

A SURVEY OF TERN ACTIVITY WITHIN NANTUCKET SOUND,
MASSACHUSETTS, DURING THE 2003 BREEDING SEASON

Final Report for Massachusetts Technology Collaborative

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INTRODUCTION

A proposed wind farm on Horseshoe Shoals in Nantucket Sound, Massachusetts, would be the largest offshore wind farm in the United States and one of the largest in the world. Few if any data are available to assess the potential risks that this offshore wind farm may pose to birds using the Sound. A survey of terns and waterfowl in Nantucket Sound is an important step in assessing the potential avian impacts of the proposed wind farm's construction and deployment.

Several of the largest tern colonies in New England are found within 20 miles of Horseshoe Shoals. Approximately 50% of the North American population of federally endangered Roseate Terns breeds within Buzzards Bay in Massachusetts (USFWS 1998), and in 2003, approximately 10,000 pairs of Common Terns nested at Monomoy Island NWR, Chatham (Carolyn Mostello, *personal communication*). Common and Roseate terns forage within, or pass through, the Sound between early May and late September as they move to and from their colonies, foraging areas, and staging sites. Color-banding studies have demonstrated that the Roseate Terns that stage in Chatham come from colonies throughout the northeastern United States and Canadian Maritimes as well as from Massachusetts colonies, and that every year, these late-summer congregations may comprise nearly the entire North American population (Trull, et al. 1999). Little is known, however, about the actual abundance, dispersal, and daily movements of these terns during these months. In addition, the areas where they focus their feeding activities within the breeding season, fall staging period, or during spring and fall migration are poorly known.

In an effort to fill some of these data gaps, we resumed systematic tern surveys of the Sound that we initiated in August 2002 during the pre-migratory staging period. Between May 15 and July 31, 2003, we conducted 13 boat surveys on Horseshoe Shoals and three aerial surveys across a broader area within a designated flight grid over Nantucket Sound (see Figure 1). We had planned to conduct our first surveys in the first week of May, but our involvement with emergency cleanup efforts relating to a late-April oil spill in and around Buzzards Bay delayed the start of our surveys. The boat surveys were designed to assess the use of the Shoals by newly arrived migrant terns and resident terns foraging from their colonies. The three aerial surveys provided an overview of the distribution of the terns within the sample area of Nantucket Sound on a given day.

Our specific objectives were:

- 1) To estimate the abundance and distribution of Common and Roseate terns on Horseshoe Shoals within the breeding season
- 2) To observe the behaviors of the terns (e.g., traveling, feeding, resting) on Horseshoe Shoals
- 3) To determine the heights at which the birds were flying, and
- 4) To detect any temporal variation in these parameters.

The timing of these surveys was based on the known average arrival dates of terns returning to Massachusetts from their wintering quarters at the beginning of the breeding season (late April - early May), and the known dates at which both adults and juvenile birds begin to disperse from the colonies at the end of the breeding season (late July-early August) (Gochfeld et. al. 1998).

METHODS

Tern behavior, distribution, and abundance on Horseshoe Shoals were estimated primarily using boat surveys supplemented by three aerial surveys. In general, our methods, described below, were identical to the protocols developed for our first survey of terns during the 2002 pre-migratory staging period (Perkins, et al. 2002), with two important modifications. These modifications were made to enhance our ability to estimate tern abundance and to increase our accuracy in spatially locating terns counted during the surveys.

1. Defined transect width for aerial surveys

As part of our methods during aerial surveys in 2002, we counted all birds visible to the naked eye or with the aid of binoculars along each transect. In 2003, we strictly defined the transect width as 600 feet, recording only those birds seen within a 300 ft-wide transect corridor on each side of the plane. Each of these corridor's inner and outer margins were visually fixed with a clinometer by measuring the angle visible at the lower edge of the window (70 degrees from the horizontal) to a point 46 degrees from the horizontal, or a total of 23 degrees. This approximated the lower one-third of the visible water surface along a vertical field of view (Figure 2).

Criteria used for the selection of transect width included:

- 1) The distance perpendicular to the transect centerline at which birds (especially terns) were detectable with the naked eye (after initial detection, identification sometimes required binoculars).
- 2) Total width was narrow enough to avoid situations in which birds were too abundant and/or were spread over too wide an area to count accurately.

