LONG-TAILED DUCK REPORT WINTER 2005-2006

NANTUCKET SOUND MASSACHUSETTS

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Project No. E159-502

September 15, 2006

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1.0 INTRODUCTION

This report summarizes the results of a study conducted during 12 field days over a four-month period (December 2005, January, February, and March 2006) to document the use of Nantucket Sound by Long-tailed Ducks (*Clangula hyemalis)* during the 2005-2006 winter season. This report is a continuation of studies that began in March 2002 at the suggestion of the U.S. Fish and Wildlife Service (USFWS), the Massachusetts Division of Fisheries and Wildlife (MADFW), and the Massachusetts Audubon Society (Mass Audubon).

Long-tailed Ducks are migratory, breeding in extensive portions of northern Canada and Alaska, and wintering on both coasts of North America and the Great Lakes (Robertson and Savard, 2002). Locally, Long-tailed Ducks are reported to arrive in numbers around Nantucket Sound during mid-November, and are usually present until mid-April, when the birds begin departing for the arctic breeding grounds (Davis 1997). Long-tailed Ducks roost at night in Nantucket Sound (Veit and Petersen, 1993) and then fly in large flocks over Nantucket Island and Tuckernuck Island to forage over the Nantucket Shoals during the day (Veit and Petersen 1993, Davis 1997). A large roost was discovered in the southern portion of Nantucket Sound, north of Tuckernuck Island during a preliminary survey flight conducted in December 2001 (USACE, 2004). However, Long-tailed duck roosting locations and movements are not well understood—it is not known if individuals follow the same daily flight patterns between Nantucket Sound and Nantucket Shoals or if there is a consistent nighttime roosting area in Nantucket Sound. Flight timing, and whether or not all of the local winter population follows this flight pattern on a daily basis, is also unknown.

2.0 METHODOLOGY

The field study employed a combination of land-based observations, airplane reconnaissance, and boat surveys to examine and observe movements of Long-tailed Ducks in Nantucket Sound. The fieldwork was conducted over 12 days beginning in late December 2005 and ending in March 2006. Because surveys were conducted by land, air, and sea, weather dictated when air and sea surveys could occur. Surveys that were conducted solely from land were conducted in all weather conditions. Many of the land-based surveys occurred on consecutive days in which observations were made during the morning (within two hours of sunrise) and again in the early evening (within two hours of sunset). Consecutive land-based survey days occurred from December 29 to December 31, 2005 (scheduled to coincide with the Audubon Christmas Bird Count – CBC), and from January 16 to January 20, and March 22 to March 23, 2006. Single-day surveys occurred on February 15 and March 6, 2006. All surveys, except the final one, involved a minimum of two land-based observers stationed at one of two locations on the western side of Nantucket Island (Figure 1).

In addition to the land-based observers, two boat observation crews were positioned off the northwestern shore of Nantucket Island on February 15 and March 6, 2006. The boat crews observed the birds as they flew farther into Nantucket Sound to determine what direction they were going to roost. The March 6 survey also included the use of two observers in an airplane flying transects off the northwest shore of Nantucket Island to follow individuals as they flew into Nantucket Sound for the evening.

2.1 Land Observation Methods

Site Selection

Before beginning the first observation session on December 29, 2005, potential locations for ground-based observations were examined to determine which site would be most suitable for counting Long-tailed Ducks as they flew into and out of Nantucket Sound. Three sites on Nantucket Island were examined—Eel Point, Esther Island, and the southern end of Madaket (Figure 1). These locations were selected based on flight descriptions in Davis 1997. Ultimately, Eel Point was designated as the preferred viewing location for Long-tailed Duck movements for reasons outlined below. The following describes the selection process for the three sites.

Esther Island

Esther Island is located at the extreme southwestern edge of Nantucket Island. It is an ideal viewing location when the ducks are flying north or south over the channel between Tuckernuck Island and Esther Island, as well as west of Tuckernuck Island when there is good visibility. However, this viewing location is inaccessible during the highest tides or when there is a strong storm surge. In addition, reaching this location on foot requires considerable time. It is difficult to determine the ducks' point of origin during the morning flights when viewed from this location. The Long-tailed Ducks were frequently seen flying over Eel Point so Esther Island was ultimately excluded. However, data obtained from three observation sessions made at this location are included in this report.

Madaket

Madaket is located at the southwestern portion of Nantucket Island, east of Esther Island. This viewing location provides an adequate vantage point when ducks are flying south of Nantucket Island and east of Tuckernuck Island. However, it is not an ideal viewing location because the ducks' point of origin from Nantucket Sound is not visible in the morning. In the evening, the direction that the ducks fly as they move into Nantucket Sound cannot be seen clearly from Madaket. Therefore, it is often difficult to determine the origin of the ducks in the morning and the destination of the ducks in the evening. Data obtained from one observation session made at this location is included in this report.

Eel Point

Eel Point is located at the northernmost point of the southwestern spur of Nantucket Island and became the preferred viewing location for Long-tailed Ducks. Although it is some distance east of the channel between Nantucket Island and Tuckernuck Island, this northern location facilitates following the nighttime flights into Nantucket Sound and identifying the direction from which the ducks come in the morning. Vehicle access to Eel Point is straightforward. In addition, it seemed that the Long-tailed Ducks turned north at Madaket and flew over Madaket Harbor for the majority of the flights. Because of the beneficial views and logistical benefits of Eel Point, the majority of the observations took place at Eel Point. Data obtained from nine observation sessions are included in this report.

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Methodology

Land-based observations were made from one of three locations (primarily Eel Point) on the western side of Nantucket Island: Eel Point, Esther Island, and Madaket (Figure 1). In the morning, the observation team (two observers and a data recorder) was in place at sunrise (as determined by the National Weather Service) and scanned the sea and horizon north of the observation point (in the direction of Nantucket Sound). The team used 10 x 50 binoculars and unaided eye to scan the horizon for movements of Long-tailed Ducks on their way out of Nantucket Sound. Observations were recorded for all flocks flying across an established line[1] within the observer's field of vision. Typically, Long-tailed Ducks were counted in the 20s, 50s, and 100s depending on the size of the flocks. When small numbers of ducks occurred (fewer than 20), individuals were counted. Poor visibility due to fog, rain, and fading daylight sometimes made counting ducks difficult. Observations made when visibility was poor are noted in the results section.

When large flocks approached, one of the spotters would begin counting. The other counter would scan the sky in all directions looking for other flocks to count. Often, several large flocks would be flying in the vicinity and each observer would communicate to each other which group he was counting. When large numbers of Long-tailed Ducks were encountered, the two observers would count different flocks simultaneously and relay the numbers of ducks and flight information to the recorder. Observations were recorded by voice recorders and later transcribed into a database for analysis.

The following data was recorded during the survey: date, time of observation, weather condition, wind direction, species, estimated number, bird behavior (flying or resting on the water), estimated height of flight, and estimated direction of flight. Flight height was estimated referencing nearby land. Morning observations continued until at least one-and-a-half hours after sunrise, when ducks were no longer being observed in flocks greater than two or three ducks. The morning surveys lasted for a minimum observation period of approximately two hours. Birds were observed until they could no longer be seen to establish the direction of flight out of Nantucket Sound.

In the evening, observation teams returned to the observation point at least two hours prior to sunset and repeated the methods used in the morning session. Evening observation sessions continued until visibility waned. The afternoon survey typically lasted two-and-a-half hours.

One of the goals of the land-based observations was to identify any repeatable, established patterns of movements into and out of Nantucket Sound as a precursor to the deployment of planes and boats for further field study.

2.2 Boat Observation Methods

Following the completion of the first phase of the afternoon and morning land-based observations, which documented Long-tailed Ducks flying north and northeast into, and flying south out of, Nantucket Sound from Eel Point, two boats were deployed to track the evening

[1] At Eel Point and Esther Island, the observers counted Long-tailed Ducks that crossed a theoretical line between themselves and a landmark on Tuckernuck Island.

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Long-tailed Ducks movements further into Nantucket Sound. Two observers were on board each boat and equipped with binoculars. The boats departed Falmouth in the early afternoon in order to view the afternoon and early evening flight. The boat surveys occurred on February 15 and March 6, 2006.

One vessel, *Patricia Lynn*, was initially positioned at a buoy north of Eel Point at the start of both boat surveys to communicate with the land observers (Figure 1). As the ducks flew into Nantucket Sound, the Patricia Lynn moved to follow the direction of the ducks. The second vessel, *Minuteman*, was positioned on the southeastern edge of Horseshoe Shoal on February 15, where it traveled back and forth (from east to west then west to east). The goal of the boat surveys was to understand further where the Long-tailed Ducks flew in the afternoon and early evening in the hope that the nighttime roosting area(s) could be determined. In addition, the *Minuteman* attempted to determine whether Horseshoe Shoal was used as a nighttime roosting location.

On March 6, *Minuteman* was stationed farther east of Horseshoe Shoal where more ducks had been seen during the previous survey on February 15 (Figure 1). Cell phones and marine very high frequency (VHF) radios were used to communicate between the different observation teams. Observers aboard each vessel communicated with each other in an attempt to track the flights of Long-tailed Ducks into Nantucket Sound.

Once a large flock was located by the land observation team at Eel Point, its location and bearing was relayed to *Patricia Lynn* (boat closest to Eel Point). *Patricia Lynn* then radioed the number of ducks and flight direction to *Minuteman*.

2.3 Airplane Observation Methods

Two observers and a recorder flew in a twin engine Cessna Sky Master 337 out of Chatham, Massachusetts on March 6, 2006. The observers and recorder were equipped with binoculars, Trimble Geo Explorer 3 Global Positioning System (GPS) unit, and voice-recording devices. The aerial surveys began at 3:10 pm and ran to after sunset. The plane followed north–-south transects starting near Monomoy and then east—west transects north of Muskeget Island while in contact by radio with the boat- and land-based observers. The aerial surveys were aided by the information obtained during the land-based observations concerning time of day and flight directions. The purpose of the survey was to identify the locations of large groups (those estimated to be comprised of 1,000 birds or more) and their flight directions. The systematic survey was comparable to the survey transects flown during the previous Cape Wind aerial surveys of 2002 through 2004. However, the southern reaches of the earlier transects were extended in order to better cover the area near Tuckernuck Island and near-shore Nantucket Island. An additional short transect was added to the eastern edge of the survey in order to cover the area close to Monomoy.

Following the completion of the preliminary daylight survey (approximately two hours), the plane proceeded to the area around Nantucket Island to look for Long-tailed Ducks returning from their daytime foraging in the Nantucket Shoals area. Transects were flown east and west along the north shore of Nantucket, Tuckernuck, and Muskeget islands to intercept flocks returning to Nantucket Sound. If the spotters observed the Long-tailed Ducks in transit, the plane attempted to follow their

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flight into Nantucket Sound and locate their roosting site(s). If observed, spotters were to record the GPS point, time, approximate direction of flight, and, when possible, the approximate numbers and species composition of the group. If, prior to darkness, no flocks were observed re-entering Nantucket Sound, the plane was to commence flying an established grid utilizing night vision equipment, and concentrate initially on the southern portion of Nantucket Sound and move farther north until roosting sites were located.

3.0 RESULTS

The general flight paths and numbers of Long-tailed Ducks were collected from various observation locations (land, air, and sea) and are presented below. Data collected during the land-based surveys was analyzed to evaluate any trends in duck flight path, flight heights with respect to headwinds and tailwinds, morning versus prior evening duck counts, and duck count per minute. Results of these analyses are presented in the sections below.

3.1 Morning and Evening Flight Paths per Survey

The predominant morning and afternoon Long-tailed Duck flight paths seen from the observation points are displayed in Figure 2.1 through Figure 2.5 and Figure 3.1 through Figure 3.6. All survey days are represented in the figures except the morning surveys conducted December 29, 2005 and January 18, 2006. Forty-five ducks, too few to be considered representative, were observed in the morning survey of January 18, 2006; December 29, 2005 was a trial run where the observers were not stationed at a specific location in order to track flight paths. The February and March surveys were also not included because too few ducks to be considered representative were observed.

The morning flight consisted of Long-tailed Ducks flying south out of Nantucket Sound. Once the birds reached the southern side of Esther and Tuckernuck islands, the flocks generally turned east along the southern side of Nantucket Island. We presume that the ducks continued to head toward the various Nantucket Shoals (Figure 4), where the Long-tailed Ducks have been documented to feed during the day (Bent 1925 in Davis 1997). In the afternoon, the Long-tailed Ducks moved in the opposite direction, heading north and northeast into Nantucket Sound from the southern side of Nantucket and Tuckernuck islands. These flight paths and behavior are consistent with existing knowledge of daily Long-tailed Duck flights (Davis 1997).

During the surveys, the duck flight was characterized as flying “near” to Eel Point (within 1000 feet), passing “midway” between Eel Point and Tuckernuck Island and passing “far away” along the eastern shore of Tuckernuck Island. In some cases with good visibility ducks could be seen flying over Tuckernuck Island. Flight path location in relation to the observation point was recorded during the majority of the land-based surveys.

3.2 Summary of Flight Paths for All Surveys with Respect to Nantucket Sound and Horseshoe Shoal

Based on a summary of flight paths from a majority of the morning surveys in December 2005 and January 2006, the estimated general direction that the ducks traveled as they moved from Nantucket Sound to Nantucket Shoals is presented in Figure 5. The majority of ducks (67%) were observed

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flying due south as they flew through Tuckernuck Channel. Observers noted that the majority of these ducks flew in from the northeast, turned south as they passed Eel Point, and proceeded to fly over Ester Island. The remaining ducks were observed flying southeast (20%) and southwest (13%) as they passed Eel Point. The roosting area (or areas) in Nantucket Sound from which the Long-tailed Ducks originate from remains unknown. However, observations from the boat and land surveys suggest that the area is located in the northeastern portion of Nantucket Sound.

Based on a summary of all flight paths from the evening surveys in December 2005 and January 2006, the estimated general direction that the ducks traveled as they moved between Nantucket Shoal and Nantucket Sound is presented in Figure 5. The vast majority of Long-tailed Ducks were observed traveling either north or northeast (99% of all observations) in the afternoon and evening as they passed the observation points. A very small number of ducks were observed flying either northwest or west (<0.2% of observations).

3.3 Flight Heights with Respect to Headwinds or Tailwinds

The elevation at which Long-tailed Ducks were flying was estimated using land masses as a reference and recorded as ducks were observed passing the observation point. Using weather data collected from Nantucket Memorial Airport (Weather Underground, 2006) the average wind speed and direction was determined for each survey session. Using this wind direction data, duck heading in relation to a headwind or tailwind was determined. Headwind was defined as those times when the general duck heading was either directly into the wind or within a ±45-degree angle of the predominant wind direction. Tailwind was defined as those times when the general duck heading was the same as the wind direction or within a ±45-degree angle of the predominant wind direction. If the predominant wind direction was perpendicular to duck heading, then neither a headwind nor tailwind was assumed and it was not included in the analysis.

Based on these assumptions, ducks were flying into a headwind during the following survey periods: December 30 evening, January 16 evening, and January 20 morning. Ducks were flying with a tailwind during the following survey periods: December 29 evening, December 30 morning, December 31 morning and January 17 morning. The January 19 morning survey was not included in the analysis because the predominant wind direction during this time period was directly perpendicular to the flight path and therefore, it was determined that the wind was neither a tailwind or headwind. The December 29 morning survey was not included because many ducks passed without being counted[2] and the January 18 morning survey was not included because of the low number of ducks observed.

Estimated duck flight elevation with headwind versus tailwind is presented in Figure 6, which is based on land-based observations from December and January surveys from Eel Point. Survey sessions from February and March were not included because methodology differed on these days as outlined in Sections 2.2 and 2.3 and so few ducks were observed during these surveys.

[2] The December 29 survey was the initial field day and time was spent evaluating potential observation locations. Observers walked to the end of Esther Island from Madaket in dense fog. Observers noted seeing and hearing thousands of Long-tailed Ducks flying east along the shore. The ducks were several hundred feet from the shore.

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Based on the results as displayed in Figure 6, there appears to be a relationship between duck flight elevation and whether ducks are flying into a headwind or with a tailwind. When flying into a headwind, 66% of the ducks were observed flying within 25 feet of the surface of the water, the majority of which were flying just above the surface of the water (within 10 feet). Smaller percentages (34%) of ducks were observed flying within mid-range elevations between 25 and 150 feet , and only four ducks (<1%) were observed flying above 150 feet when there was a headwind.

In contrast, results for estimated duck flight elevations with a tailwind were nearly opposite those of headwind flights. The majority of ducks (84%) was observed flying at higher elevations between 25 and 150 feet, approximately 15% of the ducks were observed at heights greater than 150 feet, and only 1% was seen flying less than 25 feet from the water when flying with a tailwind. One would expect to observe ducks flying at higher elevations with tailwinds to take advantage of the higher wind speed aloft. One would also expect to observe ducks commuting at low elevations when flying into a headwind to minimize the effects of the wind on forward progress. Both of these expectations are consistent with the results based on observations from Eel Point.

Observers also noted that during the evening flights, ducks crossing over Esther Island appeared to alter their flight altitude as they flew over land. As ducks approached the island, they tended to fly at high altitudes and then decrease their altitude rapidly as they flew over the water. However, during times when there was a strong headwind, ducks were observed flying just above (within ten feet) of the land and flew close to the surface when over water.

3.4 Prior Evening Survey versus Following Morning Survey

When surveys were conducted on consecutive days in December and January, the duck counts from the morning survey were compared with the duck count from the survey of the prior evening to determine whether the number of ducks flying into Nantucket Sound each evening was similar to the number of ducks flying back out each morning (Figure 7).

Based on the results, there does not appear to be any correlation between morning and prior evening duck counts (Figure 8). Little to no linear relationship (R^2 = 0.2039) exists between the number of ducks transiting north in the evening and the number transiting south the following morning (Figure 8). In most cases, there was great variability between the two survey periods. From the evening of December 29 to the following morning, the number of ducks flying into Nantucket Sound in the evening represented approximately 3% of the number of ducks flying back south the next morning. Similar variability occurred from the evening of January 16 to the morning on January 17 when the number of ducks flying south out of Nantucket Sound in the morning represented only 25% of the number that was observed flying in the previous evening. Between the evening of January 17 and the following morning, the duck count was 0.125% of the count from the prior evening while on the evening of January 19 the duck count was only 30% of the count the following morning. The only surveys which had similar duck counts flying into and out of the Sound occurred on the evening of December 30 when the count was 72% of the count the following morning.

Differences in visibility may provide some explanation for the great variability between duck counts from morning and the prior evening surveys. Visibility was limited during the following three survey

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sessions that were used in this analysis: December 29 evening (average visibility = 1.3 miles), January 18 morning (average visibility = 4 miles), and January 18 evening (average visibility = 2.5 miles). During these surveys, the number of ducks counted was lower during the session with limited visibility than the session to which it was being compared, either prior evening or the following morning.

3.5 Morning Survey versus Evening Survey

When surveys were conducted in both the morning and evening of the same day, the duck counts from the morning session were compared with duck counts from that evening to determine whether the number of ducks flying south toward Nantucket Shoal each morning was similar to the number of ducks flying back into Nantucket Sound each evening (Figure 9).

The data set was too small to plot morning survey duck counts versus evening survey duck counts to determine whether a linear relationship exists. However, based on the results of the plot for prior evening versus morning counts, it is highly unlikely that a significant linear relationship exists. There was great variability in duck counts from morning to evening surveys for every day with one exception (December 30), when the morning flight count was 54% of the evening flight count. Results for all other days showed large differences. The morning flight was 15% of the evening count on December 29. The morning count was 41% of the evening count on January 17. On January 18, the morning count was only 0.2% of the evening count and on the January 19, the evening count was only 9% of the morning.

