Appendix O

Pre-Construction Avian and Bat Survey Report

Pre-Construction Avian and Bat Assessment: 2009–2011

Block Island Wind Farm
Rhode Island State Waters

Prepared for:

DEEPWATERWIND

Prepared by:

TETRA TECH, Inc.
Aaron B. Svedlow, Lauren Gilpatrick, Brad Agius, Margo Andrews, and Paul Myers.

with assistance from

DeTect, Inc.
Karen Voltura, Jesse Lewis, April Herrett, Ron Merrit, and Adam Kelly.

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1.0 EXECUTIVE SUMMARY

Deepwater Wind Rhode Island, LLC (Deepwater) contracted Tetra Tech EC, Inc. (Tetra Tech) to complete a comprehensive baseline assessment of avian and bat resources within and surrounding the Block Island Wind Farm (BIWF) Project Area in an effort to characterize the avian and bat communities and use this information to assess the potential impacts posed to these resources by the proposed BIWF. Surveys were performed in the offshore area where wind turbine generators (WTGs) are proposed as well as adjacent offshore and nearshore areas. In addition, surveys were conducted along the southern coast of Block Island and a portion of the north shore of the Great Salt Pond. Collectively these areas comprised the BIWF Study Area.

Surveys that were part of the study included onshore sea-watch point counts, offshore boat-based transects, high definition aerial videography of the offshore portion of the BIWF Study Area, MERLIN avian radar, VESPER vertical profiling radar, Next Generation Weather Radar (NEXRAD) historical migration data review, radar validation, as well as avian acoustic monitoring and passive and active bat acoustic monitoring. These surveys were completed between February 2009 and September 2011. Sea-watch point counts, boat-based transects, and aerial videography surveys included identification of species as well as collection of data on abundance and spatial and temporal distributions, while MERLIN and VESPER radars provided additional detailed information on passage rates and flight heights. Bat and avian acoustics were collected to gain insight on nocturnal activity in the Study Area.

Survey results revealed some general overall patterns and trends in avian and bat abundance and distribution including:

1. Overall bird abundance is lower offshore than in nearshore and onshore environments.
2. Overall bird abundance offshore is higher in winter.
3. Waterfowl and seabirds were the most abundant birds offshore.
4. No raptors, and very few passerines and shorebirds, were observed offshore.
5. Bird abundance in the offshore area was lower in the area where WTGs are proposed than adjacent locations.
6. Flight heights were low in the offshore area and low in comparison with nearshore and onshore areas.
7. Flight heights were typically lower in winter when lower flying species groups such as seaducks and loons were most prevalent.
8. Gulls generally had higher flight heights than other bird groups and were constantly present throughout the year. Gulls were recorded during each survey.
9. Rare, threatened, and endangered species were almost exclusively found onshore.

The onshore point count surveys focused on the coastal waters and revealed that wintering waterfowl along with gulls dominate the nearshore waters of Block Island during much of the year. Flight heights of waterfowl were typically low while gulls, on average, flew higher. When gannets, alcids, shearwaters, and other pelagic seabirds were present, they were fewer in number and less common along the coast of Block Island than in offshore waters. Overall bird counts and encounter rates were relatively high in the onshore and nearshore areas when compared with counts from offshore.

Both the offshore boat-based surveys and aerial videography surveys demonstrated that offshore waters had a much lower abundance of birds when compared with onshore locations. Due to the presence of a greater proportion of low flying waterfowl and seabirds it was also found that flight heights were lower offshore than onshore. All surveys identified gulls, which typically flew higher than other species, as a large component of the avian community in the BIWF Study Area. It was observed that during spring and summer when gulls were the dominant group in the Study Area, a greater percentage of birds was detected flying in the rotor swept zone (RSZ). Conversely, flight heights trended lower, generally below the RSZ, alongside an increase in the diversity and abundance of other species (including seaducks, alcids, gannets, and loons), which primarily occureed during the fall and winter.

