Final Cape Wind Avian and Bat Monitoring Plan

NANTUCKET SOUND, MASSACHUSETTS

PREPARED FOR:
Cape Wind Associates, LLC
20 Park Plaza, Suite 320
Boston, MA 02116

PREPARED BY:
ESS Group, Inc.
100 Fifth Avenue, Fifth Floor
Waltham, Massachusetts 02451

Project No. E159-504

August 15, 2012

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1.0 INTRODUCTION

Cape Wind Associates (CWA) has proposed to construct a wind turbine facility and associated infrastructure in federal waters off the coast of Massachusetts. The Cape Wind project area is located on Horseshoe Shoal in Nantucket Sound, Massachusetts (Figure 1). The Nantucket Sound Action Area (Action Area), as defined in the U.S. Fish and Wildlife Service (USFWS) Biological Opinion, includes all of Nantucket Sound, the waters between Martha's Vineyard and Nantucket, and waters off the eastern shore of Nantucket (Figure 1). Since project permitting began a decade ago, the project's potential impact to bird and bat species has been carefully evaluated. In addition, CWA has worked throughout the permitting process to develop a comprehensive avian monitoring plan.

Cape Wind has done extensive research to permit the first offshore wind park in the United States. Much of this research has centered on minimizing potential wildlife impacts, especially to avian resources. Some of the key prior work that involves studies of existing avian resources in the Action Area includes the following reports and studies.

- Draft Environmental Impact Statement (DEIS), Draft Environmental Impact Report (DEIR) and Development of Regional Impact (DRI) – U.S. Army Corps of Engineers, 2004
- Final Environmental Impact Report (FEIR) – ESS Group, 2007
- Cape Wind Biological Assessment – MMS, 2008
- Cape Wind Biological Opinion – USFWS, 2008
- Final Environmental Impact Statement (FEIS) – MMS, 2009

The following avian studies were included in these documents:

- Preliminary Avian Risk Assessment for the Cape Wind Energy Project (DEIS/DEIR/DRI Appendix 5.7-A)
- A Comparison of the Years 2002-2003 with the years 1989-2001, Using Historic Data on Winter Waterbirds (DEIS/DEIR/DRI Appendix 5.7-B)
- Terns and the Cape Wind Project in Nantucket Sound (DEIS/DEIR/DRI Appendix 5.7-C)
- Late Winter/Early Spring 2002 Waterbirds Survey for the Cape Wind Energy Project (DEIS/DEIR/DRI Appendix 5.7-D)
- Spring/Fall 2002 Avian Radar Studies for the Cape Wind Energy Project (DEIS/DEIR/DRI Appendix 5.7-E)
- Spring/Summer 2002 Waterbirds Survey for the Cape Wind Energy Project (DEIS/DEIR/DRI Appendix 5.7-F)
- Fall 2002 – Winter 2003 Waterbirds Survey for the Cape Wind Energy Project (DEIS/DEIR/DRI Appendix 5.7-G)
- Evaluation of the Roseate Tern and Piping Plover (DEIS/DEIR/DRI Appendix 5.7-H)

- Biological Review of the Common Tern for the Cape Wind Energy Project (DEIS/DEIR/DRI Appendix 5.7-I)
- Bird Monitoring Using the Mobile Avian Radar System, Nantucket Sound, Massachusetts (DEIS/DEIR/DRI Appendix 5.7-J)
- Six Surveys of Waterbirds in Nantucket Sound: March 19 – June 2, 2003 for the Cape Wind Energy Project (DEIS/DEIR/DRI Appendix 5.7-K)
- Summer 2003 Waterbird Survey for the Cape Wind Energy Project (DEIS/DEIR/DRI Appendix 5.7-L)
- Fall 2003 – Winter 2004 Waterbirds Survey for the Cape Wind Energy Project (DEIS/DEIR/DRI Appendix 5.7-M)
- Massachusetts Audubon Society Nantucket Sound Tern Surveys (DEIS/DEIR/DRI Appendix 5.7-N)
- Winter/Nocturnal Duck Survey 2005, Nantucket Sound, Massachusetts (FEIR Appendix 3.6-A)
- Fall 2005 Mobile Avian Radar System Monitoring Report, Nantucket Sound, Massachusetts (FEIR Appendix 3.6-B)
- Long-Tailed Duck Report, Winter 2005-2006 (FEIR Appendix 3.6-C)
- Spring 2006 Mobile Avian Radar System Monitoring Report, Nantucket Sound, Massachusetts (FEIR Appendix 3.6-D)
- Tern Observations Near Monomoy Island, August 28-31, 2006 (FEIR Appendix 3.6-E)
- Avian White Paper for the Cape Wind Energy Project (FEIR Appendix 3.6-F)
- Mobile Avian Radar System 2002 Monitoring Report: Data Reanalysis, Nantucket Sound, Massachusetts (FEIR Appendix 3.6-G)
- Summary of Cape Wind and Massachusetts Audubon Society Aerial Surveys, 2002-2006 (FEIR Appendix 3.6-H)
- Collision Mortalities at Horseshoe Shoal of Bird Species of Special Concern (FEIR Appendix 3.6-I)
- Population Viability Analysis for the Roseate Tern Nesting in the Northwest Atlantic (FEIR Appendix 3.6-J)
- Population Viability Analysis for the New England Population of the Piping Plover (FEIR Appendix 3.6-K)

In addition, MassAudubon conducted the following pre-construction avian studies in Nantucket Sound:

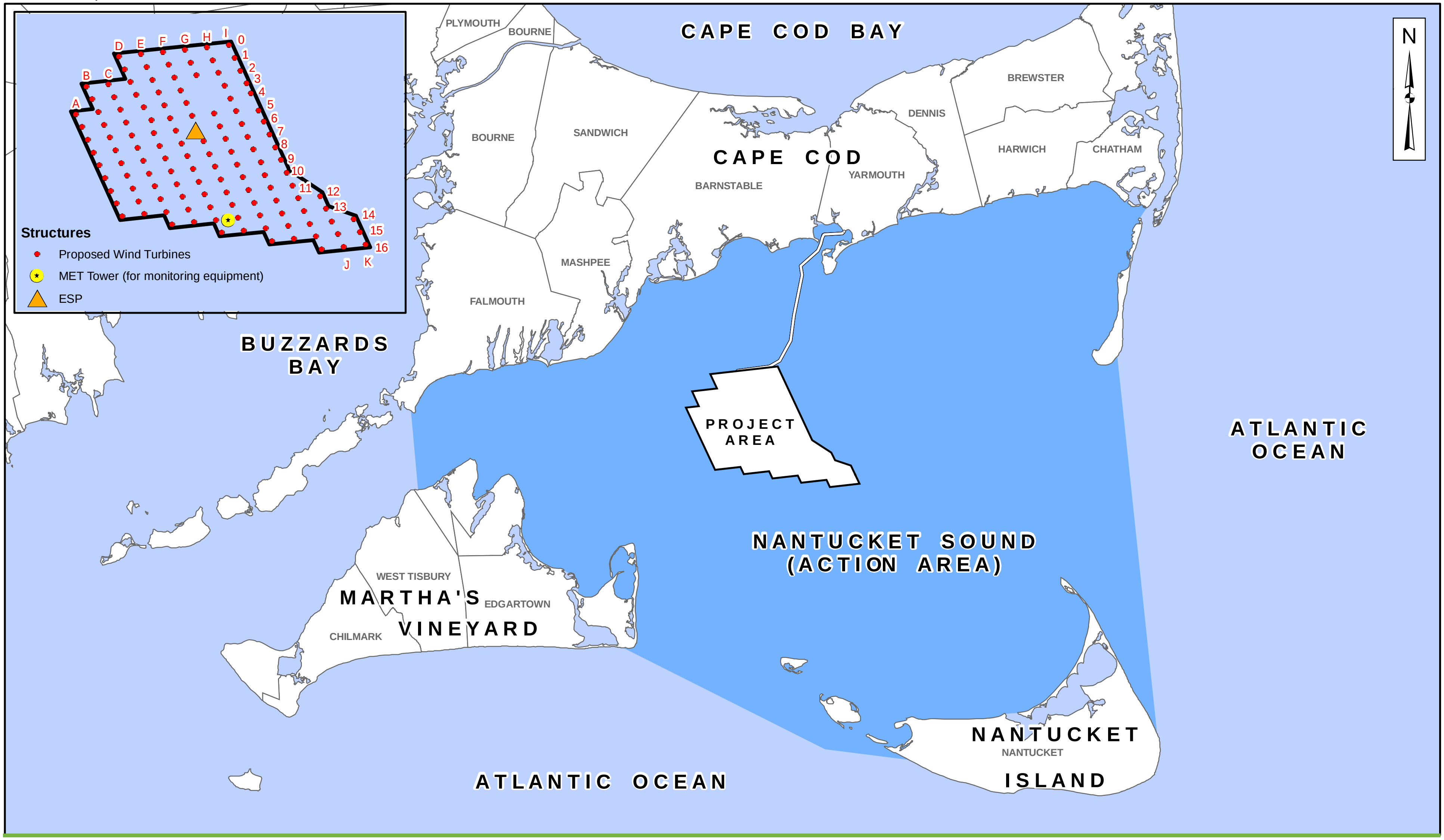
- Survey of Tern Activity Within Nantucket Sound, Massachusetts, During Pre-Migratory Fall Staging (Perkins et al. 2003)

- A Survey of Tern Activity Within Nantucket Sound, Massachusetts, During the 2003 Breeding Season (Perkins et al. 2004a)
- A Survey of Tern Activity Within Nantucket Sound, Massachusetts, During the 2003 Fall Staging Period (Perkins et al. 2004b)
- Relative Waterfowl Abundance Within Nantucket Sound, Massachusetts, During the 2003-2004 Winter Season (Perkins et al. 2004c)
- A Survey of Tern Activity Within Nantucket Sound, Massachusetts, During the 2004 Breeding Period (Sadoti et al. 2005a)
- A Survey of Tern Activity Within Nantucket Sound, Massachusetts, During the 2004 Fall Staging Period (Sadoti et al. 2005b)

These documents include studies that evaluated existing avian distribution and movements within the Action Area. They included studies that assessed the collision risk to listed species and migratory species as a result of the Cape Wind project and they also included Population Viability Analyses for Roseate Terns and Piping Plovers, two federally–listed species. The FEIS included the *Framework for the Avian and Bat Monitoring Plan for the Cape Wind Proposed Offshore Wind Facility* (Framework), which outlines the general avian and bat monitoring and mitigation requirements moving forward.

The research, monitoring program, and mitigation described in this Avian and Bat Monitoring Plan (ABMP) was first formalized in the Framework, which was included in the FEIS (MMS, 2009). Since the Framework provides the context and reasoning used to develop the ABMP, a brief overview of the Framework is provided below.

Location: G:/GIS-Projects/E159/00.mxd/504/ActionArea.mxd



CAPE WIND ASSOCIATES, LLC
Cape Wind Energy Project
Nantucket Sound, Massachusetts

Scale: 1" = 7 Miles
0 7 Miles

Source: 1) MassGIS, Towns, 2002

Legend
Project Area
Nantucket Sound Action Area

Locus Map

Figure 1

ess group
environmental consulting & engineering services

1.1 Summary of Framework for Avian and Bat Monitoring Plan

The Framework was developed after several years of consultation among representatives from the Bureau of Ocean Energy Management[1] (BOEM), the United States Fish and Wildlife Service (USFWS), the Massachusetts Division of Fisheries and Wildlife (MassWildlife) and Cape Wind Associates (CWA). The Framework includes research, mitigation and monitoring elements of BOEM's Biological Assessment (May 2008) and the USFWS Biological Opinion (November 2008). The purpose of the Framework is to outline the methodology for data collection and mitigation requirements that would be used to evaluate potential impacts to avian and bat species as a result of the project. The Framework was intended to provide guidance for the development of the more detailed ABMP and allow flexibility in the development of the mitigation and monitoring program. In accordance with the Framework, the program can be modified as necessary to incorporate new technologies and information which allows for an adaptive management approach to impact assessment. Should a monitoring component turn out to be not technically feasible, the monitoring component may be modified.

The Framework provides overall program objectives, summary of available information on monitoring techniques, summary of the existing data collected in Nantucket Sound, proposed pre-construction monitoring and mitigation programs, post-construction monitoring and mitigation programs, and reporting requirements.

The specific objectives of the Framework include the following items.

- Address and/or add to the information base for the following key monitoring questions:
  - What bird/bat species are found in Nantucket Sound and the proposed project area (Horseshoe Shoal) and what seasonal/annual variation exists in their use of these areas?
  - How often and when do birds/bats use the airspace (travel corridors and flight trajectories) in, around and over the proposed project area?
  - What is the effect of the wind energy facility on the distribution and movements of birds/bats in Nantucket Sound and the proposed project area?
  - How effective are anti-perching devices in discouraging birds from perching on turbines or the Electrical Service Platform (ESP)?
  - How can we effectively measure the numbers of bird/bat strikes or collisions with wind turbines and/or monopiles?
  - How can we answer these questions at costs that retain the project's economic viability?
- Gather and summarize existing information on monitoring techniques and their effectiveness in use at offshore wind facilities worldwide
- Evaluate the applicability of these methods for use under the Cape Wind proposed action
- Specify requirements for pre-construction (post lease):
  - tracking of movements, travel corridors, and flight trajectories of terns and plovers in and around Nantucket Sound and the proposed project area

[1] Formerly known as the Minerals Management Service (MMS)

- testing the effectiveness of anti-perching devices, radio telemetry, and acoustic monitoring to detect Roseate Terns, Piping Plovers, other avian species (including Red Knot) and bats in the proposed project area

- Specify requirements for post-construction:
  - tracking of movements, travel corridors, and flight trajectories of Roseate Terns and Piping Plovers in and around Nantucket Sound and the proposed project area
  - acoustic monitoring to detect presence of Roseate Terns, Piping Plovers, other avian species (including Red Knot) and bats in the proposed project area
  - visual monitoring of the effectiveness of anti-perching devices and altering these devices periodically if needed and based on monitoring results
  - aerial surveys of overall bird abundances and distribution in the proposed project area
  - collision detection through the use of TADS[2] or similar system
- Establish a reporting system which will effectively and timely use the results from the required monitoring to identify future adjustments to monitoring and also drive mitigation requirements.

This ABMP was developed to address these objectives which were originally proposed in the Framework and incorporates changes in consultation with BOEM, USFWS and a group of peer reviewers. The ABMP focuses on migratory birds, federally-listed avian species, and bats. The ABMP is designed to comply with the U.S. Endangered Species Act, Migratory Bird Treaty Act, and corresponding Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds (10 Jan 2001). While this ABMP has been developed primarily to monitor impacts to ESA listed species (Roseate Tern and Piping Plover) the protections afforded to these species will benefit some other species of migratory birds as described in Section 3.3 of BOEM's April 2011 Environmental Assessment.

The purpose of the ABMP is to present the methods that will be used to implement the monitoring program and address the study objectives. Each element of the monitoring program addresses one or more of the following goals as presented in the ABMP conceptual model: mitigation, technology testing and/or assessment of change between pre- and post-construction (Figure 2). The conceptual model provides the overarching framework guiding implementation of the ABMP (Figure 2).

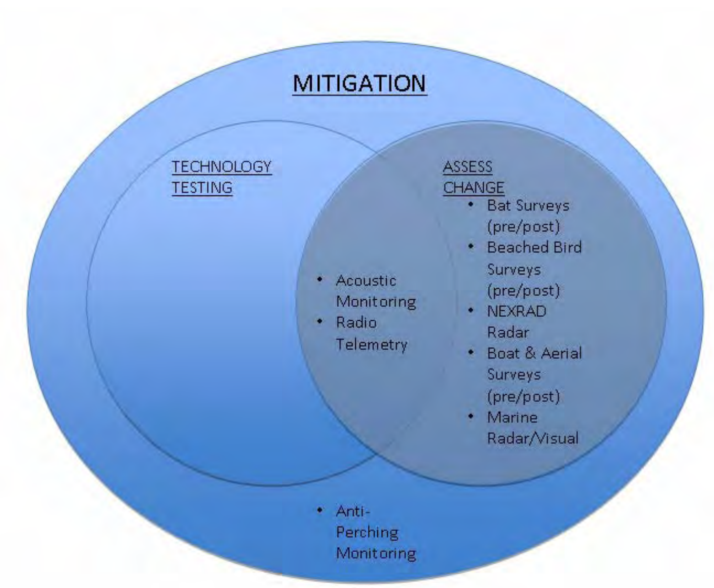


Figure 2. ABMP Conceptual Model.

In keeping with the adaptive nature of the program, the program objectives have been refined since they were originally proposed in the Framework. The ABMP includes study objectives and research

[2] Per BOEM correspondence to CWA dated August 3, 2011, BOEM and USFWS directed CWA not to use TADS and mandated that beached bird surveys and radar studies be used as a substitute for TADS.

questions that will be addressed through pre-construction, construction, and post-construction periods. The ABMP may be further refined with input and assistance from regulatory agencies prior to implementation in the field. The ABMP is intended to have the flexibility to be adjusted as needed based on new information, results of the field programs and/or technical feasibility of program implementation. Thus, the methodology may be altered through the adaptive management approach.

The monitoring protocols are being developed in coordination with BOEM and USFWS and include research (i.e. testing new monitoring techniques on Nantucket Sound), monitoring, and mitigation requirements as a result of previous regulatory review and consultation. The techniques and requirements have been fully vetted by BOEM and USFWS and have been prescribed by these agencies. The Cape Wind project is the first offshore facility proposed in North America and research techniques used in this ABMP will be instrumental in informing the development of future monitoring programs for the offshore wind industry. Previous environmental impact statements have concluded that the Cape Wind project area presents minimal to moderate risk to avian species; therefore, monitoring methods advanced through this ABMP will provide a valuable baseline of technologies that can be used in future project areas.

In accordance with the requirement of the USFWS Biological Opinion, the revised ABMP of September 21, 2011, was peer-reviewed by three subject experts. The peer review included a European scientist with experience monitoring off-shore wind projects. The comments from the peer reviewers were carefully considered and in the majority of cases, led to the revision of the monitoring protocols presented herein.

It is understood that with technological advances and as more information becomes available, CWA will work in consultation with BOEM and USFWS and may make adjustments that may become necessary to improve the plan over time. This will be accomplished, in part, through a reporting system that is aimed to effectively and in a timely manner use the results to identify future adjustments to monitoring and to drive mitigation requirements. The adaptive management approach outlined in the ABMP will provide flexibility to respond to unforeseen challenges that may arise during the implementation of the monitoring protocols. A monitoring technique may be modified or reconsidered based on technical feasibility during implementation.

1.2 Permits Required to Implement ABMP

The permits listed in Table 1 below may be required in order to implement the ABMP.

Table 1. List of permits required to implement ABMP.