2. Improved data entry system

In 2002, we entered data directly into an Excel spreadsheet, manually recording all pertinent data including the latitudes and longitudes. In 2003, we purchased a customized data entry program, "dLOG" software created by Glenn Ford Consulting, Inc., Portland, OR, which was designed specifically for aerial and boat surveys of waterbirds. The program automatically recorded latitude and longitude generated from an onboard GPS unit, and enabled us to record species and their numbers using one- or two-key species codes. This significantly reduced the recording time for each data point and increased the accuracy of the location of each sighting.

In addition to these two modifications, we were more selective about weather conditions: we conducted boat and plane surveys only on days when the wind did not exceed 15 knots. This adjustment was based on our experience in year one that higher winds created sea conditions that reduced the visibility of the birds and negatively effected our ability to detect birds.

Boat surveys

We conducted 13 boat surveys along a series of transects oriented in two parallel tracks, one mile apart. The positions of these transects were selected to sample all the waters over Horseshoe Shoals as well as the waters in the immediate vicinity of the Shoals (see Figure 1). For the purposes of this study, we defined the Shoals as the area described by the 20-ft bathymetry line. Surveys were conducted from a 33 ft powerboat, cruising at an average speed of roughly 17 knots. Surveys lasted approximately 1.5 hours. The total linear length of the boat transects was 24.9 miles.

The survey teams consisted of two observers and one recorder. Data collected included numbers of birds seen by species, behavior (traveling, feeding, or sitting), their flight altitudes, survey starting and ending times, weather (e.g., rain, sunny, cloudy), wind speed and direction, water temperature, sea state, and visibility. The observers, positioned on each side of the boat immediately aft of the wheelhouse, verbally communicated all bird sightings. The recorder immediately entered this information onto a laptop computer; geographical location of each observation was automatically logged by the computer program (dLog). All birds observed within 0.5 mile on either side of the vessel were recorded. This distance was periodically checked with the range-finding function of the onboard radar in reference to visible objects such as buoys. Flight heights of the birds were estimated by referencing objects of known height such as the top of the wheelhouse, navigational buoys, and the Cape Wind test tower. Observers used binoculars to confirm identification to species as needed.

Common and Roseate Terns were distinguished by their different flight behaviors, shapes, and plumage characteristics. We recorded all birds to species whenever possible, but it was not always possible to differentiate between Roseate and Common terns. When we could not determine with certainty whether the bird was a Roseate or Common tern we placed the sighting in a separate category of Tern species.

Aerial Surveys

Three aerial surveys were conducted along sixteen fixed, parallel transects oriented north to south. The sample grid comprised approximately 70 percent of Nantucket Sound; the transects extended from points just seaward of the south shore of Cape Cod, southward to an east-west line roughly even with Great Point, Nantucket (Figure 1). Individual transects were separated at 7,500 foot intervals, and the total combined linear length of all 16 transects was 247.4 miles. The length of the longest transect was 18.2 miles, the shortest transect was 4.5 miles, and the mean length of all sixteen transects was 15.4 miles (Figure 1). The actual sample area, defined by the width

of the transects (600 feet) times their combined length (247 miles) equaled 28 square miles comprising approximately 6 percent of the area of Nantucket Sound.

Aerial surveys were flown with a high-winged, twin-engine aircraft (Cessna Sky Master 337) cruising at an average altitude of 500 feet and at an average airspeed of 90 knots. The chosen altitude allowed us to identify birds on the sea surface but also reduced the possibility of flushing the birds from the water surface to another part of the Sound where they might have been recounted. The airspeed was the slowest at which the aircraft could safely fly. Flights were conducted only on days with light to moderate winds (not exceeding 15 knots) and on days with good atmospheric clarity (visibility >10 miles). Flights usually began mid morning, and the average duration of each survey was roughly 2.5 hrs. We recorded birds seen along or on either side of the north-south transects out to a distance of 300 feet on each side of the plane. Individual birds were identified with the aid of binoculars as needed. We did not count any species observed while we were flying the short, east-west legs between transects. Roseate and Common Tern sightings were treated as described for the boat surveys. Observations of non-avian species, such as sea turtles, were also recorded.

Each survey team was composed of a pilot, a recorder in the co-pilot seat, and two experienced observers. The two observers were positioned opposite one another on each side of the plane. All members of the team communicated through an onboard intercom system. The observers verbally communicated all bird sightings to the recorder. Data were recorded using dLog as described above. Recorded information included all species of birds, their abundances, and their behavior (traveling, sitting, or actively feeding). We also recorded starting and ending times, wind direction and velocity, sea state, visibility, and cloud cover for each transect on every survey. Surveys were conducted over a wide range of tidal stages.