Visibility does not account for the large variation in duck count numbers. The visibility during the December 29 surveys ranged from an average of 4.3 miles in the morning to an average of 1.3 miles in the evening, yet the evening count was higher. The visibility on the January 18 surveys ranged from an average of four miles in the morning to an average of 2.5 miles in the evening, yet the evening counts were much higher. These results suggest that visibility is not the only factor that explains the significant variation between counts from morning and evening surveys. Possible explanations for the variability are covered in Section 4.0.

3.6 Number of Ducks Observed versus Time of Day

The number of ducks that were counted during each minute of a given survey session was plotted against time for all surveys conducted in December and January. Results of this analysis are presented in Figures 10.1 through 10.5 and Figures 11.1 through 11.6. The results for morning surveys were all plotted over the same time frame while duck number was plotted on a log scale for ease of comparisons across different sessions. Results for evening surveys were also plotted over the same time frame with duck number plotted on log scale for ease of comparisons.

3.6.1 Long-tailed Duck Count Over Time – Morning Surveys

Long-tailed Duck count per minute for all morning surveys in December and January are shown in Figures 10.1 through 10.5. In most cases during morning surveys, when a large number (> 10,000) of Long-tailed Ducks was observed, activity (number of ducks passing observation point per minute) peaked within approximately 15 minutes of sunrise. Activity peaked during the

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morning surveys as follows: December 31, approximately 15 minutes after sunrise; January 17, approximately 3 to 7 minutes after sunrise; January 19, approximately 11 to 15 minutes after sunrise; January 20, approximately 2 minutes after sunrise. The only exception to this trend came during the December 30 morning survey when the peak duck activity occurred approximately one hour after sunrise. The December 29 morning and January 18 morning surveys were not included in this analysis because so few ducks (< 10,000) were observed during those survey sessions. During the December 29 morning survey, many ducks were observed without being counted because they passed as the observers were walking out to the end of Esther Island. In addition, visibility was poor during this survey and the ducks could barely be seen.

3.6.2 Long-tailed Duck Count Over Time – Evening Surveys

Long-tailed Duck count per minute for all evening surveys in December and January are shown in Figures 11.1 through 11.6. In most cases during evening surveys, when a large number (> 10,000) of Long-tailed Ducks were observed, activity (number of ducks passing observation point per minute) peaked within approximately 15 minutes of sunset. Activity peaked during the evening surveys as follows: December 30, approximately 5 minutes after sunset, January 16, approximately 7 minutes after sunset; January 17, approximately 15 minutes after sunset. The exception to this trend occurred during the January 18 evening survey when peak activity occurred a little over two hours prior to sunset.

3.7 Observations from Boat and Plane Surveys of February 15 and March 6

During the surveys on February 15 and March 6, the two boats were positioned in Nantucket Sound as outlined in Section 2.2. Land observers stationed at Eel Point radioed to the vessel *Patricia Lynn* the number and heading of Long-tailed Ducks passing through Tuckernuck Channel. On February 15, observers aboard the *Patricia Lynn* reported following small groups of ducks (20 to 50 ducks) flying in a northeasterly direction. Observers aboard the *Patricia Lynn* noted that many of the ducks had landed in the water about one mile south of the eastern end of Tuckernuck Shoal. The boat flushed the ducks off the water to observe the direction of flight. The boat later moved northwest of the eastern end of Tuckernuck Shoal and observed smaller groups of ducks (about 20 per group) flying in a northerly direction. At this point, the vessel was moving toward red buoy 18 on the eastern end of Horseshoe Shoal (Figure 1). *Patricia Lynn* observers reported approximately 1,500 Long-tailed Ducks during the survey period. The *Minuteman* remained positioned on the southern edge of Horseshoe Shoal and reported seeing only an occasional single or pair of Long-tailed Ducks flying within 20 feet of the water. The *Minuteman* observers did not see any substantial number of ducks flying into Horseshoe Shoal.

On March 6, the *Patricia Lynn* was again positioned north of Eel Point, while the *Minuteman* was stationed further east of Horseshoe Shoal where more ducks had been seen during the previous survey on February 15 (Figure 1). Overall, very few Long-tailed Ducks were observed by land, boat or plane observers this day. Both boats reported seeing no Long-tailed Ducks.

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In addition, the plane with observers flew transects in Nantucket Sound. From the plane, observers reported Long-tailed Ducks to be widely distributed in Nantucket Sound, from the west of North Monomoy to the vicinity of Muskeget. They were present in small numbers, with no concentrations resembling the roost near Tuckernuck Shoal observed in December 2001. Most of the ducks were sitting on the water, the few flyers showed no pattern to suggest movement towards a common destination. During the east–west transects the observers on boats reported no flights of Long-tailed Ducks and few flyers were seen from the air. Because so few long-tailed ducks were observed, observations from the plane terminated at sunset.

3.8 Observations from Land Survey March 22 and March 23

Two final surveys from land were conducted on the evening of March 22 and the morning of March 23. Approximately 500 ducks were observed during the evening survey. All the ducks were observed flying in a north or northeasterly direction as they passed Eel Point. Many of the ducks were observed resting on the water in Madaket Harbor. The following morning, only 67 ducks were observed, all flying in from the northeast. Some landed in Madaket Harbor and appeared to be foraging in the shallow waters. Observations from these two surveys were not included in the analyses because so few ducks were observed. Given the low numbers observed on February 15, March 6, 22 and 23, it was concluded that the majority of the Long-tailed Ducks had migrated north for the season.

MassAudubon and USFWS attempted to capture Long-tailed Ducks in order to radio-tag several ducks. The effort was an attempt to better track the ducks as they move between Nantucket Sound and Nantucket Shoal. MassAudubon and USFWS also noted low numbers in March and also concluded the majority of the winter population of Long-tailed Ducks had migrated north by March.

4.0 DISCUSSION

In this section, results are discussed in general and as they relate to the development of the proposed wind farm on Horseshoe Shoal. Although a few general trends are apparent, more specific conclusions on the nature of Long-tailed Duck behavior within the study area are limited based on the data collected.

Counting the large flocks was challenging. As large flocks approached, their elevation ranged from near sea level to several hundred feet in the air. Large numbers of ducks within the flocks would change their altitude and then return to their previous altitude very quickly. There appeared to be more radical altitude shifts whereas horizontal shifts were more gradual. The radical shifts in altitude were most likely related to the ducks reaction to flying over land. Often times, sea ducks appear to have a preference to fly at higher altitudes over land whereas, over water, sea ducks are commonly seen flying quite close to the surface. Of course, there are exceptions to this trend. When migrating, waterfowl are reported to fly at 200 to 4,000 feet (Smithsonian Migratory Bird Center 2005). From the land-based observations, the Long-tailed Ducks would appear on the horizon like “swarms of flies.” As the ducks approached, they were sometimes in front of, overhead, and behind the observers. The flight path continually changed during the flights. Many times, the flight path changed abruptly.

Long-tailed Ducks have been reported in the Nantucket CBC since the 2000-2001 CBC. The number of Long-tailed Ducks in the Nantucket CBC has ranged from 11,760 to 525,505. Although, the land-based

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observations on December 31, 2005 were conducted to coincide with the Nantucket Audubon Christmas Bird Count, the observations gathered did not correlate well with the reported CBC counts. ESS observations (99,500) were approximately 29 percent of the reported CBC counts (342,100). Both the ESS observations and, reportedly, the CBC observations were made from the same vicinity on Eel Point. No explanation for the discrepancy between the December 31, 2005 ESS and CBC observations is readily apparent.

Analysis of the data suggests that there is a relationship between observed duck flight elevation and predominant wind direction during the survey period. In most cases, duck flight path was either into a headwind or with a following tailwind. The majority of the ducks observed flew at elevations below 25 feet when flying into a headwind, presumably to minimize effects of the wind. However, it is not known whether they maintained this low elevation after they passed out of sight from Eel Point. In addition, when flying north in the evening, the Long-tailed Ducks often flew in over Esther Island at higher elevations and then dropped down below 25 feet as they passed through Tuckernuck Channel. Therefore, one should not assume that flight elevation remains constant as the ducks travel between Nantucket Shoal and Nantucket Sound. Davis noted that when observing the flight of Long-tailed Ducks, many continually changed altitude from near sea level to a few hundred feet as they flew through Tuckernuck Channel (Davis 1997). When flying with a tailwind, the majority of the ducks flew at higher elevations as they passed Eel Point, presumably to take advantage of the added wind speed. However, the same caveat applies in this case as well: it is not known whether elevation remained constant after the ducks passed out of sight of the observation point. Regardless of wind direction, 33% of the ducks counted during the December and January surveys were observed flying below 75 feet and 67% were flying above 75 feet. However, the height estimation was based on an observation from Eel Point and Esther Island as the ducks flew by. The observers continually noticed that the ducks would often fly high when approaching land and then decrease their altitude when flying over open water. It is likely that Long-tailed Ducks continue to fly low over water to their roosting area.

The observations of Long-tailed Duck flight paths as they flew above Tuckernuck Channel are consistent with existing knowledge of the daily winter flights. During the morning surveys, the ducks were observed flying from Nantucket Sound south toward Nantucket Shoals. During the evening surveys, the ducks flew in the opposite direction, heading from the ocean back into Nantucket Sound. The ducks passed in large flocks, split off into smaller groups, and then clustered again into larger flocks. They did not appear to fly in any kind of aerodynamic formation. Within Tuckernuck Channel, there was variation in how close to the observation point the ducks passed. During several surveys, the ducks appeared to branch off into several distinct routes ranging from within 100 feet of Eel Point to flying over Tuckernuck Island. It is not known whether ducks branched off into wider or narrower flight paths after they passed Eel Point and continued through to Nantucket Sound.

During dusk surveys, the majority of the ducks appeared to be flying in a northerly or northeasterly direction as they passed the Eel Point observation location (Figure 5). Assuming the ducks maintained those general headings, the majority of the ducks traveling north would likely pass east of Horseshoe Shoal, with some potentially flying through the easternmost edge of the project area, while those flying northeast likely passed well to the east of the proposed project area. The *Minuteman* on February 15 and March 6 confirmed that substantial numbers of ducks did not fly through or settle on Horseshoe Shoal on

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those days. Only an occasional duck flying through the area was observed near Horseshoe Shoal. However, the final duck roosting area was not discovered during any of the surveys and is not known based on a review of existing literature.

Given the general flight direction and habitat, it is plausible that the Long-tailed Ducks roost in the deeper waters of Nantucket Sound located in the central and eastern part of the Sound (Johnsgaurd 1975 in Davis 1995). (Figure 1). Other studies have shown that Long-tailed Ducks prefer deeper waters at night. In Washington, flocks were found in 9.3 meters (30.5 feet) of water and 490.8 meters (1,609.8 feet) offshore (Hirsch 1980 in Roberston and Savard 2002). In coastal Sweden, most individuals winter in water depths of 10 to 15 meters (33 to 49 feet) deep, over offshore marine shoals (Mathiasson 1970 in Roberston and Savard 2002). A quarter (26%) of the proposed wind farm is sited in waters deeper than 9 meters (30 feet).

During the morning surveys, the majority of the ducks appeared to fly in from the north (Figure 5) and head south to the ocean. Smaller numbers flew southeast and southwest through Tuckernuck Channel, leading one to assume that, if they had maintained a constant heading, they flew in from areas to the northeast or northwest. Assuming they maintained a constant heading, approximately 80% of the ducks were observed flying in from areas to the north and northeast. During aerial surveys, Cape Wind observed high densities of Long-tailed Ducks in the northeastern corner of Nantucket Sound. These findings lend support to the hypothesis that the ducks are roosting somewhere to the east of Horseshoe Shoal within Nantucket Sound. In addition, large numbers of ducks were not observed on Horseshoe Shoal by the boat observation crew on February 15 2006 when noticeable numbers were seen from land and the *Patricia Lynn*.. The smaller numbers (20%) that were observed flying in from the northwest during the mornings may have possibly flown through the Horseshoe Shoal area or from the central portion of Nantucket Sound where deeper waters are found.

There was great variation between the numbers of ducks observed flying into and out of Nantucket Sound during consecutive surveys. In many cases, the number of ducks flying into the Sound in the evening was significantly higher than the number observed flying out the next morning and vice versa. There are three possible explanations for this finding. First, not all of the Long-tailed Ducks move between Nantucket Sound and Nantucket Shoal each morning and evening. Large numbers of ducks may have remained on Nantucket Shoal or Nantucket Sound during a particular survey period for a wide variety of reasons. Wind conditions, visibility, weather and tide conditions, and food availability may all influence the number of ducks that commute each day. Davis reported that variability in flight numbers over the long term may be related to the response of the Long-tailed Ducks to tide and wind conditions (Davis 1997).

The second likely explanation for the great degree of variability is that the ducks take multiple routes between Nantucket Shoals and Nantucket Sound. Flight paths can be variable and have been reported to occur as far east of Eel Point as the Nantucket Memorial Airport (Davis 1997). It is likely that at least a portion of the Long-tailed Ducks followed routes outside the view of the observers stationed at Eel Point and on the boats to the north in Nantucket Sound. It is possible that ducks feeding on Nantucket Shoals would follow the eastern side of Nantucket Island back to Nantucket Sound in the evening.

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The final possible explanation is that observers were unable to see ducks when visibility was limited prior to sunrise and after sunset. During several evening surveys, duck observations were made right up to the point at which visibility faded, while during several morning surveys, ducks were observed just as it became light enough to see them. It is possible that some number of ducks commuted prior to sunrise and after sunset. In addition, observers noted that when the ducks were flying close to the water surface (< 25 feet from water) they were difficult to see, especially near sunrise and sunset. The large discrepancy in flight numbers between consecutive surveys is most likely due to a combination of all three of these factors to varying degrees. Ducks may not all transit every morning and evening, they likely take multiple routes between Nantucket Shoal and Nantucket Sound, and some may travel prior to sunrise and after sunset when visibility is too low for observers to see them.

Based on the survey results, duck activity generally peaked around sunrise and sunset. There was some variation in how close to sunrise or sunset peak activity occurred, but during most surveys, it occurred within a half-hour. It is also possible that significant numbers of ducks traveled at times before sunrise and after sunset when visibility was too low for them to be spotted by observers.

There was a noticeable decrease in the number of Long-tailed Ducks observed during the surveys in February and March when compared to the December and January surveys. Despite visibility of 10 miles on March 6, March 22 and 23, less than 500 ducks were observed during each survey. Average visibility during the February 15 survey was 6.5 miles when approximately 1,500 ducks were observed. Long-tailed Duck flights in February and March had greatly decreased numbers when compared with the large flocks seen during most of the surveys in December and January. In addition to the explanations discussed earlier to account for the discrepancy in duck counts between consecutive surveys, another possible explanation for the low duck numbers in February and March is that the majority of the flock that winters in Nantucket Sound had already migrated north or moved locally to a different location.

Davis (1997) reported that Long-tailed Ducks arrive in late autumn, with numbers continuing to increase until mid-December. Their numbers remain stable until mid-April when the birds begin to depart for arctic breeding grounds (Davis 1997). However, there is seasonal and yearly variability in migration times and it appeared that the Long-tailed Ducks left the area earlier than the literature documents. Although it was anticipated that the ducks would remain in the area until mid-April based on the literature (Davis 1997), this past year the spring migration appeared to occur in early March.

5.0 CONCLUSIONS

Eel Point offers a good location for viewing the morning and evening Long-tailed Duck flights between Nantucket Sound and Nantucket Shoals. Eel Point is well positioned to view birds coming out of Nantucket Sound in the morning and watching the returning flight in the evening. When visibility is good, Long-tailed ducks flying along the western side of Tuckernuck Island can be seen.

The morning flight generally consisted of Long-tailed Ducks flying south out of Nantucket Sound. Once the birds reached the southern side of Esther and Tuckernuck Islands, the flocks would turn east along the southern side of Nantucket Island. We presume that the ducks continued to head toward Nantucket Shoals, where the Long-tailed Ducks have been documented to feed during the day. In the afternoon, the Long-tailed Ducks moved in the opposite direction, heading north and northeast into Nantucket

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Sound from the southern side of Nantucket and Tuckernuck islands. These flight paths and behavior are consistent with existing knowledge of daily Long-tailed Duck flights (Davis 1997).

The vast majority of Long-tailed Ducks were observed traveling either north or northeast (99% of all observations) in the afternoon and evening as they passed the observation points. A very small number of ducks was observed flying either northwest or west (< 0.2% of observations). In the morning flights, the majority of ducks was observed flying due south (67%) as they flew through Tuckernuck Channel. Observers noted that the majority of these ducks flew in from the northeast, and then turned south as they passed Eel Point. The remainder of the ducks was observed flying southeast (20%) and southwest (13%) as they passed Eel Point.

When flying into a headwind, 66% of the ducks were observed flying within 25 feet of the surface of the water. A smaller percentage (34%) of ducks was observed flying within mid-range elevations between 25 and 150 feet during a headwind flight. Only four ducks (<1%) were observed flying above 150 feet when there was a headwind. In contrast, results for estimated duck flight elevations with a tailwind were nearly opposite those of headwind flights. The majority of ducks (84%) was observed flying at higher elevations between 25 and 150 feet when flying with a tailwind. Approximately 15% of the ducks was observed at heights greater than 150 feet and only 1% was seen flying less than 25 feet from the water when there was a tailwind.

Based on the results, there does not appear to be any correlation between morning and prior evening duck counts. Little to no linear relationship (R^2 = 0.2039) existed between the number of ducks transiting north in the evening and the number transiting south the following morning. In most cases, there was great variability between the two survey periods. Sufficient data were not available to statistically compare the flights within the same day.

During morning surveys, when a large number (> 10,000) of Long-tailed Ducks were observed, activity (number of ducks passing observation point per minute) peaked within approximately 15 minutes of sunrise. During evening surveys, when a significant number (> 10,000) of Long-tailed Ducks was observed, activity in most cases peaked within approximately 15 minutes of sunset.

The boat surveys indicated that Long-tailed Ducks passed southeast of Horseshoe Shoal during the evening flight. It appears that the majority of the Long-tailed Ducks continued north and northeast once passing Eel Point. This coincides with land-based observations from Eel Point.

Two final surveys from land were conducted on the evening of March 22 and the morning of March 23. Given the low numbers observed on February 15, March 6, 22 and 23, it was concluded that the majority of the Long-tailed Ducks had migrated north for the season.

Data collected during this study, although limited, sheds some light on Long-tailed Duck use of Nantucket Sound and offers a general characterization of Long-tailed Duck flight numbers, routes, and patterns. It appears that, based on the various attempt to track the flight paths into Nantucket Sound in the evening, the Long-tailed Ducks roosting area is likely in the central and eastern portions of Nantucket Sound.

