fish and Wildlife Service 1996). Habitat loss caused by human development and recreation, and low reproductive rates caused by human disturbance and predation were considered the primary causes of decline (Haig 1992). Disturbance and predation were intensively managed after listing, and the population increased to an estimated 1676 pairs by 2003 (U. S. Fish and Wildlife Service 2004), but was still short of the recovery goal of 2000 pairs (U.S. Fish and Wildlife Service 1996). The population south of New Jersey was estimated at 203 pairs in 2003, well short of the regional goal for the southern Atlantic Coast (DE, MD, VA, NC, SC) of 400 pairs, and North Carolina itself experienced a >50% decline in breeding pairs from 1989 to 2003 (U. S. Fish and Wildlife Service 2004).

No published accounts exist of breeding piping plovers in North Carolina from 1902 to 1960 until one pair was found on Ocracoke Island (Golder 1985). Four nests and one brood were discovered within the boundaries of Cape Hatteras National Seashore (CAHA) in 1984 incidental to monitoring of other species, and five chicks were known to have fledged that year (Golder 1985). Nine pairs were counted in 1986, again incidentally (Golder 1986), and ten pairs were discovered in 1987 in specific surveys for the plover (Cooper 1990), fifteen pairs in 1989, and varied between eleven and fourteen pairs from 1990 to 1996. The population decreased to two breeding pairs in 2003, three in 2004, and two in 2005 (Lyons 2001, 2002, 2003, 2004).

Natural and anthropogenic factors can negatively impact populations of Piping Plovers and other shorebirds. Predation, human disturbance, and inclement weather are associated with low productivity at CAHA (Coutu et al. 1990, Cooper 1990, Kuklinski et al. 1996, Lyons 2002, 2003, 2004). Limited access to adequate foraging areas was also suspected as a source of mortality (Kuklinski et al. 1996).

Human pedestrians and joggers occasionally destroy nests or kill chicks, either by intentional vandalism or by accident (Patterson et al. 1991). Furthermore, off-road vehicles (ORVs) can run over adults, nests, and chicks, which may run or crouch in vehicle tracks in response to danger. Chicks are difficult to see in this situation due to their cryptic coloration (Melvin et al. 1994). Human development and recreation result in loss or degradation of breeding habitat (Haig 1992). Off-road vehicle use has been demonstrated to destroy the wrack line thereby degrading an important foraging habitat (Goldin 1993). Breeding and nonbreeding birds are subject to disturbance (disruption of normal activities) by ORVs and pedestrians. ORV use affects the geomorphology of the beach through sand displacement and compaction, which may lead to steeper dune profiles (Anders and Leatherman 1987), which may be unsuitable for plover nesting. Destruction of the wrackline by ORVs may decrease reproductive success due to loss of important habitat used for foraging and cover (Goldin 1993).

In 1996, nest predation varied among sites and was most severe at Hatteras Spit. Nest abandonment increased from 2000 to 2002 compared to previous years. Abandonment was sometimes associated with predator trails circling nest exclosures (Lyons 2002, 2003, 2004). A nest was lost to flooding in 2002. In 2001-2003, sources of chick loss were unknown. Chick mortality, however, sometimes followed a rain event. After the disappearance of some chicks, predator trails were found where the brood was last seen, including red fox, domestic dog, and cat (Lyons 2002, 2003).

In 1990, research indicated that enforcement levels at the time were not adequate to keep pedestrians, pets, and ORVs out of restricted plover breeding areas (Coutu et al. 1990). In 1996 potential disturbance sources remained apparently outside of protected areas, and predation rather than disturbance was considered the major direct threat to reproductive success, although fieldwork did not begin until May 30 and missed the first part of the nesting season (Kuklinski et al. 1996). Documented violations of protected areas by pedestrians began to increase sharply after 2000, but this may have been due in part to more careful recording of incidents (Lyons 2002, 2003, 2004). Approximately 50-60 incidents of ORVs entering protected areas were recorded each year from 2000-2002, and in 2003 the symbolic fence was vandalized by an ORV and several instances of ORVs within the protected area were observed (Lyons 2002, 2003, 2004).

Significance of Wintering and Migratory Plover Populations

North Carolina is currently the only state on the Atlantic Coast that has piping plovers during all phases of the annual cycle (Cohen 2005). Band sightings indicate that plovers from all three North American breeding populations use CAHA during migration and/or the winter, and plovers from the endangered Great Lakes population have been documented in fall and spring migration and the wintering period (Cohen 2005). All plover breeding sites at CAHA were designated as critical habitat for wintering birds, as defined by the Endangered Species Act (Federal Register 2001) until 2004, when a court decision vacated the designation for Oregon Inlet, Cape Point, Hatteras Inlet, and Ocracoke Island (Cape Hatteras Access Preservation Alliance vs. U.S. Dept. of the Interior, 344 F. Supp. 2d 108 (D.D.C. 2004)).

Between 2000 and 2005, the highest number of nonbreeding plovers at CAHA occurred during fall migration, which begins in July and peaks between July and September (Table 1). The fall counts were highest at South Ocracoke, followed by Oregon Inlet (Bodie Island Spit, Pea Island National Wildlife Refuge, and formerly Green Island which is now largely unusable due to vegetation growth), then Hatteras Spit and Cape Point. Fall migration may last until November.

According to Cohen (2005) the first banded winter residents may appear in July, however, the majority of wintering birds arrive in August. The nonbreeding population from Dec. – Jan. likely consists entirely of winter residents. The size of the resident wintering population is not precisely known, but it may be on the order of 20-35 birds (Cohen 2005). The highest counts of wintering birds were at Oregon and Ocracoke Inlets.

Spring migrants may appear in February or early March, and their numbers peak in late March or April (Cohen 2005). Sites at Oregon Inlet have had the highest abundance of spring migrants, followed by Ocracoke Inlet, with fewer numbers at Hatteras Spit and Cape Point. Ecological factors governing the distribution and size of the nonbreeding population at CAHA are unknown.

Table 1. Median and maximum non-breeding birds seen per daily survey during fall, winter, and spring, at selected sites at Cape Hatteras National Seashore, 2000-2005. Not all sites were surveyed each day (typically only one or two were surveyed), so these numbers provide only a rough idea of the total size of the nonbreeding population. Modified from (Cohen 2005).

	Month	Oregon Inlet	Cape Point/ S. Beach	Hatteras Inlet	Ocracoke Inlet	All Sites
Median	Jul	0.49	0.18	0.45	2.21	5.67
	Aug	0.68	0.31	0.13	3.76	6.43
	Sept	0.66	0.07	0.38	4.22	5.67
	Oct	0.36	0.00	0.86	1.81	3.33
	Nov	0.82	0.00	0.07	1.00	4.21
	Dec	0.77	0.00	0.00	2.07	2.88
	Jan	0.25	0.00	0.00	1.00	1.18
	Feb	3.33	0.00	0.00	1.00	4.33
	Mar	1.25	0.00	0.00	0.75	2.75
	Apr	1.89	0.00	0.62	1.31	3.60
Maximum	Jul	32	5	21	56	56
	Aug	34	6	14	72	72
	Sept	16	5	4	37	37
	Oct	12	1	28	31	31
	Nov	15	0	8	12	15
	Dec	17	0	7	15	17
	Jan	18	0	1	11	18
	Feb	14	0	0	18	18
	Mar	12	3	4	8	12
	Apr	25	3	7	11	25

The Role of Monitoring

Monitoring protocols should be designed such that they are statistically and scientifically meaningful and defensible and results should also have direct management applicability. Monitoring techniques should be compatible with existing local and regional techniques to facilitate regional comparisons of species and further understand population trends, movement patterns, and habitat use.

The field methods described herein are loosely based on the conceptual framework described in protocols developed by Cape Cod National Seashore (Erwin et al. 2003). This protocol consists of two components: 1) the migratory / wintering component, and 2) the beached / dead bird component; both of which are modified specifically for pilot implementation at CAHA.

Abundance estimates for migratory / wintering bird species are often difficult to generate due to the brief residence by migratory birds in any given area during their respective migration and the multitude of different and distinct subpopulations that are difficult to define (e.g., Great Lakes early migrants, Cape Cod late migrants, etc.). Further, controlling for basic assumptions when estimating abundance (e.g., inter-observer reliability, identification error, detectability, and double-counting) is often difficult given limited personnel and financial resources. Therefore, the migratory / wintering component of this protocol is designed to evaluate the number of focal shorebird observations as a function of sampling site, not to estimate abundance within those sites. The beached / dead bird protocol is incorporated as a means to quantify occurrences and aid in management decisions.

Monitoring Objectives

It is not the intention of this protocol to provide data about the overall abundance (i.e., population size) of focal shorebirds due to permitting restrictions and the labor- and time-intensive nature of such studies. If desired by Park managers, abundance estimation of the focal shorebirds included in this protocol can be accomplished with this protocol if staffing and permitting limitations are removed.