RESULTS

Boat surveys

Thirteen boat surveys were conducted on Horseshoe Shoals between May 15 and July 31. A cumulative total of 250 terns were observed on the Shoals (Table 1), and terns were recorded on all but four surveys (June 18 and 25, and July 29 and 31 (Table 1, Figure 3). Of the terns seen on all nine surveys, 134 (53.6%) were traveling, 88 (35.2%) were actively feeding, and 28 (11.2%) were resting on the sea surface (Table 2). The altitude range of all traveling terns was between 5 and 250 feet (Figure 4) with an average height of 29 ft (SD=31, median = 25). The lowest point of the turbine rotors above the water surface would be approximately 70 feet (Jeff Burm, *personal communication*); over 90% of traveling terns were flying lower than 70 feet.

Over the course of the entire survey period, terns were generally distributed throughout the entire Shoal area, although more were observed in the southern portions (Figure 5). Twelve non-tern species of birds, including three species of land birds (all swallows), were recorded during the boat surveys (Table 3).

Wind speed during all boat surveys did not exceed 15 knots except on May 29, when it gusted occasionally to 20 knots. Sea states (Beaufort Scale) ranged between 0 and 5. As in all of our surveys, we did not attempt to control for tidal variation during the boat surveys.

Aerial Surveys

Three aerial surveys were conducted on June 3, July 14, and July 30. Terns were recorded on all three surveys. We observed 680 terns comprising 472 Common Terns, nine Roseate Terns, and 199 Common-Roseate-type terns, i.e., Tern species (see Methods for detail) (Table 4). Three hundred and seventy terns were recorded on July 14; 281 birds were recorded on June 3; and on July 30, the last aerial survey, only 29 terns were observed. During the survey period, sea state conditions never exceeded 3 on the Beaufort scale.

Seventy-eight percent of the terns observed on aerial surveys were recorded in the northeastern quadrant of the survey area. Specifically, 66.3% of all terns were recorded along transects 14-16, near Monomoy Island, and 54.9% of birds were seen along transect 16 alone; 33.7% were counted within transects 1-13. Only seven terns (1.0%) were observed directly over Horseshoe Shoals (see Figure 6).

Of the four hundred and seventy two Common Terns counted during the three aerial surveys 63.3% of the terns were feeding, 35.4% were traveling, and 1.3% were sitting on the water. Of the nine Roseate Terns counted during aerial surveys, three were observed actively fishing and six were traveling. Of the 199 Tern species counted, 67.8% were feeding, 31.7% were traveling, and 0.5% were resting (Table 4).

DISCUSSION

Three species of terns were observed within the area described by Horseshoe Shoals. Two sets of data lend themselves to assessing the specific nature of these observations: Figure 3 indicates that the highest numbers of birds on the Shoals were recorded by boat early in the survey period, and that tern abundance decreased thereafter, with the exception of one peak in late July. Table 2 reveals that most of the birds observed on the Shoals were traveling versus fishing or sitting. Although the data are limited, we hypothesize that the majority of terns observed on the Shoals were either passage migrants moving through these waters to breeding colonies farther north and east, and/or recently returned Massachusetts breeding residents.

It was surprising to find terns occasionally sitting (“rafting”) on the water over Horseshoe Shoals during the boat surveys. When they are within close proximity to their colonies in Massachusetts, terns rarely alight on the water (Ian Nisbet, *personal communication*). Possible explanations for these observations include that these birds were resting migrants that eventually continued their northward migration, or that the terns were recently arrived local breeders that were resting on the water. Rafting

behavior was most prevalent early in the breeding season, at a time when many terns were just arriving back into local waters.

The slightly higher numbers of birds recorded on the southern half of the Shoals during the boat surveys may have reflected the stronger currents that typically flow across the southern half of the Shoals (Len Greiner, *personal communication*). Stronger currents create stronger upwelling, and areas of upwelling often bring plankton and baitfish near the surface within capture range of the feeding terns.

During the three plane surveys, the greatest numbers of terns were found near Monomoy Island NWR. This is not surprising given that, in 2003, the Monomoy colony contained roughly 63 percent of all the breeding Common Terns in Massachusetts (approximately 10,000 pairs). This distributional pattern also may have been due to the terns' preference for foraging in Nantucket Sound's shallow margins, especially near Monomoy, where the feeding conditions are especially favorable.