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6.0 REFERENCES

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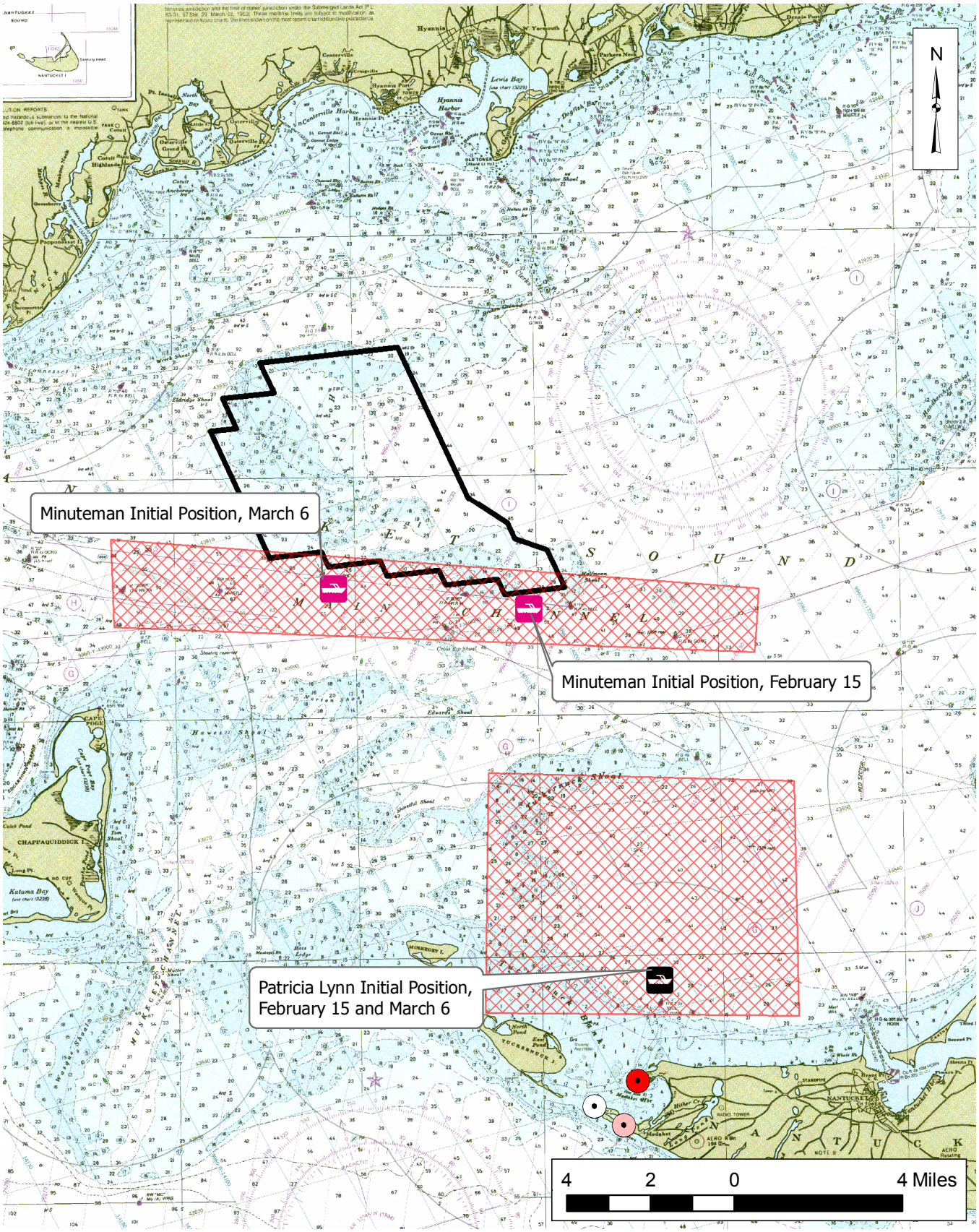
Figures

Location: G:/GIS-Projects/E159/FinalFigs/pdfs



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CAPE WIND
LONG-TAILED DUCK REPORT
Nantucket, Massachusetts

Scale: 1" = 17,500'

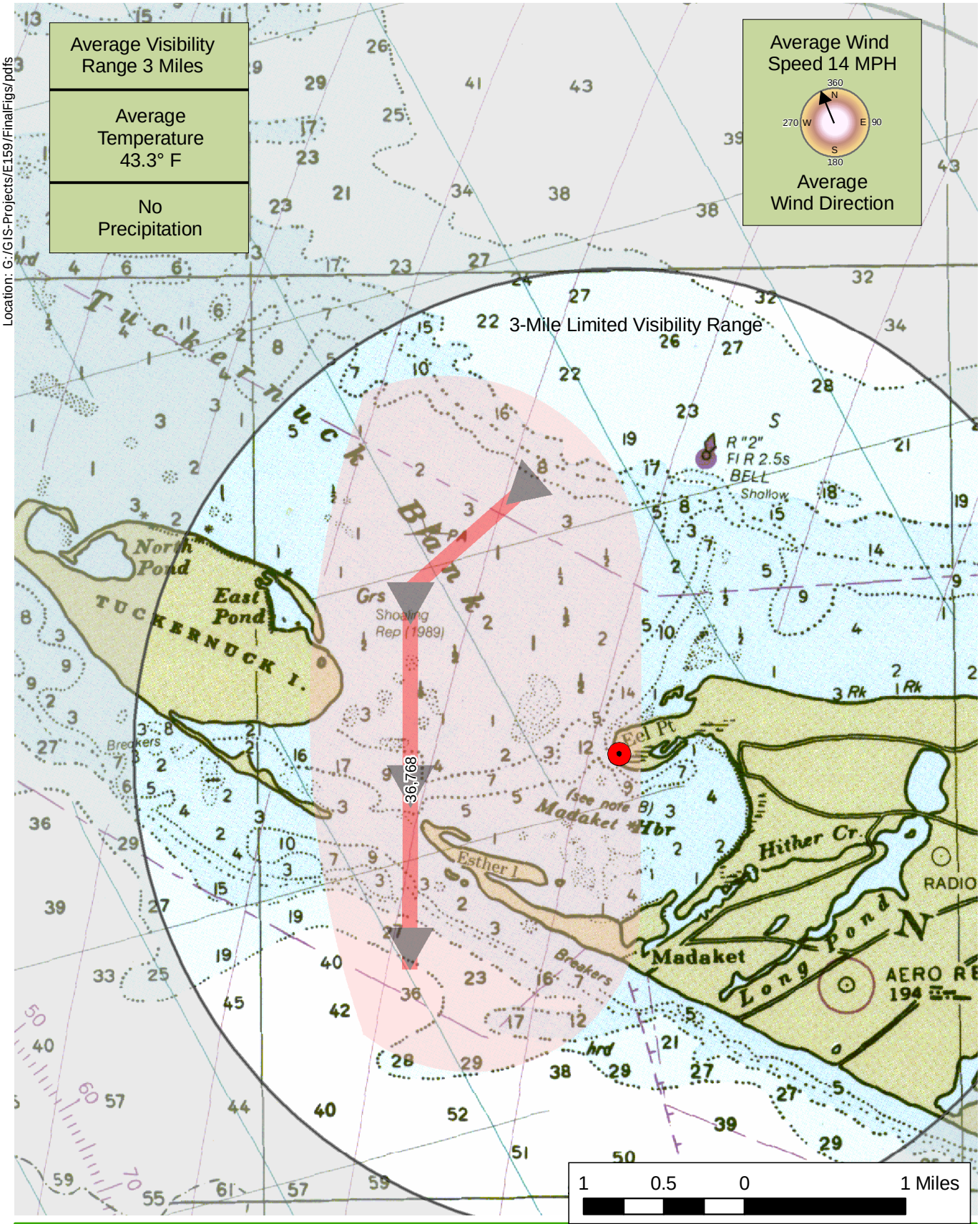
Legend
- Wind Farm Boundary
- Boat Coverage

Observation Points
- Observation Point - Eel Point
- Observation Point - Madaket
- Observation Point - Esther Island

Locus Map

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

Figure 1



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LONG-TAILED DUCK REPORT
Nantucket, Massachusetts

Scale: 1" = 4500'

Source: 1) NOAA CHARTS, NANTUCKET SOUND AND APPROACHES

Legend

Observation Point - Eel Point

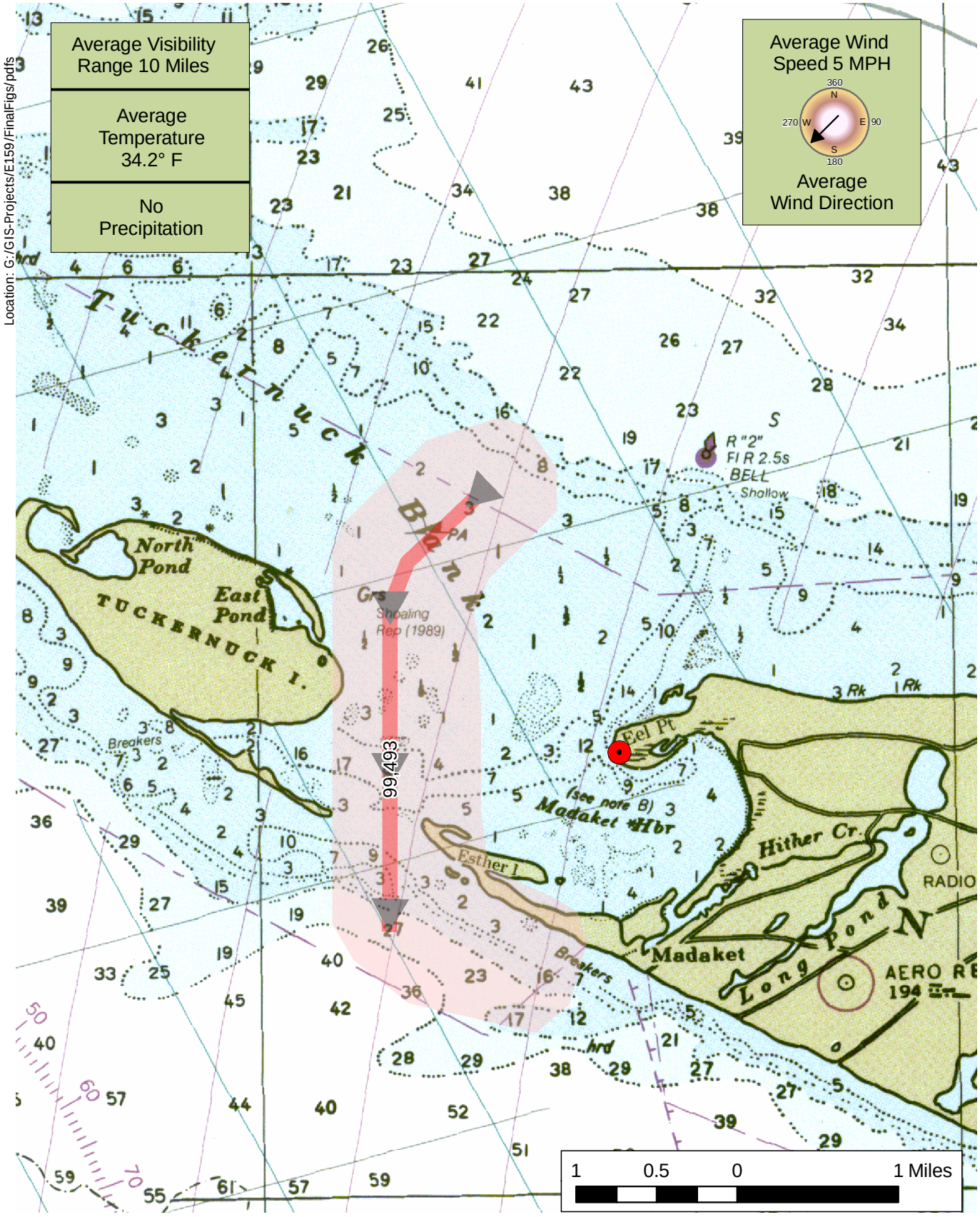
General flight path range

Source: 2) WEATHER DATA, WEATHER UNDERGROUND.COM

Note:Arrow shows predominant flight heading of ducks observed

Predominant Long-tailed Duck Heading
December 30, 2005
AM Survey

Figure 2.1



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Nantucket, Massachusetts

Scale: 1" = 4500'

Source: 1) NOAA CHARTS, NANTUCKET SOUND AND APPROACHES

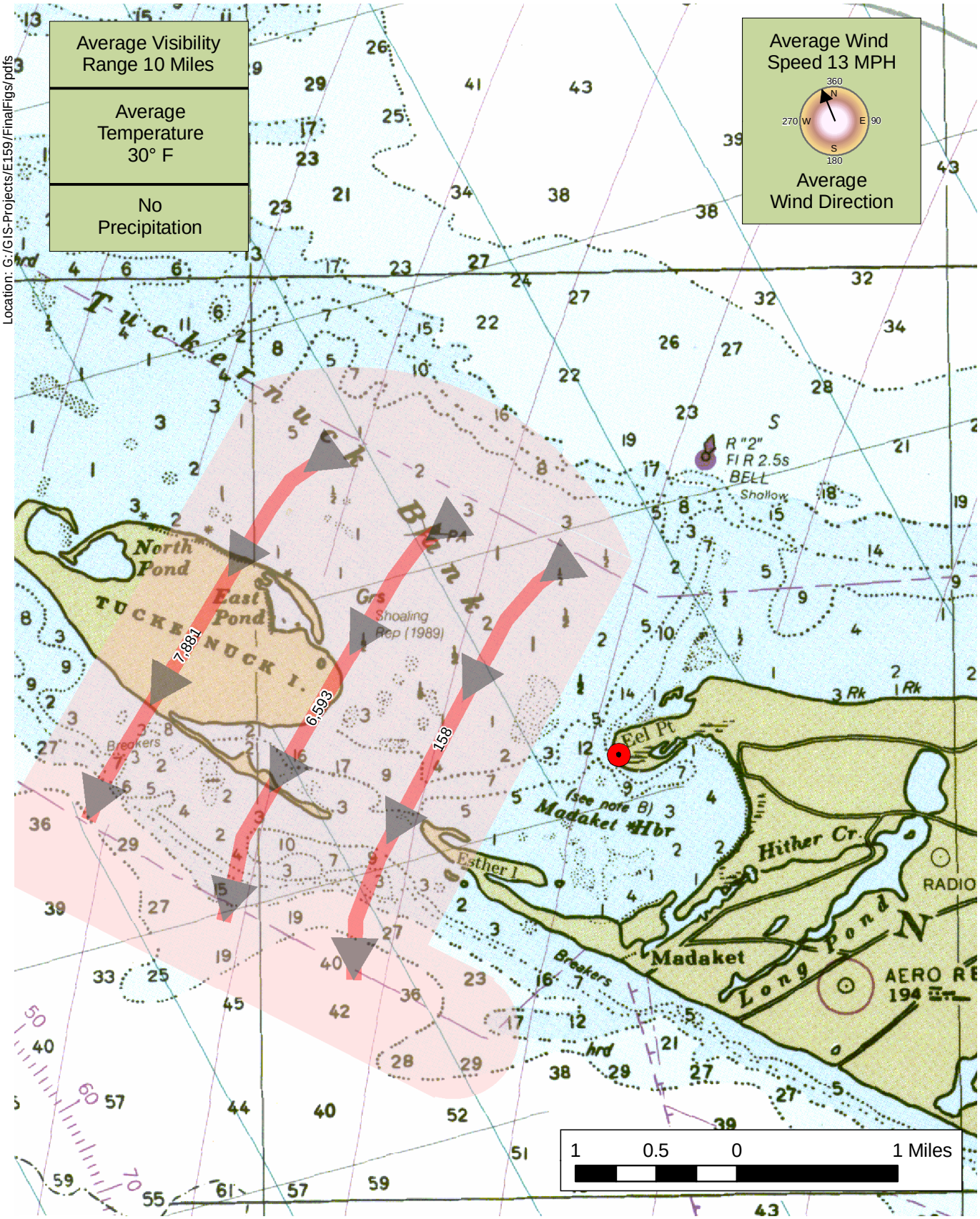
Legend
Observation Point - Eel Point
Flight Path Range

Source: 2) WEATHER DATA, WEATHER UNDERGROUND.COM

Predominant Long-tailed Duck Heading
December 31, 2005
AM Survey

Note:Arrow shows predominant flight heading of ducks observed

Figure 2.2



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Scale: 1" = 4500'

Source: 1) NOAA CHARTS, NANTUCKET SOUND AND APPROACHES

Legend

Observation Point - Eel Point

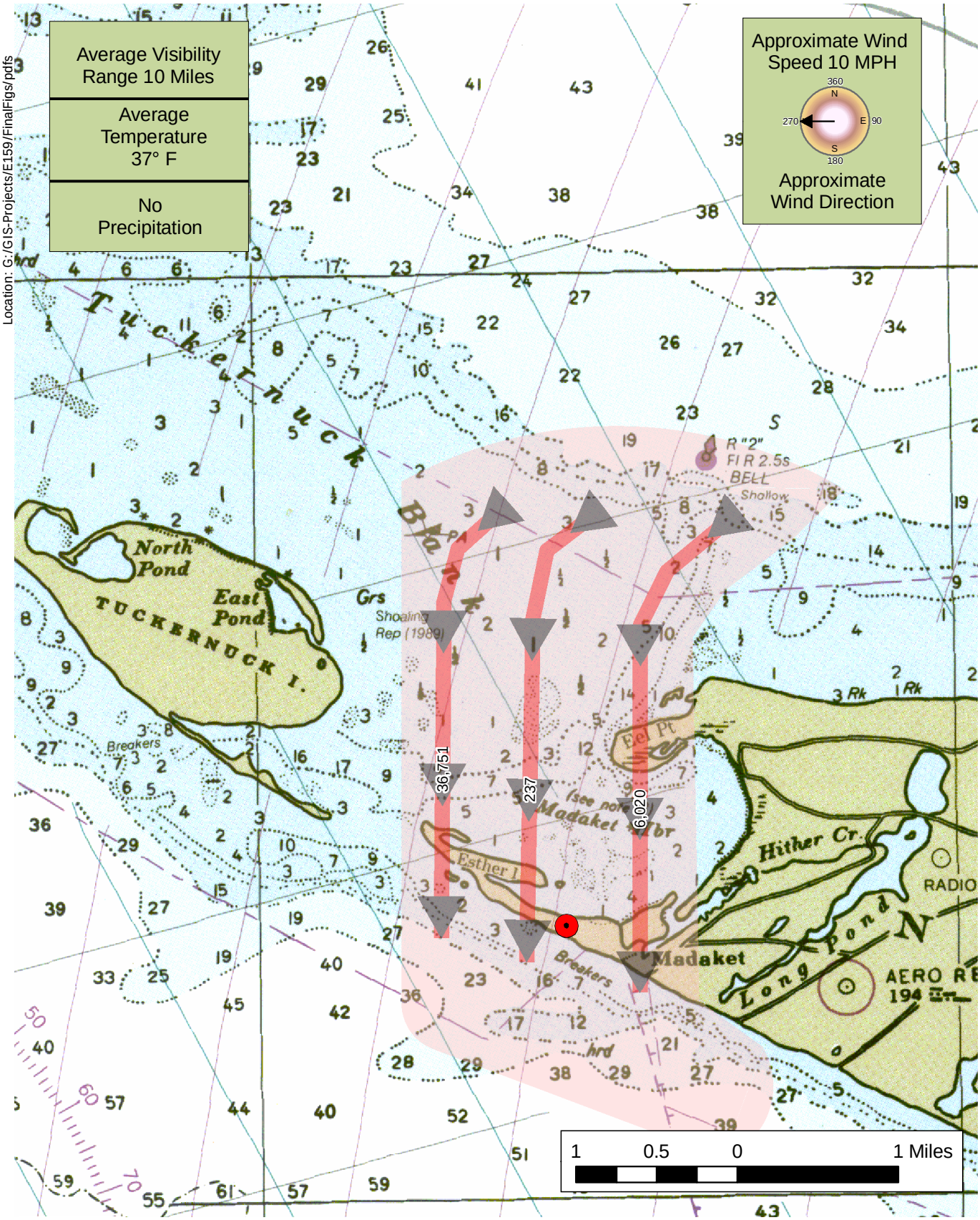
Flight Path Range

Source: 2) WEATHER DATA, WEATHER UNDERGROUND.COM

Note:Arrows show predominant flight headings of ducks observed

Predominant Long-tailed Duck Headings
January 17, 2006
AM Survey

Figure 2.3



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Nantucket, Massachusetts

Scale: 1" = 4500'