This protocol does not attempt to determine habitat "selection" or "preference" by focal shorebirds. Habitat selection is a process through which an animal uses innate and learned behaviors to use habitat and/or habitat components at specific scales for specific activities (Hutto 1985). Statements regarding habitat selection can only be based upon the results of a habitat use vs. habitat availability study and are often only inferential to the sample of animals collected for the study unless they are collected and marked randomly, which is seldom the case; although inference to local populations is typically acceptable. Habitat preference is often defined as the consequences of the selection process (Hall et al. 1997). This definition, however, is debated as preference, from a behavioral-science perspective, is most adequately established through trials in a laboratory setting when all other habitat options are presented in equal availability (Pierce and Epling 1999). The inferential ability of these results, however, is limited to the laboratory setting and fraught with confounds (Dawkins 1980). As a result, the results of data collected with this protocol should be reported as habitat "use."

Monitoring Objectives Addressed by this Protocol

- **Identify areas of consistent use (i.e., hotspots) by migratory and/or wintering focal shorebirds at CAHA and if these areas remain consistent over time.**

  Park managers require information regarding areas of active and consistent shorebird use to guide multiple management decisions. The ability to predict areas of use by shorebirds, many of which are protected through one or more statutes or regulations will allow Park managers to make decisions regarding beach closures and the type and intensity of visitor access. Identification and inventories of habitats are critical to park managers for managing designated critical habitat (none currently designated), essential habitat, and recovery areas to maintain and enhance their value for the recovery of threatened and endangered species (NPS Natural Resource Management Policies 4.4.1.1 and 4.4.2.3).

- **Determine habitat type used by migratory and/or wintering focal shorebirds at CAHA.**

  Migratory and wintering shorebirds are typically found within a set of clearly-definable habitat types. One of the main purposes of the protocol is to identify those habitat types that are most frequently used by Piping Plovers and other focal shorebirds, determine the frequency of use (based on tidal, diel, and seasonal cyclic patterns). Habitat use data will be combined with remote sensing or ground-based mapping methods to develop predicted use areas. Understanding of habitat use is critical to park managers for managing designated critical habitat (none currently designated), essential habitat, and recovery areas to maintain and enhance their value for the recovery of threatened and endangered species (NPS Natural Resource Management Policies 4.4.1.1 and 4.4.2.3).

- **Determine spatial and temporal variability in beached birds at CAHA.**

  Off-road vehicles and predation (both from natural predators and visitor uses) have been implicated in the declines of Piping Plover and other focal shorebird populations. This monitoring objective is aimed at collecting data on the frequency, distribution, and cause of mortality in beached birds, to the extent discernable from remains found during systematic population surveys. Data on human-induced mortality (either directly or indirectly) is critical for NPS managers to have in order to minimize human impacts on native animals, populations, and communities in general (NPS Natural Resource Management Policy 4.4.1).

Monitoring Objectives not Addressed by this Protocol

- Estimate relative abundance of migratory and/or wintering focal shorebirds at CAHA.
- Determine focal-shorebird habitat composition.
- Determine focal-shorebird habitat quality.
- Determine focal-shorebird habitat use as a function of habitat availability.
- Determine migratory patterns of the Atlantic Coast population of focal shorebirds.
- Determine the timing of banded focal-shorebird migration through CAHA.
- Determine proportion of banded focal shorebirds at CAHA during the migratory and wintering period.

Sampling Design

The population of interest in this protocol are the focal shorebirds that migrate through and/or winter at CAHA. All accessible coastal areas at CAHA deemed as potential focal shorebird migratory and/or wintering habitat are included in the initial sampling design, and is defined as the sampling frame. The sampling units used for this protocol are the park miles. There are 63 park miles at CAHA. In order to facilitate consistency among wildlife programs at CAHA, the park miles chosen as the sampling unit of this protocol are loosely associated with the Sea Turtle Management Zones, established by the North Carolina Wildlife Resources Commission. A shared, or similar, sampling unit among the sea turtle- and shorebird-monitoring programs may further increase the utility of these data in assisting with management decisions.

The sampling regime for this protocol consists of a two-tiered sampling approach: a combination of 1) high- and 2) low-intensity sampling units. The high-intensity units are spits / points in the Park and the low-intensity units are all other oceanside / beachfront areas. Spits / points in CAHA include five sites: Bodie Island Spit, Hatteras Island Cape Point, Hatteras Island Spit, Northeast Ocracoke Island, and Ocracoke Island Spit. Because of the logistical challenges (e.g., long travel times between sampling sites, etc.) at CAHA, the Park is divided into 4 sub-units (Figure 3): Bodie (Figure 4), Middle Hatteras (Figure 5), South Hatteras (Figure 6), and Ocracoke (Figure 7). High-intensity units are composed of three subsets, oceanside (o), bayside (b), and interior (i), to result in units of relatively equal size and observability. Because of the dynamic nature of CAHA, the dimensions of the units that occur in spit- or point-areas often vary seasonally or dramatically after an extreme weather event and will require frequent monitoring via remote sensing and ground-truthing to determine if subset boundaries remain accurate and representative of the unit. Therefore, high-intensity unit subsets will be delineated in a GIS prior to implementation of fieldwork.

High- and low-intensity sites are sampled on the same day. The sampling schedule is designed in alternating fixed daily intervals (e.g., Monday: high-intensity – 07:00 – 12:00, and low-intensity sites – 13:00 – 18:00, Tuesday: low-intensity – 07:00 – 12:00, and high-intensity sites – 13:00 – 18:00) throughout the annual sampling event. Predicted tidal peaks for 2006 are bimodally distributed (Figure 1), with the majority of annual high-tide peaks occurring generally between 0700 and 1200 and the majority of low-tide peaks between 1300 and 1800. By alternating the high- and low-intensity sampling units, this maximizes the likelihood of sampling sites at or within two hours of tidal peaks and capture varying patterns of counts of migratory / wintering focal shorebirds as a function of tide both seasonally and annually. We suspect that this bimodal diurnal pattern is not similar across years and becomes undetectable when $\geq$10 years of predicted tide data are aggregated, however, this alternating schedule during pilot implementation will increase the sample size of measurements at tidal extremes and further assist us in protocol refinement.

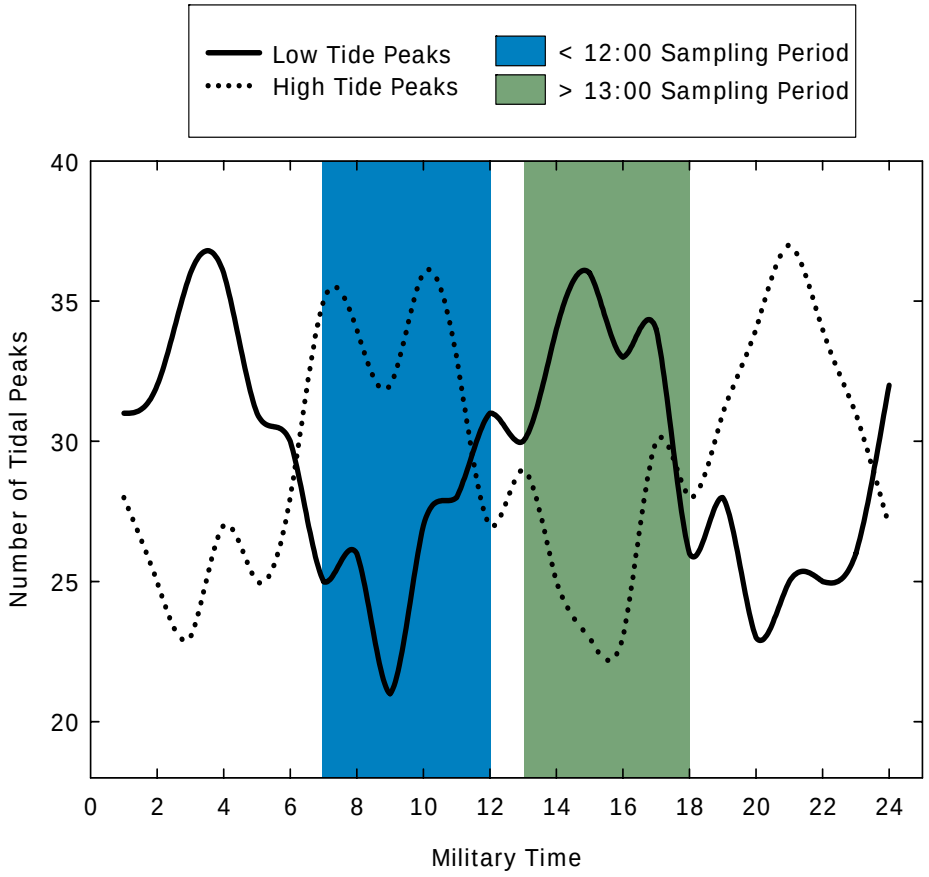

Figure 1. Distribution of tidal peaks at CAHA in 2006. Sampling times, represented by the blue and green shaded areas, are selected to ensure the highest probability of collecting data during extremes of the tidal cycle.