Permit	Issuing Authority	ABMP Component	Status
Federal Bird Banding Permit	United States Geological Survey	Telemetry	Application to be filed
Federal Migratory Bird Scientific Collection Permit	USFWS	Telemetry & Beached Bird Surveys	Application to be filed
Federal Scientific Purposes, Enhancement of Propagation or Survival (Recovery) Permit	USFWS	Telemetry & Beached Bird Surveys	Application to be filed

Monomoy National Wildlife Refuge Special Use Permit	USFWS	Telemetry	Application to be filed
Waquoit Bay National Estuarine Research Reserve	To be determined	Telemetry	May be required depending on final location & size of ARTS
State Scientific Collection Permit	Massachusetts Division of Fisheries & Wildlife	Telemetry	Application to be filed
Massachusetts Bird Banding Permit	Massachusetts Division of Fisheries & Wildlife	Telemetry	Application to be filed

2.0 PRE-CONSTRUCTION PROTOCOLS

The pre-construction program consists of five components: radio telemetry, acoustic monitoring, anti-perching monitoring, bat surveys, and beached bird surveys. The pre-construction work will serve as a pilot study to provide information to evaluate data collection methods and help in the development of an appropriate post construction study design (NWCC 1999). The goal of some of the pre-construction programs is to field test the effectiveness of the monitoring techniques and evaluate their use for post construction monitoring. The goal of the remaining programs is to collect data that can be used to measure changes between pre- and post-construction conditions. The pre-construction acoustic monitoring and radio telemetry programs are primarily designed to test the effectiveness of the technology, though we do expect to collect useful data. Anti-perching monitoring is a mitigation requirement, which focuses on the effectiveness of perching deterrents. The beached bird and bat surveys have been designed to collect data on metrics that will be used to evaluate the potential effects of the wind farm on birds and bats.

The pre-construction program is expected to begin in April 2013 and continue through the calendar year. The different components are broken down by month below.

Table 2. Preconstruction Program Schedule 2013–2014

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Beached Birds												
Bat surveys												
Anti-perching monitoring												
Acoustic monitoring												
Tern capture and tagging												
Tern tracking (12 times)[3]												
Semipalmated plover capture/tagging												
Semipalmated plover tracking (twice weekly)												

[3] Tern tracking duration may end sooner if tagged birds depart Nantucket Sound before the middle of September.

2.1 Radio Telemetry

Piping Plover (threatened) and Roseate Tern (endangered) are found seasonally within Nantucket Sound. Pre-construction radio telemetry will be used on surrogate species, Semipalmated Plover and Common Tern (Massachusetts special concern), to assess the feasibility and safety of tracking Piping Plovers and Roseate Terns post-construction. The work will focus on testing the effectiveness of this research technique. Cape Wind will work with the Massachusetts Division of Fisheries and Wildlife (DFW) and USFWS to further develop and implement the plan.

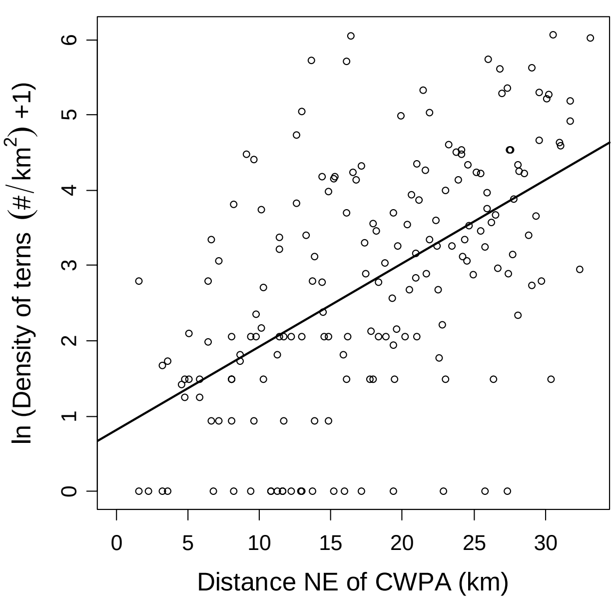
Cape Wind is currently consulting with an experienced United States Geological Survey (USGS) research biologist on the Northeastern Roseate Tern Recovery Team who has over thirty years of experience capturing and banding birds. This research biologist would assist Cape Wind to secure regulatory permits and oversee all tern capture and tagging. Cape Wind is also currently consulting with a piping plover expert recommended by the USFWS to oversee plover capture and tagging. The plover expert will also assist Cape Wind with the permit applications needed for the plover radio telemetry program.

Roseate Tern Background

Roseate Terns do not nest at or immediately near the Cape Wind project area. The project area is not within the foraging range of any major Roseate Tern nesting colonies and is likely only within the foraging range of other terns nesting on the Monomoy Islands (USFWS 2008). Prior research suggests that both Common and Roseate Terns forage and transit in greater numbers in areas outside of Horseshoe Shoal than within Horseshoe Shoal.

During the permitting process for the project, Cape Wind and MassAudubon flew 37 aerial surveys during the tern fall staging period from 2002 to 2004 (ESS 2006). The data show significantly higher tern density in the northeast portion of Nantucket Sound. A regression analysis shows that as distance from the center of the Cape Wind project area increases northeast, the density of terns also significantly increases (slope = 0.11, $r^2 = 0.29$, $F_{(1,179)} = 74.99$, $P < 0.0001$) (Figure 3).

Figure 3. Density of terns regression analysis for distance northeast of Project Area.



However, Roseate Tern foraging activity and commuting flights do occur over Horseshoe Shoal when terns arrive in late April to early May (Gochfeld et al. 1998) and during the post-breeding period (July-mid-September).

During the early part of the post-breeding period, also known as the staging period, Roseate Terns leave their nesting colonies and disperse widely to feed, rest, and roost prior to fall migration. The principal staging area for the majority (50-60%) of the Northwest Atlantic population of Roseate

Terns is the tidal flats in and around southeastern Massachusetts (Harris 2008). These areas include the northeast corner of Nantucket Sound and South Beach in Chatham near the colony-site on south Monomoy Island. Large numbers of post-breeding terns also gather at the western end of Nantucket and the nearby islands (Hatch and Brault 2007). Terns in lesser numbers are reported by Trull et al. (1999) in other Massachusetts coastal locations.

The Massachusetts Audubon Society's Coastal Waterbird Program, Antioch New England, and US Geological Survey Patuxent Wildlife Research Center began a multi-year study in 2007 to better understand Roseate Tern habitat use and post-breeding movements across southeastern Massachusetts. In the first year of study, staging areas and habitat use followed existing staging patterns as described in the literature (Trull et al. 1999) and counts made by birders in the region (Bird Observer and Massbird database). In 2007, thousands of terns staged at Sippewissett Marsh, Falmouth (eastern Buzzards Bay) and regularly on Long Beach, Plymouth (western Cape Cod Bay). In 2008 the study documented terns having much higher abundance on outer Cape Cod staging sites (Hatches Harbor, Provincetown and the Nauset Marsh Complex, Orleans and Eastham) than previously reported (Harris 2008). The data suggest that post-breeding movements are complex, with back-and-forth travel among staging areas and annual variation reflecting prey availability (Hatch and Brault 2007). Staging areas are further discussed in Section 2.1.2 Methods and Schedule and shown in Figure 6. Tern Staging Areas 2010.

Piping Plover Background

Piping Plovers are beach dwellers and are found widely around the coastal areas of Nantucket Sound with a particular concentration on South Monomoy in Chatham (Melvin and Mostello 2007). Approximately 50 extant Piping Plover breeding sites are located along Nantucket Sound (USFWS 2008). Plovers feed and nest on beaches and are not thought to spend much time in offshore areas during the breeding season. Aerial surveys conducted by CWA and MAS (2002-2006, including 52 non-winter aerial surveys and 44 non-winter boat surveys) detected few shorebirds offshore. Paucity of shorebird observations and absence of Piping Plovers may reflect limitations of survey methods, but it is also plausible that shorebirds, including plovers, make infrequent use of Nantucket Sound (USFWS 2008).

Plover migration corridors along the coast are not well known. Widespread observations of plovers roosting and foraging on beaches throughout their Atlantic Coast range during spring and fall support the hypothesis that migration routes follow the coastline (USFWS 1996). Piping Plovers are relatively sedentary in their breeding areas, but behavior during the intervening periods is largely unknown (Elliott-Smith and Haig, 2004). No observations have been reported of plovers crossing Horseshoe Shoal during the Cape Wind and MassAudubon aerial and boat surveys, but they may do so during migration or post-breeding dispersal. The presence of plovers breeding on Nantucket and Martha's Vineyard indicates that plovers do make over-water crossings. Nantucket and Martha's Vineyard may also provide migration stop-over habitats (BOEM 2009).

Radio Telemetry Background

Radio telemetry is the most thoroughly developed technique with the longest history of use in wildlife tracking studies. Procedures to track wildlife by airplane were outlined nearly 30 years ago by the USFWS (Gilmer et al. 1981). Roseate Terns (Rock et al. 2007) and Piping Plovers (Cohen et al.

2008; Drake et al. 2001) have been successfully tracked using radio telemetry. Perrow et al. (2006) used radio tracking to assess Little Tern (55g) foraging territories near the most important breeding colony in the United Kingdom in relation to a wind farm two kilometers away. Radio-tracking is referenced as one of the most appropriate techniques to monitor offshore birds for offshore wind projects (Walls et al. 2009).

Despite radio telemetry's demonstrated effectiveness in wildlife tracking studies, there are several factors that may make the collection of useful data challenging in this study. Transmitter weight and battery life have greatly improved, but the study length (approximately 77 days for terns and 45 days for plovers) is near the end of the battery life of the transmitter. The small sample size and potential for tag failure or loss may limit the ability for statistical analysis of the survey results. Furthermore, if detrimental affects to the birds are caused by the radio tags, the usefulness of radio tracking may also be limited. Annual and within-year variability in tern staging areas may also increase the difficulty in tracking terns. However, the object of the research is to inform the feasibility of the technologies in the project area and the planned research is expected to provide useful feedback on the technology and the protocol.

2.1.1 Study Objectives

The objective of the pre-construction telemetry study is to test and refine the use of radio telemetry on surrogate species that have the closest behaviors and life histories to the Roseate Tern and Piping Plover. The surrogate species were identified through consultation with USFWS during the ESA Section 7 Consultation. Common Tern will be used as a surrogate for Roseate Tern and Semipalmated Plover for Piping Plover. If this radio tag attachment proves satisfactory and safe to these similar species, radio tags will be attached to Roseate Terns and Piping Plovers in subsequent years subject to the approval of USFWS and Massachusetts DFW.

A secondary objective of the pre-construction radio telemetry as outlined in the Framework is to track the post-breeding movements, flight trajectories and travel corridors of Common Tern and Semipalmated Plovers in and around Nantucket Sound and the project area. The aim is to evaluate radio telemetry's potential for subsequent use on Roseate Terns and Piping Plovers to track post-breeding movements. Tracking methods using automated radio-tracking systems (ARTS) (Green et al. 2002) will also be tested and refined during the pre-construction monitoring program.

2.1.2 Methods and Schedule

Twelve Common Terns and twelve Semipalmated Plovers will be tagged with radio transmitters and tracked by airplane. Stationary receivers will be mounted on the Cape Wind meteorological (MET) tower near the southern end of the project area and two local beaches as described below (Figure 5). Mobile tracking by airplane, rather than by boat, is likely the most advantageous method given the large geographic area. Common Terns will be tracked at least 12 times between July 15 and September 30 (77-day duration) However, the latest research suggests that Common and Roseate Terns may be departing for migration earlier than previously reported in the literature (J. Spendelow, personal communication 2011). Cape Wind will consult again with Dr. Jeff Spendelow of USGS who is currently examining tern departure dates on Cape Cod. Tracking duration and frequency will be dependent upon tern and plover departure dates and the life of the transmitter batteries. Semipalmated plovers will be tracked twice weekly during the month of August (31-day duration).

At the request of BOEM and USFWS, the first aerial surveys will begin immediately (within 24 hours-weather dependent) following the attachment of the radio tags so that birds will not be missed before they migrate out of the area.

Bird Capture

The North American Bander's Manual for Banding Shorebirds (Gratto-Trevor 2004) was the primary source consulted to determine a suitable method to trap plovers and terns. Shorebirds are considered nongame migratory birds and so are subject to the U.S. Migratory Bird Treaty Act. Therefore, CWA will first apply for a banding permit from the U.S. Bird Banding Laboratory (United States Geological Survey [USGS], PWRC, Bird Banding Laboratory, 12100 Beech Forest Road, STE-4037, Laurel, Maryland 20708-4037, USA) to band the target species. Work may occur on Monomoy Island which would require obtaining a National Wildlife Refuge Special Use Permit. Additional permission from the banding office will be needed to use radios tags. CWA will apply for the following permits:

- Federal Bird Banding Permit, 50 CFR parts 13 and 21 from USGS – this permit covers bird capture and banding with leg band. CWA will also request to use auxiliary markers such as color bands, on captured birds.
- Federal Migratory Bird Scientific Collection Permit, 50 CFR Parts 10, 13, 21.23 from USFWS– this permit covers the attachment of the radio transmitters to captured birds.
- Federal Scientific Purposes, Enhancement of Propagation or Survival Permits (i.e. Recovery Permit)—this permit covers working with federally-listed species
- Massachusetts G.L. c. 131, Sec. 4(2) State Scientific Collection Permit (Commercial) from the Massachusetts DFW – this permit will cover the capture and attachment of radio tag birds under state law. Additional approval will be necessary to collect Common Terns, a state-listed species of special concern.
- Massachusetts G.L. c. 131, Sec. 4(2) Massachusetts Bird Banding Permit from the Massachusetts DFW – this permit covers bird capture and banding with leg band.

Common Tern Capture

Common Terns will be captured during the post breeding period (mid July) on one of the various staging areas on Cape Cod. A staging area is defined as an area where concentrations of mixed species of terns, predominantly Common and Roseate, spend the daylight hours resting and feeding (Trull 1998). Potential capture locations include South Cape Beach, Mashpee Popponesset, Mashpee or South Beach, Chatham. Cape Wind will consult with DFW and USFWS to locate publicly accessible staging areas to trap Common Terns. A number of techniques may be used to capture Common Terns including drop nets or whoosh nets. The first choice is to use drop nets over a loafing area. Capture techniques and locations will remain flexible to address the uncertainty of when and where Common Terns will be encountered and subsequently trapped and will be addressed in capture permit applications.

Semipalmated Plover Capture

Semipalmated Plovers do not nest in Massachusetts, but are found along intertidal flats and sandy beaches from late July to early September. A number of techniques may be used to capture plovers including drop nets, whoosh nets, funnel traps and/or bal-chatri (noose carpet) (Fraser 2010, Drake et al. 2001). Locating publicly accessible areas to trap Semipalmated Plovers will be done in consultation with DFW and USFWS. A possible capture location is on the Monomoy Islands or South Beach in Chatham. Drop nets over intertidal feeding areas are the first choice for capture. Capture techniques and locations will remain flexible to address the uncertainty of when and where Semipalmated Plovers will be encountered and subsequently trapped.

Bird Tagging

Birds will be removed from the trap or net by hand using the bander’s grip (upright, with the bird’s head between the bander’s index and middle finger). Glue will be used to attach transmitters to the bird. Other tern and plover researchers have used either a transmitter attached to a leg band or a transmitter glued directly to a bird’s back (Rock pers. comm. 2009, Black pers. comm. 2009, and Mostello pers. comm. 2010, Cohen et al. 2008; Drake 2001). Based on recommendations from the USFWS, the transmitter will be glued directly on to the back of the terns and plovers.

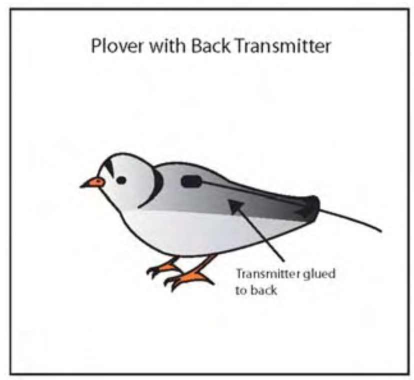


Figure 4. Glue-on Back Transmitter.

The effective duration of the glue attachment has been found to vary but the transmitter is not permanently attached and will eventually fall off over time. Black (pers. comm. 2009) found that tags glued on the back of Roseate Terns fell off after a few weeks. Cohen found that transmitters attached to backs of Piping Plovers have a mean retention of 17± 7 d (range 3-57 d) (Cohen et al. 2008). Ultimately the health of the birds will be the overriding factor in determining the best tagging technique with the least detrimental impact. Our objective will be to use only enough glue necessary to keep the transmitters attached for the study periods. The adhesives have been shown to deteriorate over time, which allows the transmitters to eventually fall off.

Using the glue-on back method, feathers on the back will first be clipped or trimmed as necessary to create a suitable area for transmitter attachment. The radio transmitter will then be glued to the back of the bird using cyanoacrylate glue (DUROQuick Gel® Henkel Consumer Adhesives, Inc., Avon, OH (Figure 4). Attaching transmitters is a two-person job (Warnock and Warnock 1993). One person will hold the bird in the left hand with the head between the second and third fingers, and the wings between the first and second fingers and third and fourth fingers, leaving the right hand free for clipping. Scissors will be used to clip a 10 mm length of the posterior element of the dorsal feather tract, about 5 mm above the uropygial gland. The second person will mix the epoxy for 1.5 minutes and then apply the epoxy to the bird and radio tag. Epoxy is placed on the cleared area on the bird’s back with a flat toothpick. Epoxy will also be applied to a radio tag after it has been scored with sandpaper. The tag will be held in place for approximately one minute until a firm bond is set.

Bird bands will be obtained in coordination with USGS from the Patuxent Wildlife Research Center. The bands come in various sizes and are inscribed with a unique eight or nine digit number. Semipalmated plovers will be banded with size 1A or 1B bands. Common Terns are likely to be already banded by DFW. The butt-end band, a round band with two edges that butt evenly together when closed correctly, will be used. The band will be made of a hard metal, typically stainless steel, monel or incoloy, which will last longer in the salt-water environment than standard aluminum bands.

Bands will be attached using the following methods as outlined in the *North American Bird Banding Manual* (Gustafson et al. 1997). The band will be placed on the tarsus and, when closed, should be free enough to move up and down without abrasively rubbing either round or elliptical tarsi. Closed butt-end bands, lock-on, and any other closed bands will be opened before being placed on the bird's tarsus. When placed on the tarsus, the ends of the closed band should meet tightly and squarely. Special banding pliers will be used to close bands tightly. Care will be taken that the band numbers are not marred in the process of closing the band. Care will be taken to ensure that the ends of the band do not overlap. The right band size gives a proper fit when it is closed with butt-ends meeting tightly. Lock-on bands can be squeezed shut with the fingers and the flange folded over with a pair of pliers.

As wear on the band will likely occur along the bottom edge where the band number normally would rest, the band may be applied upside down on the bird's foot. This will place the band numbers farther from the wearing edge.

Radio Tags

Following research into radio tag manufacturers, availability, applicability to species and input from DFW and USFWS, the following recommendations are made. The weight of the tag as a proportion of the body mass of the bird needs prime consideration when selecting an appropriate tag (Walls et al. 2009). Guidelines suggest that the tag should not exceed 3% of the body mass of the tagged bird (Wall et al. 2009; Gaunt and Oring 1997). Accordingly, plovers and terns will be tagged with the Holohill BD-2 1.2 g tags based on weight and battery life given a pulse rate of 40 ppm (Table 2). The 1.2 g tag weight for plovers is comparable to tags used on Plovers by Cohen et al. (2008) and transmitters used by Drake et al. 2001. The 1.2 g tag for terns weighs (0.1 g) more than tags used (leg attachment) by Rock et al. (2007), but is less than the range of geolocator weights (1.7-2.0 g) (leg attachment) placed on Common and Roseate Terns by Massachusetts DFW (Mostello pers. comm. 2010). Radio tags would be placed on the largest individuals to minimize potential effects to birds. Late season breeders will not be targeted for tagging since these are typically younger, less experienced breeders that might be more susceptible to potential impacts from tags. The distribution between male and female birds will be further developed with USFWS and DFW. The tradeoffs of battery life versus weight, study period, and effects of tags on birds and adhesive duration will continue to be evaluated through the pre-construction year of monitoring. Ultimately, the tag size and model utilized will be selected in consultation with USFWS and DFW.