Source: 1) NOAA CHARTS, NANTUCKET SOUND AND APPROACHES

Legend

Observation Point - Smith Point

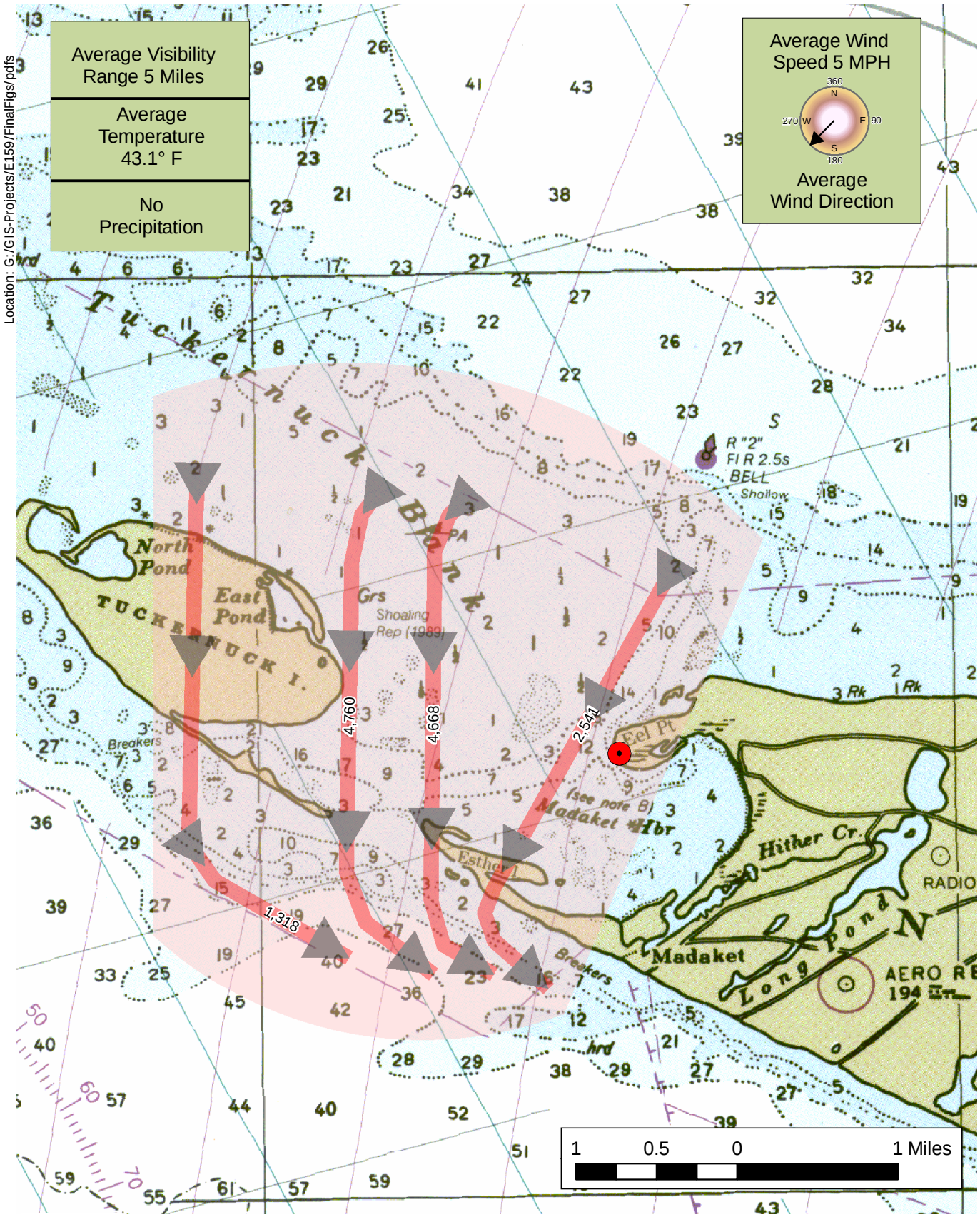
General flight path range

Source: 2) WEATHER DATA, WEATHER UNDERGROUND.COM

Predominant Long-tailed Duck Headings
January 19, 2006
AM Survey

Note:Arrows show predominant flight headings of ducks observed

Figure 2.4



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Nantucket, Massachusetts

Scale: 1" = 4500'

Source: 1) NOAA CHARTS, NANTUCKET SOUND AND APPROACHES

Legend

Observation Point - Eel Point

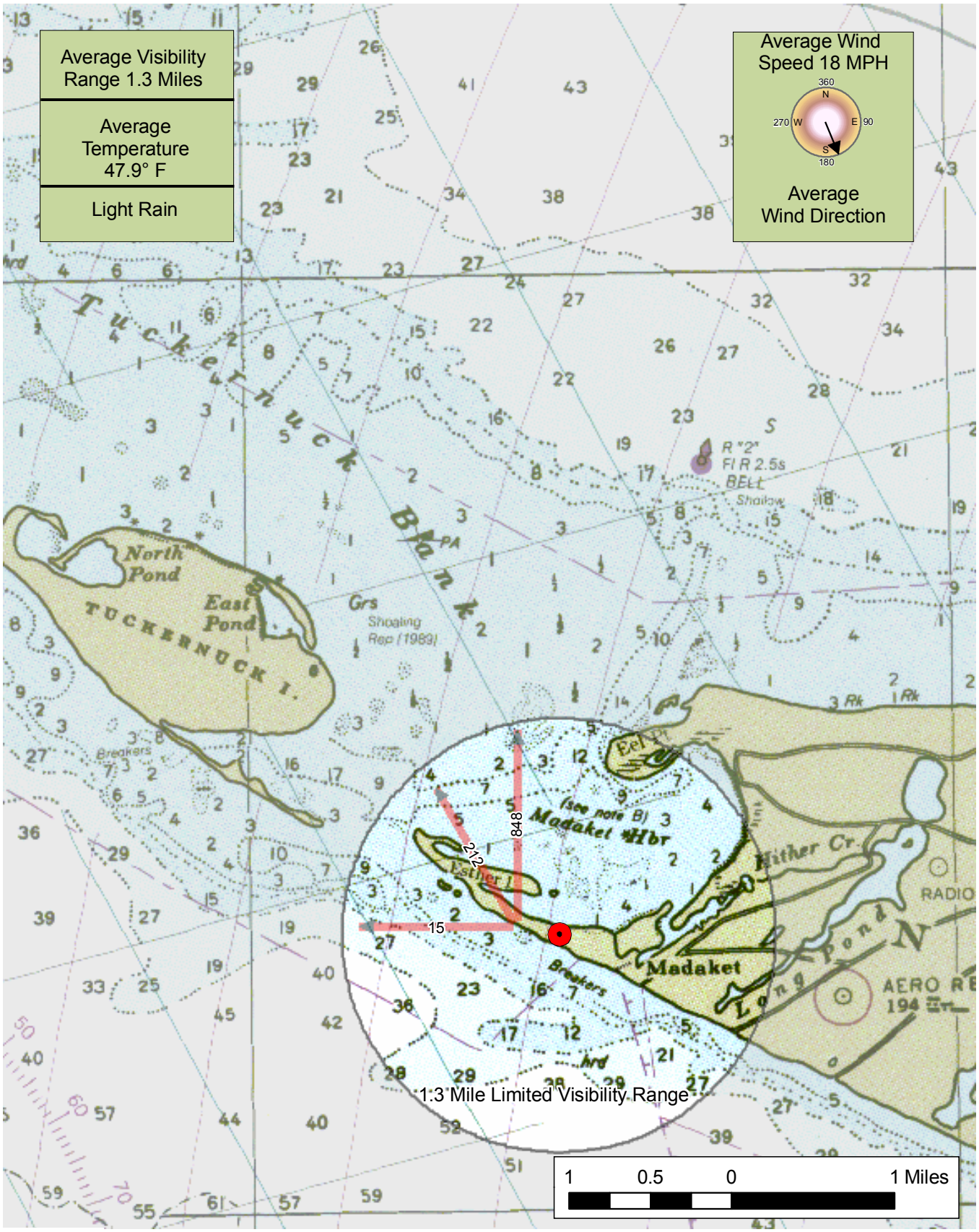
General flight path range

Source: 2) WEATHER DATA, WEATHER UNDERGROUND.COM

Predominant Long-tailed Duck Headings
January 20, 2006
AM Survey

Note:Arrows show predominant flight headings of ducks observed

Figure 2.5



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LONG-TAILED DUCK REPORT
Nantucket, Massachusetts

Legend
Observation Point - Madaket

Predominant Long-tailed Duck Heading
December 29, 2005
PM Survey

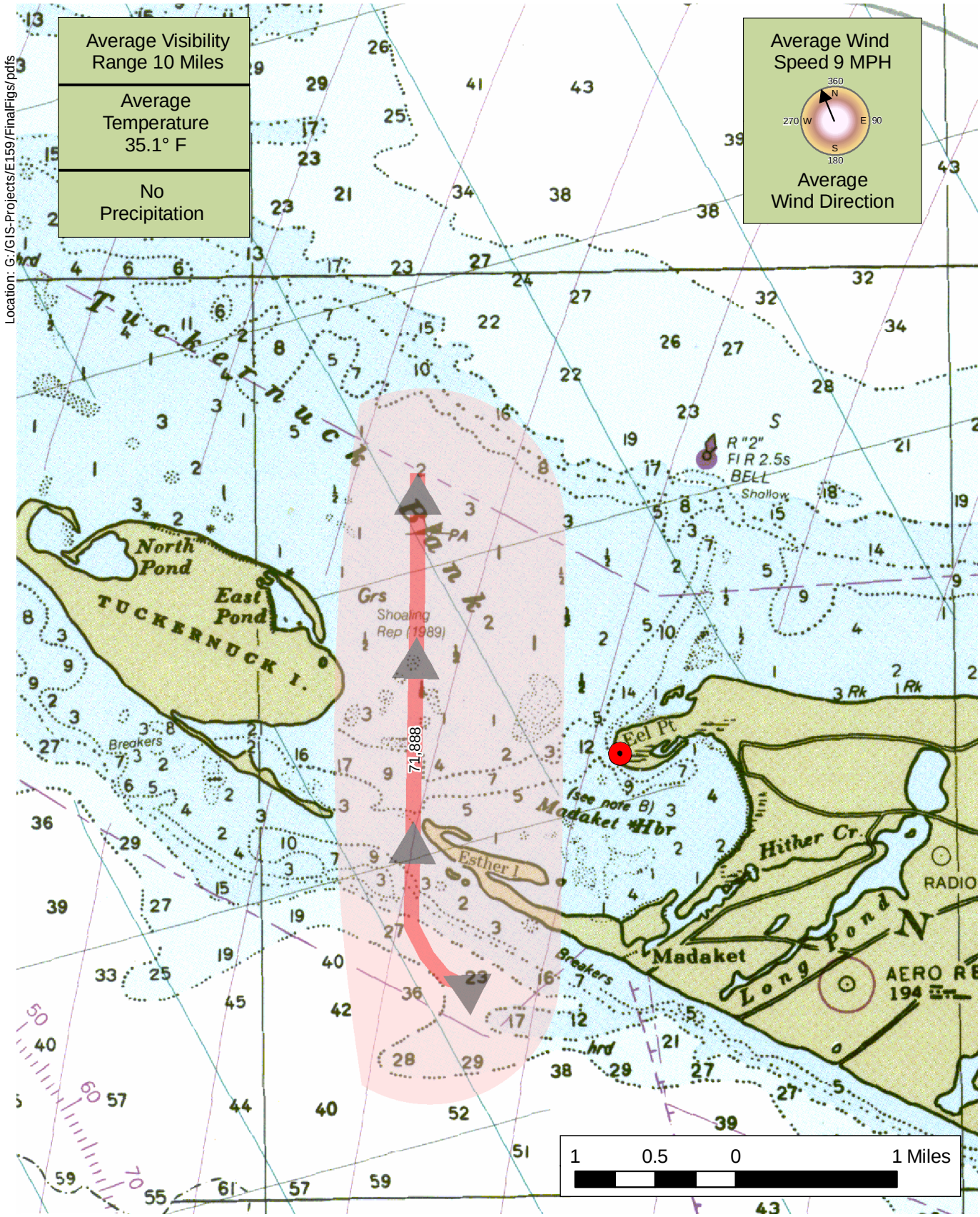
Scale: 1" = 4500'

Source: 1) NOAA CHARTS, NANTUCKET SOUND AND APPROACHES

Source: 2) WEATHER DATA, WEATHER UNDERGROUND.COM

Note:Arrows show predominant flight headings of ducks observed

Figure 3.1



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Nantucket, Massachusetts

Scale: 1" = 4500'

Source: 1) NOAA CHARTS, NANTUCKET SOUND AND APPROACHES

Legend

Observation Point - Eel Point

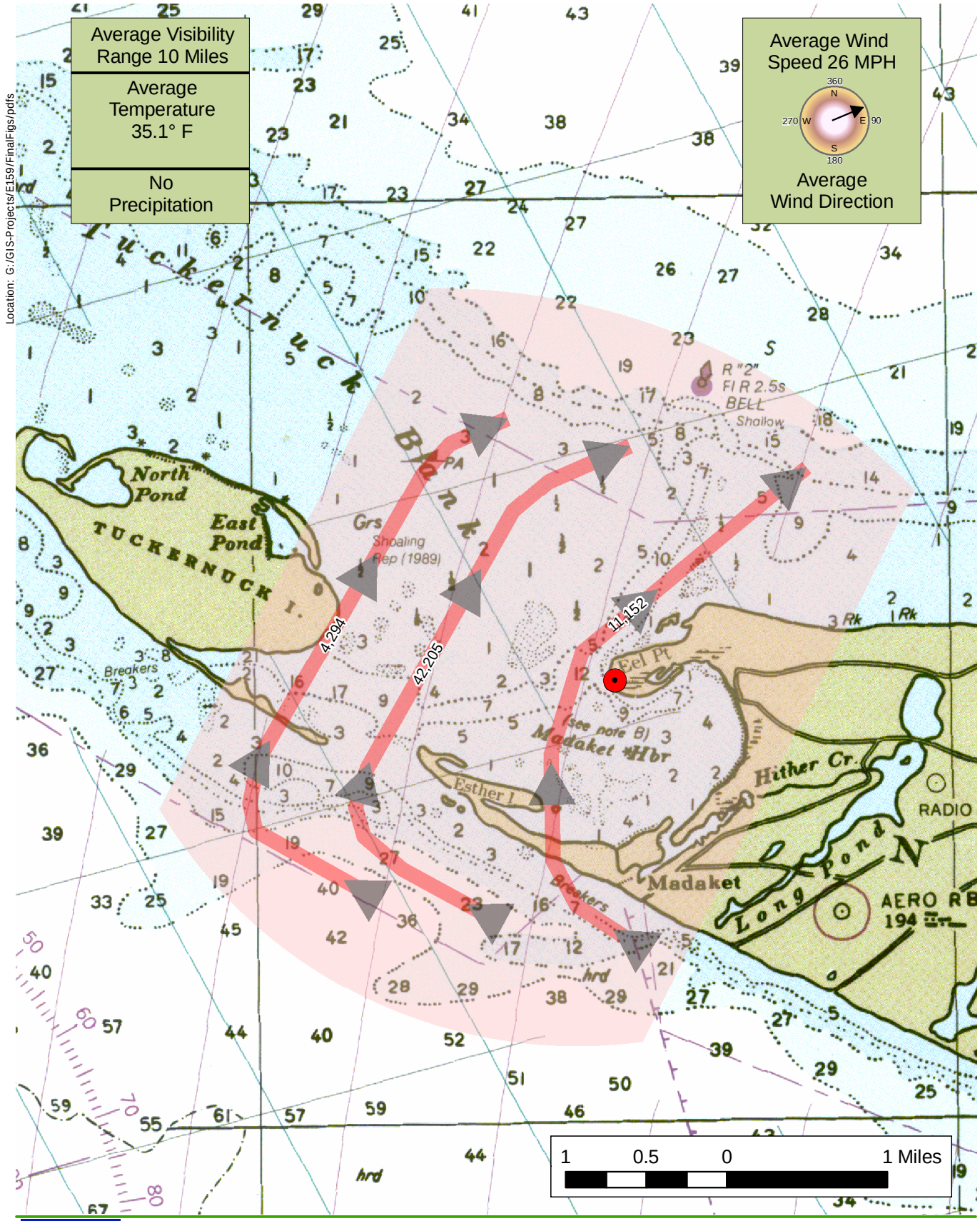
General flight path range

Source: 2) WEATHER DATA, WEATHER UNDERGROUND.COM

Predominant Long-tailed Duck Heading
December 30, 2005
PM Survey

Note:Arrow shows predominant flight heading of ducks observed

Figure 3.2



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LONG-TAILED DUCK REPORT
Nantucket, Massachusetts

Scale: 1" = 4500'

Source: 1) NOAA CHARTS, NANTUCKET SOUND AND APPROACHES

Legend

Observation Point - Eel Point

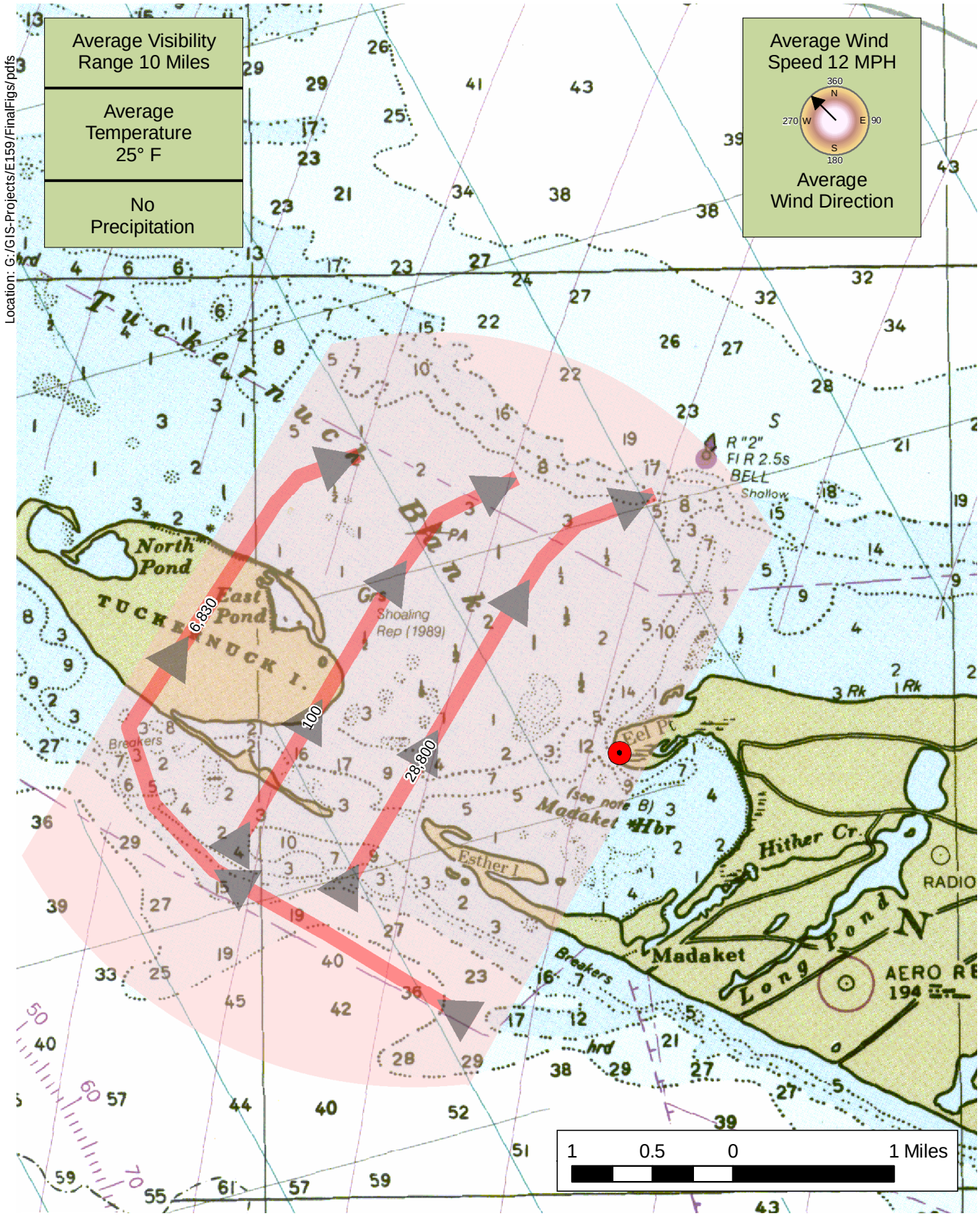
General flight path range

Source: 2) WEATHER DATA, WEATHER UNDERGROUND.COM

Predominant Long-tailed Duck Headings
January 16, 2006
PM Survey

Note:Arrows show predominant flight headings of ducks observed

Figure 3.3



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Nantucket, Massachusetts

Scale: 1" = 4500'