The data from this year's boat and aerial surveys suggest the hypothesis that Horseshoe Shoals is more important as a migratory stopover point or "refueling" area for terns than as a feeding area for locally nesting resident terns. This hypothesis cannot be tested fully without marking and tracking individual terns. We plan additional surveys in 2004 and will begin our boat surveys earlier. Beginning our surveys at an earlier date may provide additional information on the use of Horseshoe Shoals by migratory terns. We also will increase the number of aerial surveys. A second year of surveys will help us determine whether our observations this past breeding season are consistent from year to year, or if there is a shift in local distribution or abundance of terns based on availability of food or other factors.

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Table 1: Terns observed during the 2003 breeding season boat surveys on Horseshoe Shoals by date.

| Date | Common Tern | Roseate Tern | Tern Sp. | ALL TERNS |
|---------------|--------------------|---------------------|-----------------|------------------|
| 15-May-03 | 37 | 0 | 53 | 90 |
| 22-May-03 | 49 | 0 | 6 | 55 |
| 29-May-03 | 45 | 1 | 6 | 52 |
| 5-Jun-03 | 15 | 0 | 2 | 17 |
| 11-Jun-03 | 3 | 0 | 0 | 3 |
| 18-Jun-03 | 0 | 0 | 0 | 0 |
| 25-Jun-03 | 0 | 0 | 0 | 0 |
| 2-Jul-03 | 0 | 2 | 0 | 2 |
| 10-Jul-03 | 2 | 0 | 2 | 4 |
| 17-Jul-03 | 1 | 0 | 0 | 1 |
| 28-Jul-03 | 20 | 5 | 1 | 26 |
| 29-Jul-03 | 0 | 0 | 0 | 0 |
| 31-Jul-03 | 0 | 0 | 0 | 0 |
| Totals | 172 | 8 | 70 | 250 |

Table 2: Frequency of behavior of terns observed during 2003 breeding season boat surveys on Horseshoe Shoals, Nantucket Sound. Vessel refers to birds observed following a fishing boat.

| Species | FEEDING | SITTING | TRAVELING | VESSEL |
|----------------|----------------|----------------|------------------|---------------|
| Common Tern | 24.4% | 13.4% | 62.2% | 0% |
| Roseate Tern | 0% | 0% | 100.0% | 0% |
| Tern species | 64.3% | 7.1% | 27.1% | 1.4% |
| All Terns | 35.2% | 11.2% | 53.6% | |

Table 3: Non-tern bird species and numbers observed during 2003 breeding season boat surveys on Horseshoe Shoals, Nantucket Sound.

| Species | Number |
|--------------------------|---------------|
| Red-throated Loon | 4 |
| Common Loon | 44 |
| Wilson's Storm-Petrel | 20 |
| Northern Gannet | 7 |
| Double-crested Cormorant | 19 |
| White-winged Scoter | 35 |
| Laughing Gull | 1 |
| Herring Gull | 36 |
| Great Black-backed Gull | 142 |
| Gull species | 10 |
| Tree Swallow | 1 |
| Purple Martin | 1 |
| Barn Swallow | 2 |
| Total | 322 |

Table 4. Bird species and numbers observed during 2003 breeding season aerial surveys over Nantucket Sound (3 flights: 6/3, 7/14, 7/30).

| Species | Number |
|--------------------------|---------------|
| Common Loon | 32 |
| Wilson's Storm Petrel | 1 |
| Northern Gannet | 1 |
| Double-crested Cormorant | 258 |
| Laughing Gull | 16 |
| Herring Gull | 84 |
| Great Black-backed Gull | 213 |
| Gull species | 56 |
| Roseate Tern | 9 |
| Common Tern | 472 |
| Least Tern | 2 |
| Tern sp. | 199 |

Figure 1. Nantucket Sound study area and associated features, including aerial and boat transect routes, and area of proposed wind farm, major tern colonies.