Table 3. Recommended Radio Tags for Radio Telemetry Study.

Radio Tag	Target Species	Mean Species Weight (g)*	Percent Body Weight	Nominal Battery Life	Estimated Study Period**
BD-2 1.2 g	Semipalmated Plover	53 (fall weight)	2.3%	63 days	45
BD-2 1.2 g	Piping Plover	53 (43-63)	2.3%	63 days	45
BD-2 1.2 g	Common Tern	123.0 ± 8 male 127.2 ± 9.7 female	1.0%	63 days	92
BD-2 1.2 g	Roseate Tern	112.5 (88-139)	1.1%	63 days	92

*Nol and Blanken 1999, Elliot-Smith and Haig 2004, Nisbet 2002, and Gotchfeld et al. 1998
**Study period includes a two week period for attaching the transmitters and evaluating bird health.

There is little data on the effects of transmitters on plovers or terns. Rock et al. (2007) found that leg-mounted transmitters representing <1.2% body weight for Common, Artic and Roseate Terns did not compromise reproductive success, though direct impacts (i.e. weight loss) to tagged birds were not assessed. The Massachusetts DFW has encountered significant weight loss in Common Terns tagged with geolocators, whereas similar affects were not apparent with Roseate Terns (Mostello pers. comm. 2010). The literature also has little data on the effects of radio tags on Semipalmated or Piping Plovers. The health of tagged birds will be assessed prior to tracking. Protocols for measuring effects of tagged birds will be further developed with USFWS and Massachusetts DFW.

Radio-tracking Methods

Tagged birds will primarily be located from the air using the ATS R4500S receiver, which functions as a datalogger and Global Positioning System (GPS) unit and toggles between tracking antennas. The R4500S receiver will record the time and signal strength of each transmitter located. A 3-Element folding Yagi antennae will be used to track radio tag signals during the survey. Two antennas will be needed, one to attach to each wing strut on either side of the airplane. The antennas will be attached using standard kits available from Advanced Telemetry Systems, Inc.

Three automated radio-tracking systems (ARTS) (Green et al. 2002) with data logger will be installed; one on the Cape Wind MET tower, one at a public beach on Waquoit Bay and one at Monomoy Island to assess presence/absence of tagged birds (Figure 5). These locations were selected to provide broad coverage of the areas where terns are expected to transit. The Waquoit Bay and Monomoy sites were also selected since they are located within past tern staging areas on publically-owned lands (Figure 5). The receivers will be fitted with a 1.2-m multi-directional antenna. The ARTS will collect continuous data throughout the study period (mid-July through mid-September). The receivers will continually scan through transmitter frequencies and store data when a transmitter comes into range (2-5 km per Advanced Telemetry Systems).

Transmitter range will vary whether the receiver station is used from the air or from one of the ARTS stationed on land or the MET tower, which is 10 m above sea level. Green et al. (2002) studied Bar-tailed Godwits in Sweden tagged with Holohil BD-2G 1.75 g transmitters. The transmitters were detected by ARTS 3-4 km away when a plane flew by with transmitters at a 100 m altitude.

Aerial radio telemetry tracking will be conducted using a high-winged aircraft such as a Cessna 172, Cessna 182, Cessna Super Cub or a Cessna Skymaster. Tracking involves flying at low altitudes and low speeds. An aircraft will be chartered and take off from the Barnstable Municipal Airport on Cape Cod, Massachusetts. Because Common Terns and Semipalmated Plovers may be found in different shore areas, the flight plan will depend on the species being tracked. For terns, the aerial survey will initially focus by flying over known staging areas where the birds are tagged on southern Cape Cod, Nantucket, and Martha's Vineyard (Figure 6). If tagged birds are not found during this initial flyover, the survey area will be expanded to include known staging areas further north in Provincetown and west in Plymouth, Massachusetts. The tracking method may be modified depending on the success of locating tagged birds and their location. Flights for plovers will initially focus on the southern side of Cape Cod and Monomoy Island. If tagged plovers are not found during the initial flyover, the survey area will be expanded with flights over the north side of Nantucket and Martha's Vineyard.

As described in Gilmer et al. (1981) and implemented by Ackerman et al. (2009) and Rock et al. (2007), basic aerial survey methods are the following:

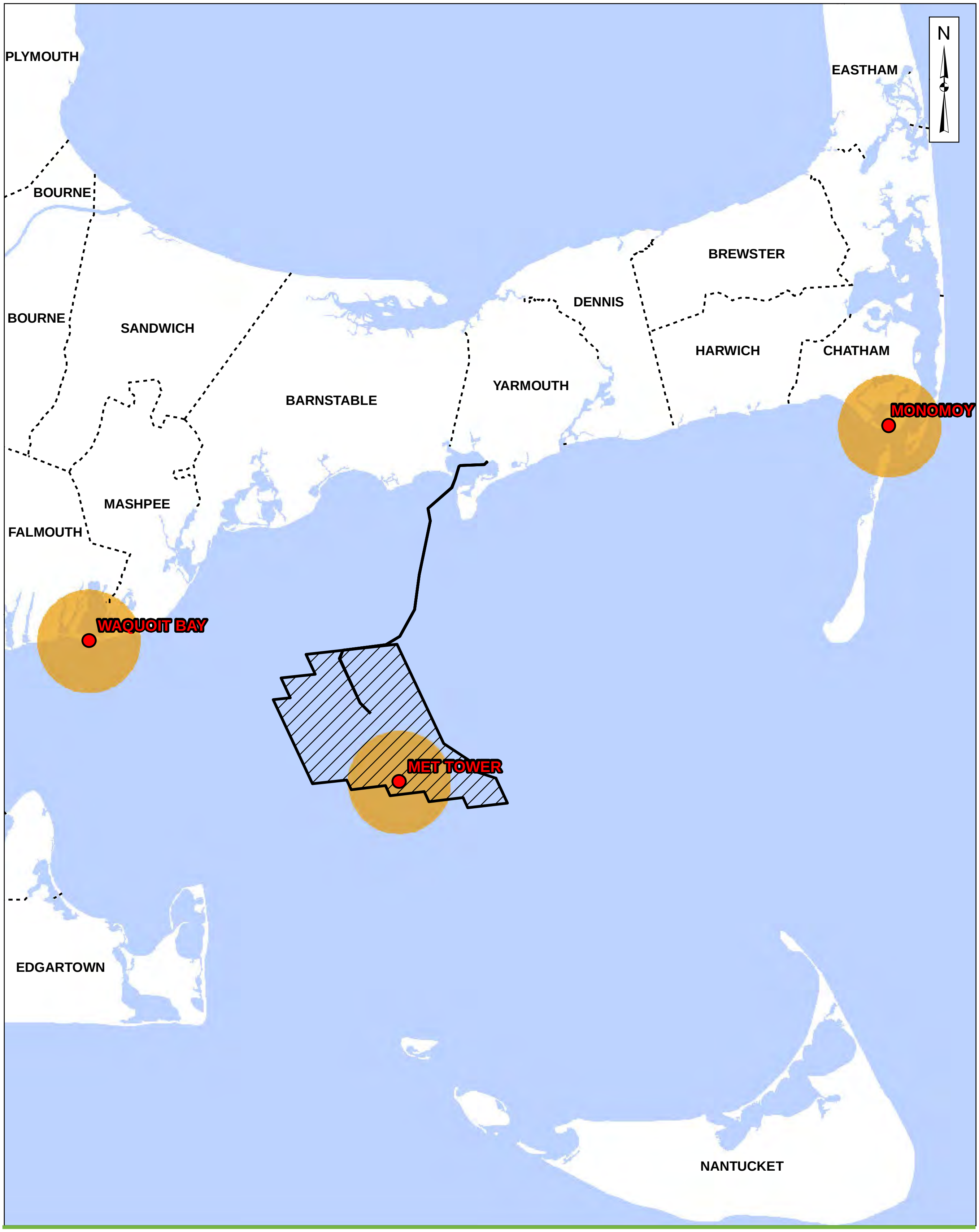
1. Receiver operator will begin the search with the switchbox set to "both" right-wing and left-wing antenna to cover both sides of the aircraft.
2. At start, the RF gain (adjustment for receiver sensitivity) will be set to the maximum setting.
3. Aircraft altitude should be low, between 150 to 300 meters.
4. Operator will scan through various transmitter frequencies until a steady signal is received.
5. After receiving a signal, the receiver operator will switch the switchbox between the left and right signal to determine which side the signal is coming.
6. The aircraft will then be directed to fly in the direction of the signal (to the right or left) and the switchbox is set back to the "both" setting. Flying straight towards the signal will cause a signal null.
7. As the aircraft gets closer to the transmitter, the signal strength will increase again and at this point the operator can begin to pinpoint the location of the bird.
8. The receiver operator will again toggle between right and left switches to determine on which side of the airplane the bird is located. The RF setting may need to be turned down at this point since the target is closer and louder.
9. Based on which side is stronger, the pilot will be directed to make a 360-degree turn. If the signal strength remains consistently strong on the same side, then the target bird is located within the radius of the airplane's 360-degree turn.
10. Circling and toggling between left and right switches will continue until the bird is located.

11. After the bird is located visually, its position will be recorded using GPS. Tagged birds will be tracked and located with GPS until they begin foraging, stop to rest, or reach land. CWA will seek to equally balance the number of times each tagged bird is located in order to minimize bias from over-representation of any single bird.

Surveys will last for a maximum of four hours to avoid operator fatigue and optimize available fuel. Depending on the number of birds tracked and the distance they are followed, it may not be possible to track each bird during every survey. Flight plans may need adjustment based on tagged bird locations and movements. We anticipate that approximately 25% of each four-hour flight will cover the project area; however, this percentage may increase or decrease depending on where signals from tagged birds are received.

In addition to using ARTS and aerial surveys to track tagged birds, Cape Wind will also coordinate tracking with shorebird monitors from the Massachusetts DFW and MassAudubon. These monitors may be able to spot birds with transmitters and report their positions to Cape Wind.

Location: G:/GIS-Projects/E159/00-mxd/504/Birds/Bird-Sens-Locs-PreConstr2.mxd



CAPE WIND

Nantucket Sound, Massachusetts

Source: 1) MassGIS, Town Data, 2002
2) ESS, Cape Wind Project Data, 2006-11

Legend

- Automated Radio-Tracking System (ARTS)
- Cape Wind Submarine Cable
- Cape Wind Project Area
- ARTS 3 Kilometer Radius Estimated Range

Pre-Construction Locations for Automated Radio-Tracking System

Figure 5

Location: G:/GIS-Projects/00-mxd/504/Bird/Tern_Staging_areas.mxd

AVIAN MONITORING PLAN
Cape Wind Project
Nantucket Sound, Massachusetts

Tern Staging Areas 2010

0 10 Miles

ess group
environmental consulting
& engineering services

Source: 1) Tern Staging Locations,
Compilation from Trull et al. 1999, NHESP, 2007 and Jedrey et al. 2010 (MassAudubon),
Roseate Tern Recovery Team, 2007, MMS Biological Assessment, 2008

Figure
6

Methods to Assess Sufficiency of Negative Data

Prior to initiating the study, CWA will conduct a trial survey to assess the range and detectability of the radio tags in an offshore environment. Tags will be placed in known locations and a field team will test the range of the radio tag signal by scanning for its frequency at varying distances from an airplane. The range of the ARTS on the MET tower and land will also be examined by measuring the detection range of transmitters from a boat. A logistic regression using distance to the radio tags as the independent variable and "detection" or "no detection" as the response variable will determine the approximate distance that radio tags can be detected using the final ABMP radio tracking methods and equipment. These results will help guide future radio tracking efforts.

2.1.3 Data Analysis

The data collected during the telemetry surveys will be downloaded from the receiver and imported into Excel for further processing using the basic software package ATSWinrec available from Advanced Telemetry Systems. During the survey, the receiver will be set to the aerial mode. The following data is collected when in aerial mode.

- Year, month, hour, minute, second (in separate fields within the excel spreadsheet)
- Transmitter frequency
- Signal strength
- Number of pulses received during the recorded scan
- Pulse rate of detected transmitter
- Number of valid pulses during scan
- Calculated measurement from variable rate transmitters
- X and Y coordinates if GPS is used (this will be X & Y of airplane)
- How long ago GPS position was taken in seconds

This pre-construction study is intended to serve as a pilot study that will be used to gather preliminary data that can be used to refine post-construction survey methodology. Multiple observations of the same tagged bird during the study will be treated as dependent observations. This raw data will be uploaded into Ranges software (or other similar software) for further processing. The GPS coordinates of bird sightings will be loaded into the software for habitat maps, ranges and other analyses to be completed. Maps that include polygon overlays of tern and plover use of the project area and the surrounding area based on the telemetry surveys will be produced. The geographic information systems extension tool, Animal Movement, may also be used to analyze results. Data will be presented to show concentric circles around 95% of observations, 75% of observations and 50% of observations (See Figure 2 in Rock et al. 2007 for example). The 50% density circle will show the greatest concentration of tern and plover locations.

Data from the ARTS on the Cape Wind MET tower, Waquoit Bay, and Monomoy Island will be downloaded and processed to determine the presence/absence of the tagged birds passing within the vicinity of the ARTS. Passage rate will be the metric used to compare results from each detector. Pre-construction ARTS data analysis methods will be refined for use during post-construction.

The telemetry results will be used in conjunction with acoustic monitoring, beached bird surveys, aerial surveys, boat surveys, NEXRAD radar, marine surveillance radar and visual observations in order to develop a clearer understanding of collision risk and changes in avian distribution in the project area.

2.2 Avian Acoustic Monitoring

As prescribed in the Framework, the purpose of the acoustic survey is to test the feasibility of using the technology in the offshore environment, collect presence/absence data on bird species, and identify bird calls to species when possible. Bird calls can be recorded and analyzed to determine species occurrence. However, the use of acoustic technology may have limitations offshore. These limitations include the bias of the recording unit to collect calls from louder and lower-flying birds and interference from ambient background noise from wind, waves, and precipitation (Walls et al. 2009).

Farnsworth and Russell (2005) set up two pressure zone microphones (PZMs), housed in flower pots for protection, on an offshore oil platform in the Gulf of Mexico in the fall of 1999. The purpose of the study was to evaluate an acoustic recording method to study nocturnal bird migration over the Gulf of Mexico. The range of the PZMs varies with weather conditions but generally records in the 6-9 kHz range with a cone of detection 300 meters high and 250 meters wide, and the 2-5 kHz range with a cone of detection 600 meters high and 1000 meters high (Farnsworth and Russell 2005). The study results and conclusions illustrate some of the challenges of offshore acoustic monitoring as well as some of its potential. Challenges included the failure of one of the PZM units shortly after deployment. Several nights of data collected had to be rejected due to unfavorable recording conditions. Ambient background noise also reduced the efficiency of the PZM unit and limited the recording frequency primarily to 6-9 kHz, which reduced the number of species that could be detected. Thus, offshore acoustic monitoring studies need to account for ambient background noise and methods to reduce its influence on recordings. Despite the challenges faced during this pilot study in the Gulf of Mexico, offshore acoustic monitoring does have potential, as the equipment successfully recorded bird calls, and the microphone and its energy supply did not show any signs of corrosion after operating for 41 nights.

Hill and Hüppop (2008) installed directional microphones (Sennheisser ME67) on the research platform FINO 1 in the southeastern North Sea approximately 45 km north of the Eastfrisian island Borkum. Special software was developed for automatic detection and registration of calls to overcome the impacts of noise from wind, rain, and waves. The microphones collected 73,506 files of bird calls between 2004 and 2007. The data showed clear time patterns of migration for many species including Common Terns, both seasonal and daily (Hill and Hüppop 2008).

2.2.1 Study Objectives

Because acoustic technology requires additional field testing to determine whether it can provide useful data, the pre-construction study will focus on the effectiveness of the technology. If successful, acoustic monitoring may provide useful species-specific occurrences of migratory or resident birds. CWA will collect and analyze pre-construction acoustic data to address the following study objectives:

- Determine whether it is possible to acquire useful data using acoustic equipment to record bird calls given the potentially high ambient background noise levels in the offshore environment.
- The equipment will collect presence/absence of Roseate Terns, Piping Plover and other migratory birds if possible.
- Determine the range at which acoustic monitoring equipment is able to detect bird calls.
- Determine any necessary modifications to the acoustic monitoring set-up or protocols to collect more valuable data during future monitoring efforts.

2.2.2 Methods and Schedule

The acoustic monitoring system will be developed in consultation with Andrew Farnsworth, PhD, of the Cornell Lab of Ornithology or another avian acoustic expert. A total of six Autonomous Recording Units (ARUs) will be deployed during this pre-construction study as follows:

At the MET tower, the acoustic monitoring program will run from May through October and at least three 24-hour intervals from November to April. To improve reliability, two ARUs will be set up on the MET tower prior to construction. Each ARU consists of a microphone, amplifier, frequency filter, programmable computer, software that schedules, records, and stores the data, and a disk drive to store the data. Each ARU microphone will be covered with a wind screen to reduce ambient background noise and the ARU will be placed in a flower pot on the deck of the MET tower. It may be possible to arrange the ARUs to estimate the elevation of the bird when the call is made. It is assumed that the ARUs will be able to be placed on the MET tower at a height above the ambient background noise of waves. The height of the MET tower deck is 10 meters above mean low water (elevation 0.0 NAD 83). The exact range of the ARUs is uncertain, but with the microphones positioned at 10 meters above the water on the deck of the MET tower, the expected range is several hundred meters. The ARUs can run for up to 70 days off D-cells or 12-volt batteries. The ARUs will be retrieved at the end of the study period and the data will be downloaded.

Additionally, one ARU will be placed in a Roseate Tern breeding colony and one ARU will be placed near a Piping Plover nesting area. These data will be used to verify the effectiveness of acoustic microphones for detection of these species and discrimination among other shorebird species.

Two ARUs will be placed under the existing operational wind turbine at the Massachusetts Maritime Academy (MMA) in Bourne, Massachusetts. The objective of the study is to determine if the noise of the turbine blades affects ARUs from detecting bird calls. The ARUs will run in April, May, September, and October to capture calls from neotropical migrants. A standard noise meter will also run to capture the background noise of the turbine blades, wind, and waves from the nearby bay. The results of the noise meter will be compared to the effectiveness of the ARUs in determining noise effects of the turbine blades.

Methods to Assess Sufficiency of Negative Data

Methods to assess the sufficiency of negative data were developed in consultation with Dr. Andrew Farnsworth. An initial noise survey using a calibrated noise meter will be conducted on the MET tower. The noise survey will be conducted under a variety of conditions and will be used to assess the ambient background noise level. The survey results will be analyzed to determine those frequencies that will be difficult to detect using the ARU, given the ambient background noise levels. Following the initial noise assessment, the ARU range and capabilities will be tested using bird call playback units. Bird calls will be played from varying distances from a playback unit mounted on a boat. It should be possible to collect useful data on the ARU range and effectiveness with this initial upfront noise survey and bird call playback (Farnsworth pers. comm. 2010). A logistic regression will be used to evaluate detection of the bird calls from the bird call playback units. Distance from the ARU will be the primary independent variable with the ability to detect the bird call as the response variable. The results of the trial tests will be used to develop and deploy an ARU system that rejects as much noise from the ocean surface as possible.