As part of the BIWF avian and bat surveys a regional scale screening assessment of migratory bird activity in the vicinity of the proposed project was conducted using archived data from NEXRAD (WSR 88-D). Data were queried for the years 2006 through 2010 and divided into spring (March 16–June 30), summer (July 1–September 15), fall (September 16–December 15) and winter (December 16 –March 15). Data were analyzed to determine if the proposed project location offshore of Block Island, Rhode Island is an area with significantly increased activity compared to other sites in the area.

Fourteen sites along the Northeast coast were sampled for the analysis. The actual proposed location of the turbines is outside the coverage area for the NEXRAD system, so a test site (site 1), located northeast of the proposed wind farm, was selected that was in closest proximity to the project coordinates. A total of seven sites including the test site were selected offshore along the coasts of Massachusetts, Rhode Island, Connecticut, and Long Island, New York. Seven additional sites were modeled inland in Connecticut, Massachusetts, and New York. These 14 sites were covered by the Boston and New York City radar stations and were each located 72.23 kilometers (km) from the radar antenna. Each sample site covered an area of approximately 9.26 km in diameter.

Results suggest that the proposed site is not the most active in terms of bird activity and ranks fifth (1 being the highest activity level and 7 being the lowest) amongst the seven offshore locations in the study when compared to all other sites throughout the year. When comparing all 14 sites offshore and onshore the test site again ranked in the lowest group, 12th out of 14. Tetra Tech also analyzed seasonal activity levels at all sites. The Block Island site ranks near the bottom of the distribution (11th of the 14 total sites; 5th of the 7 offshore sites) in nocturnal spring migration activity levels. During nocturnal fall migration the Block Island site ranks slightly higher (10th of the 14 total sites) and in the middle of the distribution for just the offshore sites (4th out of 7). Visibility analysis further suggests that there are few periods during night migration when low visibility conditions exist. The NEXRAD results, in addition to the results of the BIWF MERLIN radar, VESPER radar, and acoustic monitoring surveys, indicate that the proposed project likely posses little risk to nocturnal migrants. There appear to be few nights during migration that have low visibility coiniciding with high passage rates, which would indicate elevated risk to nocturnal migrating passerines and bats.

A comprehensive risk evaluation and impact assessment was prepared as part of the baseline avian and bat assessment. Five categories of risk were evaluated: (1) disturbance during construction, (2) displacement of foraging birds, (3) barrier effects on flying/migrating birds, (4) direct habitat loss/change, and (5) collision. Once the turbines are installed and operational there is likely to be some disturbance to avifauna from the rotation of the turbine blades, the noise of the blades rotating, and the physical presence of a novel structure in the marine landscape. The presence of the WTGs may restrict access to food resources within the turbine array. It is expected that the responses by loons, seaducks, seabirds, and terns occurring in the BIWF Project Area would be similar to those of birds at existing offshore wind facilities. Fox et al. (2006) found that the displacement of birds from areas where WTGs are operational constitutes, at worst, an effective loss of habitat within the turbine array and, at best, at least some percentage of habitat loss. Potential disturbance and displacement effects will be reduced as much as is reasonably practicable through avoidance and minimization measures implemented during the design, construction, and operational phases of the project.

Results of the risk assessment (Section 6) indicate that even in a worst case (hypothetical) scenario where the majority of birds within a 4 km avoidance threshold of the BIWF Project Area are affected by the turbines, the portion of the region's avian and bat populations that would be impacted should be minor and are not likely to incur any reductions in population fitness. The limited number of birds in close proximity to the proposed BIWF turbines and the flight patterns of birds in the BIWF Study Area indicate that even at the worst case hypothetical level of impact, there is unlikely to be significant effects on birds and bats in the Study Area and Rhode Island Sound region as a result of implementation of the BIWF project.

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2.0 INTRODUCTION

Tetra Tech EC, Inc. (Tetra Tech), on behalf of Deepwater Wind Rhode Island, LLC (Deepwater), has completed a comprehensive assessment of the avian and bat communities found within the Block Island Wind Farm (BIWF) Study Area. The Study Area is located approximately 5.6 kilometers (km) (3.0 nautical miles [nm]) southeast of Block Island, Rhode Island (RI) and comprises the the location where five offshore wind turbines are proposed (the Project Area), along with coastal areas of Block Island and offshore areas adjacent to the proposed turbine locations (Figure 2.1.1). The purpose of the assessment was to characterize the Study Area's avian and bat communities to meet permitting requirements, provide baseline data that may be used to evaluate potential impacts resulting from the proposed development, and measure any changes to these resources that may occur following construction.