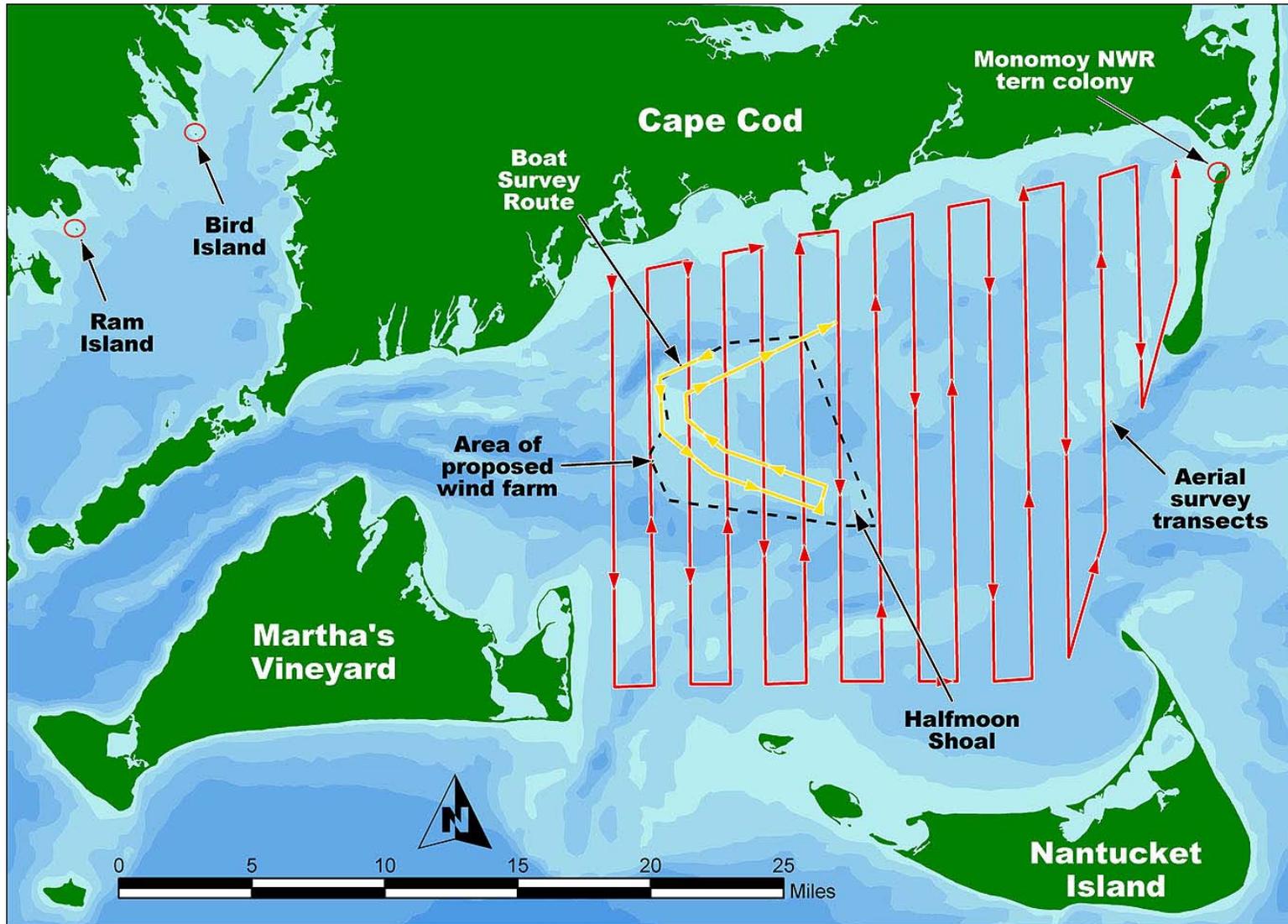


Figure 2. Viewing angles and distances used in aerial surveys.