2.2.3 Data Analysis

Acoustic recordings will be analyzed using a software package (Raven) available from the Cornell Lab of Ornithology. The analysis will be used to identify species, relative frequency of occurrence and altitude if possible.

The acoustic monitoring results will be used in conjunction with telemetry, beached bird surveys, aerial surveys, boat surveys, NEXRAD radar, marine surveillance radar and visual observations in order to develop a clearer understanding of collision and changes in avian distribution in the project area.

2.3 Anti-perching Monitoring

Anti-perching deterrents will be used on the MET tower and subsequently on the electrical service platform and wind turbines to minimize perching opportunities for all avian species (including listed species, migratory, and other resident species). The USFWS Biological Opinion notes that some raptors prey on terns, and if anti-perching measures are ineffective, it may provide these raptors perching locations that would allow them to intercept transiting terns more easily. If anti-perching measures prove effective, then the effects from any increased predation will be discountable (USFWS 2008).

As prescribed in the Framework, the purpose of anti-perching monitoring is to evaluate the effectiveness of various bird perching deterrents that will be field-tested on the MET tower prior to the construction of the wind park. In accordance with the Framework and the lease agreement issued to CWA for the project, the perching deterrents are required as a form of mitigation for the project. These deterrents include a fence to prevent access from the side, a stainless steel wire on top of the railing and a 0.65-meter-tall panel to restrict visibility of any avian species from the deck. Bird behavior around the deterrents will be analyzed to determine whether the anti-perching techniques are effective and will guide selection of the anti-perching deterrents that will be used on the wind turbines and electrical service platform following construction. If the proposed deterrent system proves not to be effective, an alternate system may be proposed.

2.3.1 Study Objectives

The cameras proposed for use in anti-perching monitoring have been used in marine environments. The video camera technology has been previously tested and should only require minimal refinement or modification. CWA has identified a video photographer, SeeMore Wildlife Systems/Zatz Works, with extensive experience installing and operating remote video camera systems in harsh wilderness environments. With support from SeeMore Wildlife Systems/Zatz Works, CWA will collect and analyze pre-construction data on anti-perching devices to address the following study objectives:

- Determine the most effective video camera set-up and positioning to provide a view of bird behavior around perching deterrents.
- Determine whether perching deterrents are effective at discouraging birds from landing on offshore structures.

2.3.2 Methods and Schedule

The Framework calls for monitoring of the anti-perching devices on the MET tower with remote video cameras for a length of time that provides sufficient data on anti-perching devices. Monitoring of anti-perching devices will occur from April to October when federally-listed and other migratory birds are known to be present in Nantucket Sound. This time period also coincides with the time period when terns may be present and potentially vulnerable to predation. A remote camera monitoring system produced by SeeMore Wildlife Systems/Zatz Works (or comparable) that is suitable for use in an offshore environment will be installed on the MET tower. The remote camera system will include both thermal and visible light cameras and a microwave transmission system. The thermal camera will be used to evaluate bird behavior around perching deterrents at night and during periods of low visibility. The visible light/thermal camera system will be equipped with trigger mechanisms to limit the amount of data that will need to be reviewed and processed.

A portion of the MET tower will remain free of perching deterrents and serve as a control zone for the study. Perching deterrents will be installed uniformly around remaining areas of the MET tower to serve as the test zone. The camera system will be configured with fields of view focused equally between the control and test zones on the MET tower. The most likely configuration will have the camera system placed centrally on the MET tower focused out towards the boundary between the control and test zones. Although the field of view of the camera system will be limited to a portion of the MET tower, this study design will yield useful data to determine the effectiveness of the perching deterrents.

Data collected from the cameras will be relayed by the microwave transmission system to a remote receiving station that will be set up on the mainland. An appropriate remote receiving station location will be selected in consultation with SeeMore Wildlife Systems/Zatz Works. Finding a site at a relatively high elevation is the key element in identifying an inland location for the receiving station, since the station needs a clear line of sight to the MET tower. From the receiving station, the images/data will be uploaded to an FTP site or e-mailed.

The observations recorded by the cameras will be analyzed to determine whether birds displayed avoidance behavior around the anti-perching deterrents in the test zone in comparison to the control zone. CWA anticipates that after data has been collected, each observation will be classified as either a bird displaying avoidance or attraction behavior. Any bird that lands in either the MET tower control zone or in the test zone with the anti-perching devices will be considered to be displaying "attraction" behavior. Any bird that enters the camera's field of view and does not land in the control or test zone will be classified as "avoidance" behavior. Multiple observations of the same bird will be treated as independent observations. Therefore, it is possible that a bird may display avoidance behavior on one occasion and attraction behavior on another occasion.

Methods to Assess Sufficiency of Negative Data

Prior to initiating the study, SeeMore Wildlife Systems/Zatz Works will conduct several trial tests with the cameras to establish appropriate settings for the triggering software and field of view. This will minimize the number of false positives collected during the actual study. The camera will be field tested to ensure that it captures bird movements near the control and test zones.

2.3.3 Data Analysis

The results will be analyzed to provide recommendations for subsequent studies or alterations to anti-perching devices. The total number of bird observations will be reported as well as an evaluation of bird behavior at the control and treatment sites. A Chi-Squared test will be used to evaluate significant differences in bird (all species observed) avoidance behavior displayed at the control and treatment zones. Additionally, if enough observations are recorded, a logistic regression could be used to evaluate covariates such as bird species and time of day.

2.4 Bat Surveys

A variety of methods exist for observing nocturnal behavior of bats that can be used to determine presence/absence of bats and evaluate bat mortality risk from wind farms. Some of these methods include moon-watching, ceilometry, night-vision imaging, thermal infrared imaging, radar detection, acoustic monitoring, and radio telemetry (Kunz et al. 2007). Each method has its own strengths, weaknesses, and biases that need to be taken into consideration when designing a study (Kunz et al. 2007). There is no method available that can fully assess natural variation in bat populations and the potential impacts of wind turbines (Kunz et al. 2007). The Framework has called for the use of acoustic monitoring (AnaBat detectors) to monitor for bats in the project area.

The ultrasonic calls produced by bats can be recorded and converted into data that can be used to distinguish bat species. The most commonly used recording and data conversion device is the AnaBat detector produced by Titley Electronics Inc. (http://www.titley.com.au/). Although the detector is capable of recording bats at a variety of ranges depending on species and background conditions, acoustic detection of bats introduces several biases related to the intensity and frequency of the calls. Bats vocalize at different intensities; therefore, bats that vocalize at lower intensities will be less frequently recorded than those that vocalize at higher intensities (Kunz et al. 2007). Bats that call at higher frequencies are also detected less than those that call at lower frequencies since higher frequencies are attenuated more rapidly in the air (Kunz et al. 2007). It is also important to note that bat detectors record the number of bat calls rather than an actual number of bats recorded. Multiple calls may represent a single bat calling multiple times or multiple bats each calling a single time. Thus, the data collected can provide population indices or statistical proxies of relative activity or abundance, rather than raw bat counts (Hayes 2000).

According to BOEM, bats are not expected to forage over Nantucket Sound and bats likely only pass through the project area sporadically during migration and when traveling from the mainland to island habitats (BOEM 2009). The seven species of bat in southeastern Massachusetts, big brown bat (*Eptesicus fuscus*), little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis*), eastern pipistrelle (*Pipistrellus subflavus*), silver-haired bat (*Lasionycteris noctivagans*), red bat (*Lasiurus borealis*), and hoary bat (*Lasiurus cinereus*) have all been detected on Martha’s Vineyard (Buresch 1999). Although resident and migrant bat populations have been documented on Martha’s Vineyard and Nantucket, it is not clear how bats travel to and from the islands (BOEM 2009, DeGraaf and Yamasaki, 2001; Buresch 1999). Since bats inhabit islands in Nantucket Sound, over-water crossing must occur (BOEM 2009).

The New Jersey Department of Environmental Protection (NJDEP) recently funded a baseline ecological study in the waters off the New Jersey coast in which an AnaBat detector was used in an offshore environment. The Final Ocean/Wind Ecological Baseline Studies Report released in 2010 (Geo-Marine 2010), included an Appendix on bat use of offshore areas. A total of 54 calls were archived: 25 unidentifiable, 19 Eastern red bats, six big brown/silver-haired bats, three Myotis species (Myotis sp.), and one hoary bat (Geo-Marine 2010).

Studies from an existing offshore wind farm in Scandinavia found that during calm weather with very light wind conditions, a number of different bat species traveled out from land to forage for insects over open water (Ahlen et al. 2007; Ahlen et al. 2009).

2.4.1 Study Objectives

The purpose of the pre-construction bat surveys is to characterize any existing bat use of the project area as outlined in the Framework. CWA will collect and analyze data to address the following study objectives:

- Determine if bat species are present inside the project area and the adjacent waters in the Action Area.
- If Bats are detected, determine which species are present.
- Determine the frequency and timing of any bat use of the project area.

The data collected during the pre-construction phase will provide a baseline so that if any bats are found, any changes in bat use of the project area can be assessed during post-construction.

Data will be collected inside and outside the project area in accordance with a Before-After-Control-Impact (BACI) study design (Anderson et al. 1999; DeLucas et al. 2005).

2.4.2 Methods and Schedule

Pre-construction equipment testing and bat surveys will be conducted from April to October to determine whether bats are present in the project area. Two AnaBat SD2 Bat Detectors available from Titley Electronics will be used to record bat calls from a survey vessel, which will actively transit the area as described below. The AnaBat detector was first proposed for use in the Framework and is the standard technology used by state and federal agencies. In addition, Dr. Eric Britzke of the U.S. Army Corps of Engineers is developing an automated software package that can be used to identify bat calls to species with the AnaBat detector. AnaBat units are designed to detect ultrasonic frequencies up to 120 kilohertz (kHz). The use of two detectors will ensure continuous data collection even if one of the detectors malfunctions.

Each AnaBat detector set-up will consist of the bat detector, microphone and an external 12-Volt battery. The detector and battery will be housed inside a waterproof fiberglass box. The microphone will be placed inside a polyvinyl chloride (PVC) pipe which will extend up from the fiberglass box. The microphone will be pointed towards a plexiglass sheet angled at 45-degrees, which will deflect any bat calls towards the microphone.

Equipment used for the active bat monitoring will be obtained primarily from Titley Electronics and includes the following.

- AnaBat™ SD2 Bat detector.
- CF card/s: up to 4 GB cards may be used.
- CF card reader.
- USB to Serial adaptor.
- Chirper: used to confirm that the AnaBat Detector is logging calls.
- Power options: the detector will be run on a 12-Volt battery.
- Microphone will be installed inside a PVC tube
- The Standard Mic (Black Low Energy Mic) available from Titley Electronics will be used on the bat survey vessel. The Standard Mic is designed to be attached directly to the detector unit.

Vessel Survey Route

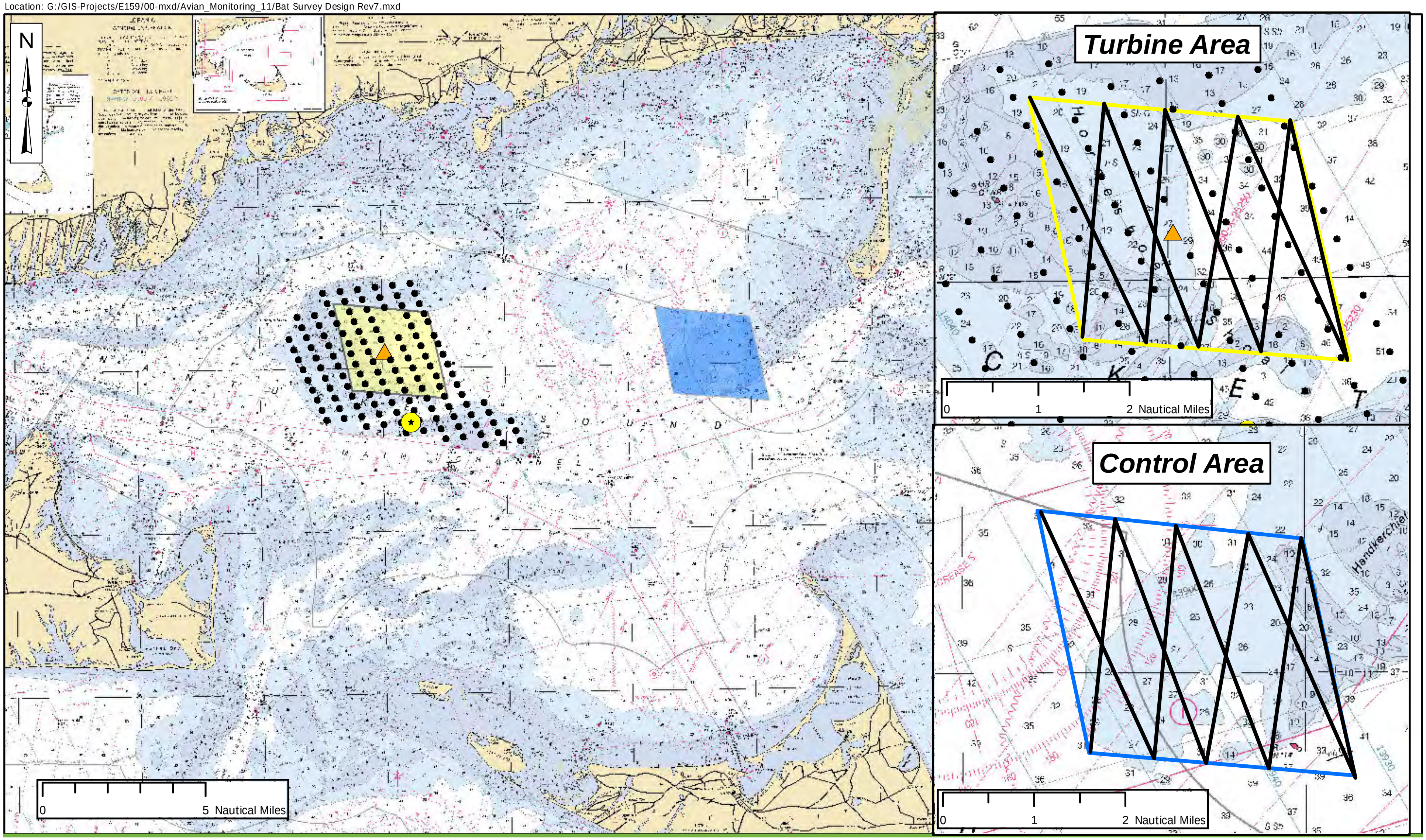
The bat survey vessel will follow a defined route inside the project area and a reference area within portions of the Action Area. A proposed trackline layout (or survey design) for a shipboard Anabat detector study was developed and is shown in Figure 7. The trackline corresponds to spaces between wind turbine locations. One trackline will focus on the project area, while a second trackline will focus on a reference area. The reference area was selected because it has similar water depths and is located approximately the same distance from land as the project area, which makes it a suitable control site. The trackline layout was designed to be completed in a single night, between mid-April and mid-November, which corresponds to approximately 10 hours of darkness. The total linear mileage of the trackline layout is 50 nautical miles. Therefore, a survey vessel traveling at 10 knots should be able to complete the survey in a single night. Current methods for mobile, land-based AnaBat surveys prescribed 20 miles per hour (Britzke and Herzog 2011). A previous study conducted using an Anabat detector mounted to a land-based vehicle, showed that data could be collected at speeds up to 20 miles per hour (17 knots).

The trackline pattern is commonly referred to as a double-saw tooth, because the trackline doubles back on itself at the eastern-most extent of the project area and reference area. The survey vessel will start on either the north or south corner of the western edge of each survey area and continue traveling along one of the two tracklines, oscillating north and south as it makes its way from one side of the survey area to the other. The survey design minimizes the spatial bias of the survey, maximizes the data coverage within the survey area, and minimizes the amount of time the survey vessel is off-line (Geo-Marine 2010).

Methods to Assess Sufficiency of Negative Data

Prior to each use on the survey vessel the AnaBat detectors will be calibrated and field tested to ensure they are working properly. A signal transmitter (Anabat chirper) will be used to calibrate the detectors. In addition to regular calibration, the range of the Anabat detector will be tested. The detector range will be tested by playing pre-recorded bat calls (from the AnaBat chirper) from a boom extended off the side of the survey vessel at varying distances. By employing a range of bat call frequencies and intensities with the AnaBat chirper at varying distances from the AnaBat detector, a logistic regression will be used to estimate the range of detection for the AnaBat detector.

Location: G:/GIS-Projects/E159/00-mxd/Avian_Monitoring_11/Bat Survey Design Rev7.mxd



BAT MONITORING PLAN
Cape Wind Project
Nantucket Sound, Massachusetts

Scale: as shown

Source: 1) NOAA Chart 13237
2) ESS, Survey Tracklines, 2011

Legend

- Control Area Tracklines (25nm)
- Project Area Tracklines (25nm)
- Control Study Area
- Project Study Area
- Proposed Wind Turbines
- MET Tower
- ESP

Conceptual Bat Survey Routes

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Figure
7

2.4.3 Data Analysis

The data stored on the SD2 AnaBat detector will be downloaded and assessed. CWA will use some of the assumptions of Gannon et al. (2003) and Hayes (2000) and Sherwin et al. (2000), as cited in Arnett et al. 2007, when analyzing bat calls. A bat pass will be considered a sequence of echolocation calls consisting of two or more individual calls (Gannon et al. 2003 and Thomas 1988, O'Farrell and Gannon 1999, as cited in Arnett et al. 2007). Bat passes will be treated as discrete, independent, events. We will assume that species consistently call at either high or low frequencies and that 35 kHz (average minimum call frequency) can be used as a threshold to accurately separate these species into two groups. Finally, we will assume that the number of bat passes is a valid reflection of bat activity in the area. Species call analysis will be completed through the use of existing call libraries including those developed by Mr. Eric Britzke at the U.S. Army Corps of Engineers.

AnaLookW software will be used to manage, view and measure bat call data after it is downloaded from the AnaBat Detector. The data will be processed first to separate into high or low frequency calls and further broken down into groups or species when possible. CWA expects that they will be able to separate bat calls into a minimum of three groups during this process. Bat presence/absence and a metric of bat abundance based on the number of bat passes will be developed. The pre-construction results will be used to develop a call library of bats that may be occurring over the project area. These data can be used to further refine the post-construction bat monitoring as described in Section 4.4. The data will provide a baseline of bat activity prior to constructing the wind farm.

An evaluation of bat activity within the project area as compared to the reference area will be conducted using Jacobs' Selectivity Index (Jacobs, 1974; Fox and Petersen, 2006): $D = (r - p)/(r + p - 2rp)$, where r represents the level of bat activity within the project area when compared to the entire survey route (r = bat activity within project area / total bat activity detected) and p is the proportion of the vessel survey conducted within the project area as compared to the entire survey coverage (p = area of project area surveyed / total boat survey area). The Jacobs' Selectivity Index calculates a relative degree of habitat selection by bats, D. D ranges from -1 to +1, where +1 indicates exclusive preference for the project area, -1 indicates complete avoidance by bats and 0 is no preference between the project area and reference area. We expect that during pre-construction surveys, the level of bat activity between the project area and reference area will not differ, and that D will be equal to or near 0.