In the high-intensity sampling regime, the spits / points are sampled in their entirety during each sampling event. The observer will begin observations in the unit (oceanside, soundside, or interior) closest to the access point for the site to avoid observer influence on birds prior to measurement. In the low-intensity sampling regime, only the unit specified is sampled during the designated time. No site is sampled at an interval of less than four days to avoid any potential observer influence on focal-shorebird presence. The sampling regime is on a rotating schedule with an eleven-month duration. Table 2 outlines the sampling schedule for high- and low-intensity units and is intended to be conducted on a five-day work week, beginning Wednesday of each week with Mondays and Tuesdays off. We used a Mersenne-Twister algorithm to generate the random order for sampling for high- and low-intensity sampling units. The migratory component of this protocol is defined as July – October and February – May. The wintering component is defined as November – December. High- and low-intensity sites are sampled from July – May to capture both of these periods.

Each unit is sampled for an hour; composed of three 20-minute sub-samples as a means to address within site variability. The mean of the sub-samples is used for analysis. This technique results in a snapshot of counts and will likely result in a conservative estimate (i.e., underestimate) of counts.

Sampling frequency of the high-intensity units coincides with the recommendations of the International Shorebird Survey (i.e., at intervals no greater than every 10 days between 1 May and 15 June, and 1 July and 1 December). The sampling strategy for the beached bird protocol and the migratory / wintering protocol are the same, as these two protocols are implemented simultaneously.

Table 2. Example annual shorebird monitoring schedule for sites at Cape Hatteras National Seashore. Shaded cells indicate sampling to occur before 12:00 and unshaded cells indicate sampling to occur after 13:00.

Order	Park Sub-unit	High-intensity Site (Park Mile)	Low Intensity Sites (Park Mile)
1	Ocracoke	PM 75o, PM 75s, PM 75i	PM 62, PM 69, PM 71
2	South Hatteras	PM 58o, PM 58s, PM 58i	PM 40, PM 46, PM 49
3	Middle Hatteras	PM 45e, PM 45i, PM 45s	PM 29, PM 39, PM 44
4	Bodie	PM 4o, PM 4s, PM 4i	PM 2, PM 3, PM 18
5	Ocracoke	PM 59o, PM 59s, PM 59i	PM 63, PM 64, PM 73
6	South Hatteras	PM 58o, PM 58s, PM 58i	PM 50, PM 51, PM 57
7	Middle Hatteras	PM 45e, PM 45i, PM 45s	PM 30, PM 32, PM 35
8	Bodie	PM 4o, PM 4s, PM 4i	PM 23, PM 25, PM 27
9	Ocracoke	PM 75o, PM 75s, PM 75i	PM 61, PM 65, PM 74
10	South Hatteras	PM 58o, PM 58s, PM 58i	PM 47, PM 52, PM 56
11	Middle Hatteras	PM 45e, PM 45i, PM 45s	PM 37, PM 38, PM 42
12	Bodie	PM 4o, PM 4s, PM 4i	PM 21, PM 22, PM 28
13	Ocracoke	PM 59o, PM 59s, PM 59i	PM 66, PM 70, PM 72
14	South Hatteras	PM 58o, PM 58s, PM 58i	PM 41, PM 48, PM 53
15	Middle Hatteras	PM 45e, PM 45i, PM 45s	PM 31, PM 33, PM 34
16	Bodie	PM 4o, PM 4s, PM 4i	PM 0, PM 20, PM 26
17	Ocracoke	PM 75o, PM 75s, PM 75i	PM 60, PM 67, PM 68
18	South Hatteras	PM 58o, PM 58s, PM 58i	PM 54, PM 55
19	Middle Hatteras	PM 45e, PM 45i, PM 45s	PM 36, PM 43
20	Bodie	PM 4o, PM 4s, PM 4i	PM 1, PM 19, PM 24

Rationale for Design Selection

The need for focal shorebird use-pattern information at CAHA is imperative for management decisions. Therefore, the initial sampling design includes all beach and spit areas at CAHA. In order to facilitate the logistical issues related to measuring all sampling sites across the Park in a random order, we divided the Park into four sub-units with approximately an equal number of sampling sites within each sub-unit. This reduces travel time and increases the number of samples acquired in the first sampling season to facilitate analyses and subsequent sampling design refinement. The sampling design of this protocol also controls observation effort by regulating the amount of time each the observer spends in each sampling site, thus allowing for an evaluation of number of observations as a function of effort.

Sampling Frequency and Replication

The migratory component of this protocol is defined as July – October and February – May. The wintering component is defined as November – December. High- and low-intensity sites are sampled from July – May to capture both of these periods. Given the sampling schedule presented in Table 2, each high-intensity site will be resampled every five sampling days and each low-intensity site will be resampled every 20 sampling days.

Given the sampling schedule, the time between consecutive observations of any given site is likely adequate to maintain independence of observations, avoid autocorrelation, and/or observer influence from successive observations, although this will be evaluated after the first season of data collection.

Recommended Number and Location of Sampling Sites

Given the sampling schedule presented in Table 2, this schedule should result in approximately 40 replicate samples for each high-intensity sampling unit and approximately 10 for each low-intensity sampling unit during

one annual sampling event. After analysis of the first year of data, we expect a reduction in the numbers of samples necessary to effectively address the monitoring objectives.

Level of Change that Can be Detected for the Amount/Type of Sampling Being Instituted

Our sampling objective, from which we will base our preliminary evaluation and analysis of sampling effort after the first year of data collection, is that we are 95% confident that all focal shorebird observation estimates are within 20% of the estimated true value.

Field Methods

Sequence of Events during Field Season

This protocol is designed such that it can be conducted by one person. In general, procedures are as follows:

- Prepare necessary field gear
- Refer to table to determine sampling unit
- Travel to site
- Refer to map to familiarize self with spatial distribution of site and landmarks if available
- Fill out all possible information at top of datasheet (e.g., name, weather, etc.)
- Set stopwatch / timer for one hour
- Begin measurement of site by walking from one end of the site to the other and back again at approximately 2mph and record all pertinent information about each focal shorebird observation (e.g., time, car count, focal-shorebird observations, activity, habitat, breeding display / potential breeding display)
- At the end of the day's sampling, return to office and enter data from datasheets into database

Details of Taking Measurements, with Example Field Forms

Migratory / Wintering Component Methods

The technique for quantifying focal shorebird observations consists of surveying all areas within a designated sampling unit. This technique consists of broad surveys of habitat within the entire sampling unit in the allotted time.

All observations of focal shorebirds are recorded on the data form (Appendix I) and all fields on the form must be completed while measuring the sampling unit. Tide is recorded to verify predicted tides and document wind tides or flooding. Wind direction is determined with a compass with appropriate declination set, wind speed is estimated, and temperature is recorded from a field thermometer in degrees Fahrenheit.

Observations begin at one end of the unit closest to the access point. Observers should plan their line though each unit such that the entire unit is observed once and maximize unit observation. If available, the observer should make attempts to walk along an area of the beach with the widest field of view. If the unit is too wide to be covered with two parallel lines (i.e., one in each direction), then the observer should zig-zag across the unit to maximize unit coverage. Pace of observers should be approximately 2mph such that linear units may be traversed once in each direction during the allotted time period (i.e., the observer covers the length of the unit in one direction in 30 minutes and returns to the starting point by the end of the allotted time period) while allowing for time for data entry. If entire unit is observed in less than 1 hour (e.g., very few observations made), the observer will continue to traverse and monitor the unit until time has expired. Each unit is observed for one hour in three 20-minute intervals (subsamples) and a stopwatch is used to monitor amount of time observed. Data collected during each interval are kept separate on the datasheet.

When focal shorebirds are observed, time, species code, count, activity type, and habitat are recorded. Habitat types are described in Table 3 and conceptually represented in Figure 2. If suspected breeding behaviors are observed, this information is recorded in the comments section and communicated to Park personnel for confirmation. If the bird is banded, make note of band observation but do not devote time to determining band information as this time will detract from unit observation time. The number of vehicles observed in the sampling is recorded on the data form after the unit is completed. If breeding display / potential breeding display is observed, enter this information in the comments field and in the appropriate section of the database. Consistent observations of breeding displays / potential breeding displays in any given area will trigger a focal shorebird nesting monitoring protocol currently under development. If brood-rearing birds are observed, record this information in the comments section. Other relevant information is recorded in the comments section.

All observations are made with binoculars. Use spotting scope only if necessary as the time involved in setting the scope up reduces the amount of time observer is observing focal shorebirds. Observers should use extra efforts to minimize disturbance to birds.