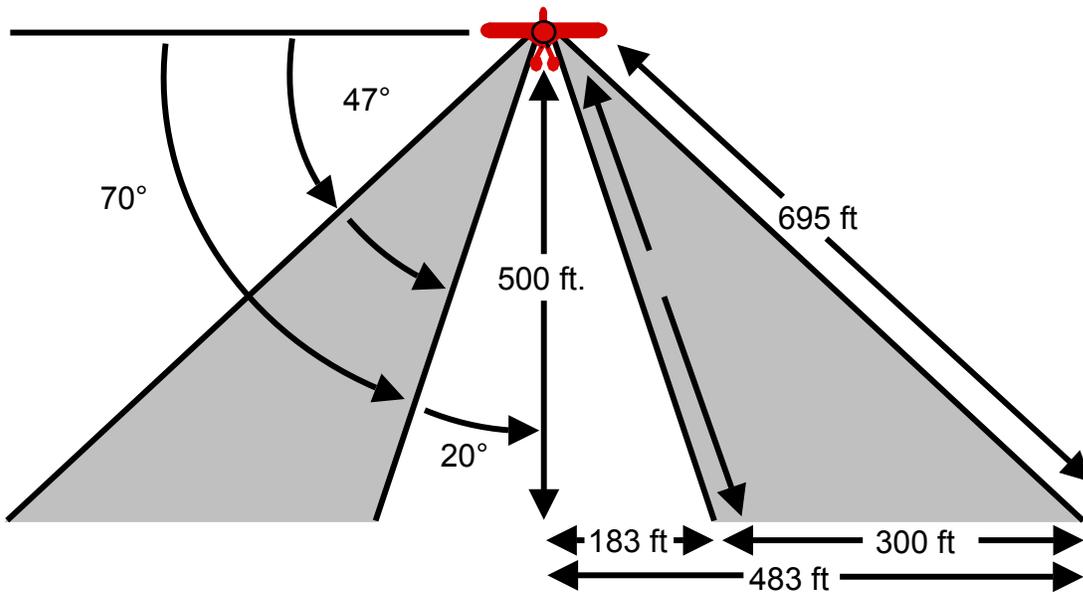


Figure 3. Total numbers of terns observed during 2003 breeding season boat surveys on Horseshoe Shoals, Nantucket Sound by date.

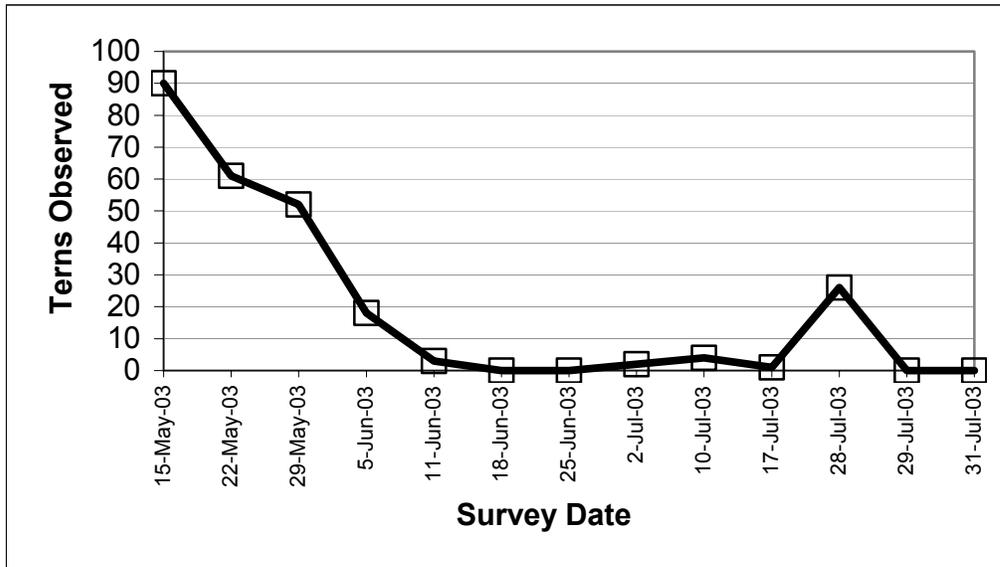


Figure 4. Frequency distribution of flight heights of terns (in feet) observed during 2003 breeding season boat surveys on Horseshoe Shoals, Nantucket Sound. Numbers are based on all surveys combined.