Prior to initiating the study, Deepwater developed an Avian and Bat Study Plan in cooperation with the U.S. Fish and Wildlife Service (USFWS) to:

1. Address gaps in existing data;
2. Identify the specific survey techniques and analyses required to determine the level of impact, if any, on avian and bat species within the Study Area; and
3. Help comply with state and federal regulatory requirements.

This study plan was subsequently approved by the USFWS in summer 2009. All data collected and analyzed as part of this study are further evaluated in National Environmental Policy Act (NEPA) documentation submitted to the U.S. Army Corps of Engineers as part of Deepwater's permit application for the proposed BIWF and Block Island Transmission System (BITS) projects.

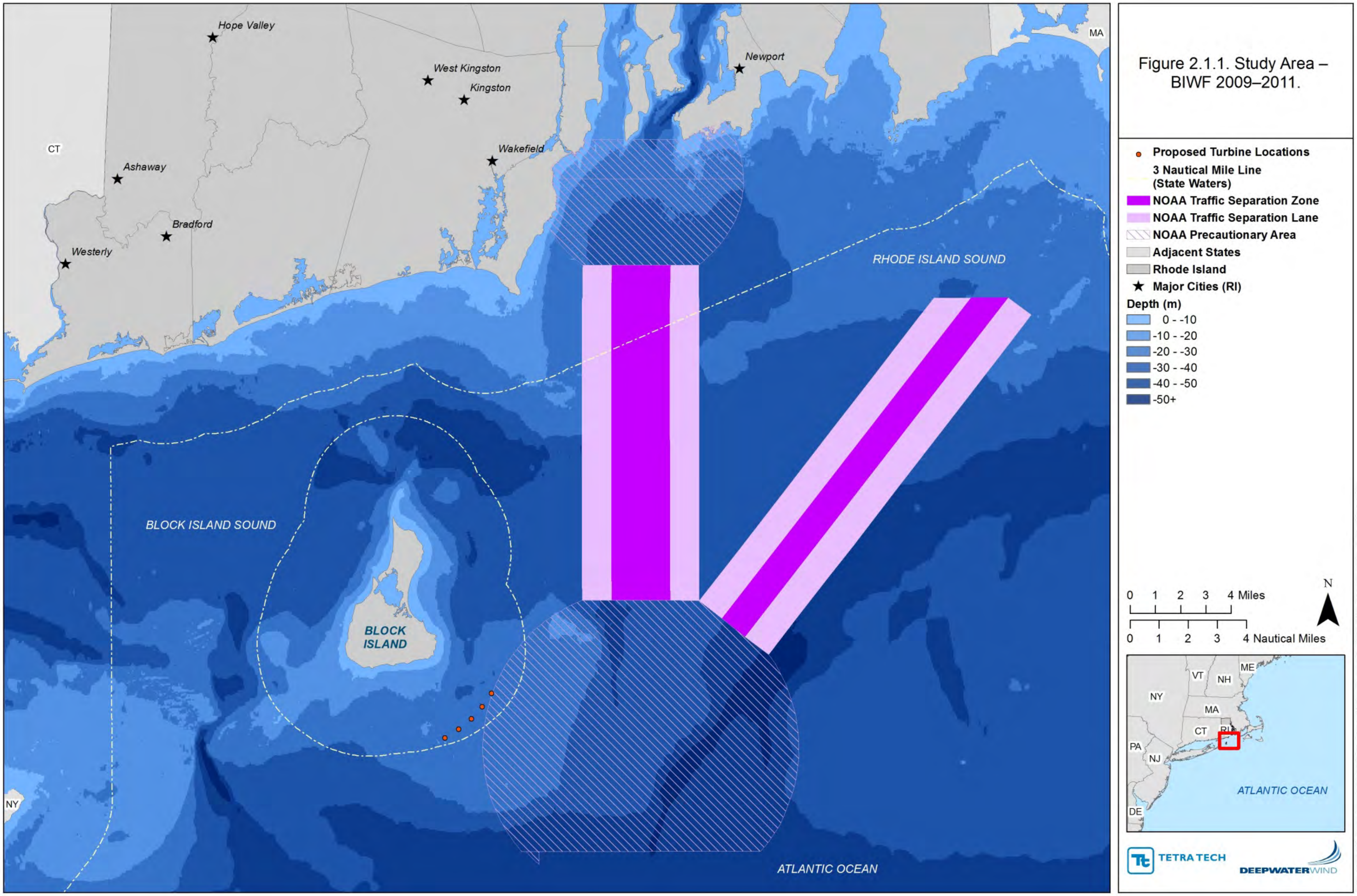


Figure 2.1.1. Study Area – BIWF 2009–2011.

2.1 PROJECT HISTORY AND BACKGROUND

In January 2006, Rhode Island Governor Carcieri launched an initiative called RIWINDS, which sought to supply 15 percent (%) of the state's total electricity demand using power generated from offshore wind resources. Then in 2008 the state issued a request for proposals (RFP) soliciting the development of offshore wind power projects. Following an exhaustive vetting process, the state selected Deepwater as the preferred developer for Rhode Island's first offshore wind project(s).

In the summer of 2008, the state approved funding for the development of a Special Area Management Plan (SAMP) covering the offshore waters of Rhode Island. The SAMP is being executed by a joint partnership between the Coastal Resources Management Council (CRMC) and the University of Rhode Island (URI). URI's role is to provide data to the CRMC, which it will then use to execute SAMP's regulatory framework. The SAMP preparation process is expected to be completed in 2012.

In January 2009 the state entered into a joint development agreement with Deepwater under which Deepwater agreed to, among other things, build, own, operate, and maintain the Block Island Wind Farm. Separately, the joint development agreement also contemplates the subsequent development of an additional wind farm facility in federal waters.