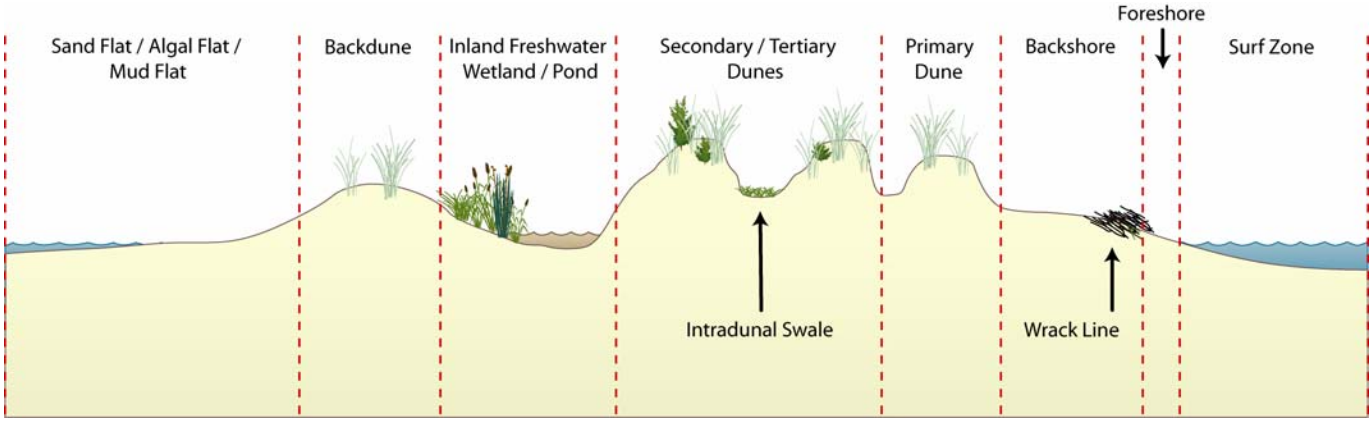

Figure 2. Conceptual diagram of general juxtaposition of habitat types identified in SECN Migratory, Wintering, and Beached Shorebird Monitoring Protocol.

Table 3. Habitat-type classifications and descriptions for SECN Migratory, Wintering, and Beached Shorebird Monitoring Protocol ((Bloom 1998), (Hoffman and Shroyer 2004), (Leatherman 1979), York, L., SERO Coastal Geomorphologist, SERO, NPS).

Habitat	Data-form Abbreviation	Habitat Description
Backdune	**BD**	The dune farthest from the beach
Backshore	**BS**	Beach zone landward of the berm crest and the normal high-tide line; this zone is subject to wave action only during storm or extreme high tide conditions
Blowout	**BL**	A flat or bowl-shaped area in the primary dune line where dune sand has been eroded away by wind; the bowl in this area may accumulate water or be eroded to the water table
Foreshore	**FS**	The intertidal area that lies seaward of the berm crest
Inland freshwater pond	**FP**	Freshwater wetland resource with $\geq$ 50% open water
Inland freshwater wetland	**FW**	Freshwater wetland resource with < 50% open water
Intradunal swale	**IS**	Low-lying areas between primary dune and backdune; may have wetland / wetland fringe vegetation of short hydroperiod
Mud flat / Algal flat	**MF**	Area of minimal wave action and exposed at low tide; predominantly devoid of vegetation; substrate typically composed of sand, silt, and clay; areas occasionally have thin algal layer; commonly located between barrier islands and mainland;
Overwash	**OW**	A breach in the primary dune line resulting from swash uprush during storms or extreme high tides; often produces a fan-like feature as sand is deposited inland beyond the dune system(s)
Primary dune	**PD**	The dune closest to the beach; land feature formed from an accumulation of windblown sand; these features are often covered with vegetation
Salt marsh / Tidal creek / Brackish Marsh	**SM**	Area dominated by non-woody, halophytic plant species and tidally influenced
Sand flat	**SF**	Accretion zone from downdrift of offshore sediment transport with minimal vegetative cover and slight elevation above sea level (e.g., a spit); occasionally has ponded water; exposed at low tide
Secondary dune, tertiary dune, etc.	**SD**	Dune between primary dune and backdune, increasing with distance from beach; land feature formed from an accumulation of windblown sand; these features are often covered with vegetation
Surf zone / Open water	**SZ**	Area immediately seaward of the foreshore
Wrack line	**WL**	Beach zone where marine debris (natural and artificial) is deposited; often indicates high-tide line

Beached Bird Survey Component Methods

Beached / dead bird surveys are often used to document mortality associated with chemical spills (Van Pelt and Piatt 1995), however these surveys may also be used to document mortalities associated with other events (e.g., hurricanes, recreation, etc.).

This component of the protocol is conducted simultaneously with the migratory / wintering component. All observations of beached birds are recorded on the data form (Appendix I) and all fields on the form must be completed while measuring the sampling unit. Habitat types are described in Table 3 and conceptually represented in Figure 2. All activities related to handling animal specimens must adhere to the guidelines set forth in the Safe Handling Procedures for Animal Material and/or Remains SOP. If only partial remains are discovered, the structures used for identification should be recorded in the comment section of the data form. If species identification of remains is uncertain in the field, a specimen should be collected for expert consultation in accordance with Park collection guidelines (e.g., Law Enforcement) and if observer has appropriate federal and state permits. Observer records condition of carcass and any evident signs of mortality. After evaluating beached bird and recording pertinent information, mark bird with flagging tape and move to avoid upper beach to avoid recounting during the next sampling event. If carcass is radiomarked or banded, collect device and/or band, record information in the comments section on the data sheet, and contact the organization responsible for radiomarking or banding.

This protocol may also be conducted without the migratory / wintering component in the event of an extreme weather event, chemical spill, or other catastrophic event to evaluate beached / dead birds to aid in management decisions.

Study Area

Although this protocol will be initially implemented at CAHA, it was designed for use at multiple Parks to address other management questions. The four National Seashores in the SECN, CAHA, CALO, CUIS, and CANA, provide key habitat to many shorebirds.

Cape Hatteras National Seashore is part of the east coast barrier island system (Figure 3). The Seashore consists of 14,326 ha of land and 121 km of virtually unspoiled beach. The U.S. Fish and Wildlife Service administers Pea Island National Wildlife Refuge within the boundary of the Seashore. The Seashore has recently been designated a Globally Important Bird Area by the American Bird Conservancy because of the importance of the seashore habitats to avian breeding, migration, and wintering. Developmental pressures outside the Park and visitor and recreational uses represent the major categories of threat to the integrity of natural resources at CAHA. As is the case in all National Seashores in the SECN, adjacent property development has resulted in direct loss and fragmentation of habitat upon which numerous park wildlife species were partially dependent. Other threats to natural resources include the introduction of non-native plants and animals, off-road vehicle use, and dredging of channels adjacent to the park.

Cape Lookout National Seashore is largely undeveloped and accessible only by boat. CALO is composed of three barrier islands covering 90 km of the central coast of North Carolina. Most of the Seashore consists of North and South Core Banks, a 71-km long barrier system oriented in a southwest to northeast direction and separated by the infrequently maintained New Drum Inlet. CALO extends into the Atlantic Ocean from its southern end, and abandoned Portsmouth Village is located at its northern end. The other barrier system within the Seashore, Shackleford Banks, extends westward from Cape Lookout and, while smaller (13 km), is considered ecologically more diverse than Core Banks (National Park Service Southeast Coast Network 2004).

Canaveral National Seashore consists of approximately 23,472 ha within the Mosquito Lagoon watershed and has more than 32 km of beach. This National Park unit represents an excellent example of a relatively stable barrier beach backed by a productive lagoon system. Mosquito Lagoon is the northernmost part of the Indian River Lagoon system, which contains the highest species diversity of any estuary in North America (Schmalzer 1995) and provides critical habitat for many rare and state- and federally-listed species (National Park Service Southeast Coast Network 2004). CANA has a single dune ridge, approximately 3-4-m tall that is relatively stable and backed by scrubby vegetation dominated by saw palmetto (*Serenoa repens*).

Cumberland Island National Seashore is one of the largest undeveloped barrier islands on the southern Atlantic Coast. CUIS is the southernmost barrier island of Georgia, is approximately 26-km long and has an area of almost 15,000 ha. CUIS is considered a Globally Important Bird Area by the American Bird Conservancy for its wide

variety of birds and the value this barrier island park has for protection of these birds. In addition to diverse terrestrial, estuarine and freshwater systems, the Seashore hosts an extensive dune system (National Park Service Southeast Coast Network 2004).