2.5 Beached Bird Surveys

The results of collision mortality estimates developed during the permitting process suggest that avian collisions resulting from the wind farm are anticipated to be infrequent events. Local movements of seaducks in Nantucket Sound generally occur below rotor height. Very recent evidence from operating windfarms off the shores of Denmark and Sweden shows that these waterbirds avoid turbines very effectively in the course of migratory flights, so that the risk to these birds at Horseshoe Shoal is expected to be very small. Collision risk for Roseate Terns was calculated in the FEIR (ESS Group, 2007) with an expected mortality of 0.8 Roseate Terns/year. The estimate for Piping Plover mortality was far less than one plover/year based on estimates from MassWildlife on the number of birds potentially crossing the project area and information on collision probability. The USFWS

Biological Opinion included a collision mortality estimate of 4 to 5 Roseate Terns per year on average. The FWS estimated that mortality of Piping Plovers due to collision is unlikely to be higher than 0.5 plovers/year.

Beached bird surveys are required by BOEM and the FWS as discussed in their letter to CWA dated August 3, 2011 as a method to assess avian mortality as a result of the wind farm operation. A beached bird is any dead or injured bird that has washed up onto a beach. Beached bird surveys will be conducted to determine if the number of dead birds washing up on representative beaches, changes significantly following the start of operation of Cape Wind's WTG's.

Prior research conducted on the currents, winds, tidal flows, and oil spill modeling projections during the preparation of the DEIS and FEIS provides the background context for the beached bird survey protocol. A summary of these studies is provided below.

The *Simulation of Oil Spills from the Cape Wind Energy Service Platform in Nantucket Sound* (Report No. 4.1.3-1 in BOEM 2009) provides an analysis of predicted oil spill trajectories, coverage areas, and minimum travel times to shore that is useful for this discussion. An oil spill from the ESP was modeled for all four seasons of the year, using predicted tides and observed wind conditions. The model simulated where oil would move over the course of 10 days, if the oil was instantaneously released at the ESP. The model was run for 100 different wind/tide scenarios to evaluate the variability of spill trajectory and generated a probability analysis of where the oil would go and how fast it would arrive on shore. The report is applicable to the beached bird surveys because it provides a model on which probable trajectories of a bird carcass floating to shore can be based.

At the direction of BOEM we assumed that a bird carcass floating on the sea surface will behave similarly to oil on the water surface for some period of time, given that the driving forces behind movement of both are dominated by wind and current velocities. Based on this assumption, the following conclusions are drawn from the oil spill model:

- If a bird were killed in the wind turbine field, the carcass has a high probability of coming ashore somewhere along the beaches of Nantucket Sound (>90%).
- Although the model predicts the probability of a bird carcass coming ashore as greater than 90% within 10 days, the model illustrates that during most seasons, the location where the bird carcass may come ashore is highly variable.
- The model predicts the most probable landfall locations would be the southern shore of Cape Cod and the east and northeastern shores of Martha's Vineyard (20-30% of model projections).
- The probability of bird carcasses coming ashore on Nantucket Island is always small (<10%).
- The shortest predicted time for a bird carcass to reach shore is approximately 4.8 to 11.3 hours (worst-case scenario for oil spills).

Studies on bird carcass floating rates were also examined prior to developing the beached bird survey protocol. Wiese (2003) studied the sinking rates of bird carcasses on the water. The study was conducted as a means of improving estimates of seabird mortality from oiling, which Wiese believes may be underestimated since carcasses may be lost at sea. Wiese assessed how long it took clean, lightly oiled and heavily oiled murre (*Uria* sp.) species to sink on the water. The carcasses were kept in wooden pens and attached to a wharf. Scavenging was prevented by surrounding the pen with chicken wire, but Wiese simulated scavenging in a sub-set of the carcasses by cutting them open and removing some flesh. Other carcasses were left intact. The results demonstrate that the carcasses remained buoyant for longer than anticipated. There was no relationship between body mass and buoyancy. Birds floating quickly lost buoyancy during the first few days, but did not completely sink. Five of the 12 non-oiled carcasses sank after five days. All of the non-oiled carcasses sank by day 17. The results indicate that there was no difference in sinking rates between oiled and unoiled carcasses. The majority of floating, unscavenged murre carcasses sank within 6 to 11 days. Wiese concluded that if birds are scavenged at sea, the number of days the carcasses remain afloat under natural conditions may be substantially shorter than the 6 to 11 day estimate derived from the experiment. He noted that gulls often pick at carcasses and open their body cavity which allows internal gases to escape. Once these gases escape, buoyancy is lost as the bodies get water-logged. Other experiments cited by Wiese found estimates of 8.4 and 7.6 days afloat (Ford et al. 1991). Another study by Ford determined that carcasses remained afloat for 15-20 days (Ford et al. 1996).

In conclusion, existing studies indicate that carcasses remain afloat for days as opposed to hours. When this finding is combined with the oil spill trajectory model results (shortest transit times to shore ranging from 4.8 to 11.3 hours) it is possible that a bird carcass struck by a wind turbine could end up on the southern shore of Cape Cod or the eastern shore of Martha’s Vineyard.

2.5.1 Study Objectives

The purpose of the pre-construction beached bird surveys is to continue documenting baseline (ambient) bird carcass deposition rates around Nantucket Sound. Prior to conducting beached bird surveys, CWA will conduct carcass drift tests to verify the predictions made by the oil spill model and prior studies on carcass sinking rates, if technically feasible. CWA will then collect pre-construction data to establish a baseline level of bird carcass deposition rates at sample beaches. Some of the surveys will be conducted at beaches that have been surveyed as part of the Seabird Ecological Assessment Network (SEANET), an existing beached bird survey program, in prior years. The results of the CWA pre-construction survey will be combined with historic SEANET data so that the baseline mortality rate can be characterized. Past results of beached bird surveys on the south shore of Cape Cod have shown that there is considerable interannual and seasonal variation in carcass numbers (Harris et al. 2006). In addition, the results of other beached bird surveys have typically shown that there is a wide range in the number of carcasses that wash up onshore due to variable environmental conditions (Camphuysen, 1998). The pooling of the CWA data with historic SEANET data will allow CWA to develop the best estimate possible of the baseline mortality rate.

2.5.2 Methods and Schedule

Cape Wind will first conduct a carcass drift test in Nantucket Sound to develop an estimate of the number of birds that reach the shores of Nantucket Sound, if technically feasible. The carcass drift test will be conducted under a variety of wind and tide conditions to assess how these conditions influence the percentage of carcasses that are recovered. Different size bird carcasses may also be used to assess how bird size and weight influences recovery rate.

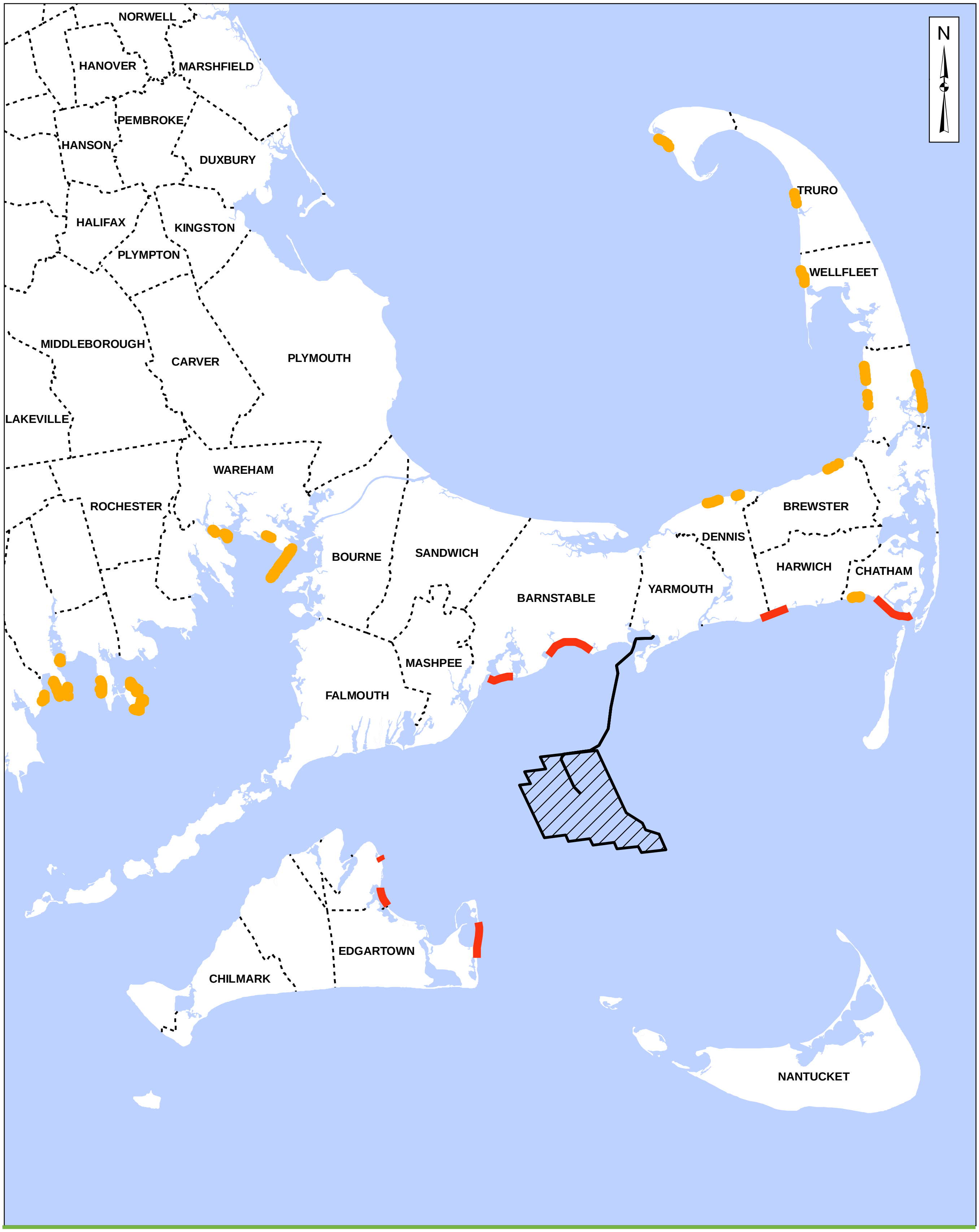
Cape Wind has been consulting with SEANET to collect existing survey data, determine locations of surveyed beaches in Nantucket Sound and discuss survey protocols. Any baseline information on beached birds along Nantucket Sound shorelines will be extremely valuable for comparison with beached bird surveys that will be conducted during wind farm operation. SEANET surveys occurred in the early 2000s along the south shore of Cape Cod. There is currently only one SEANET survey being conducted along the southern beaches of the Cape. There are no beaches currently being surveyed on Martha's Vineyard or Nantucket (S. Courchesne pers. comm. 2011). CWA will conduct beached bird surveys at targeted beaches consistent with established SEANET protocols and available historical data sets in order to perform a robust analysis.

The methodology for these beached bird surveys is adapted from SEANET protocols (SEANET, 2010) and will be implemented at select Nantucket Sound beaches. CWA selected beaches that had been surveyed by SEANET volunteers in the past and have a greater likelihood of having carcasses wash up on them based on the results of the oil spill trajectory modeling described above. The representative beaches selected will include four beaches on the south shore of Cape Cod and three beaches on the eastern shore of Martha's Vineyard for a total of 19.3 km of beach (Figure 7). The length of each beach varies from 0.5 to 4.7 km. Beaches in Buzzards Bay and Cape Cod Bay that are currently being surveyed as part of the SEANET program will serve as control beaches (Figure 8). Control beach data will be obtained from SEANET through their existing data set.

Field biologists will be deployed on a monthly basis (each beach will be surveyed for one day per month for 12 months) to check for carcasses on selected beaches. The results of monthly surveys have been shown to yield comparable results to weekly surveys, and the advantages gained from conducting weekly surveys over monthly surveys are relatively small (Seys et al. 2002). Field biologists will time their surveys to coincide with peak migration times. Data from previous years, NEXRAD radar, weather conditions and MassAudubon online reports will all be utilized to determine peak migration times.

Prior to conducting the first survey, the characteristics of the beach including width, substrate type, and level of human disturbance will be assessed. The start and end location of the survey area will remain consistent from survey to survey. The surveys will be conducted at low tide, or just after high tide after any new carcasses could be deposited. Field biologists will survey the beach with a focus on the wrack line, where most carcasses are usually found. Secondary focus will be on the extreme high tide line and upper beach where older carcasses are sometimes found. If the beach is narrow enough for the entire area to be viewed in a single walk down the beach, then the surveyor will only search for carcasses on the walk down from the start to the end point. If the beach is wider, then the wrack line will be surveyed during the walk down and the extreme high tide line and upper beach will be surveyed on the walk back.

Location: G:/GIS-Projects/E159/00-mxd/504/Birds/Beach-Surveys.mxd



CAPE WIND

Nantucket Sound, Massachusetts

Scale: 1" = 8 Miles

0 8 Miles

Legend

SeaNet Control Beach Location

ESS Proposed Beach Surveys

Cape Wind Submarine Cable

Cape Wind Project Area

Proposed Test and Control Beaches for Beached Bird Surveys

Figure 8

ess group

environmental consulting & engineering services

Source: 1) MassGIS, Town Data, 2002
2) ESS, Cape Wind Project Data, 2006-11

When a bird carcass is discovered, the following information will be recorded: species information, examiner information, GPS location, weather conditions, specimen condition, wing chord, culmen (bill length), tarsus (leg measurement), degree of emaciation, and likely cause of mortality (if possible). Each carcass found will be photographed (Figure 9). The photograph will include a ruler or calipers placed in the field of view for scale. The carcass will be positioned as necessary to show off important field marks that may be used to confirm species identity. At least one photo of the ventral side and one photo of the dorsal side will be taken. All beached birds that are substantially intact (i.e. minimally scavenged) will be collected and sent to a professional trained in performing necropsy on birds. CWA will consult with the necropsy experts to determine suitable candidates for necropsy. Whenever possible, the professional performing the necropsy should attempt to determine the cause of mortality, within the general categories of trauma (collision), gunshot, poisoning, disease, predation, starvation, drowning (fisheries interaction), or other causes. Any Piping Plover or Roseate Tern carcasses found during the beached bird surveys will be immediately sent to USFWS for examination and possible necropsy. CWA will retain any dead bats that are found.

Figure 9. Sample beached bird photo with label and calipers for scale. (From SEANET Protocols, 2010)

2.5.3 Data Analysis

The results of the bird carcass drift surveys will be used to develop an estimate of the bias in the recovery rates of birds. The pre-construction results will be analyzed to develop a mean carcass encounter rate (# carcasses/km) for each beach surveyed. The encounter rate will also be calculated across all beaches combined and for each month. Data from necropsies will be used to calculate the relative frequency of each cause of death. The beached bird survey results will be used in conjunction with telemetry, acoustic monitoring, aerial surveys, boat surveys, NEXRAD radar, marine surveillance radar, and visual observations in order to develop a clearer understanding of collision.

3.0 CONSTRUCTION MONITORING PROTOCOLS

Building upon information obtained during the pre-construction survey activities presented above in Section 2.0, avian monitoring will continue during the construction period. Monitoring will include studies to detect migratory and resident birds, as well as federally-listed avian species. Passive monitoring will continue from equipment deployed on the MET tower while the balance of structures (wind turbines and ESP) that will be utilized in post-construction monitoring are constructed. Autonomous Recording Units (ARUs) will continue to gather data on avian acoustic signatures and the video camera system will continue to monitor the effectiveness of the anti-perching devices deployed on the MET tower.

4.0 POST-CONSTRUCTION MONITORING PROTOCOLS

The post-construction monitoring protocols consist of nine primary components: radio telemetry, avian acoustic monitoring, anti-perching monitoring, bat surveys, beached bird surveys, NEXRAD radar analysis, abundance and spatial distribution aerial surveys, boat surveys, and marine radar surveillance. These components may be modified or revised based on the results of the pre-construction monitoring program and/or updated technology availability. The goal of the post-construction monitoring program is to document movements and locations of avian species and presence of bats in Nantucket Sound and determine how the wind park may be impacting the distribution of birds in the project area. After 3 years of post-construction monitoring, all of the data will be reviewed by BOEM to determine whether additional post-construction monitoring is needed.

4.1 Radio Telemetry

Post-construction radio tracking will be used to document movements and locations of Roseate Terns and Piping Plovers over Nantucket Sound and the proposed project area. The post-construction radio telemetry program will likely begin as the wind turbines start to become operational.

4.1.1 Study Objectives

The study will focus on Roseate Tern and Piping Plover distribution and movements after the wind farm is operational. CWA will collect post-construction, radio tracking data to address the following study objectives:

- Track Roseate Tern distribution and flight trajectories in the project area and Action Area during the post-breeding period (July 15 – September 15).
- Track Piping Plover distribution and flight trajectories in the project area during the month of August.

4.1.2 Methods and Schedule

Assuming the pre-construction radio tracking of Common Terns and Semipalmated Plovers is effective and safe for the birds, radio transmitters will be attached to adult Roseate Terns and adult Piping Plovers using the similar methods as pre-construction radio tracking. The final number of birds to be sampled needs to be determined. Based on a power analysis, 25-30 tagged birds will be sufficient for detecting large effect sizes (Figure 10). However, this large number of tags will need to be balanced with potential impacts of tagging to listed species and operational management. The goal would be to tag 25 birds of each species if the health of birds is not compromised. Determinations of feasibility will be made in the field in consultation with species experts and/or resource agencies. Roseate Terns and Piping Plovers would be trapped using the same methods that were used to trap birds during pre-construction unless consultation with USFWS and DFW determines that another method should be used (See Section 2.1.2).

Post-construction radio tracking will involve the use of passive monitoring stations. There will be no aerial surveys conducted post-construction for two primary reasons: 1) there are safety concerns with tracking birds near the wind farm and 2) the use of ARTS receivers will provide the data needed to address the study objectives on a continual basis and more efficiently than aerial surveys. Receivers will be deployed on the ESP, the MET tower and wind turbines to provide at least 75% coverage of the project area as required by BOEM and USFWS (Figure 11). This deployment will use an omni-directional dipole antenna instead of a Yagi antenna. Because the receivers function as a datalogger, data will be downloaded and analyzed after retrieval. The passive monitoring stations will provide approximately 97% coverage of the project area and will be used to collect presence/absence data.