2.2 STUDY AREA DESCRIPTION

The Study Area was located in the temperate marine waters of southern New England in Rhode Island Sound within 5.6 km (3 nm) of the southeastern corner of Block Island and on Block Island. The offshore portion of the Study Area was largely within state waters and contained water depths of less than 46 meters (m) (150 feet [ft]). With the exception of portions of Block Island, no additional islands, exposed ledges, or other land masses occurred within the Study Area. Benthic substrata were relatively diverse, ranging from areas of cobble/rock with a high bottom roughness and complexity to more homogeneous areas of sandy substrate (Malek et al. 2010). The Block Island, or onshore, portion of the Study Area consisted of immediate shoreline, intertidal zone, and immediate nearshore waters. The offshore portion of the Study Area consisted of the area from Block Island seaward to just over 5.6 km (3 nm) and the northern portion of the Great Salt Pond (Figure 2.2.1).

Offshore areas of Rhode Island Sound are known to contain wintering and foraging habitat for seaducks and seabirds (Gochfeld et al. 1998, O'Brien et al. 2006). These species exploit the range of fish and other aquatic organisms present in the Sound's variable water depths and benthic habitats. The area harbors migratory birds during seasonal movements from breeding to wintering grounds; however, the full extent of the use of this area by migrating birds, including passerines, had not been well documented prior to the RI Ocean SAMP.

Little is known about bat activity in offshore waters along the Atlantic coast. Coastal and nearshore areas may be used during late summer/fall and spring migration periods by several species. However, given the Study Area's distance from the shore of Block Island, and even greater distance from mainland New England, it is unlikely that the Study Area's offshore waters are used by bats for daily foraging activity or extensive migration.