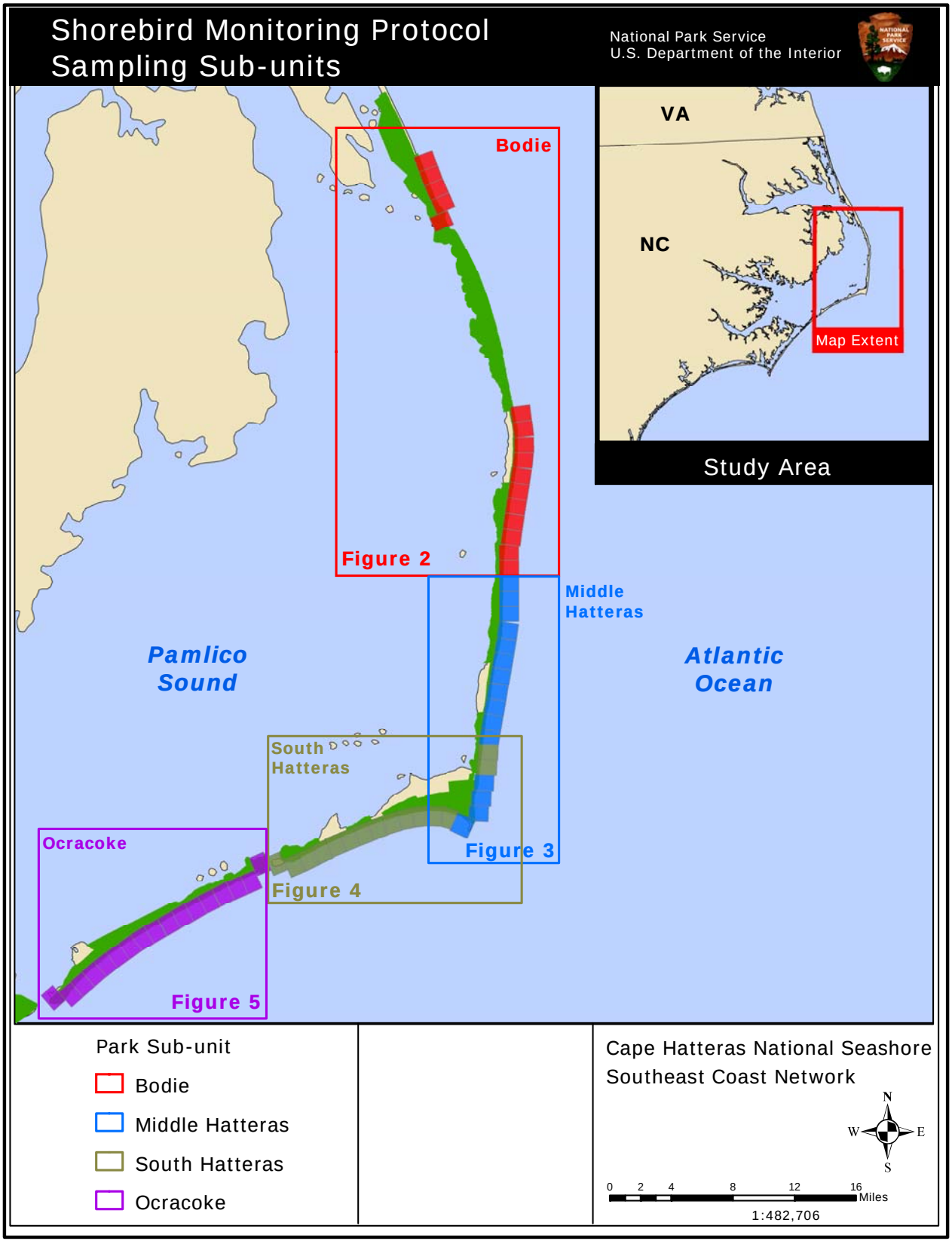

Figure 3. Cape Hatteras National Seashore sub-units identified in the SECN Migratory, Wintering, and Beached Shorebird Monitoring Protocol.

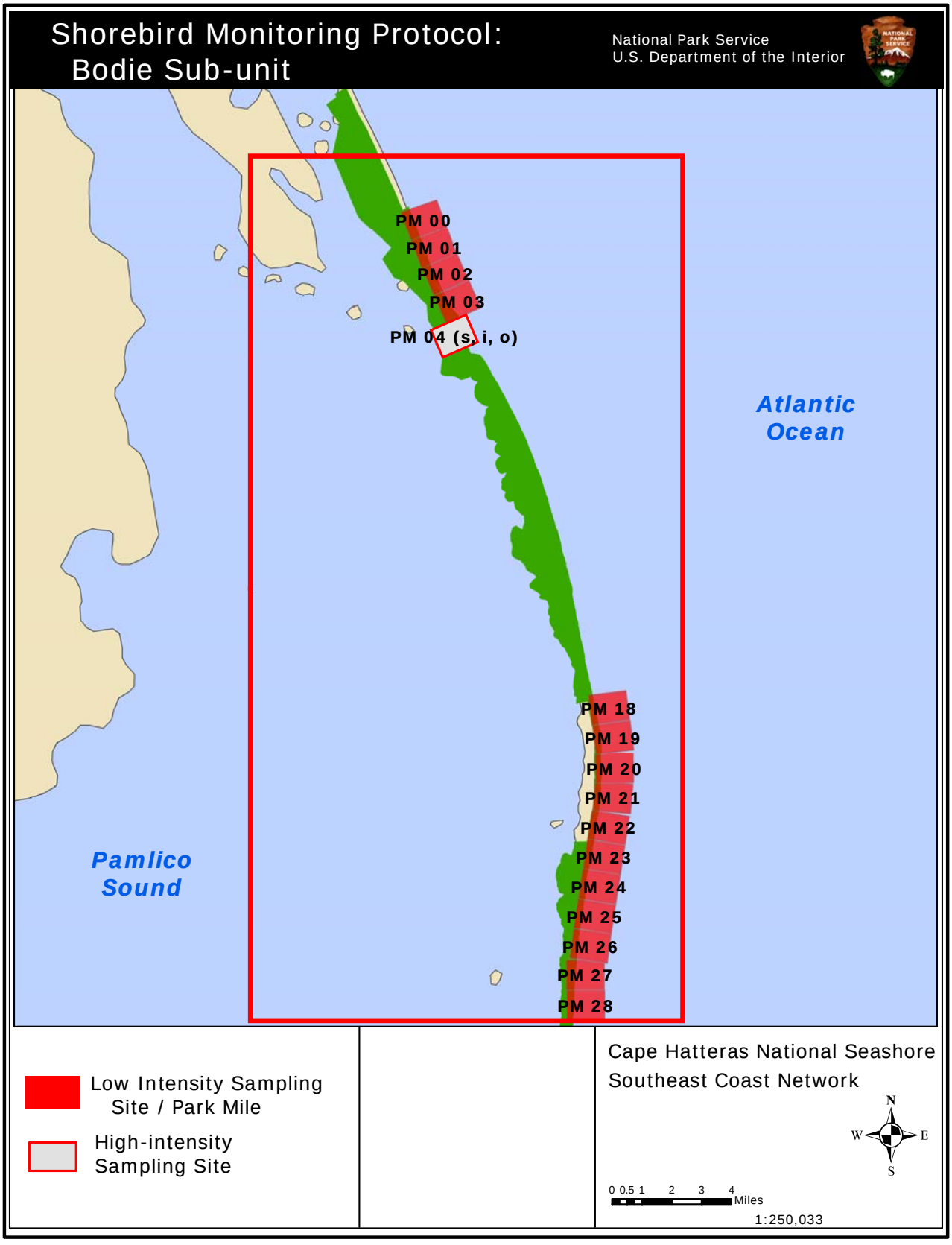

Figure 4. Bodie sub-unit in SECN Migratory, Wintering, and Beached Shorebird Monitoring Protocol.

Figure 5. Middle Hatteras sub-unit in SECN Migratory, Wintering, and Beached Shorebird Monitoring Protocol.

Figure 6. South Hatteras sub-unit in SECN Migratory, Wintering, and Beached Shorebird Monitoring Protocol.