Source: 1) NOAA CHARTS, NANTUCKET SOUND AND APPROACHES

Legend

Observation Point - Eel Point

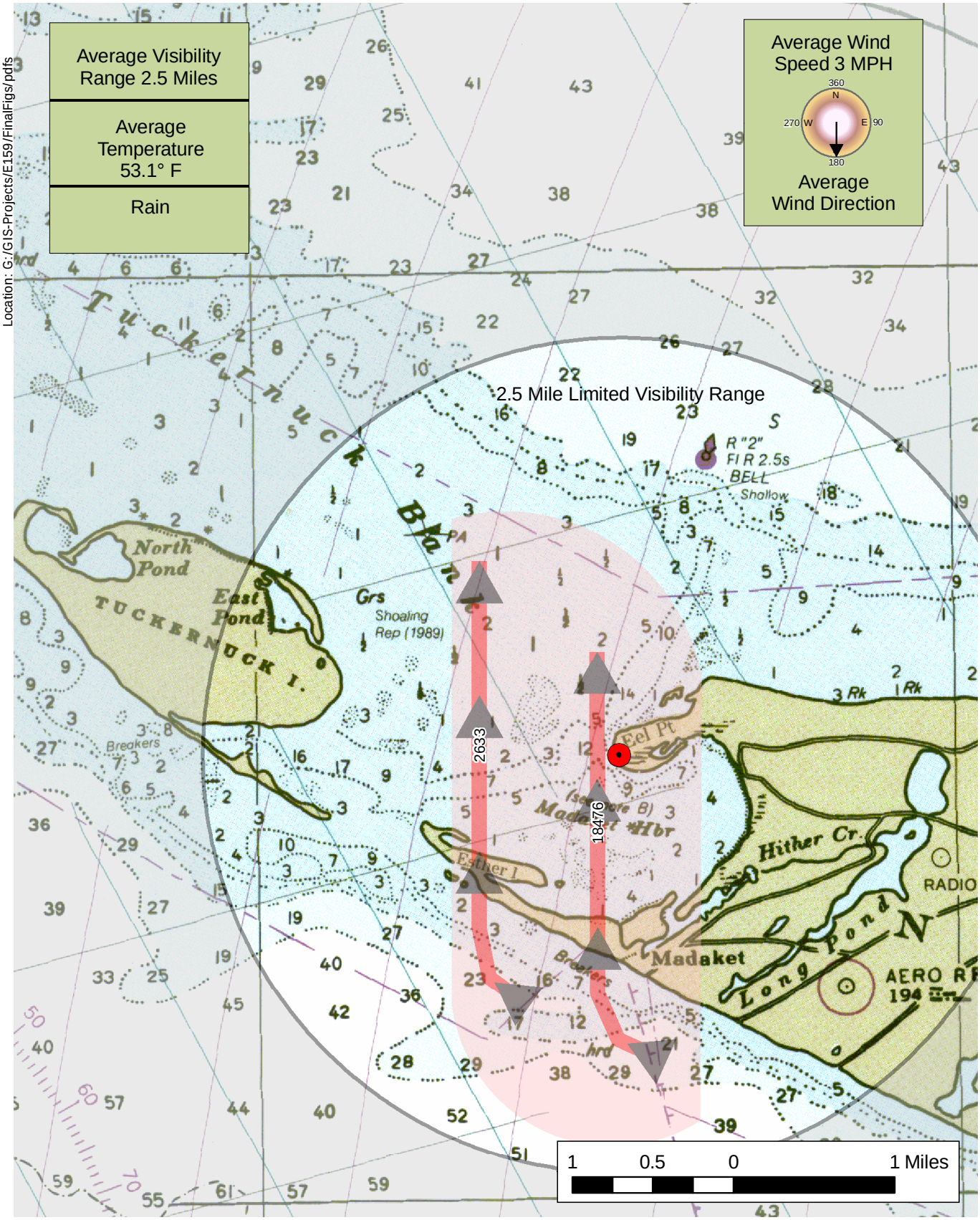
General flight path range

Source: 2) WEATHER DATA, WEATHER UNDERGROUND.COM

Predominant Long-tailed Duck Headings
January 17, 2006
PM Survey

Note:Arrows show predominant flight headings of ducks observed

Figure 3.4



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LONG-TAILED DUCK REPORT
Nantucket, Massachusetts

Scale: 1" = 4500'

Source: 1) NOAA CHARTS, NANTUCKET SOUND AND APPROACHES

Legend

Observation Point - Eel Point

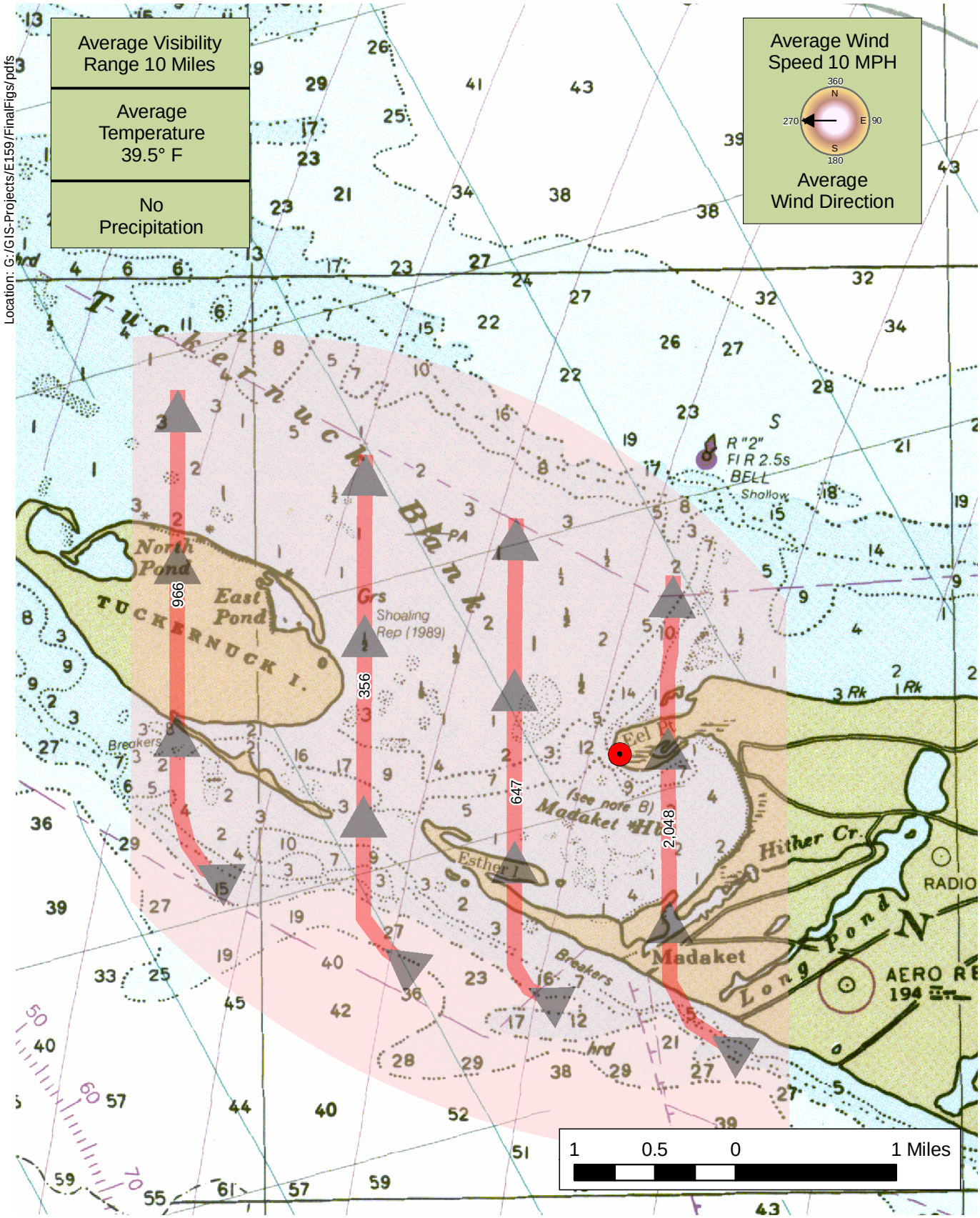
General flight path range

Source: 2) WEATHER DATA, WEATHER UNDERGROUND.COM

Predominant Long-tailed Duck Heading
January 18, 2006
PM Survey

Note:Arrows show predominant flight headings of ducks observed

Figure 3.5



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LONG-TAILED DUCK REPORT
Nantucket, Massachusetts

Scale: 1" = 4500'

Source: 1) NOAA CHARTS, NANTUCKET SOUND AND APPROACHES

Legend

Observation Point - Eel Point

General flight path range

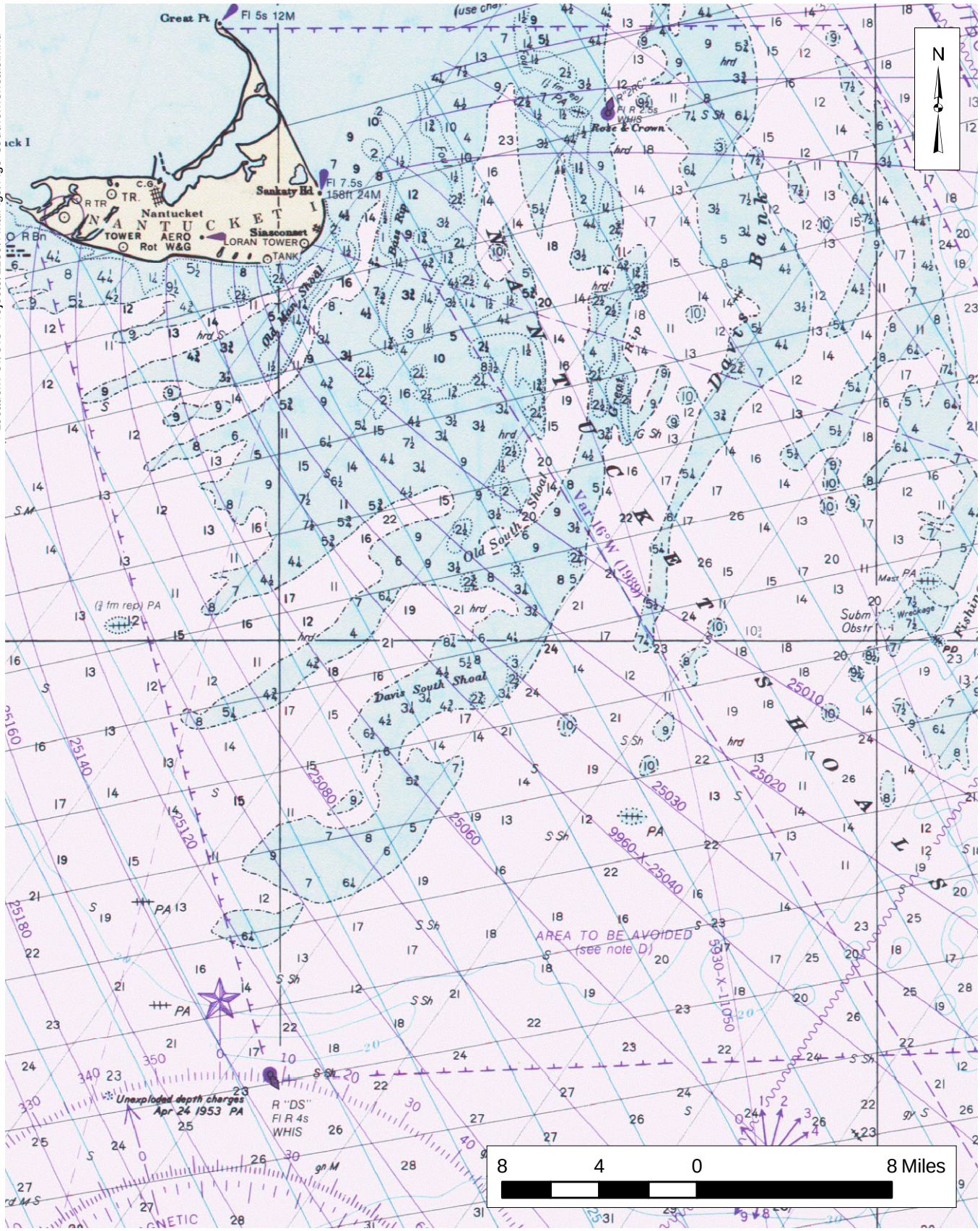
Source: 2) WEATHER DATA, WEATHER UNDERGROUND.COM

Predominant Long-tailed Duck Headings
January 19, 2006
PM Survey

Note:Arrows show predominant flight headings of ducks observed

Figure 3.6

Location: G:/GIS-Projects/E159/FinalFigs/Fig5-SouthernShoals.mxd



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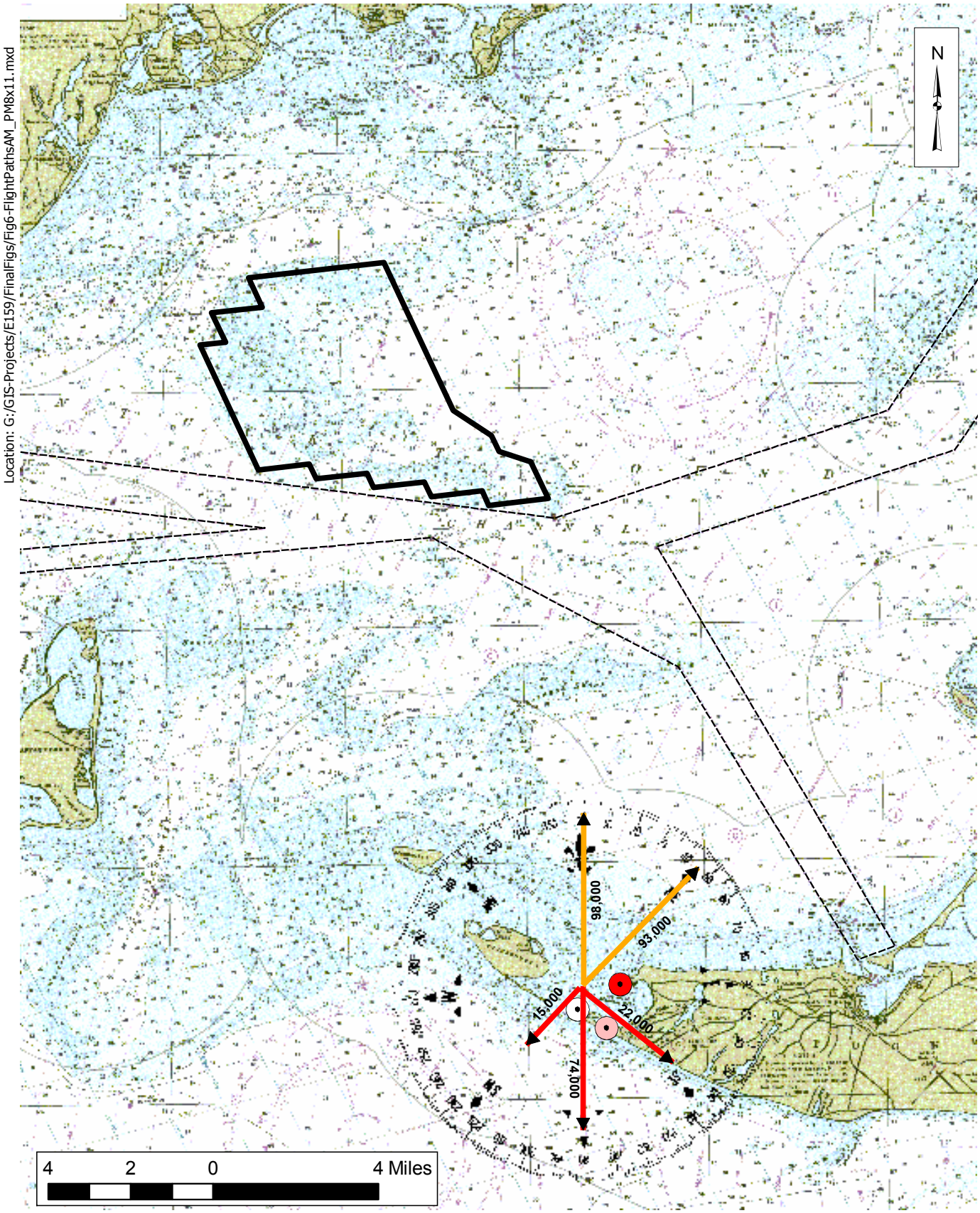
LONG-TAILED DUCK REPORT
Nantucket, Massachusetts

Scale: 1" = 30,000'

Source: 1) NOAA, NOAA Chart Nantucket Sound and Approaches, 2001

Nantucket Shoals

Figure 4



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CAPE WIND
LONG-TAILED DUCK REPORT
Nantucket, Massachusetts
Scale: 1" = 17,500'
Source: 1) NOAA, NOAA Chart Nantucket Sound and Approaches, 2001
2) ESS, Site Boundary, 2006
Note: Predominant estimated flight headings of majority of ducks are displayed above.