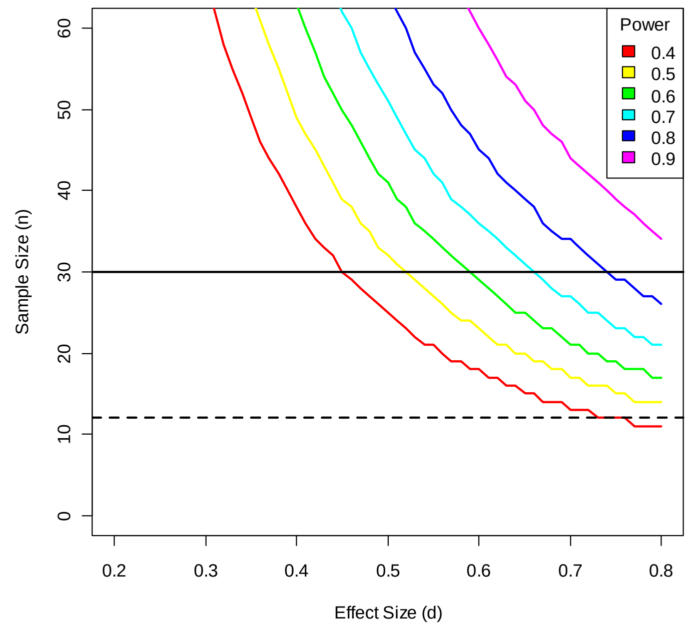


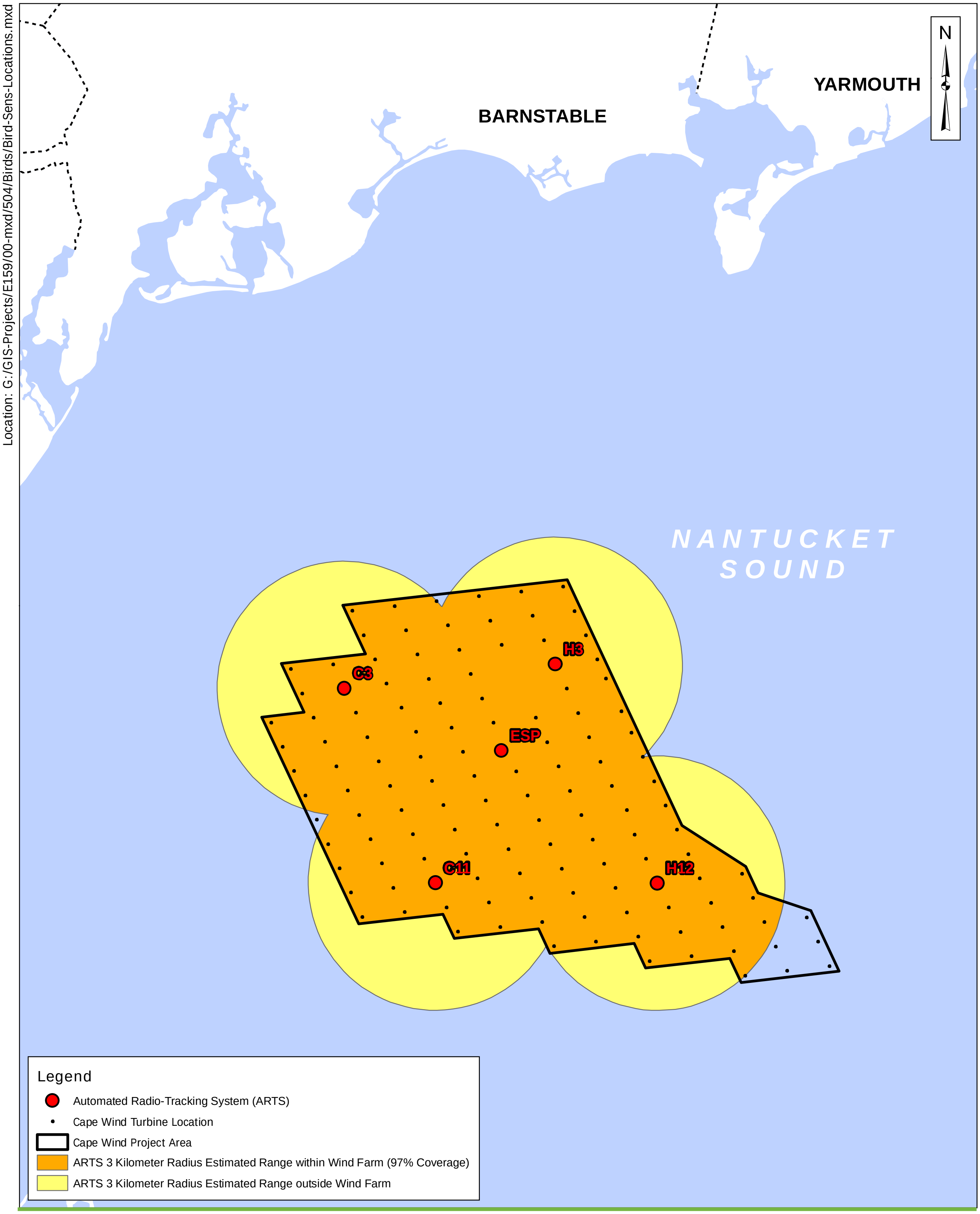
Figure 10. Power analysis for number of radio tags to be used in post-construction study.

4.1.3 Data Analysis

Each ARTS unit includes a datalogger which will continuously record signals from a tagged bird anytime it passes within range of the receiver. Each data point recorded by the ARTS includes information on date, time, signal strength, and the bird tag identification number. The data from each ARTS will be downloaded and processed to gather presence/absence data of each tagged bird at various points in time. The analyses will be dependent on the results of the pre-construction pilot study using ARTS.

In addition, by comparing the time stamp associated with each record with records of the same tagged bird from multiple receivers, it may be possible to map flight trajectories through the project area.

The telemetry results will be used in conjunction with beached bird surveys, aerial surveys, boat surveys, acoustic monitoring, NEXRAD radar, marine surveillance radar and visual observations in order to develop a clearer understanding of collision and changes in avian distribution in the project area.



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CAPE WIND
Nantucket Sound, Massachusetts

Scale: 1" = 2 Miles
0 2 Miles

Source: 1) MassGIS, Towns, 2002
2) ESS, Cape Wind Project Data, 2006-11

Post-Construction Locations for Automated Radio Tracking System

Figure 11

4.2 Avian Acoustic Monitoring

The purpose of the post-construction avian acoustic monitoring is to record calls of all bird species and determine the presence/absence of birds in the airspace around the project area. In addition, post-construction avian monitoring will test the feasibility of recording bird calls from microphones mounted on offshore wind turbines. The post-construction monitoring program may require modifications based on the results of pre-construction monitoring effectiveness. The sound of the rotating turbine blades may limit the effectiveness of acoustic monitoring.

4.2.1 Study Objective

Assuming the pre-construction acoustic monitoring is effective; CWA will collect and analyze acoustic data to address the following study objectives:

- The equipment will be used to measure presence/absence of Roseate Terns, Piping Plover and other migratory birds if possible.
- Evaluate whether microphones are capable of recording bird calls from wind turbines given ambient background noise.

The acoustic data will be used in combination with the other monitoring program results to validate the field parameters used to assess risk of collision to birds and to determine whether focal species are being displaced from habitat within the wind farm.

4.2.2 Methods and Schedule

Acoustic microphones will be placed on ten WTGs and the ESP if pre-construction monitoring is effective. One microphone would be placed on WTGs at each of the four corners of the project area for example: WTGs A4, I0, K16, A12, one in the approximate middle of the western and northern sides (WTGs A8, F0), and four placed at random in the interior of the project array (WTGs H3, E5, G8, D11) (Figure 11). These would record flight calls of birds over the project 24 hours a day, seven days a week, from May through October and during three 24-hour intervals per month from November through April, weather permitting, to determine bird presence or absence in the airspace in and around the project site. The power source (batteries) would likely need replacement three times during this period or the recorders may run off of the wind turbines.

4.2.3 Data Analysis

Acoustic recordings will be analyzed using a software package available from the Cornell Lab of Ornithology. The analysis will be used to identify species, relative frequency of occurrence, and altitude if possible.

The acoustic monitoring results will be used in conjunction with beached bird surveys, aerial surveys, boat surveys, telemetry, NEXRAD radar, marine surveillance radar and visual observations in order to develop a clearer understanding of collision and changes in avian distribution in the project area.

4.3 Anti-perching Monitoring

As outlined in the Framework, the objective of the post-construction, anti-perching monitoring is to evaluate the effectiveness of anti-perching devices that will be installed on wind turbine platforms and the Electric Service Platform (ESP). Anti-perching has been proposed as mitigation for the project. The results of the pre-construction anti-perching study and post-construction study will be used to modify the perching deterrents if necessary.

4.3.1 Study Objectives

CWA will collect and analyze data collected by video camera and field biologists to address the following study objectives:

- Evaluate the effectiveness of anti-perching deterrents on the ESP and wind turbine platforms for all avian species.

4.3.2 Methods and Schedule

Following construction, two video cameras will be placed on the ESP and two random turbine platforms (suggested WTGs A4 and I0) to monitor the effectiveness of the anti-perching deterrents. The camera on the MET tower will remain. Assuming the camera system used during the pre-construction monitoring was sufficient, the same camera system available from SeeMore Wildlife Systems (or comparable) will be used. The purpose of the cameras is to measure the effectiveness of anti-perching devices. Since the ESP provides more potential perching areas than the WTGs, two cameras will be used on the ESP. Although the Framework suggests six cameras on six WTGs, monitoring the effectiveness of the anti-perching devices on the ESP, the MET tower, and two turbines is adequate to provide sufficient data for analysis. The limited value added in terms of data gathered from monitoring several more WTGs does not offset nor justify the high cost of additional cameras.

Biologists will be deployed to the ESP and select turbines to monitor avoidance or attraction around perching deterrents. Biologists will observe bird behavior around the turbines that might not necessarily be picked up by the video cameras. The biologists will observe birds from behind a blind on the ESP to reduce any bias in the results due to the presence of humans on the turbine deck. Biologists deployed on turbines will not use blinds since they will focus on behavior of birds at adjacent turbines. The biologists will be deployed during the tern breeding season from mid-May to late July and the staging season from mid-August to late September to observe tern behavior around the ESP and adjacent turbines. Attraction or avoidance behavior of all bird species will be recorded. Observers will collect 32 hours of observations (staggered during day light hours) in field journals and photo document birds where possible.

4.3.3 Data Analysis

The results of the anti-perching monitoring will be summarized based on observations of bird behavior near the anti-perching devices. As in the pre-construction studies, bird behavior will be categorized into “avoidance” and “attraction” behaviors. Using results from the pre-construction anti-perching study to estimate expected avoidance behavior near anti-perching structures, a Chi-squared test will again be employed to determine if the anti-perching structures on the ESP are functioning similarly to anti-perching structures on the MET tower.

4.4 Bat Surveys

The post-construction bat monitoring will be used to monitor bat activity within the proposed project area. Survey data will help assess any impacts that may occur from the CWA wind farm on bat activity over Nantucket Sound.

4.4.1 Study Objectives

The post-construction bat surveys will attempt to address the following objectives.

- Determine how many bat species (or distinct recognizable taxonomic units (RTU)) occur in the project area.
- Compare bat activity level between the pre- and post construction vessel surveys
- Evaluate bat activity intensity within and outside the project area.

4.4.2 Methods and Schedule

Post-construction bat survey methods follow pre-construction methods. Two AnaBat SD2 Bat Detectors will be used to record bat calls from a survey vessel. The bat survey vessel will follow the route inside the project area and a reference area within portions of the Action Area as shown in Figure 7. A proposed trackline layout (or survey design) for a shipboard Anabat detector study was developed and is shown in Figure 7. One trackline will focus on the project area, while a second trackline will focus on a reference area. The reference area was selected because it has similar water depths and is located approximately the same distance from land as the project area, which makes it a suitable control site.

In addition, Cape Wind will install AnaBat detectors in up to 13 locations or 10% of the project turbines (Figure 12). At each location, an AnaBat detector will be mounted within the nacelle of the selected turbine (approximately 257 feet above the water), if technically feasible. Using these passive monitoring station locations, bats migrating or foraging near nacelle height may be detected. The data stored on the SD2 AnaBat detector will be downloaded remotely each night utilizing cellular phone network coverage in the project area. The data will be downloaded periodically to the GetMyLog website. The GetMyLog website is a dedicated site that will be used to connect directly to the detectors, verify their status, change recording settings, and upload data. The system will be used to gauge battery power and change settings such as division ratio, sensitivity setting, and record start and end times of the SD2 AnaBat detectors.

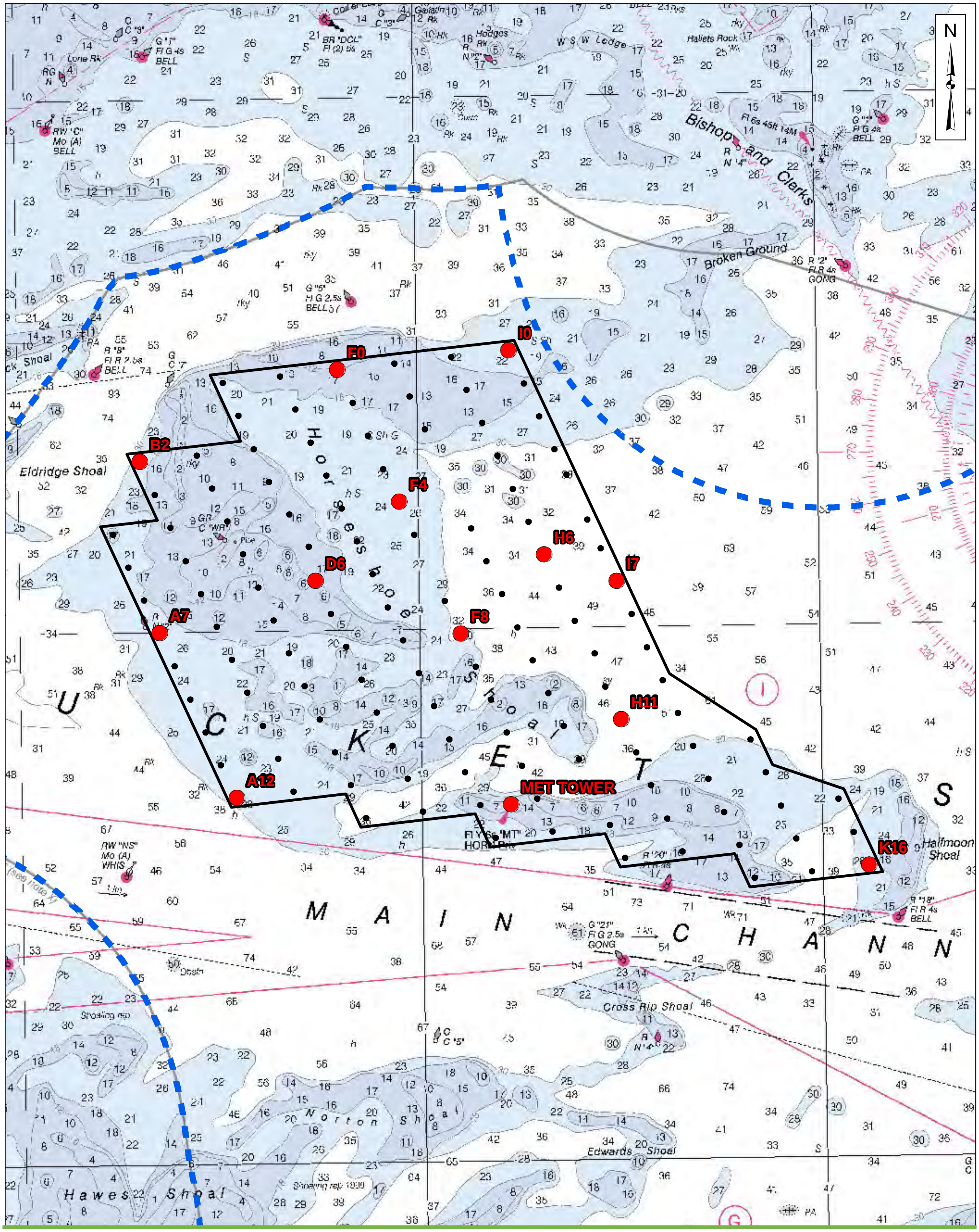
The results of the pre-construction survey will be used to adjust AnaBat detector settings and data transmission in order to optimize data collection during the post-construction surveys. Additional testing and calibration with the bat chirper will be necessary to assure proper AnaBat detector settings at each of the thirteen monitoring stations. AnaBat detectors will be monitored for three years (from April to October in each year) following the completion of construction.

4.4.3 Data Analysis

Jacob's Selectivity Index will be calculated using the same data analysis methods that were used during pre-construction for bat detectors placed on vessels. The calculation of Jacobs' Selectivity Index in the project area and reference area will be used to determine if there is any significant change in bat activity post-construction. A simple two-sample t-test can be used to determine if the mean index value in the project area has changed from pre- to post-construction. This comparison can be made by month or for the entire study period. The calculation of the mean index value in the reference area can be used to determine whether any observed change is limited to bat activity in the project area or whether it is part of a larger change in bat activity in the action area.

Data downloaded from the detectors stationed on wind turbines post-construction will be compared with each other to evaluate whether certain sides of the project area receive more or less bat activity. Evaluation of activity level among the post-construction sites will be made with a simple one-way ANOVA (no pre-construction data) and followed by a Tukey's HSD post-hoc test if the ANOVA is significant.

The timing and duration of bat activity through the project area will be analyzed. Additionally, results describing the spatial variability in bat activity and the year to year variation in that activity will be discussed if activity is detected. If possible, species specific migration habits will also be discussed to determine which bats have most likely been influenced by the presence of the wind farm.



CAPE WIND
Nantucket Sound, Massachusetts

Scale: 1" = 1.5 Miles
0 1.5 Miles

Source: 1) NOAA, Nautical Chart 13237, 2011
2) ESS, Cape Wind Project Data, 2006

Legend
- AnaBat Detector Monitoring Station
- Cape Wind Turbine Location
- 3 Nautical Mile Line
- Cape Wind Project Area

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Post-Construction Locations of AnaBat Detectors

Figure 12

4.5 Beached Bird Surveys

The beached bird surveys conducted during the pre-construction phase will be repeated for three years after the wind farm begins operations. The results of the post-construction monitoring will be compared with the pre-construction results to assess any effect of the wind farm on background avian mortality levels.

4.5.1 Study Objectives

CWA will conduct post-construction beached bird surveys to determine whether there is any significant increase in the avian mortality rate following the start of the wind farm operation. The results will be compared with results obtained from pre-construction surveys at test beaches as well as control beaches in Buzzards Bay and Cape Cod Bay that are monitored by SEANET volunteers. In addition, the beached bird data will also be used in conjunction with NEXRAD radar data and the results of the aerial surveys to address the beached bird survey study objective. As described in Section 4.6, the NEXRAD radar data is expected to provide data on the timing of the spring and fall migration of neotropical migrants, while aerial surveys will provide data on the migration timing of larger waterbirds. The results of these studies will provide an understanding of bird migration intensity through the project area. As outlined in their letter of August 3, 2011, BOEM requires that CWA relate bird mortality measured from beached bird surveys to the intensity of bird movement through the project area.

4.5.2 Methods and Schedule

Beached bird surveys will be conducted at the same beaches using the same methods that are described in the pre-construction monitoring section (Figure 8). Surveys will be conducted once per month on the same schedule as the pre-construction surveys.

4.5.3 Data Analysis

The beached bird survey results will be used to calculate the mean carcass encounter rate (# carcasses/km) for each beach surveyed, all beaches combined and encounter rate per month to evaluate any seasonal affects. The post-construction encounter rates will be compared with the pre-construction encounter rate to assess changes in mortality levels. The predominant wind direction will be obtained from offshore weather buoys and summarized for each month during post-construction monitoring. The wind data will be reviewed in conjunction with the oil spill report to evaluate where dead birds would have theoretically washed up had they collided with a wind turbine. Assuming the data are normally distributed, two sample T-tests will be used to determine if there is any significant difference between pre- and post-construction carcass encounter rates as a measure of avian mortality.