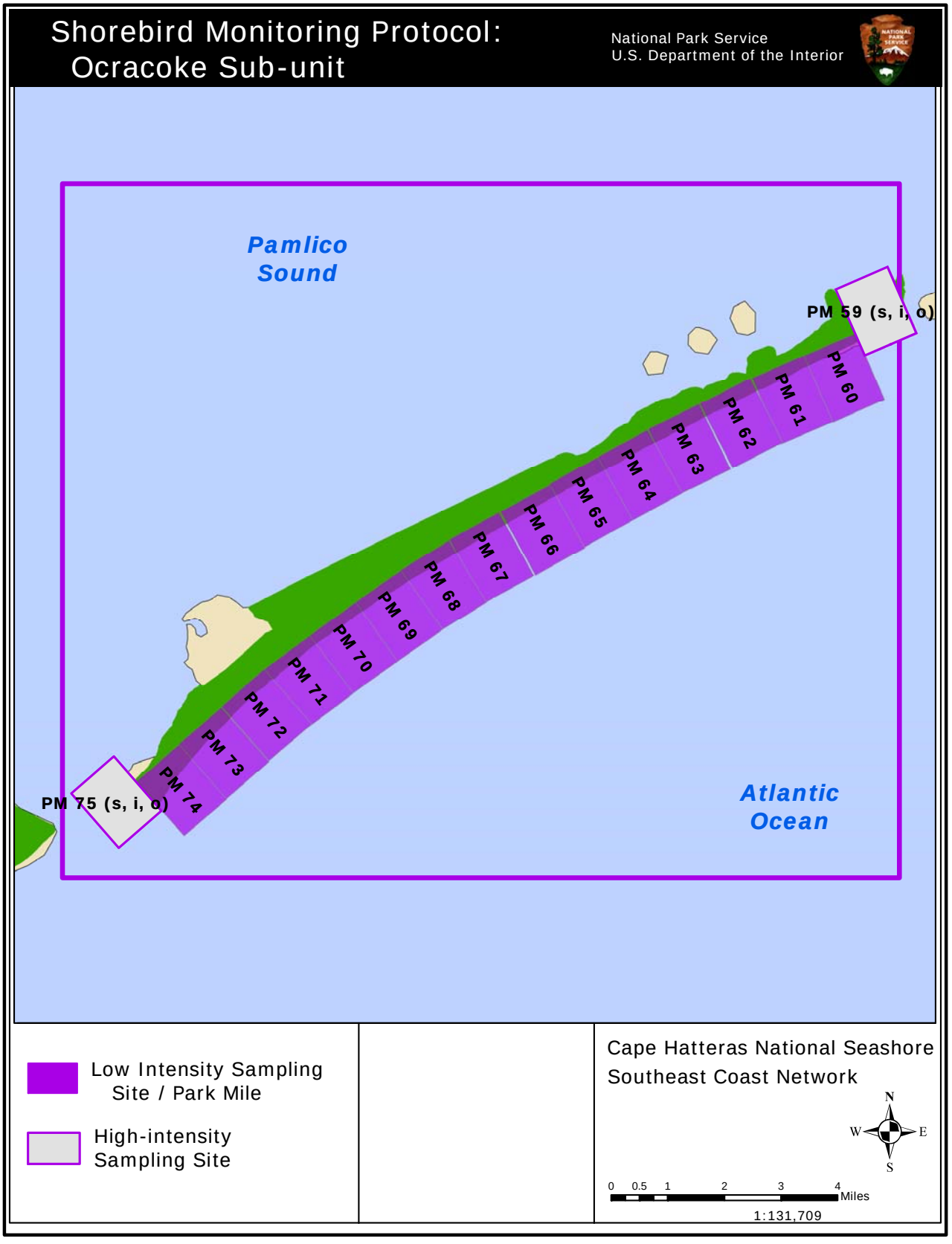

Figure 7. Ocracoke sub-unit in SECN Migratory, Wintering, and Beached Shorebird Monitoring Protocol.

Post-Collection Sample Processing (e.g., Lab Analysis, Voucher Specimen Preparation)

No birds will be collected under the migratory / wintering component of this protocol. Samples of birds may be collected, however, under the beached bird component of this protocol if directed by Park management, another federal agency, or a state agency. In this case, specimens will be collected under their specimen collection protocols.

End-of-Season Procedures

Upon the conclusion of the sampling season, the field technician will inventory, clean, store, repair, and/or re-order equipment for next field season. The technician will closeout with Park personnel to finalize transfer and storage of any Park property used during the field season and provide any assistance required relating to sampling season finalization. The technician will assist with training activities or preparation training materials for next-season's personnel as required. The technician will also summarize their personal notes and make recommendations for increasing efficiency of protocol and/or protocol implementation.

The technician will provide the Park a copy of the populated database. Another copy of the database will be provided to the SECN Science Information Specialist and the SECN Wildlife Ecologist. All completed data forms will also be provided to the Science Information Specialist. Data storage and archival procedures will be conducted as outlined in the SECN Data Management Plan.

Data Handling, Analysis, and Reporting

Metadata Generation

Still in Development - CW

Overview of Database Design

A protocol-specific database has been developed to store and manage data collected following the methods described herein (Figure 8). Instructions on the use of the database are included in SOP 10.1.1.4. The database is designed to house shorebird wintering and migratory shorebird observation data and general field notes. Additionally, the database will house any beached bird data as appropriate.

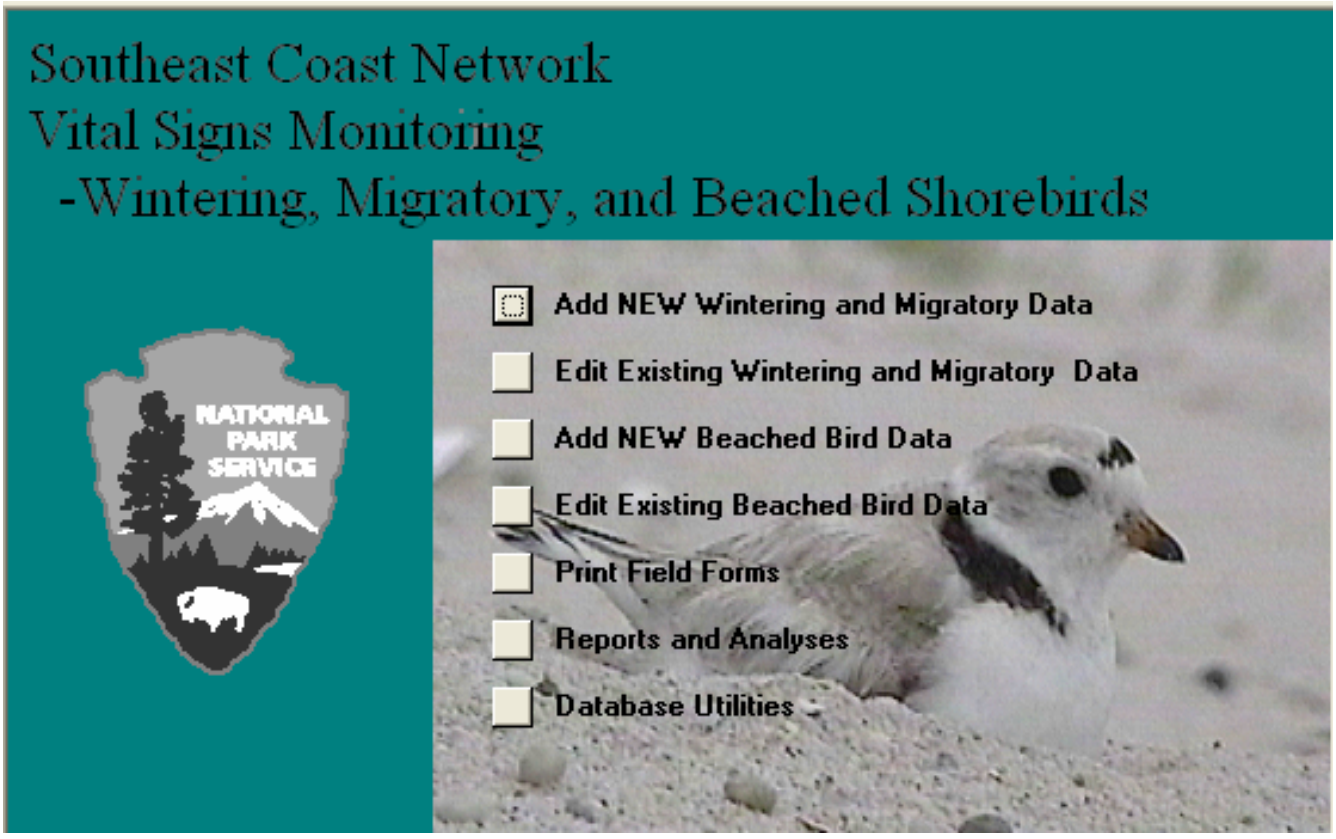

Figure 8. Main menu of the SECN Migratory, Wintering, and Beached Shorebird Monitoring Protocol. Instructions on the use of the database are included in SOP 10.1.1.4.

The database is designed to automatically generate several reports and analyses (described below), as well as print out field data sheets as needed.

Data Entry, Verification, and Editing

The data collector is responsible for entering all data into the accompanying database at the conclusion of daily sampling activities. The SECN Wildlife Ecologist will subsample 10% of all datasheet entries monthly to verify accurate data entry. If errors are detected, all datasheets entries for that month will be checked. The database has several quality control measures incorporated into its design to ensure the highest integrity of data possible.

Recommendations for Routine Data Summaries, Statistical Analyses to Detect Change, and Long Term Trend Analysis

SECN staff will evaluate the adequacy (statistical, logistical, management utility) of the CAHA Piping Plover migratory / wintering monitoring pilot protocol as data are collected. SECN staff will conduct analyses after the first season of data collection to evaluate the number of samples collected, aggregation of units, and minimum required sample size and refine the sampling schedule accordingly. SECN staff will also address the adequacy of comparisons of these data with those collected by other regional organizations. Additional analyses will be conducted as appropriate. Data from high-intensity units will be evaluated for autocorrelation in an effort to refine sampling frequency; however, autocorrelation is unlikely due to the short residence time of migratory birds in any given location in the Outer Banks.

Our sampling objective for this protocol is that we want to be 95% confident that all focal shorebird observation estimates are within 20% of the estimated true value. Therefore, we will use an infinite population sample size equation to determine the sample size necessary to meet this objective. Data collected during the first sampling event (11-month period) will be used to determine sample-size requirements 1) high-intensity sites, 2) low-intensity sites, and 3) all sites combined. The uncorrected finite population sample size estimate was chosen because of CAHA's juxtaposition within the breeding, migratory and wintering range of the piping plover and birds present at CAHA at any given time are likely to be an aggregation of multiple sub-populations of piping plovers (e.g., early migrants, late winter residents, etc.). These sub-populations are difficult to define and we would not consider the sub-populations to be finite populations in a temporal context.