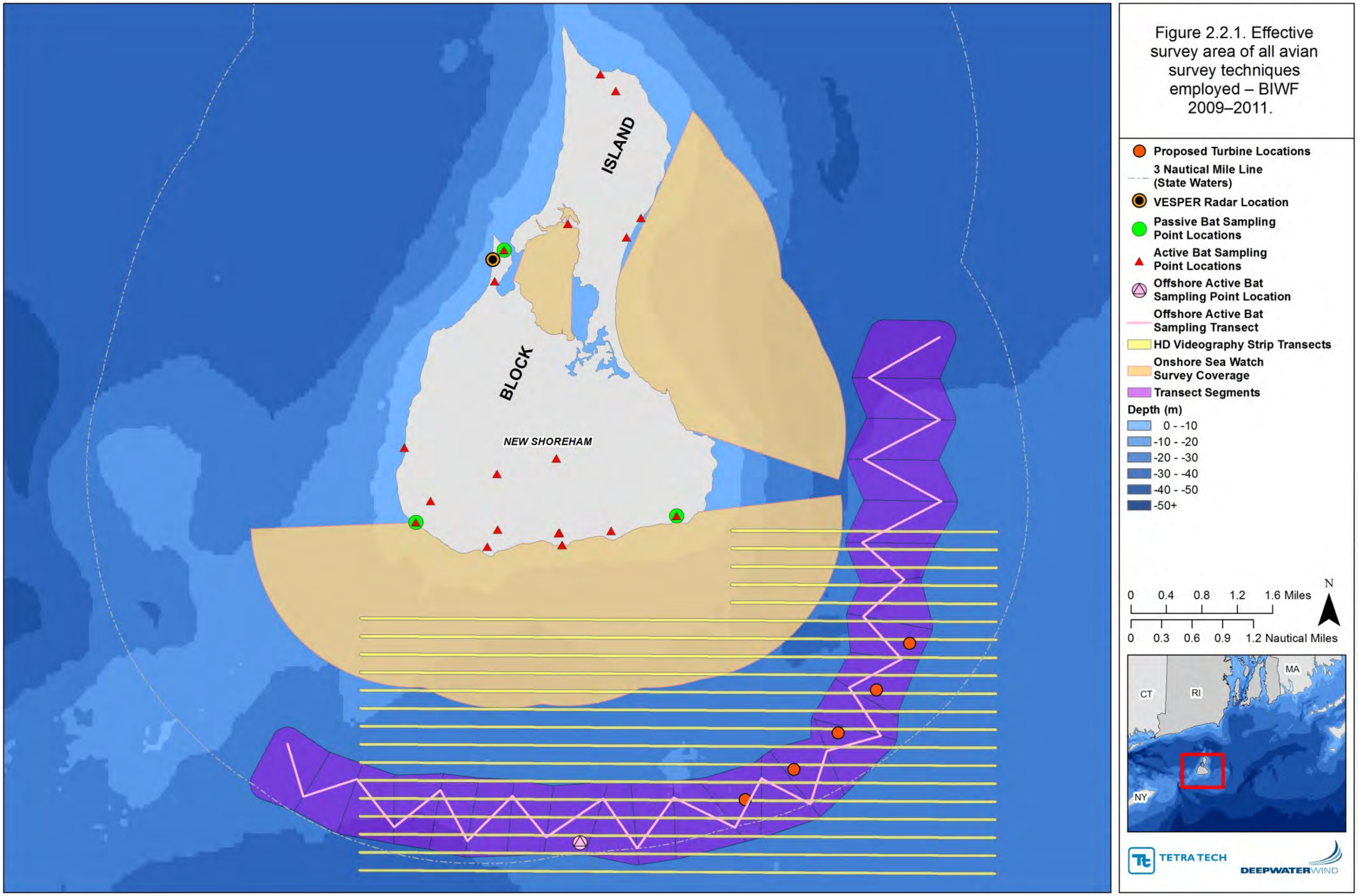


Figure 2.2.1. Effective survey area of all avian survey techniques employed – BIWF 2009–2011.

2.3 STUDY GOALS AND OBJECTIVES

The goal of this study was to collect baseline data on birds and bats that can be used to evaluate potential impacts resulting from the proposed BIWF project and to help comply with state and federal regulatory requirements. To achieve this goal, objectives were developed to ensure provision of the appropriate level of data and analyses needed to satisfy all state and federal environmental review processes including the Migratory Bird Treaty Act, the Endangered Species Act (ESA), and NEPA. Specific objectives identified for this study include:

1. Determine the general species composition of the avian and bat communities during both the summer and winter residency and spring and fall migration periods.
2. Estimate the overall encounter rate of individual bird and bat species within the Study Area, as well as the encounter rate of species groups.
3. Identify both the spatial and temporal distribution patterns, including flight ecology, of the avian and bat communities within the Study Area.
4. Identify and evaluate the spatial and temporal use of the Study Area by both state and federal rare, threatened, and endangered (RTE) species.
5. Perform a qualitative risk assessment.