Legend
- Wind Farm Boundary
- Shipping Channel

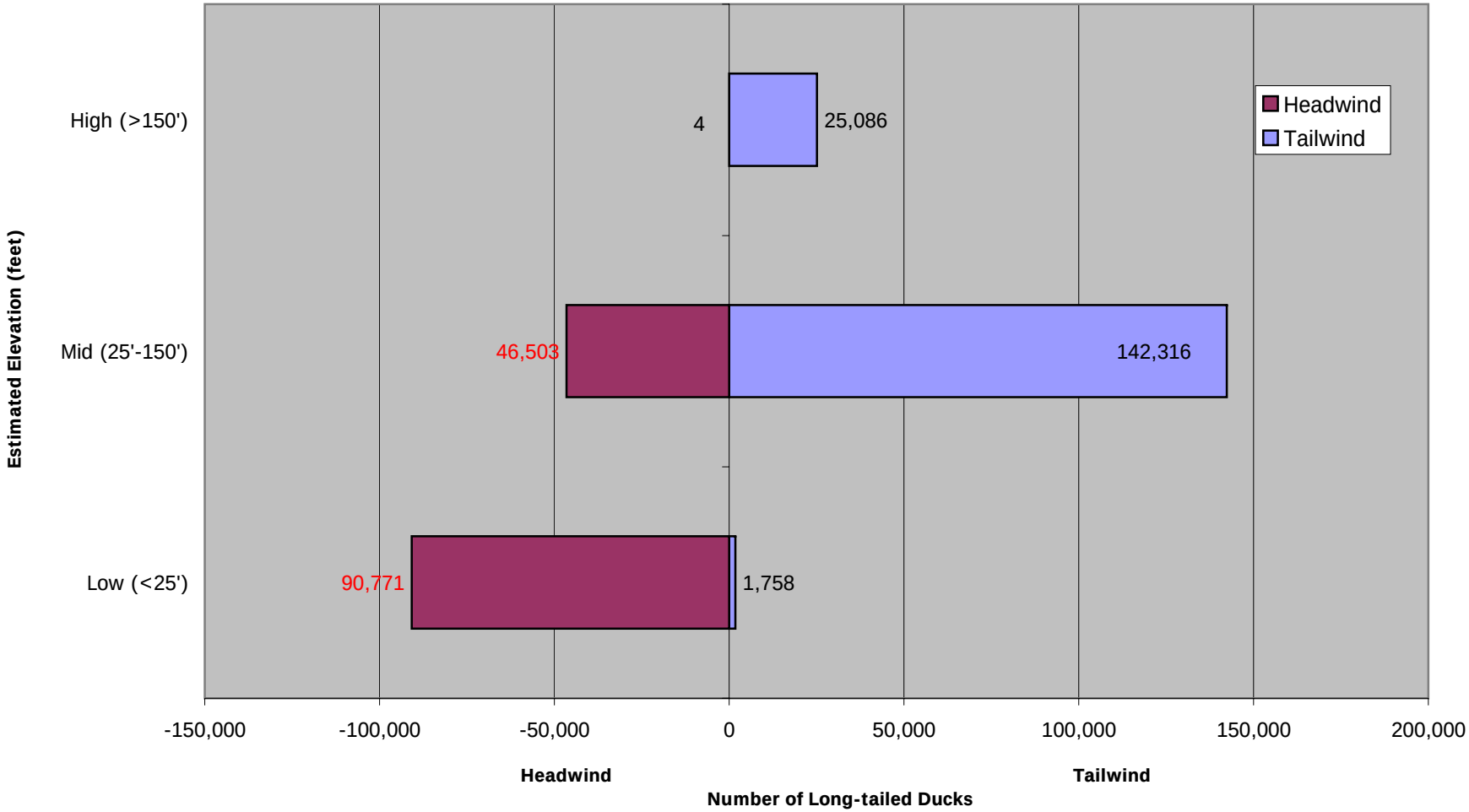
Observation Points
- Observation Point - Eel Point
- Observation Point - Madaket
- Observation Point - Esther Island

- AM Flight Paths
- PM Flight Paths

Summary of Long-Tailed Duck, AM and PM Flight Headings

Figure 5

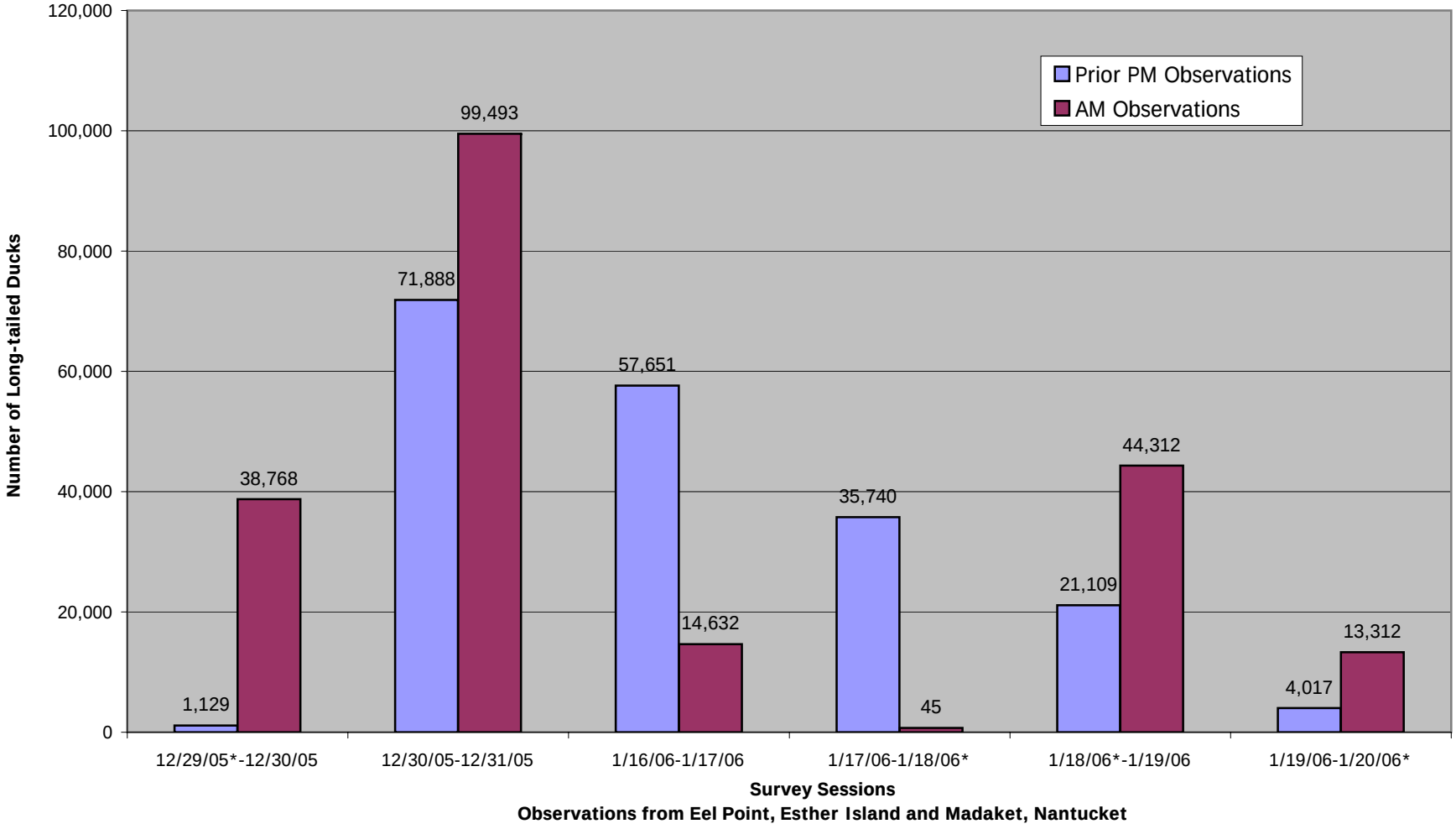
Figure 6. Estimated Long-tailed Duck Elevation, Headwind vs. Tailwind Observations from Eel Point, Nantucket



Notes: Observations from following surveys - *12/30/05 AM, 12/31/05 AM, 1/16/06 PM, 1/17/06 AM, *1/18/06 PM, *1/20/06 AM

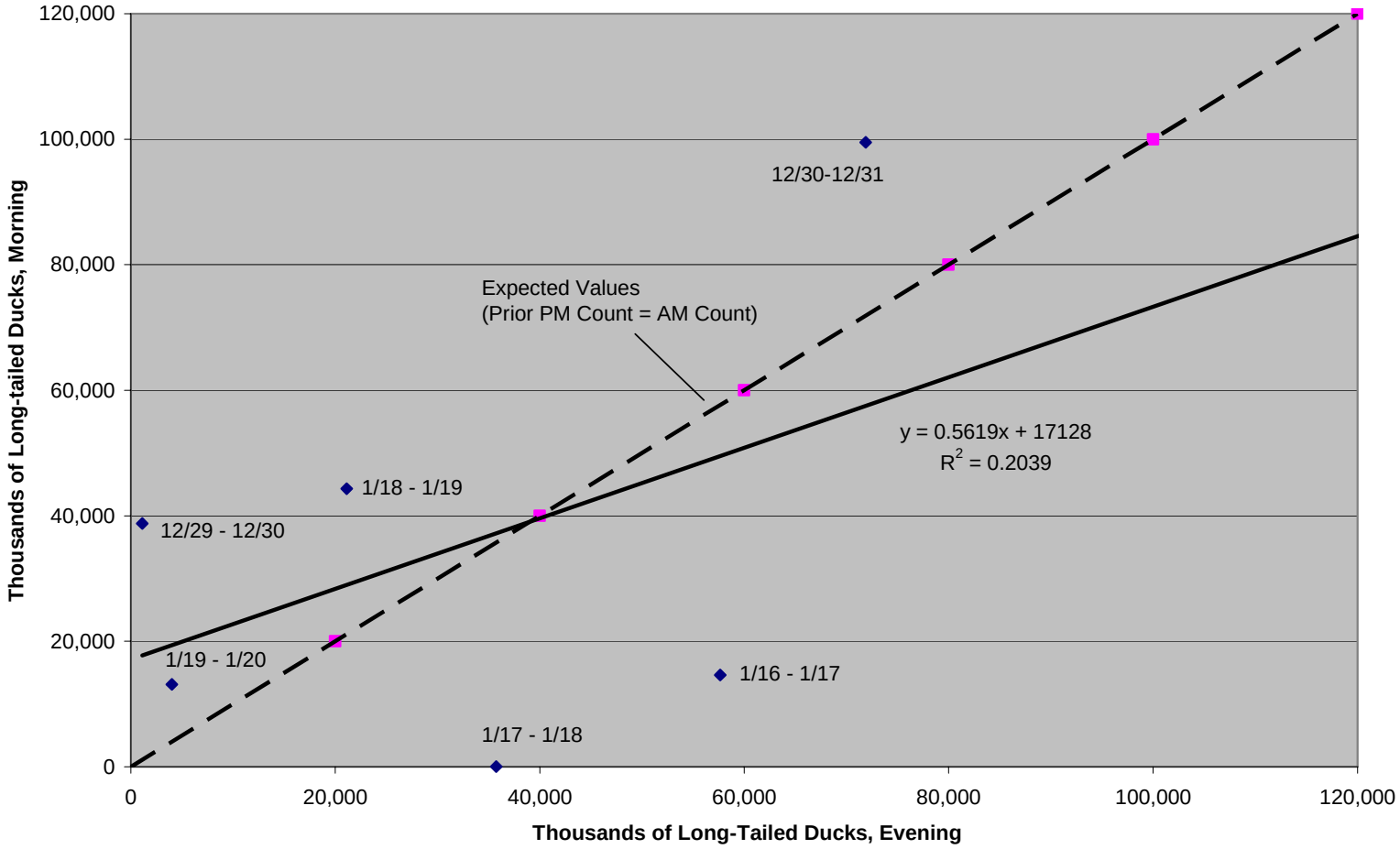
**Average visibility <5 miles*

Figure 7. Long-Tailed Duck Counts — Prior Evening vs Morning Surveys



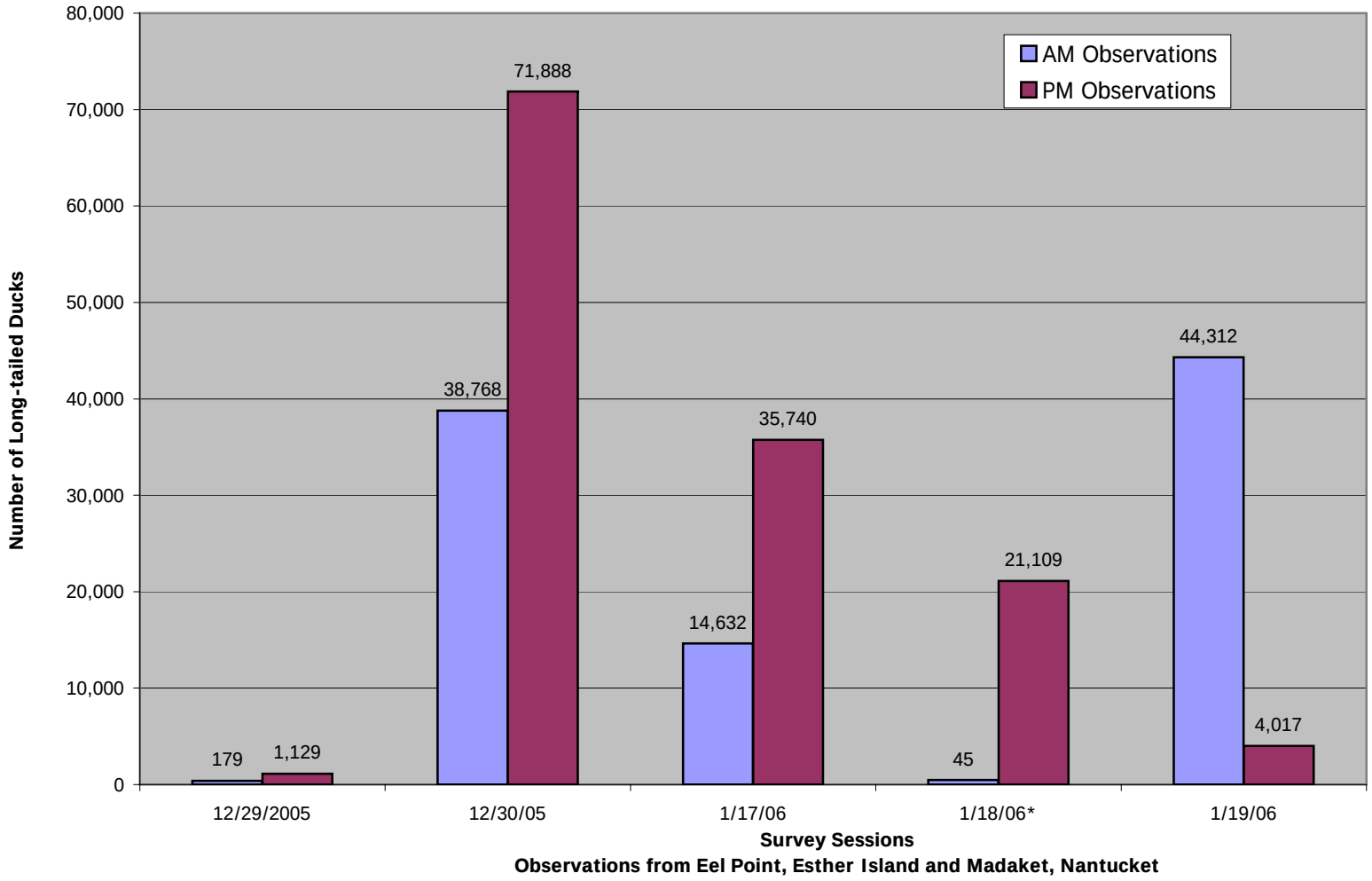
Notes: Visibility* < 5 miles on 12/29/05 PM, 1/18/06 AM, 1/18/06 PM and 1/20/06 AM
Surveys from Eel Point on 12/30/05 AM, 12/30/05 PM, 12/31/05 AM, 1/16/06 PM, 1/17/06 AM, 1/17/06 PM, 1/18/06 PM, 1/19/06 PM, 1/20/06 AM
Surveys from Esther Island on 12/29/05 PM, 1/19/06 AM,
Survey from Madaket on 1/18/06 AM

Figure 8. Number of Long-tailed Ducks Correlation (Prior PM versus AM)



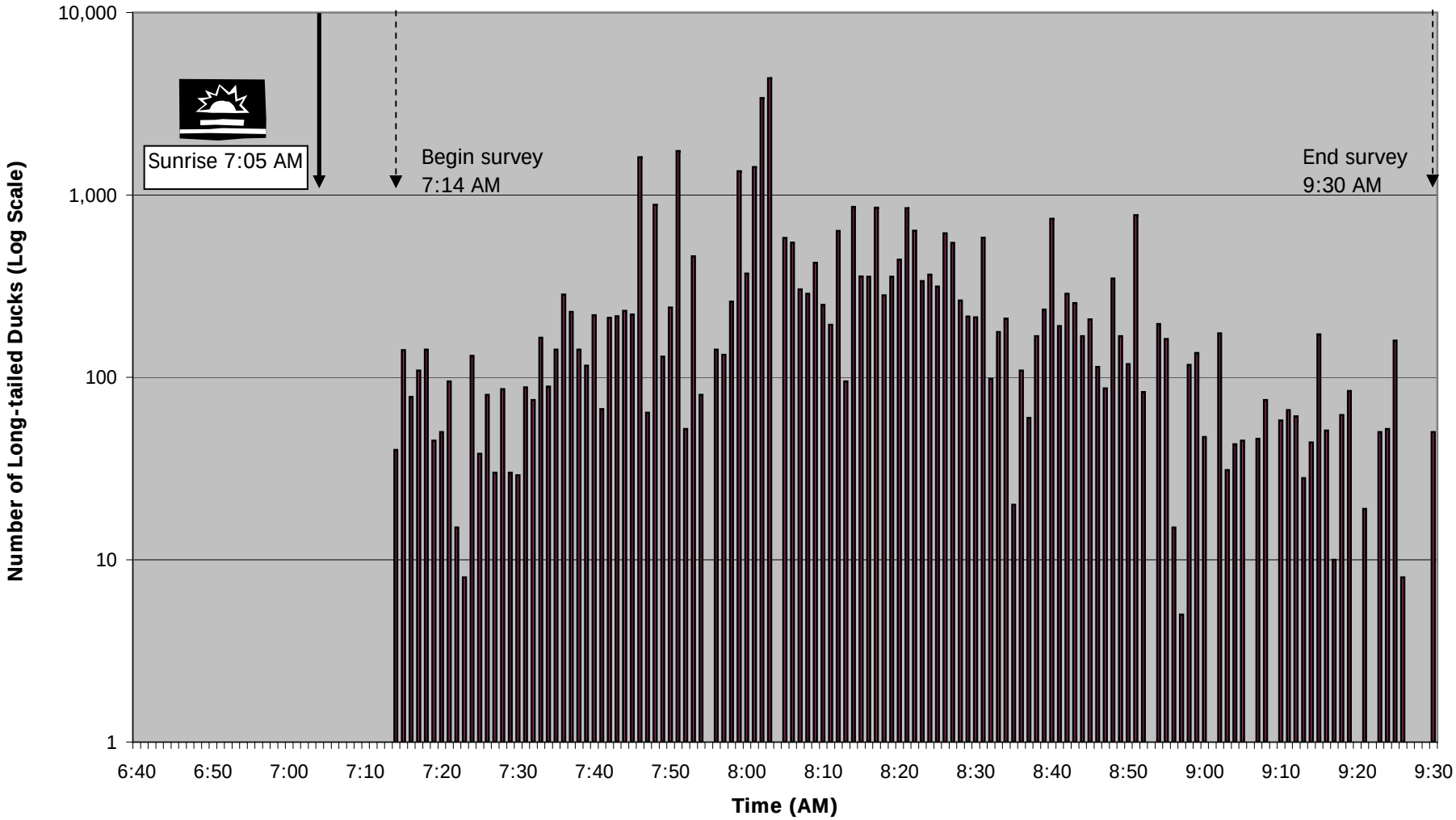
Notes: Data set includes following surveys: PM to AM, 12/29-12/30, 12/30-12/31, 1/16-1/17, 1/17-1/18, 1/18-1/19, 1/19-1/20, which are labeled next to the corresponding point in the figure above. All observations were taken from Eel Point, except 1/19 AM observations from Esther Island.