Potential analysis tools are discussed below in the context of the monitoring objectives for this protocol:

- **Identify areas of consistent use (i.e., hotspots) by migratory and/or wintering focal shorebirds at CAHA and if these areas remain consistent over time.**

Use is considered consistent if repeated patterns of observations are recorded for any given sampling site on a monthly, quarterly / seasonally, or annual basis and if the patterns are repeated over time. The database included with this protocol has report functions that provide general summary statistics on number of observations by species, site (Park Mile), habitat type, tidal stage, car count, and any given temporal delineation (e.g., month, season, etc.). The distribution of the data will dictate the statistical technique used for trend analysis. Several parametric (e.g., ordinary least squares regression, etc.) and non-parametric (e.g., Sen slope, Kendall test, etc.) options exist to evaluate trends. These options will be explored further after completion of the first year of data collection. Predictive abilities will come from modeling patterns in habitat use in combination with data generated from a Land Cover / Land Use protocol currently under development.

- **Determine habitat type used by migratory and/or wintering focal shorebirds at CAHA.**

The database included with this protocol has report functions that provide general summary statistics on number of observations by habitat type. Proportion of habitats used by focal shorebirds over an annual basis should remain consistent across years if habitat availability remains constant, however this is seldom the case in most systems particularly barrier islands in lower latitudes. CAHA is a very dynamic system with shorebird habitats changing on short temporal scales. In contrast, if habitat use patterns change in the absence of extreme weather events, other possible factors associated with changing habitat use patterns will be investigated.

Results from this protocol will be integrated with a Land Use / Land Cover protocol currently under development. This will facilitate further integration among the suite of priority SECN vital signs and supplement our integrated monitoring framework. Further, the assimilation of data among these two protocols will continue to refine our predictive abilities of focal shorebird habitat use and allow Park managers to make proactive management decisions regarding the focal shorebirds included in this protocol.

- **Determine spatial and temporal variability in beached birds at CAHA.**

Patterns in beached birds will likely be sporadic and episodic. Expected small sample sizes will limit analysis potential; however this information will be critical in identifying potential spatial and temporal patterns of take as a result of human-induced mortality, predation, contaminants, and/or disease. The database included with this protocol has report functions that provide general summary statistics on number of beached bird observations by species, site (Park Mile), habitat type, tidal stage, car count, and any given temporal delineation (e.g., month, season, etc.).

Recommended Reporting Schedule

Reports can be generated at any time through the database as deemed necessary by Park management. The SECN Wildlife Ecologist will further summarize, analyze, and interpret these data on an annual basis and make available to Park personnel.

Recommended Report Format with Examples of Summary Tables and Figures

The protocol database includes several standard reports to both support park staff in routine management decisions and to facilitate information sharing among NPS and partners (Figure 9). These reports quickly summarize shorebird observations by habitat type, time of year, intensity of recreational use, and location (Figure 10 -).

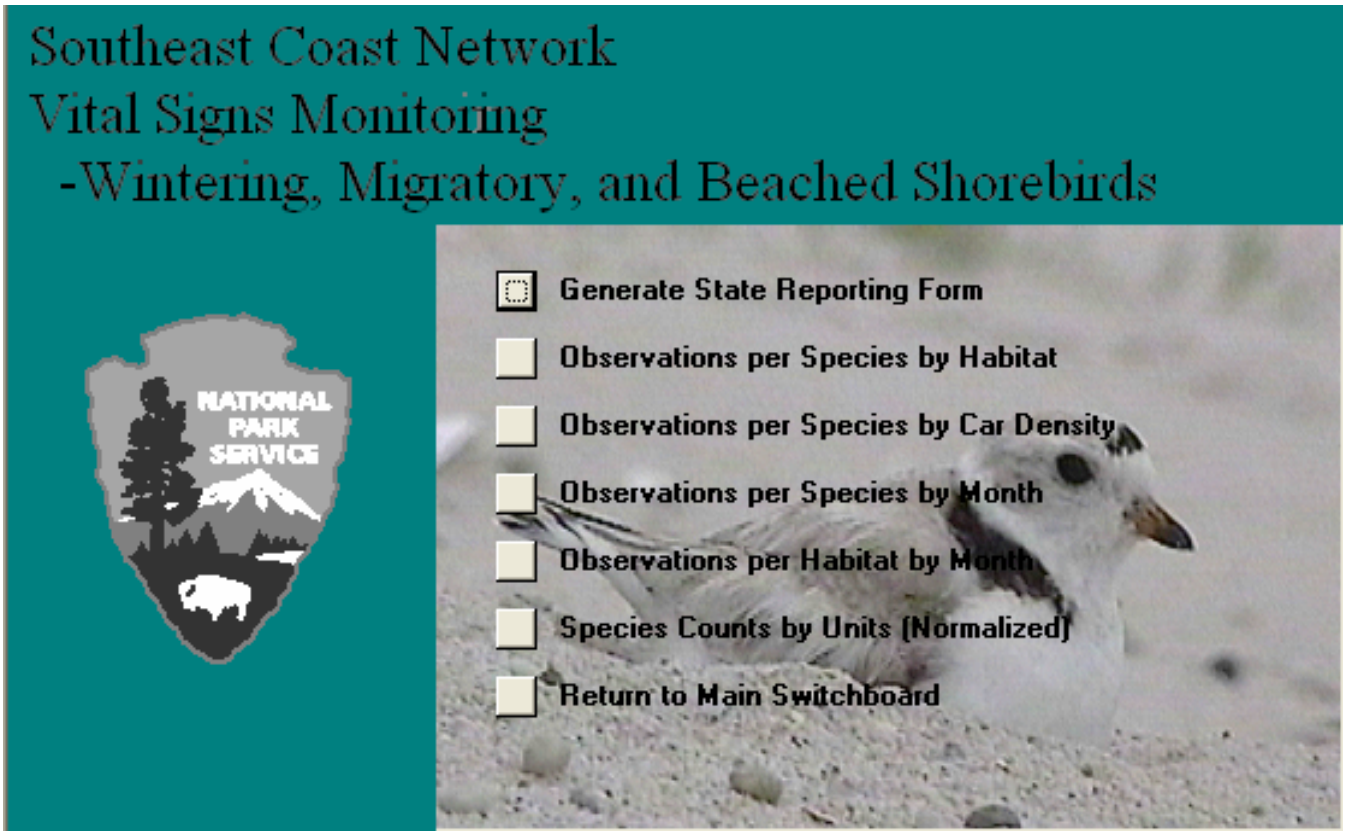

Figure 9. Reports and Analyses menu from the SECN Migratory, Wintering, and Beached Shorebird Monitoring Protocol database.

Standard reports generated by the database include the following:

- *North Carolina Wildlife Resources Commission (NC-WRC) non-breeding Piping Plover observation form* (Figure 10). Observation reporting forms can be generated to facilitate reporting of observations made at CAHA and CALO to NCWRC.
- *Shorebird observations vs. Habitat* (Figure 11). Observation data are presented to show the habitat types where the majority of birds are observed. Total observations for each species are also included.
- *Shorebird Observations vs. ORV Use* (Figure 12). Observation data are presented to show the degree to which the density of ORVs present during observations might affect observation rates. Total observations for each species are also included.
- *Shorebird Observations per Month by species* (Figure 13). Observation data are presented to show distribution of observations for each species over time.
- *Shorebird Observations per Month by habitat* (Figure 14). Observation data are presented to indicate whether there might be temporal patterns to habitat use.

- *Average number of observations per hour per sampling unit by* species (Figure 15). The database generates a crosstab query that summarizes average counts of all shorebird species for each sampling unit. Observation data are corrected for differences in sampling effort among high- and low-intensity sampling sites.
- *International Shorebird Survey Reporting Form* (*still in development*). Similar to the NC-WRC reporting form, the database will automatically generate a reporting form to facilitate easy submission of shorebird observation data to the ISS program.

Non-breeding Piping Plover Observation Form
(July 14 – April 30)

Date 1/1/2005 Name of observer Joe DeVivo

General description of location: Ocracoke Island Spit, Interior, Park Mile 75 (Site No. PM75i)

Latitude_____ Longitude_____(if known)

Number of piping plovers observed 1 tide: Low

General activity (check all that apply)

foraging	X
roosting	
territorial displays	
other	

explain:_____

All birds observed to be moving (on the ground) were assumed to be foraging. Sedentary birds were coded as roosting. Any breeding behaviors noted were categorized as territorial behavior. All other behaviors (such as flying) are noted in the OTHER category

Habitat

oceanfront	
sandbar/shoal	
sandflat/mudflat	X
overwash	
other	

explain:_____

All birds observed within Foreshore, Backshore, or wrackline habitats are denoted in the "oceanfront" category. Only birds observed in the surf zone are included in the sandbar/shore category. Habitats included in the "other" category include Backdone, Freshwater Ponds, Freshwater Wetlands, Intradunal Swales, Dunes, and Salt Marshes.

Please send all completed forms to Sue Cameron, NCWRC, 253 White Oak Bluff Rd., Stella, NC 28582
or send electronically to camerons@coastalnet.com

Figure 10. Example North Carolina Wildlife Resources Commission non-breeding Piping Plover observation form. Location, count, tidal, activity, and habitat data are automatically generated based on data collected during sampling.