2.4 REVIEW OF EXISTING DATA AND LITERATURE

Prior to initiating the avian and bat field investigations Deepwater completed a review of existing data, research, and literature to better understand the avian and bat community in the Study Area and surrounding region. A review of existing information helped provide a foundation for characterizing the bird and bat assemblages in the region and helped identify data gaps where additional site-specific information was necessary.

2.4.1 AVIAN ECOLOGY AND DISTRIBUTION

Detailed maps on seasonal and geographic ranges of avian species in and around Rhode Island Sound were reviewed in Proctor and Lynch (2005), Onley and Scofield (2007), Leslie (2008), and Poole (2005). In 2009–2010 as part of the RI Ocean SAMP study Paton, Winiarski et al. (2010 and 2011) conducted in-depth avian surveys of Rhode Island Sound, Block Island Sound, and the Inner Continental Shelf using boat-based, land-based, and aerial survey methodologies. The Paton, Winiarski et al. (2010) interim report provides a thorough review and analysis of published and unpublished historical data from the region as well as specific results from the avian portion of the RI Ocean SAMP study.

Prior to Paton, Winiarski et al. (2010 and 2011) most surveys, with the exception of some performed prior to 1990, in and around Rhode Island Sound focused on avian species in nearshore habitats. Therefore the nearshore seasonal variation and abundance patterns in the Rhode Island Sound region are well understood; there remains, however, a general lack of basic data on birds in offshore waters (Paton, Winiarski et al. 2010). According to Paton, Winiarski et al. (2010 and 2011) only two systematic offshore avian surveys of the area were performed before 2009. These studies were conducted by the National Marine Fisheries Service (NMFS) in 1978 and 1979 (Powers 1983) and the Cetacean and Seabird Assessment Program (CSAP) from 1978 to 1988 (Manomet Bird Observatory [MBO] 1988). Unfortunately an effective comparison cannot be made between the NMFS and CSAP studies and the more recent RI Ocean SAMP and BIWF studies due to inconsistencies in the level of effort and study boundaries of the early studies, and dissimilar survey methods (Paton, Winiarski et al. 2010). However, the general patterns of species occurrence (21 total avian species were encountered during the NMFS study, and 34 total species during CSAP) and seasonal distribution of birds in the NMFS and CSAP study areas do provide some perspective on historical patterns of avian occurrence (Powers 1983, MBO 1988). A holistic assessment of the existing data on avian occurrence patterns in the greater Rhode Island Sound region must be centered on the results of the RI Ocean SAMP data. The following is an overview of the RI Ocean SAMP avian survey results and an introduction to the avifauna of the BIWF Study Area and greater RI Ocean SAMP study area.

Results from the RI Ocean SAMP study (Paton, Winiarski et al. 2010), which included a review of historical data, show that the nearshore and offshore waters of Rhode Island Sound, Block Island Sound, and the Inner Continental Shelf provide important avian habitat throughout the year. Paton, Winiarski et al. (2010) reported that nearshore areas with shallow waters support a variety of species including terns, gulls, and shorebirds during summer, and seaducks, loons, and alcids (primarily razorbill) during winter. A total of 796 land-based surveys were conducted for the RI Ocean SAMP study, which documented a total of 465,039 individual birds representing 121 species. The volume of birds observed nearshore during the land-based RI Ocean SAMP study suggests that the shallow waters of nearshore areas provide vital habitat to possibly millions of migratory birds during some part of their annual cycle (Paton, Winiarski et al. 2010).

A total of 54 boat-based surveys were also conducted as part of the RI Ocean SAMP study, which documented a total of 13,170 individual birds representing 56 species (Paton, Winiarski et al. 2010). Great black-backed gulls and herring gulls were the most frequently observed species during the boat-based SAMP surveys, although detections of common loon, Wilson's storm-petrel, Cory's shearwater, and gannets were also common. Seasonally, boat-based surveys documented 24 avian species during summer, 29 species during fall, and 21 species during winter in the SAMP study area. These data suggest that species diversity increases during periods of migration and as birds arrive to overwinter in the area. This is supported by the large numbers of wintering waterfowl, loons, and gannets in the RI Ocean SAMP dataset.