Although the proposed study design will allow CWA to determine if there is any significant change in beached bird encounter rates between pre-construction and the operation of the wind farm, linking any changes to the wind farm through a causal relationship will be more difficult to assess for several reasons. As discussed in the pre-construction monitoring section, past reports on beached bird studies have shown that there is a great deal of interannual and seasonal variability in the carcass encounter rates (Harris et al. 2006). Any significant changes observed between pre- and post-construction encounter rates could be due to natural variation as opposed to the operation of the wind farm. It is also difficult to link a dead bird with a turbine collision, even if a necropsy is performed. Harris et al. (2006) reported that of the beached birds sent in for necropsy in her study, a definitive cause of death was not determined in most cases. In a study of beached bird surveys by Stephen and Burger (1994), trauma is defined as "debilitating skeletal or soft tissue injury unassociated with gunshot." Orloff and Flannery (1992) and Brown and Hamilton (2006) found that common injuries associated with wind turbine collisions included those of the head, neck, and wings, including amputation. These structural injuries are best defined as trauma for the purpose of categorizing cause of death.

In an effort to assess the rate of collision with wind turbines, the relative frequency of different causes of mortality will be examined. Data from necropsies on birds found during pre-construction and post-construction will be compared. The extent of the difference between the number of birds found to have died of trauma during the pre-construction and post-construction periods will be analyzed. The analysis will assume that a necropsy determination of "trauma" is a suitable proxy for an assumed collision with a WTG.

The historic SEANET data will provide valuable information that can be used to establish a background avian mortality range for comparison with post-construction survey results. In addition, multiple beaches throughout Buzzards Bay and Cape Cod Bay that are currently monitored by SEANET volunteers will serve as control beaches. The availability of control beaches that are independent and are presumed to be outside the influence of the wind farm will allow for a BACI study design. Data from these control beaches will be used to determine whether any significant increase in bird mortality observed at the test beaches on the south shore of Cape Cod have a possible link to the wind farm or are simply part of a larger, regional trend that is also occurring at control beaches.

The beached bird survey results will be used in conjunction with aerial surveys, boat surveys, acoustic monitoring, telemetry, NEXRAD radar, marine surveillance radar and visual observations in order to develop a clearer understanding of collision and changes in avian distribution in the project area.

4.6 NEXRAD Radar

The United States established a national network of weather surveillance radars using WSR-57 (weather surveillance radar) radar in 1957. The WSR-57 radar has a wavelength of 10 cm (S-band) and a transmitter power of 500 kilowatts (Gauthreaux and Belser 2003). The national network provided ornithologists the ability to conduct quantitative studies of bird migration (Gauthreaux 1970). In the mid-1990s, most of the WSR-57 radars in the national network were replaced by new Doppler weather surveillance radar called the WSR-88D (Weather Surveillance Radar-1988 Doppler) (Gauthreaux and Belser 2003a). This new weather surveillance radar is also call NEXRAD radar, which stands for next generation radar. In the early 1990s, Sid Gauthreaux and Carol Belser of Clemson University pioneered using the new radar system to track daily and seasonal migration patterns on species specific and national scale (Gauthreaux and Belser 1998, Gauthreaux and Belser 2003). The WSR-88D is well suited to studying bird distributions and movements aloft, and their responses to factors that affect their distributions and movements, across large spatial extents and temporal scales (Ruth et al. 2008).

4.6.1 Study Objectives

BOEM requires CWA to conduct a post-construction radar study that will be used to relate bird mortality measured from beached bird surveys to intensity of bird activity during peak spring and fall migration of Neotropical birds in the project area. CWA is currently consulting with several radar experts who are capable of measuring the intensity of bird movement through the project area. The radar study will measure the peak spring (April–June) and fall (August–October) migration of Neotropical birds in the project area. This will provide a measure of flux in the intensity of small bird migration over the project area.

4.6.2 Methods and Schedule

The WSR-88D operates in two modes. In precipitation mode, the volume of coverage pattern samples an altitude from the height of the antenna to 21 km above ground level and to the maximum range of 460 km in 9–14 scans at antenna elevations from 0.5° to 19.5° every five to six minutes. The radar scan covers 0.5° to 4.5° every 10 minutes in clear air mode (Gauthreaux et al. 2003). The WSR-88 produces two products that are useful in tracking avian migration—base reflectivity and base velocity. Reflectivity is usually presented in unit of Z, a standard measure of radar meteorology and denotes the amount of echo caused by distributed targets (rain, insect, birds) in the volume of space being measured (Diehl and Larkin 2004). Base reflectivity displays the relative reflectivity (dBZ) in each pulse volume (1 km x 0.96°) in a 360° sweep out to a distance of 230 km with the antenna elevated 0.5° (Gauthreaux et al. 2003). As the distance from the radar increases, the altitudes sampled also increases (Gauthreaux and Belser 2003). WSR-88D radars measure target speeds moving towards and away from the radar unit (Diehl and Larkin 2004). The base velocity shows the mean radial velocity of targets in the same pulse volumes delimited for base reflectivity measurements (Gauthreaux et al. 2003). Assessing base reflectivity and base velocity can be used to quantify the amount of bird migration, the flight speed of migrants, and the direction of flight (Gauthreaux and Belser 2003, Gauthreax, et al. 2003, Ruth et al. 2008). In 2008, the spatial resolution of pulse volumes at the lowest elevations for WSR-88D was increased 8-fold to 250 m x 0.5°. This enhancement, coupled with recently developed data processing methods that reduce biases in radar measures (Buler and Diehl 2009), will provide more precise and accurate radar measures of biological activity than was previously possible.

4.6.3 Data Analysis

Base reflectivity and base velocity from the WSR-88D radar in Taunton, Massachusetts (112 kilometers from the project site) will be analyzed, and the density of birds flying (km^3) and the primary flight direction will be determined. Long range data from the WSR-88D from Upton, New York may also be used to supplement the data from Taunton. The minimum radar beam height of the Taunton radar over the Project, ranges from 150 – 300 meters (dependent upon the location within the project area). The area below this altitude is not viewable by the Taunton radar.

The radar study will be used to correlate the results of the beached bird survey. When combined with aerial surveys over the Sound, which will document migration peaks for larger, low flying sea ducks and sea birds, BOEM has deemed that this will provide an adequate understanding of bird migration intensity through the project area. Possible analysis includes the use of a Kolmogorov-

Smirnov two sample one-tailed test to see if the peak migration is in sync with the "peak" dead bird count on the beach as measured during beached bird surveys.

The NEXRAD survey results will be used in conjunction with aerial surveys, boat surveys, acoustic monitoring, telemetry, beached bird surveys, marine surveillance radar, and visual observations in order to develop a clearer understanding of collision and changes in avian distribution in the project area.

4.7 Abundance and Spatial Distribution Surveys

Cape Wind and MassAudubon collectively flew 125 systematic aerial surveys to document avian species and distributions in Nantucket Sound from March 2002 to March 2006 (ESS 2006). Surveys occurred in daylight throughout different seasons. Surveys occurred throughout the fall through early spring when large concentrations of wintering sea ducks[4] and waterbirds[5] congregate in Nantucket Sound. Surveys also specifically targeted times when terns are present in the project area. The preconstruction abundance and spatial distribution studies provide a good reference for a BACI study design (NWCC 1999).

4.7.1 Study Objective

CWA will collect post construction data and analyze aerial pre- and post-construction survey data to address the following study objective:

- Document any changes in relative abundance and distribution of avian species within Nantucket Sound following construction.

4.7.2 Methods and Schedule

Surveys will be conducted by air using the same general methods that were used to collect data on avian species during the preparation of the National Environmental Policy Act and the Massachusetts Environmental Policy Act review processes. This will allow for statistical comparison with pre-construction avian surveys and minimize bias.

CWA will fly five (5) aerial surveys from May to late July (tern breeding period), four (4) surveys during the tern fall staging period from mid-August to late September, and ten (10) surveys during the winter (mid-October to mid-April) to monitor sea ducks and waterbirds for an annual (4 seasons) total of 19 aerial surveys.

The flight plan for winter sea ducks and waterbirds is illustrated in Figure 13. The flight plan during the tern breeding and staging period will shift to include a transect near Monomoy Island (Figure 14) as was done in the Mass Audubon surveys (Perkins et al. 2003; Perkins et al. 2004a; Perkins et al. 2004b).

[4] For the purposes of this report, sea ducks are designated as Common Eiders, Long-tailed Ducks and scoters (Black-winged Scoters, White-winged Scoters, and Surf Scoters).
[5] For the purposes of this report, waterbirds are designated as loons, grebes, Northern Gannets, American Black Ducks, American Goldeneyes, mergansers, Alcids (Dovekies and Razorbills).

Instead of flying at the pre-construction altitude of 76 meters (250 feet), the post-construction flight elevation will be raised to 152 meters (500 feet)[6] (Similar to elevations flown during pre-construction MassAudubon surveys). The flight elevation has been raised above the height of the wind turbines for safety concerns. This flight height will be confirmed to be safe by a professional research flight pilot prior to the start of surveys. The surveys will be flown in a plane that will maintain an air speed of approximately 90 knots, or the slowest speed the aircraft can safely fly. The flight lines will be slightly adjusted from pre-construction flight paths so that they are above the height of the turbines and between turbine strings. Any proposed changes to the flight height or air speed resulting from safety concerns of a professional research pilot will be resolved between CWA, BOEM, and USFWS prior to the start of surveys. Consultation with FAA will occur if deemed necessary.

Birds will be counted and identified along 16 transects spaced approximately 2,286 meters (7,500 feet) apart. Any dead birds observed on the water will also be counted. Surveys will be flown at different times of the day, at different tides, and in somewhat varying weather conditions, but only when visibility is either good or excellent to ensure that birds can be seen. No observations will be made when sea states are greater than three (wave heights 0.5 to 1.5 meters) to ensure birds on the water can be seen. Flights will not take place during inclement weather when the safety of the pilot and survey crew would be compromised.

Consistent with pre-construction aerial surveys, the survey team will consist of the pilot, a data recorder, and two observers. The pilot will maintain the airplane on transect, at the correct altitude and speed, and at the proper wing level altitude. Two observers will be seated on either side of the airplane. An aluminum rod will be attached perpendicular to the wing strut on each side of the airplane to delineate the transect boundaries. A clinometer will be used to measure the calculated angle for the placement of these aluminum rods. The distances between the airplane’s float and the aluminum rods will be verified initially by flying over the airport at 152 meters (500 feet) using pre-measured 200-meter (656-foot) markers on the ground. The area visible between the float on the airplane and the aluminum rod will provide each observer with a 200-meter (656-foot) transect width within which all birds shall be counted. The observers will not be able to see the area directly below the airplane.

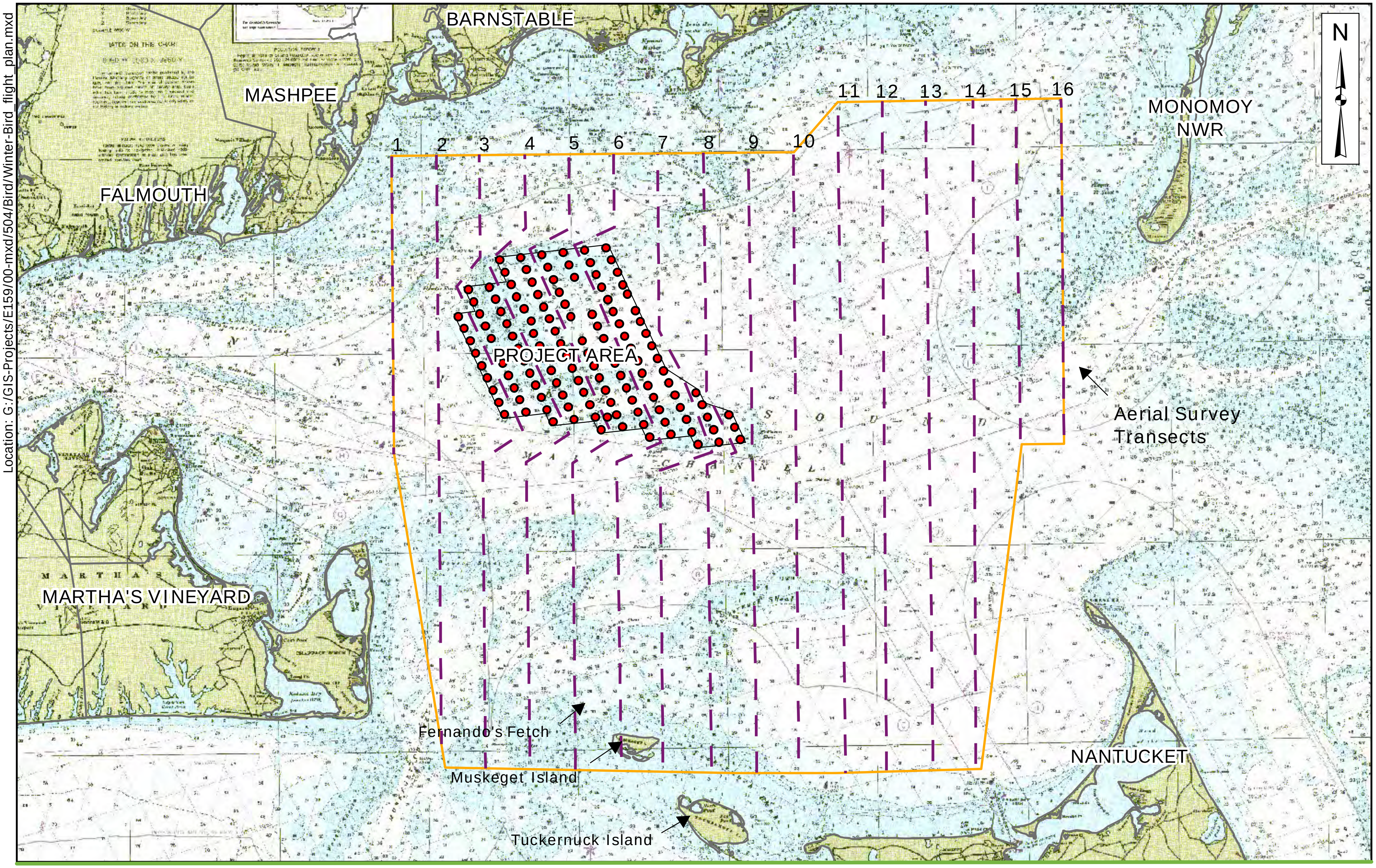
The data recorder and observers will maintain direct communication using aviation headsets. The observers will identify species, number of species, activity of bird (i.e., foraging or flying), and time of sighting. In addition to live sightings, any dead birds observed on the water surface will also be recorded and included in the reported counts. The data recorder will be responsible for entering the data identified by the observers into DLog and record a GPS position of the location at the beginning and end of each transect in addition to a GPS point every minute during each transect. Each observer’s sightings shall be independently recorded on an audiotape linked directly to each headset.

[6] The final flight altitude may be modified based on safety concerns or input from the Federal Aviation Administration (FAA).

4.7.3 Data Analysis

Results of the surveys will be transferred to a geographic information systems (GIS) map to show abundance and spatial distribution of key bird species during specific times of year (tern breeding season, tern fall staging, winter sea ducks, and winter waterbirds). The results of the post-construction monitoring survey will be compared with pre-construction aerial surveys. Evaluation of tern density and habitat use of the project area between pre- and post-construction avian surveys can be made with Jacobs' Selectivity Index (Jacobs, 1974; Fox and Petersen, 2006): $D = (r - p)/(r + p - 2rp)$, where r represents the relative proportion of terns spotted within the project area when compared to the entire aerial survey (r = terns within project area/total terns detected) and p is the proportion of the aerial survey conducted within the project area as compared to the entire survey coverage (p = area of project area/area of entire survey). The Jacobs' Selectivity Index calculates a relative degree of habitat selection by terns, *D*. *D* ranges from -1 to +1, where +1 indicates exclusive occupation of the project area, -1 indicates complete avoidance by terns and 0 is no preference. Calculating the Jacobs' Selectivity Index for each pre-and post-construction aerial survey will give a measure of tern occupancy of the project area before and after construction to see if tern use of the project area has changed. A simple two-sample t-test can be used to see if the mean index value has changed from pre- to post-construction. This comparison can be made by season (e.g. – pre- versus post-construction tern fall staging aerial surveys) or for the entire year encompassing all aerial surveys. Additionally, this method can be used to evaluate habitat use by other sea birds such as sea ducks and other winter waterbirds.

The aerial survey results will be used in conjunction with beached bird surveys, boat surveys, acoustic monitoring, telemetry, NEXRAD radar, marine surveillance radar, and visual observations in order to develop a clearer understanding of collision and changes in avian distribution in the project area.



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CAPE WIND AVIAN MONITORING PLAN

Nantucket Sound, Massachusetts

Scale: 1" = 4 Miles

0 2 4 Miles

Source: 1) NOAA Chart #13229
2) ESS, Approximate Site Boundary

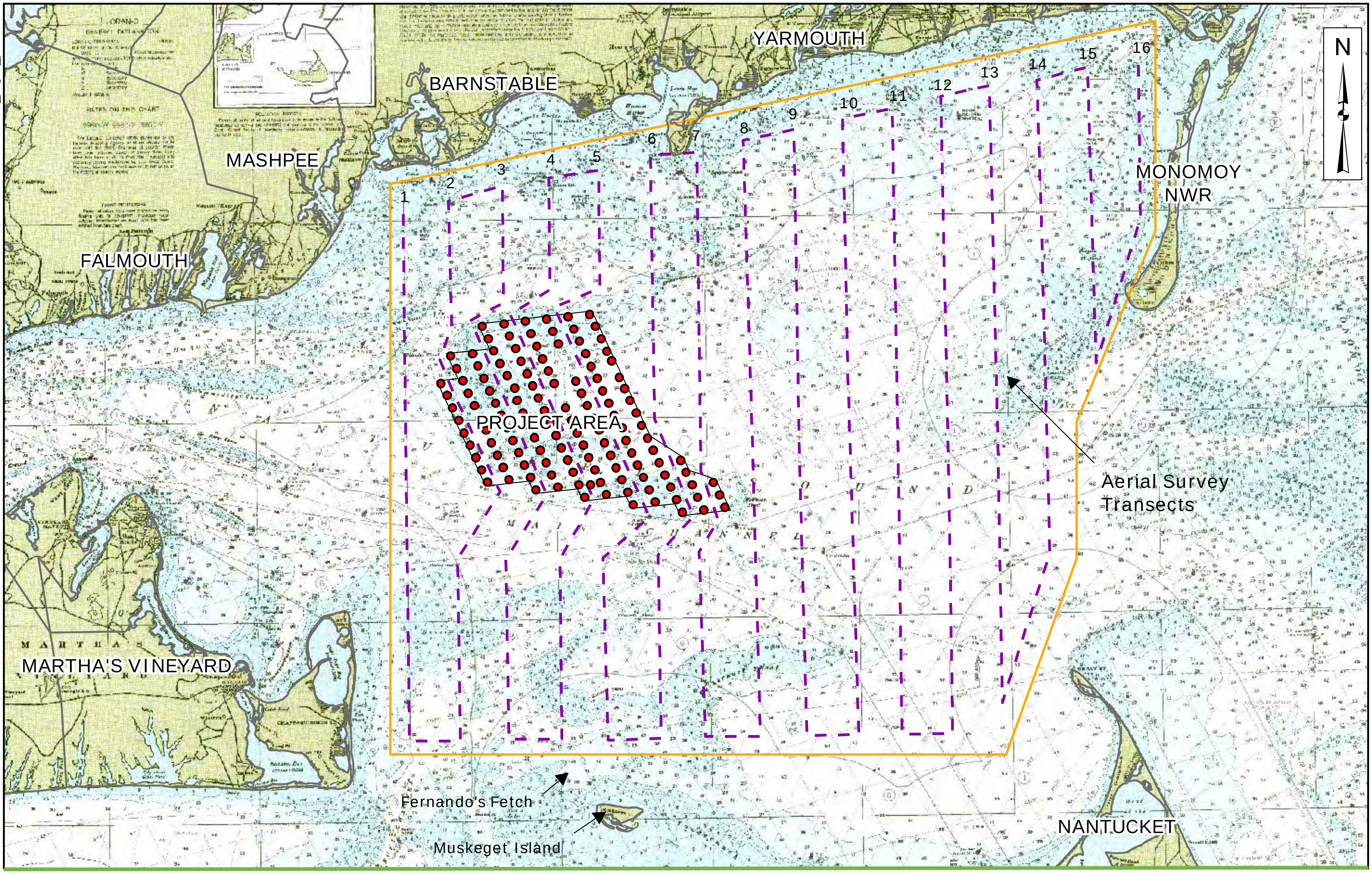
Legend

- Turbine Location
- Survey Transects
- Project Area
- Study Area Boundary

Flight Plan for Winter Sea Ducks and Waterbirds

Figure 13

Location:G:/E159/00-mxd/504/Bird/Tern_flight_plan.mxd



CAPE WIND AVIAN MONITORING PLAN

Nantucket Sound, Massachusetts

Scale: 1" = 4 Miles

0 4 Miles

Source: 1) NOAA Chart #13229

2) ESS, Approximate Site Boundary

Legend

- Turbine Location
- Survey Transects
- Project Area
- Study Area Boundary

Flight Plan for Tern Breeding and Staging Period

Figure 14

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4.8 Boat Surveys

Post-construction boat surveys will focus on providing additional information on tern use of the project area. Boat surveys will enhance the ability of field biologists to identify terns to species level. Boat surveys will also provide an opportunity for field biologists to detect Piping Plover use of the project area, if present. The existing boat survey data collected during the permitting phase of the project will allow CWA to assess changes from pre-construction to post-construction in terms of numbers of birds observed, species abundance, behavior, and flight altitudes.