Figure 9. Long-Tailed Duck Counts — Morning vs Evening Surveys (Same Day)



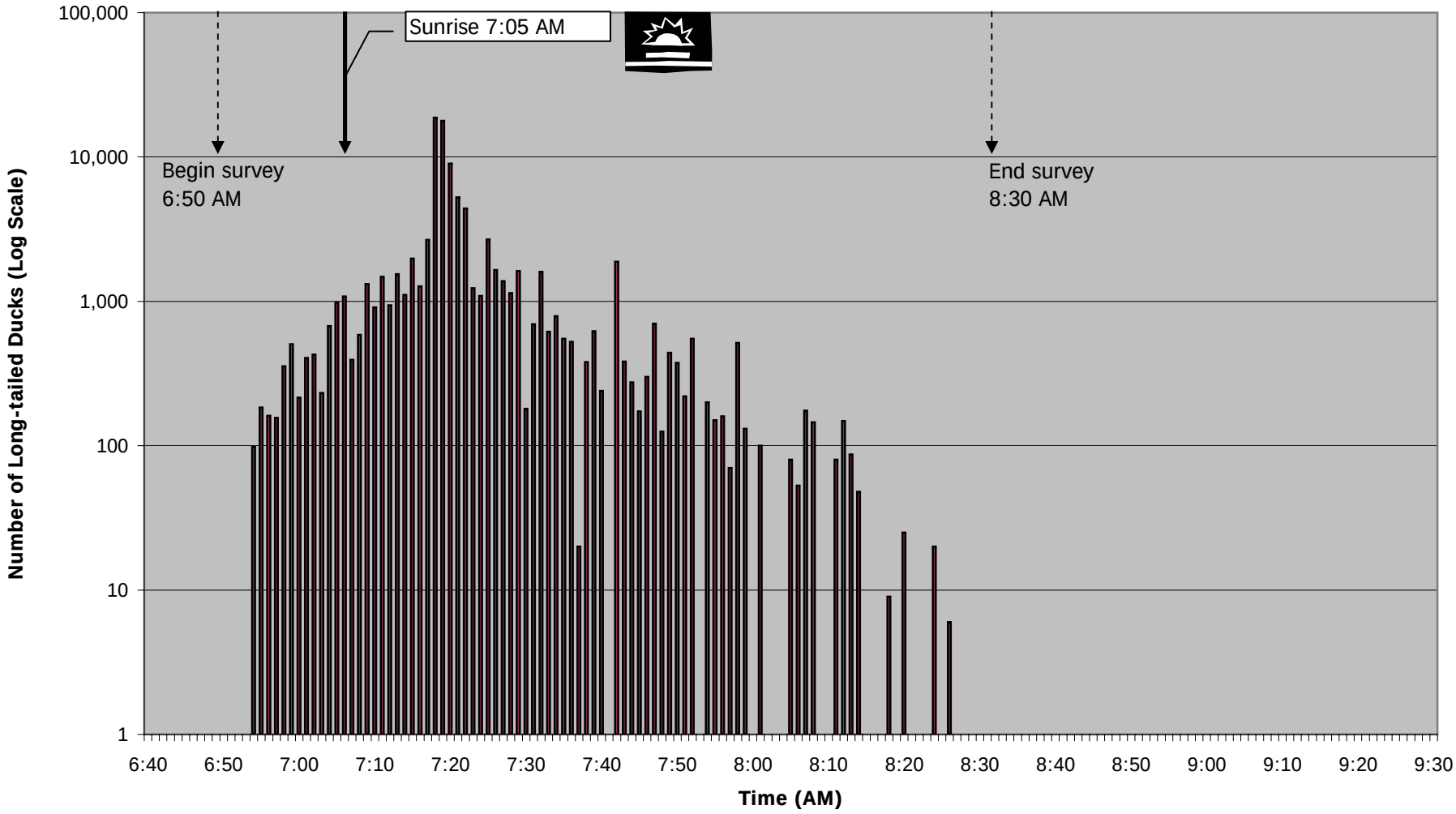
Notes: Visibility* < 4 miles on 1/18/06 AM and PM
Surveys from Eel Point on 12/30/05 AM, 12/30/05 PM, 1/17/06 AM, 1/17/06 PM, 1/18/06 PM, 1/19/06 PM
Surveys from Esther Island on 12/29/05 AM, 12/29/05 PM, 1/19/06 AM
Survey from Madaket on 1/18/06 AM
During 12/29/05 AM Survey, many ducks passed in fog without being counted; results are not representative

Figure 10.1 Number of Long-tailed Ducks per Minute — December 30th, 2005, AM Survey



Notes: Observations from Eel Point
Visibility 3 miles
Winds NNW 14 mph

Figure 10.2 Number of Long-tailed Ducks Per Minute — December 31st, 2005, AM Survey



Notes: Observations from Eel Point
Visibility 10 miles
Winds NNE 5 mph

Sunrise

Survey Start/End

Figure 10.3 Number of Long-tailed Ducks per Minute — January 17th, 2006, AM Survey

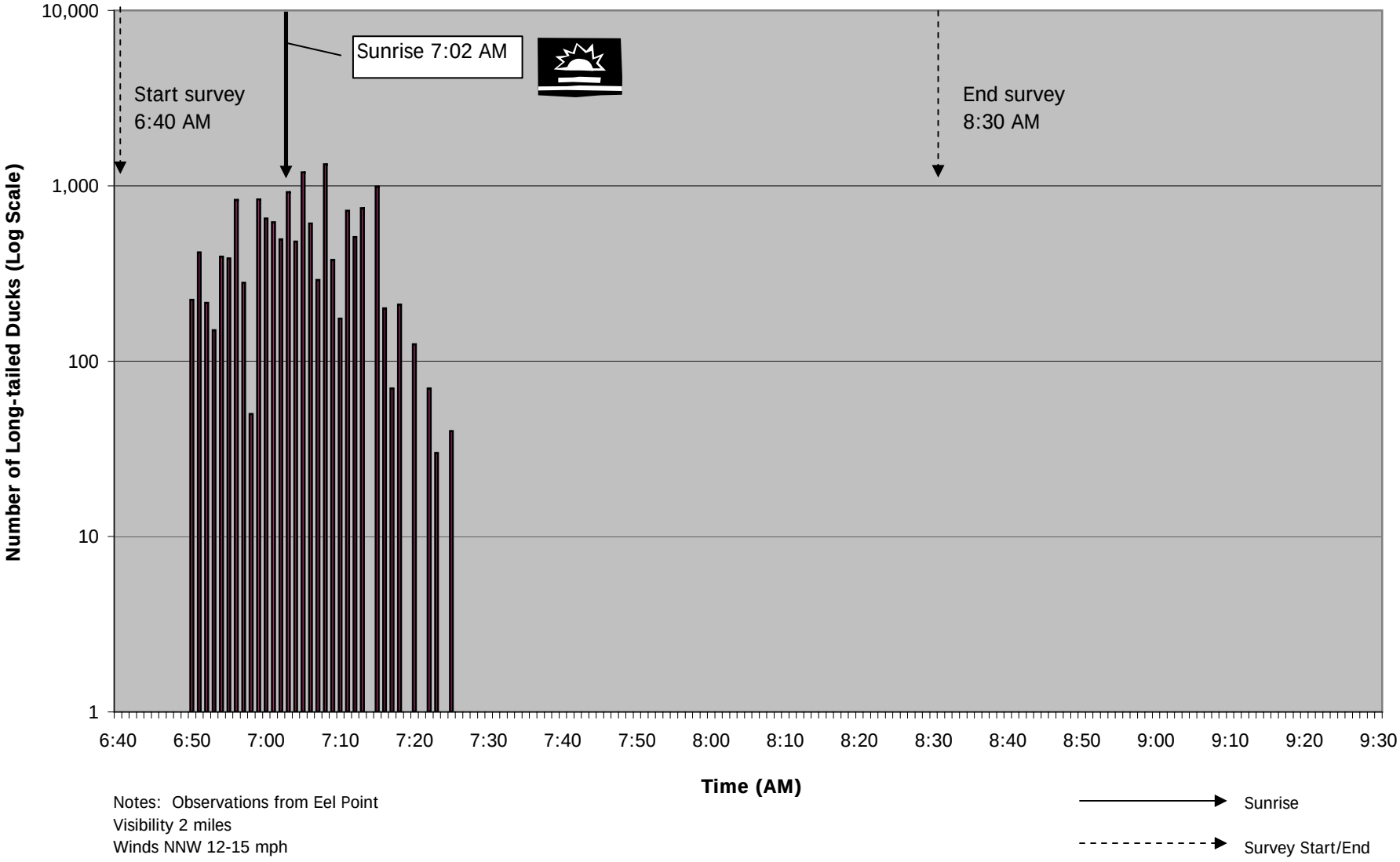


Figure 10.4 Number of Long-tailed Ducks per Minute — January 19th, 2006, AM Survey

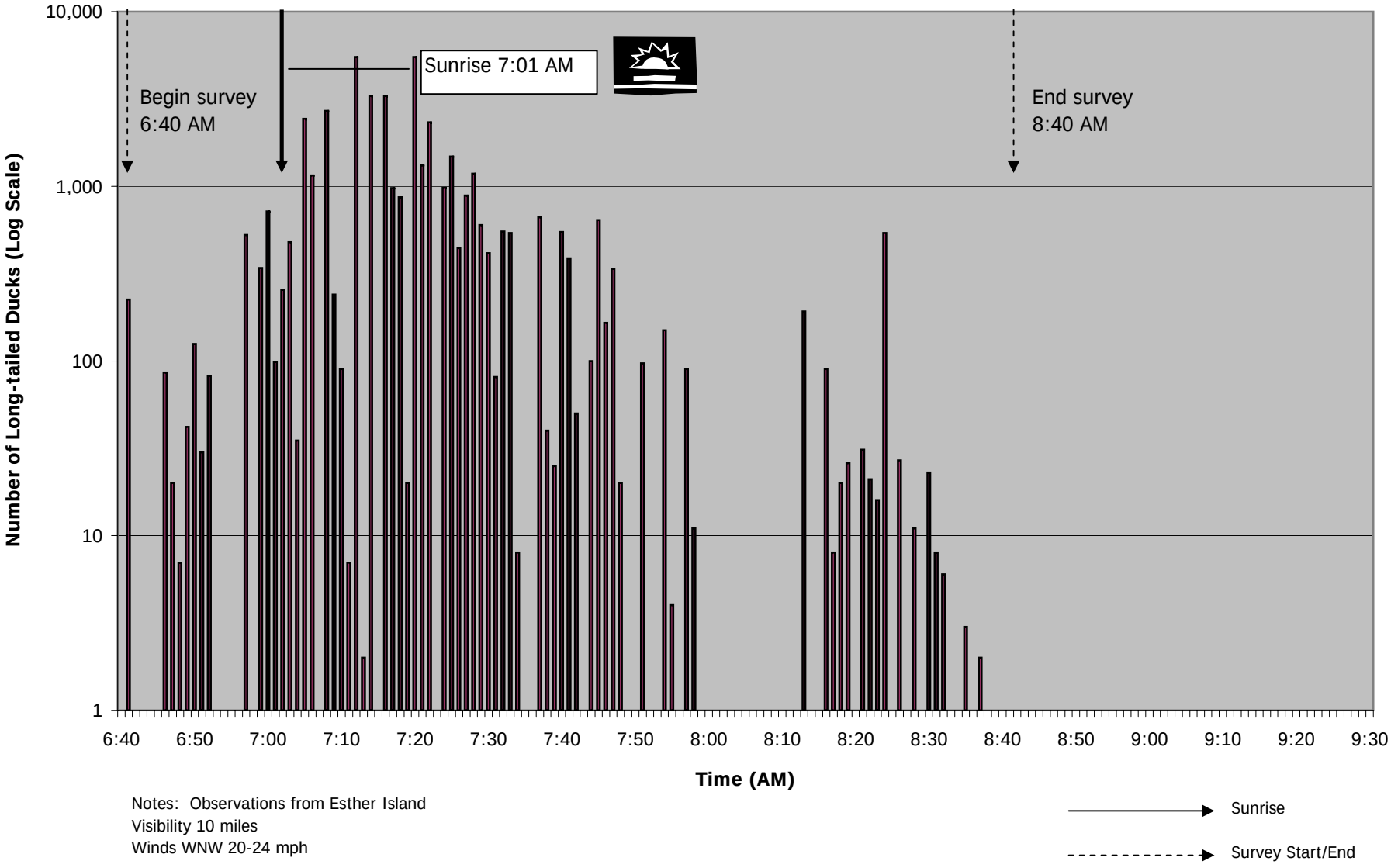
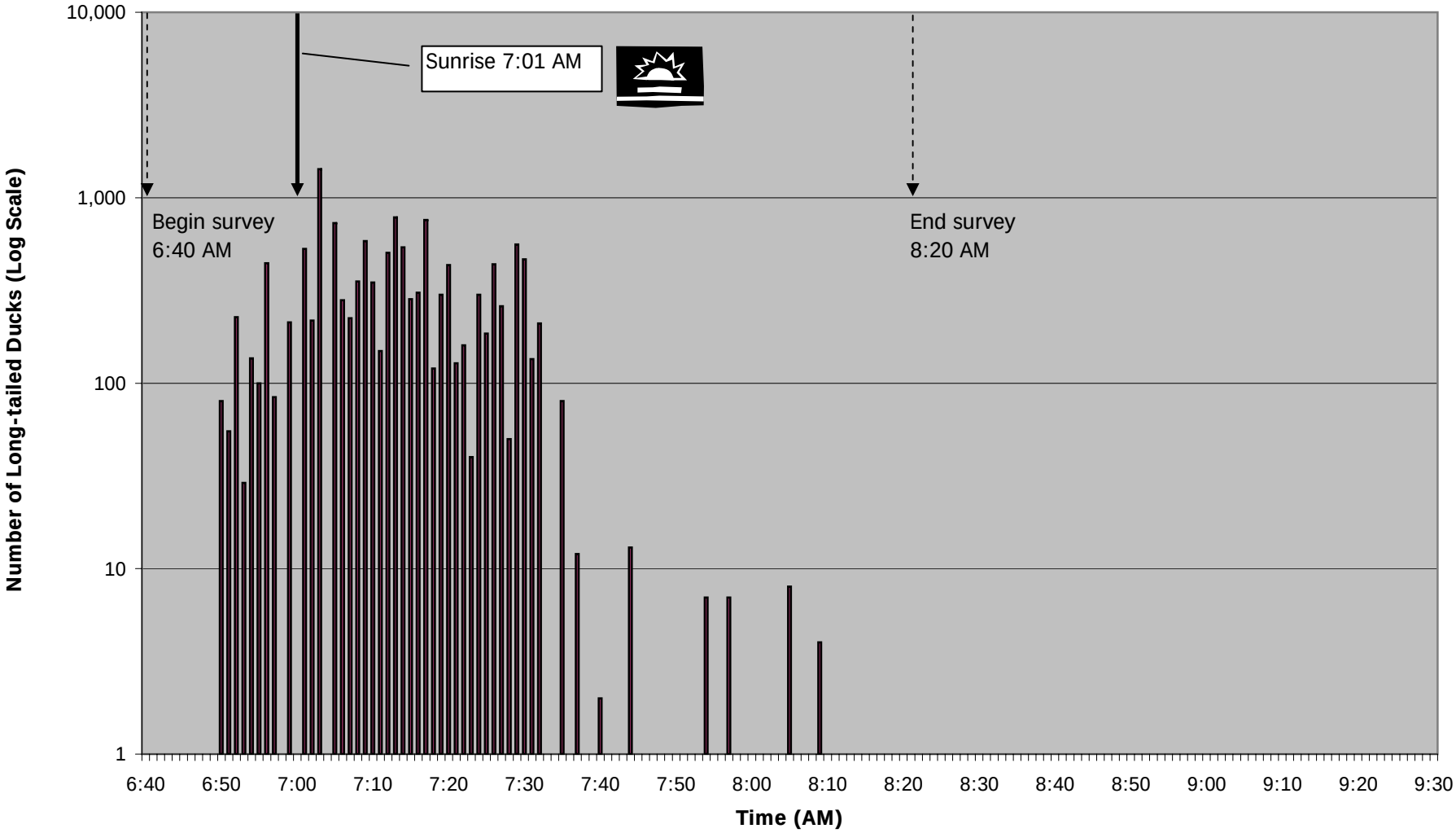
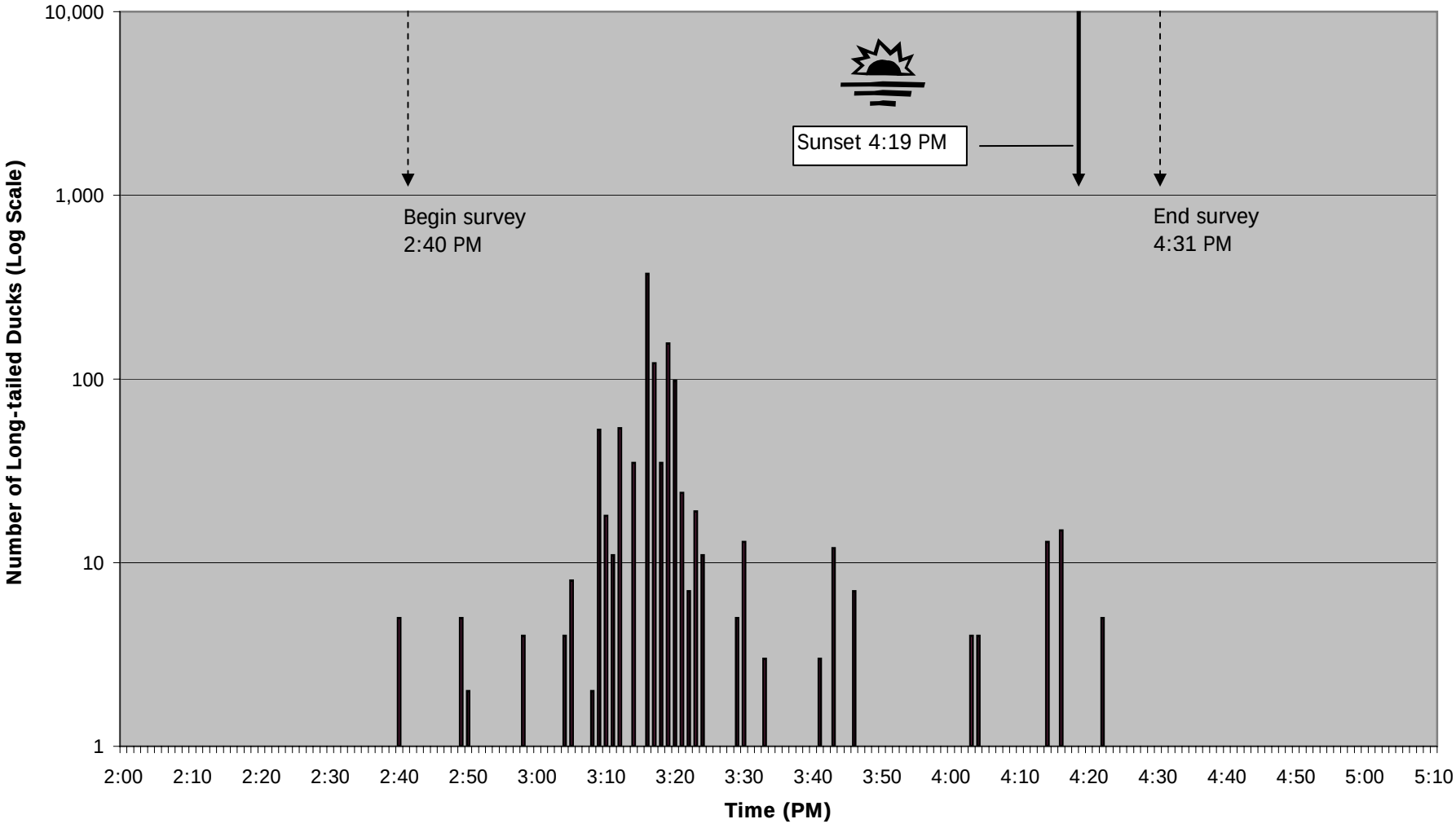


Figure 10.5 Number of Long-tailed Ducks per Minute — January 20th, 2006, AM Survey



Notes: Observations from Eel Point
Visibility 5 miles
Winds SW 13-15 mph

Figure 11.1 Number of Long-tailed Ducks per Minute — December 29th, 2005, PM Survey