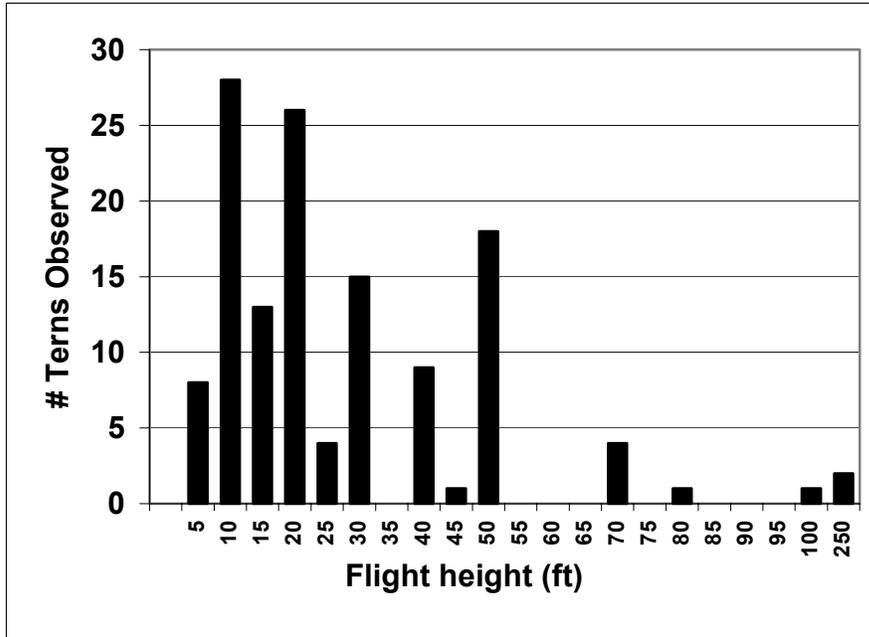


Figure 5. Distribution of tern sightings by species observed during 2003 boat surveys of Horseshoe Shoals, Nantucket Sound. Numbers of terns seen is indicated by the circle diameter and are based on all surveys combined.

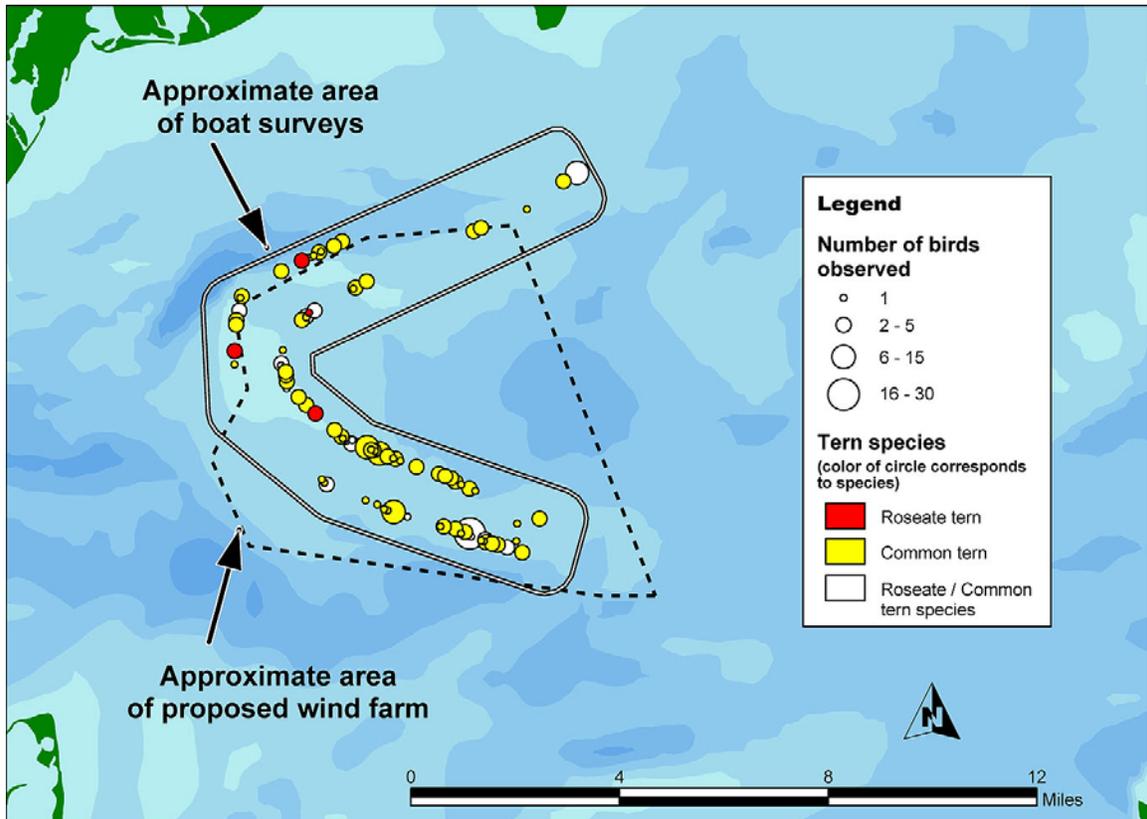


Figure 6. Summary distribution map of terns by species observed during 2003 breeding season aerial surveys of Nantucket Sound. Number of terns seen at any one location represents the combined total of three aerial surveys and the magnitude indicated by the diameter of the circle.