4.8.1 Study Objectives

Boat surveys will be used to determine Roseate and Common Tern abundance, distribution, behavior (e.g. traveling, foraging, and resting), flight heights, and flight trajectories at the wind farm. The post-construction boat survey results will be compared with the pre-construction boat survey results to assess changes to tern use of the project area as a result of the wind farm operation.

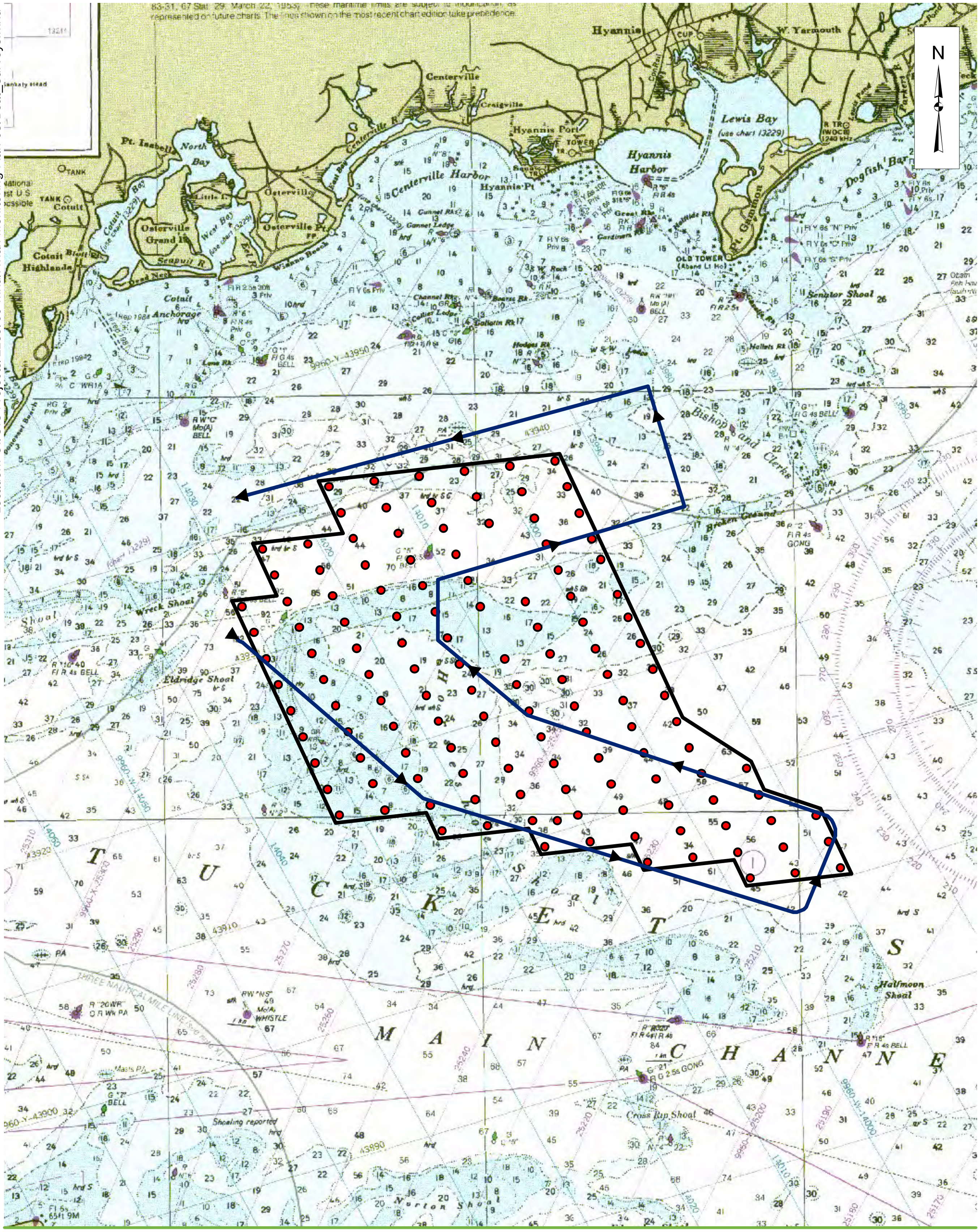
4.8.2 Methods and Schedule

Six boat surveys will be conducted during the tern breeding period from May 1 to July 15. During the tern staging period, four surveys will be completed between August 11 and September 23. The surveys will be conducted for three years following construction.

Boat surveys will follow the protocol and route established by MassAudubon in 2002 through 2004. The surveys will be conducted along a series of transects oriented in two approximately parallel tracks, one mile apart. The positions and dimensions of these transects will be selected to sample the water over project area as well as a portion of the waters within the larger action area. The boat surveys will begin and end at waypoints in the northeast portion of Horseshoe Shoal, and follow a roughly crescent-shaped route out to and back from waypoints near the southeastern portion of Horseshoe Shoal, just west of Halfmoon Shoal (Figure 15). Surveys will be conducted from a powerboat, cruising at an average speed of roughly 10 knots. Surveys will last approximately 2.2 hours. The linear length of the transect will be approximately 24.9 miles.

The boat survey teams shall consist of two field biologists equipped with range-finders/clinometers and one recorder. The data collected will include numbers of birds seen by species, behavior (feeding, sitting, or traveling), flight altitudes, flight direction, survey starting and ending times, weather (e.g., rain, sunny, cloudy), wind speed and direction, water temperature, sea state, and visibility. The observers, shall be positioned on each side of the boat immediately aft of the wheelhouse and verbally communicate all bird sightings to the recorder. Data will be recorded on a laptop computer using dLog, a computer program which records the geographical location of each observation. All birds observed within 0.5 mile on either side of the vessel shall be recorded. This distance will be periodically checked with the range finding function of the onboard radar in reference to visible objects such as buoys. Flight heights will be estimated to the maximum extent possible on subsets of terns using a combination range finder/clinometer. Binoculars will be used to confirm identification of species as needed.

Location: G:/GIS-Projects/E159/00-mxd/Avian Monitoring Plan 08/Boat_Surveys.mxd



CAPE WIND AVIAN MONITORING PLAN

Nantucket Sound, Massachusetts

Scale: 1" = 10,000'

0 10,000 Feet

Source: 1) NOAA, NOAA Chart Nantucket Sound and Approaches, 2001
2) ESS Site Boundary, Turbines, 2006

Legend
- Proposed survey route
- Wind Farm Boundary
- Proposed wind turbines

Post-Construction Boat Survey Route

Figure 15

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Flight behaviors, shapes, and plumage characteristics will be used to distinguish Common and Roseate Terns. All birds will be recorded to species whenever possible. In cases where it is not possible to differentiate between Roseate and Common Terns, the observation shall be recorded in a separate category of an undifferentiated tern species.

4.8.3 Data Analysis

The results of the post-construction surveys will be compared to the pre-construction surveys to determine if there are any detectable changes in bird use of the project area. CWA will specifically focus on changes in tern abundance, distribution, and flight height. The data may be used to verify the parameters that were used in the collision risk model prepared for the FEIR. The results will also be used to validate findings from other components of the ABMP (i.e. acoustic, telemetry, and aerial surveys). Boat surveys can be used to validate or refute any negative data collected from acoustic monitoring, telemetry and aerial surveys.

The boat survey results will be used in conjunction with beached bird surveys, aerial surveys, acoustic monitoring, telemetry, NEXRAD radar, marine surveillance radar and visual observations in order to develop a clearer understanding of collision and changes in avian distribution in the project area.

4.9 Marine Surveillance Radar and Visual Surveys[7]

To assess the wind farm's impact on the distribution and movements of small birds (i.e. Roseate Tern and Piping Plover) and non-ESA listed species, a small, portable marine surveillance radar will be utilized in association with visual observations. The radar will also be used to measure potential bird collisions with wind turbines. The information gathered from this method will be used in conjunction with other monitoring techniques (i.e. boat and aerial) to address objectives in the Framework.

4.9.1 Study Objectives

The marine radar survey will be used to gather data on the flight trajectories of birds, primarily focusing on terns and plovers (if present) during the spring and summer and seaducks and waterbirds during the fall and winter. The radar and visual observations will also be used to determine how birds respond to the presence of the wind farm in terms of behavior, flight trajectories, and flight altitudes. The radar survey and visual observations will also provide data that will be used in conjunction with the other monitoring programs to validate the field parameters used to assess risk of collision to birds.

4.9.2 Methods and Schedule

A variety of radar units exist, but not all are suitable for use in ornithological studies. Radars can be classified based on their mode of operation and are most commonly grouped as surveillance radars, Doppler radars or tracking radars (Desholm et al. 2006). Marine surveillance radars,

[7] The use of marine radar was originally ruled out in the Framework as a method to assess the wind farm impact on the focal species for several reasons. However, a modified post-construction marine radar survey has been given additional consideration based on comments received during the peer review process.

which are typically small units used on ships or planes, will be used for the post-construction study (Desholm et al. 2006).

The methods described below have been adapted from previous radar/visual surveys conducted at the Horns Rev wind farm in Denmark (Christensen et al. 2004). A marine surveillance radar unit will be mounted on the ESP to track bird movements and flight trajectories within the project area. The radar will be oriented horizontally to provide a wide area of coverage. The radar survey will be conducted to match the timing of boat surveys. Accordingly, the survey will run six times during the tern breeding period (May – July), four times during the tern staging period (mid-August to mid-September) and every other month during the winter (mid-November to March).

The range of the horizontally-aligned radar will vary with weather conditions, but is expected to have a maximum range of approximately 10 miles. The radar will be operated from the ESP, which will provide coverage of most of the project area during favorable conditions. Bird echoes appear on the radar display as individual dots moving at varying speeds (Christensen et al. 2004). The flight path of either an individual bird or a flock of birds will appear as a series of closely spaced dots or a track. Tracks observed on the radar display will be traced onto a transparency that is placed over the display or recorded using radar software. Desholm et al. (2004) found that radar tracks often disappear or fade, then reappear later. The use of a transparency will allow the radar operator to connect disjointed radar tracks into a single flight trajectory for a bird or group of birds. The transparency will also include the location of wind turbines, ESP and MET tower to provide a frame of reference. The tracks on the transparencies will be digitized into a GIS database for further analysis. Flight altitude will be measured by placing the radar in the vertical position, using an optical method or other suitable methodology.

The radar operations will occur in conjunction with up to two field biologists collecting visual observations to identify bird species, behavior, numbers and flight altitude. The field biologists will be stationed on the ESP and will record bird observations using binoculars, laser range finder/ clinometer to measure bird altitudes. Observations will be collected along pre-determined transects that originate at the ESP. The transects will be established to provide visual coverage in the four cardinal directions with the ESP at the center. The field biologists will observe and record data on all birds that cross the pre-determined transects. The field biologists observations will be used to field verify some of the data being collected by the marine radar unit.

The marine radar unit is not always capable of distinguishing individual birds from flocks of birds (Walls et al. 2009). However, the radar will provide data that will be used to evaluate relative bird numbers over time and patterns of bird movements within the project area (Wall et al. 2009). Visual observations will be used to supplement these data.

4.9.3 Data Analysis

The digitized bird tracks will be plotted in a GIS and used to evaluate bird flight trajectories in the project area. The data will be processed to calculate the number of bird tracks/hour, or a similar metric of relative bird abundance. Tern, plover (if found) and seaduck data will also be processed to determine the number of bird crossings of the project area per day, average flight altitude, avoidance behavior near the wind turbines and to validate the field parameters used to assess risk of collision to birds. Marine radar and visual observations can be used to validate or refute any negative data collected from acoustic monitoring, telemetry and aerial surveys.

The marine radar and visual observations will be used in conjunction with beached bird surveys, aerial surveys, acoustic monitoring, telemetry, NEXRAD radar and boat surveys in order to develop a clearer understanding of collision and changes in avian distribution in the project area.

5.0 REPORTING

The results of all avian and bat monitoring efforts described above will be provided to BOEM and USFWS in a series of reports that will be issued by CWA. It is anticipated that, following review, BOEM will make the final reports available to the public. The raw data from all surveys and monitoring activities will be stored according to accepted archiving practices by CWA and remain accessible, upon request, to BOEM and USFWS for the life of the lease. All data, analyses, and summaries regarding non-ESA birds, as well as listed species, will be included in these reports. Data collected will also be made available pursuant to any permit requirements.

A comprehensive annual report will be issued to present the results of survey and monitoring efforts from the previous calendar year, an evaluation of the effectiveness of the monitoring techniques, and monitoring plans / program refinements proposed for the coming year. Reports will be issued according to the following anticipated schedule:

December 15, 2013: Report covering the results of **2013 Pre-construction** monitoring activities**,** expected to include the results of beached bird surveys, AnaBat surveys, anti-perching monitoring, acoustic monitoring and radio telemetry of surrogates species.

December 15, 2014: Report covering the results of **2014 Construction** monitoring activities, expected to include the results of AnaBat surveys, anti-perching monitoring, and acoustic monitoring.

Post Construction[8]

March 15, 2015: bi-monthly report on post construction anti-perching monitoring (January and February 2014)

May 15, 2015: bi-monthly report on post construction anti-perching monitoring (March and April 2014)

July 15, 2015: bi-monthly report on post construction anti-perching monitoring (May and June 2014)

September 15, 2015: bi-monthly report on post construction anti-perching monitoring (July and August 2014)

November 15, 2015: bi-monthly report on post construction anti-perching monitoring (September and October 2014)

December 15, 2015: Report covering the results of **2015 Post Construction (Year 1)** monitoring activities, expected to include the continued results of beached bird surveys, AnaBat surveys, anti-

[8] Post construction monitoring will commence upon final installation of avian and bat monitoring equipment. Equipment installation will be concurrent with project installation; therefore dates listed above are subject to change due to project schedule.

perching monitoring, and acoustic monitoring as well as the results of NexRad analysis, and aerial surveys and radio telemetry tracking of Roseate Terns and Piping Plovers.

December 15, 2016: Report covering the results of **2016 Post Construction (Year 2)** monitoring activities expected to include the continued results of NexRad analysis (if determined necessary), beached bird surveys, AnaBat surveys, anti-perching monitoring, acoustic monitoring, aerial surveys and radio telemetry tracking of Roseate Terns and Piping Plovers.

December 15, 2017: Report covering the results of **2017 Post Construction (Year 3)** monitoring activities expected to include the continued results of NexRad analysis (if determined necessary), beached bird surveys, AnaBat surveys, anti-perching monitoring, acoustic monitoring, aerial surveys and radio telemetry tracking of Roseate Terns and Piping Plovers.

In addition to the reports described above, all federally and state listed avian collisions (with vessels, aircraft, turbines or structures) will be documented and reported within 24 hours to BOEM [David Bigger, (703) 787-1703] and USFWS [Tom Chapman, (603) 223-2541]. With respect to state- only listed species CWA will notify the Massachusetts Division of Fish and Wildlife, Dr. Thomas French (508) 389-6300. For these species, and to the extent necessary, CWA will cooperate with the responsible agencies as they coordinate with their respective law enforcement officers to arrange for the proper chain of custody, handling and disposition of any injured or dead specimens. Fatalities of non-listed species will be reported annually to BOEM and the USFWS, or as otherwise stipulated or conditioned by any subsequently issued salvage, collection or scientific permit. In addition to any information that may be required under other permits, minimum data collection includes standard data collected during bird and bat fatality studies at wind plants including: name of person who found carcass or witnessed incident, species, date/time, location, weather, identification of the vessel, aircraft, turbine (turbine number), or structure involved and its operational status when the strike occurred, and known or suspected cause of death (if possible) and status of carcass (complete, incomplete, scavenged, time since death [approximate], etc.). Bird/carcass photographs will also be provided when necessary to document species identification or other relevant attributes. Carcasses of non-listed species shall be retained (for examination and documentation) in a freezer in zip-lock or similar bags with the above listed information included on non-degradable paper. For any banded or marked birds, the presence and nature of the band (number on band should be recorded) or marking will be recorded and included in reports. In addition for Federal or research bands and marking, information (band or other identification number) will be reported to the USGS Bird Banding Laboratory (see http://www.pwrc.usgs.gov/BBL/homepage/call800.htm).

6.0 SUMMARY

These monitoring protocols provide the likely methods and tests that will be used to implement the final ABMP and address the research questions that are outlined in the Framework. The data gathered during the pre-construction and post-construction studies will be used to assess potential impacts to bird and bat populations. The studies include radio tracking, beached bird surveys, NEXRAD radar analysis, avian acoustic monitoring, anti-perching monitoring, bat detection surveys, abundance and spatial distribution surveys, and radar with associated visual observations. The monitoring protocols include proposed methods to assess the sufficiency of negative data to the maximum extent practicable as required in the USFWS Biological Opinion (11/11/08). Additional modifications to the monitoring protocols may be made as a result of pre-study field testing and results obtained during pre-construction monitoring. Based on reviews of monitoring reports by BOEM and USFWS, BOEM may authorize the discontinuation of, or adjustment to the monitoring protocols.

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