Notes: Observations from Esther Island
Visibility 1 mile
Winds SSE 18 mph

Sunset

Survey Start/End

Figure 11.2 Number of Long-tailed Ducks per Minute — December 30th, 2005, PM Survey

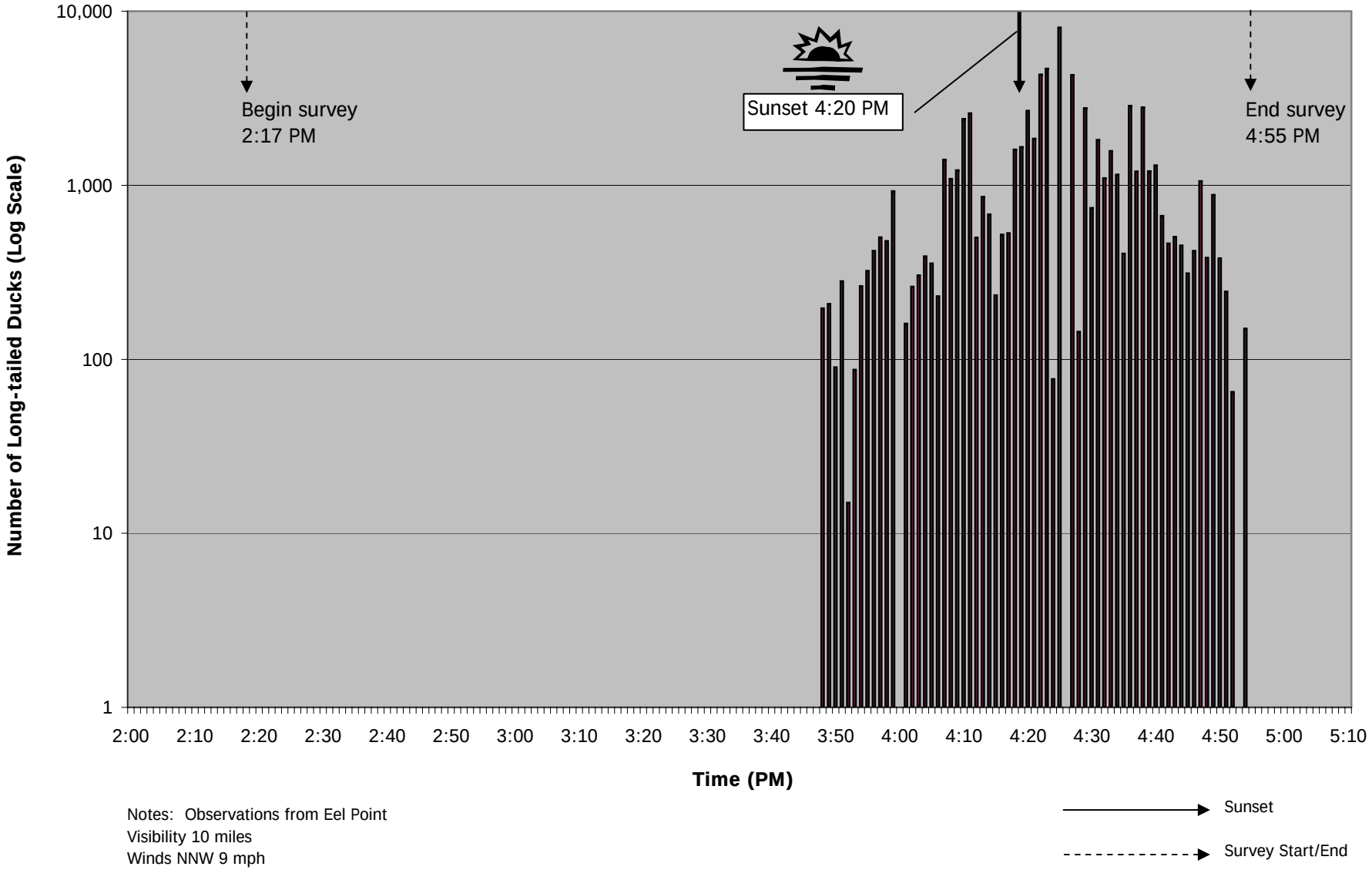
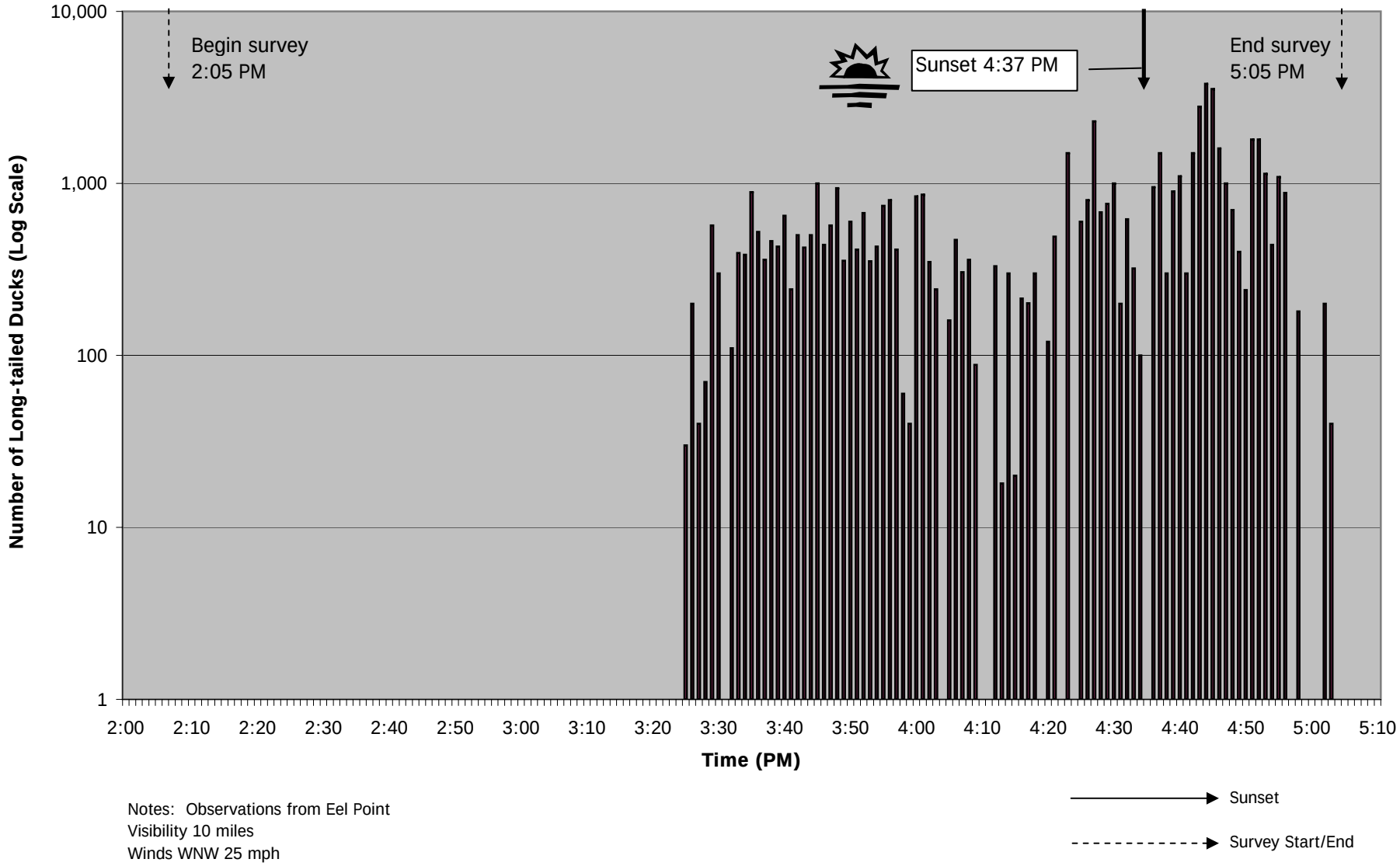
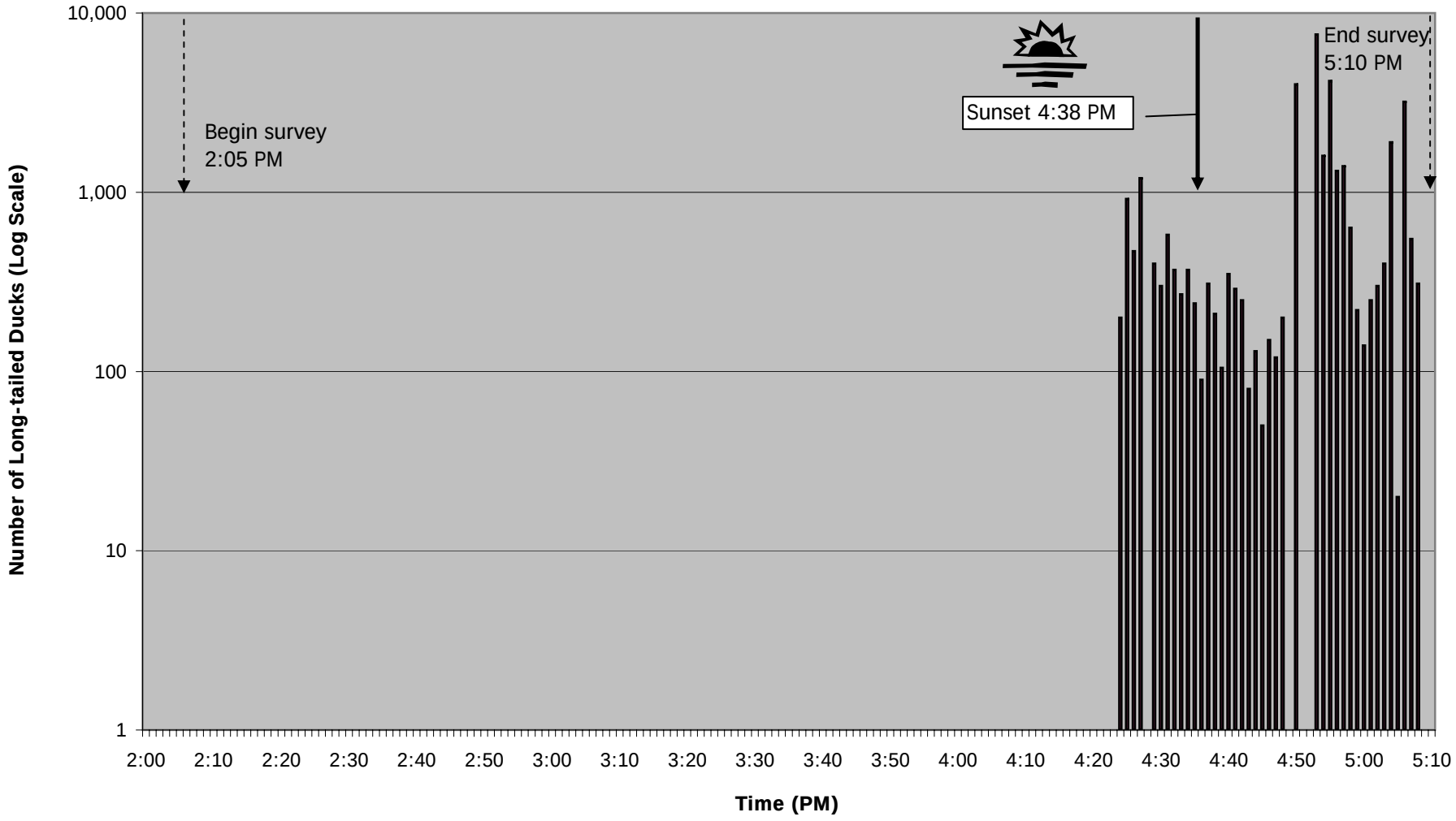


Figure 11.3 Number of Long-tailed Ducks per Minute — January 16th, 2006, PM Survey



Notes: Observations from Eel Point
Visibility 10 miles
Winds WNW 25 mph

Figure 11.4 Number of Long-tailed Ducks per Minute — January 17th, 2006, PM Survey



Notes: Observations from Eel Point
Visibility 10 miles
Winds E 5-9 mph

Figure 11.5 Number of Long-tailed Ducks per Minute — January 18th, 2006, PM Survey

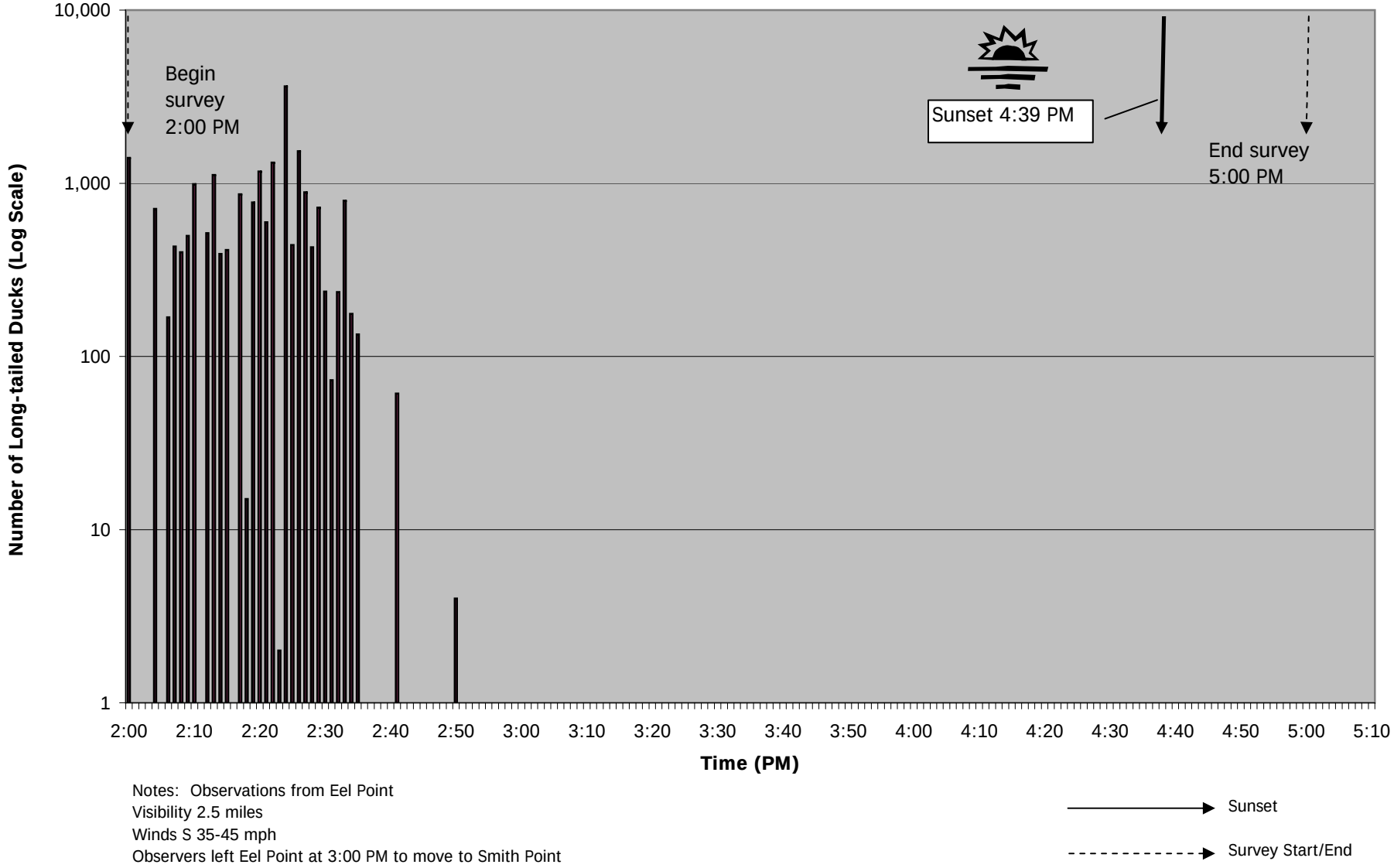
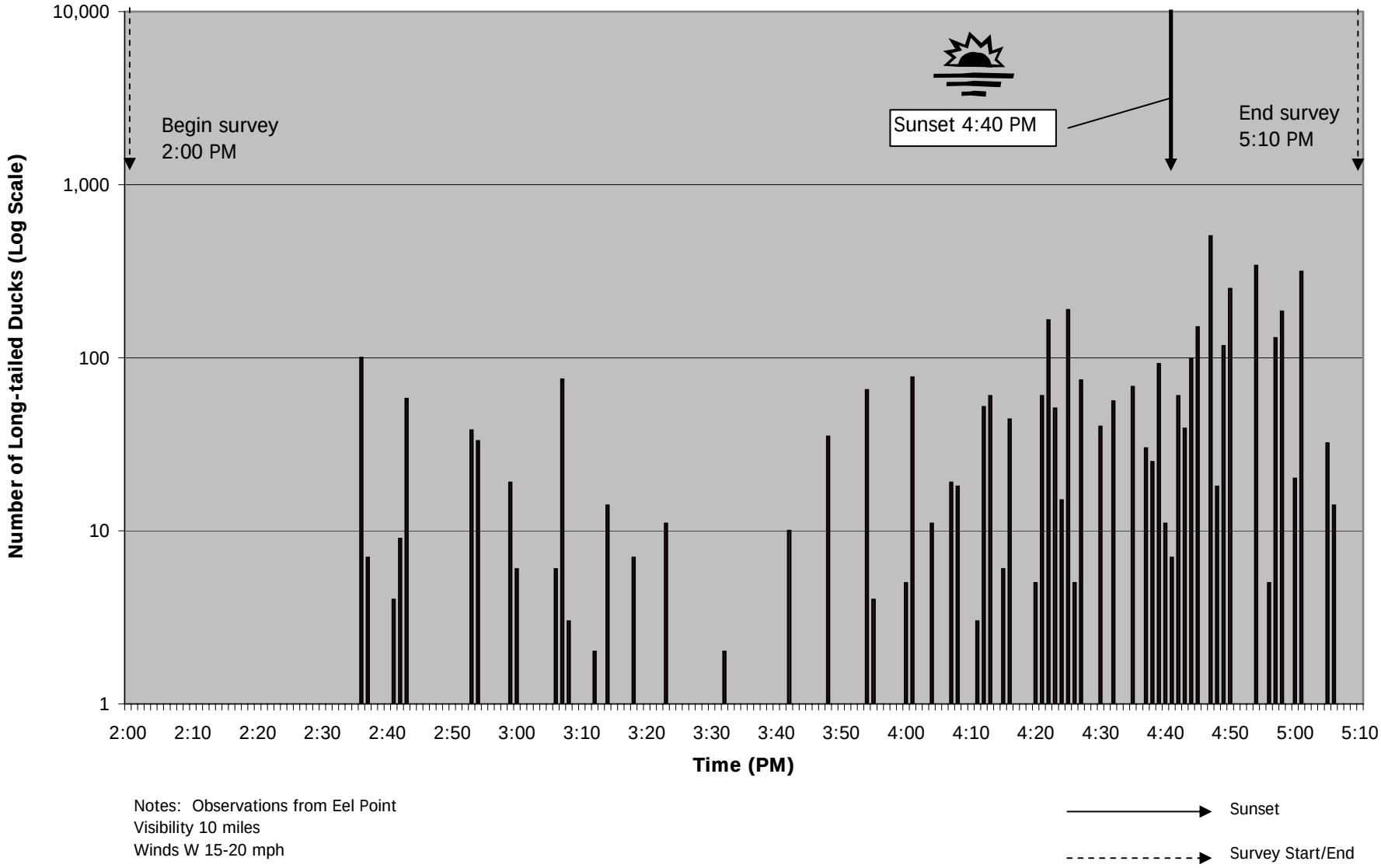



Figure 11.6 Number of Long-tailed Ducks per Minute — January 19th, 2006, PM Survey