Distribution of Habitats in which Shorebirds were Observed

[BD - Backdune; BS - Backshore; BL - Blowout; FS - Foreshore; FP - Inland Freshwater Pond; FW - Inland Freshwater Wetland; IS - Intradunal Swale; OW - Overwash; PD - Primary Dune; SM - Salt Marsh, Tidal Creek, or Brackish Marsh; SF - Sand Flat; SD - Secondary Dunes; MF - Mud Flat or Algal Flat; WL - Wrack Line; SZ - Surf Zone]

Common Name	*Total Observations*	*BD*	*BL*	*BS*	*FP*	*FS*	*FW*	*IS*	*MF*	*OW*	*PD*	*SD*	*SF*	*SM*	*SZ*	*WL*
Wilson's Plover	2					100.0%										
Red Knot	5					100.0%										
Piping Plover	28			14.3%	7.1%	14.3%			42.9%				10.7%			10.7%

Figure 11. Example report depicting the proportion of observations per species as a function habitat of ORVs present within the sampling area during the period of observation. Data shown are for illustrative purposes only and do not

reflect actual conditions.

Percentage of Observations by Car Density Category per Species

Common_Name	Total Observations	0	1-10	11-50	50+
Piping Plover	28	3.6%	42.9%	50.00%	3.6%
Red Knot	5		40.0%	60.00%	
Wilson's Plover	2	100.0%			

Figure 12. Example report depicting the proportion of observations per species as a function of the number of ORVs present within the sampling area during the period of observation. Data shown are for illustrative purposes only and do not reflect actual conditions.

Total Observations Per Species by Month

Common Name	Total Observations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Piping Plover	28	28											
Red Knot	5	5											
Wilson's Plover	2	2											

Figure 13. Example report depicting the total number of shorebird observations per species by month. Data shown are for illustrative purposes only and do not reflect actual conditions.

Total Observations Per Habitat Type by Month

Habitat	Total Observations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Backshore	4	4											
Foreshore	11	11											
Inland Freshwater Pond	2	2											
Mud Flat / Algal Flat	12	12											
Sand Flat	3	3											
Wrack Line	3	3											

Figure 14. Example report depicting the total number of shorebird observations per habitat type by month. Data shown are for illustrative purposes only and do not reflect actual conditions.

qxtb_Normalized_Species_Counts_By_Unit2 : Select Query

Loc_Name	Loc_Description	Total Normalized Coun	American Avoce	American Oyste	American Wooc	Baird's Sandpip	Bar-tailed Godw	Black-bellied Pl	Black-neck
PM04i	Bodie Island Spit, Interior, Park Mile 4	3	0	0	0	0	0	0	
PM45i	Cape Hatteras Spit, Interior, Park Mile 45	3	0	0	0	0	0	0	
PM58o	Hatteras Island Spit, Oceanside, Park Mile 58	3	0	0	0	0	0	0	
PM02	Bodie Island, Park Mile 2	2	0	0	0	0	0	0	
PM46	Hatteras Island, Park Mile 46	1.5	0	0	0	0	0	0	
PM04o	Bodie Island Spit, Oceanside, Park Mile 4	1	0	0	0	0	0	0	
PM45s	Cape Hatteras Spit, Southern Oceanside, PM 45	1	0	0	0	0	0	0	
PM58i	Hatteras Island Spit, Interior, Park Mile 58	1	0	0	0	0	0	0	
PM75s	Ocracoke Island Spit, Oceanside, Park Mile 75	1	0	0	0	0	0	0	
PM58s	Hatteras Island Spit, Soundside, Park Mile 58	1	0	0	0	0	0	0	
PM59i	Northeast Ocracoke Island, Interior, PM 59	1	0	0	0	0	0	0	
PM59s	Northeast Ocracoke Island, Soundside, PM 59	1	0	0	0	0	0	0	
PM62	Ocracoke Island, Park Mile 62	1	0	0	0	0	0	0	
PM75o	Ocracoke Island Spit, Soundside, Park Mile 75	1	0	0	0	0	0	0	

Record: 9 of 30

Figure 15. Example query that calculates average observations per hour for each shorebird species for all sampling units. Each column (individual species and the overall total) can be "sorted" to allow park staff to identify sampling areas that have the highest observation rates.

Data Archival Procedures

To be Developed. CW & KDK

Personnel Requirements and Training

Roles and Responsibilities

During pilot implementation, this project will be supervised by the SECN Wildlife Ecologist. A 12-month SCA Conservation Associate will collect and enter field data. The SECN Wildlife Ecologist will summarize, analyze, and interpret the data. All data collected will be managed by the SECN Science Information Specialist through the data management system currently under development. The FTE expenditure for field-data collection during pilot implementation is 1.0.

Training Procedures

Training will occurs for the first two weeks of each field season and will be led by Park personnel and the SECN Wildlife Ecologist. Components of training include: Park orientation, Park operations, equipment use (e.g., vehicles, computers, etc.), focal-shorebird bird identification, protocol implementation, habitat identification, data entry, and data transfer. The SECN Wildlife Ecologist will evaluate field personnel through test trials (e.g., double observer).

Operational Requirements

Annual Workload and Field Schedule

This protocol is designed for 1.0 FTE, with observations to occur 11 months out of the year. If additional observers are available on any given day, then additional units are sampled in the order set forth in Table 2. Intermittent use of double-observers when available will allow for estimation of population abundances for all focal species during the periods with double observers (analysis techniques of these data are not included in this protocol).

Facility and Equipment Needs

- 4WD vehicle
- 8-10X binoculars
- Map of sampling unit(s)
- Data sheets
- Habitat descriptions
- Compass
- Flagging tape
- Field guide and necessary bird-identification materials
- Field thermometer
- Watch with stopwatch function
- Daypack
- Personal protective gear

Startup Costs and Budget Considerations

Item	Cost (USD)
SCA stipend with housing provided	26,000.00
Equipment and materials	1,000.00
TOTAL	**27,000.00**

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Appendix 1. Forms

SECN Form 10.1.1.1. Migratory / Wintering Bird Monitoring Field Data Form

Date	**Tide**[1] L H W F	**Wind Direction**[2] N NE E SE S SW W NW
Location	**Weather**[3] S PC C R SN	**Wind Speed (mph)** < 10 > 10
Observer(s)	**Temperature**[4]	**Car Count** 0 1-10 11-50 51+
Comments		

Military Time	Species Code	Count	Activity[5]	Habitat[6]	Breeding[7]	Other Comments
			M F S			
			M F S			
			M F S			
			M F S			
			M F S			
			M F S			
			M F S			
			M F S			
			M F S			
			M F S			
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			M F S			
			M F S			
			M F S			
			M F S			
			M F S			

(1) – L = Low, H = High, W = Wind, F = Flood (Wind-tide)
(2) – one of eight cardinal directions
(3) – S = Sunny, PC = Party Cloudy, C = Cloudy, R = Rain, SN = Sleet/Snow
(4) – Degrees Fahrenheit
(5) – M = Moving, F = Flying, S = Sedentary
(6) – Habitat description and codes should accompany this form
(7) – Breeding Behavior Observed (Check if observed)

Habitat Codes					
BD	Backdune	FW	Inland Freshwater Wetland	SD	Secondary Dune
BL	Backshore	IS	Intradunal Swale	SF	Sand Flat
BS	Blowout	MF	Mud Flat / Algal Flat	SM	Salt Marsh, Tidal Creek, or Brackish Marsh
FP	Inland Freshwater Pond	OW	Overwash	SZ	Surf Zone
FS	Foreshore	PD	Primary Dune	WL	Wrack Line

SECN Form 10.1.1.2. Beached / Dead Bird Monitoring Data Form.

Date	**Tide**[1] L H W F	**Wind Direction**[2] N NE E SE S SW W NW
Location	**Weather**[3] S PC C R SN	**Wind Speed (mph)** < 10 > 10
Observer(s)	**Temperature**[4]	**Car Count** 0 1-10 11-50 51+
Comments		

Military Time	Species Code	Count	Habitat[5]	Condition[6]	Signs[7]	Other Comments[8]
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	
				DF DD M P	O P S V	

(1) – L = Low, H = High, W = Wind, F = Flood (Wind-tide)
(2) – one of eight cardinal directions
(3) – S = Sunny, PC = Party Cloudy, C = Cloudy, R = Rain, SN = Sleet/Snow
(4) – Degrees Fahrenheit
(5) – Habitat description and codes should accompany this form
(6) – DF = Dead fresh, DD = Dead decayed, M = Moribund (dying), P = Partial carcass
(7) – O = Oiled, P = Predated (blood evidence), S = Scavenged, V = Vehicle-related
(8) – Make note if specimen is collected to aid in identification

Habitat Codes					
BD	Backdune	FW	Inland Freshwater Wetland	SD	Secondary Dune
BL	Backshore	IS	Intradunal Swale	SF	Sand Flat
BS	Blowout	MF	Mud Flat / Algal Flat	SM	Salt Marsh, Tidal Creek, or Brackish Marsh
FP	Inland Freshwater Pond	OW	Overwash	SZ	Surf Zone
FS	Foreshore	PD	Primary Dune	WL	Wrack Line