Large concentrations of birds occur offshore as winter residents. Data from year-round RI Ocean SAMP surveys show that species such as loons, grebes, gannets, seaducks, alcids, and certain gulls occur in the greatest concentrations during winter. Spring and fall migrations bring numerous migrant species through the area in large concentrations, many of which spend the summer in the region including shearwaters, storm-petrels, jaegers, and terns. Additionally, large numbers of waterfowl and shorebirds move through the area during spring and fall migration.

Although nearshore areas provide habitat for a greater diversity of species, certain species such as gannets, shearwaters, storm-petrels, and alcids regularly occur primarily in deeper offshore waters (Paton, Winiarski et al. 2010). Some species such as loons (Gaviiformes), grebes (Podicipiformes), and waterfowl (Anseriformes) are dependent on the ocean only during portions of their annual cycles, while three orders of seabirds (Charadriiformes, Procellariiformes, and Pelecaniiformes) are specifically adapted to depend on the ocean for food year round. These pelagic seabird species only come to shore during breeding and nesting periods (Schreiber and Chovan 1986). Seabirds are adapted to forage on specific ecological niches and these adaptations are apparent in their individual physical characteristics such as body mass, bill shape, and wing area (Spear and Ainley 1997, 1998). Some seabirds forage on the ocean surface (storm-petrels) while others dive to variable depths for prey (such as alcids and loons).

Avian distribution over the ocean is closely associated with forage timing and location; distribution can be patchy and is influenced by factors such as water temperatures, depth, currents, upwellings, wind direction, and ocean floor topography (Spear and Ainley 1997, Fauchald et al. 2002)(Elphick 2007).

Paton, Winiarski et al. (2010) reported variable flight heights, with many observations of birds flying below 25 m (82 ft). Gulls, gannets, and loons were observed flying above 25 m (82 ft) more frequently than other species. Flight altitudes can be variable depending on weather conditions, season, and species (Kerlinger 2009).

Avian Species and Flight Ecology

Loons (Gaviidae) occurred in large concentrations in the RI Ocean SAMP study area during winter, generally from October to May. Paton, Winiarski et al. (2010) estimated that during the winter, the Ocean SAMP area supports the equivalent of 54% of the breeding population of loons in the northeast. During spring (April and May) and fall (October and November), loons that winter further south of the SAMP study area pass through during migration to and from breeding areas (Paton, Winiarski et al. 2010). Two species regularly occur in the region: common loon and red-throated loon (Proctor and Lynch 2005). During the RI Ocean SAMP study, loons primarily used the area during December and January. Almost half of the loons Paton, Winiarski et al. (2010) observed were flying below 10 m (33 ft), with 9% flying above 25 m (82 ft) and 1% flying over 125 m (410 ft). Higher flight altitudes were determined to be associated with migratory movements (Paton, Winiarski et al. 2010). Loons generally concentrated <10 km (6.2 miles [mi]) from shore and preferred water <20 m (66 ft) deep for foraging, though this species can occur much further offshore depending on the availability of prey fish and weather conditions (Daub 1989). Loons molt during winter, and for a period usually between February and April they are completely flightless as their wing feathers are replaced (Howell 2010). Paton, Winiarski et al. (2010) indicated that loons moved further offshore as winter progressed. These data suggest that loons spend winter foraging mainly in nearshore areas and then move further offshore as flight feathers are replaced. Data from telemetry studies show that loon populations from New York winter off the coast of Massachusetts, Rhode Island, and New Jersey, while loons from Maine and New Hampshire generally winter in the Gulf of Maine.

During the RI Ocean SAMP surveys two species of grebes (Podicipedidae), horned grebe and red-necked grebe, were observed almost exclusively in nearshore areas during winter months. Grebe detections peaked in March suggesting that individuals wintering further south migrate through the study area during spring to breeding lakes in the north (Paton, Winiarski et al. 2010). Only two red-necked grebes were seen during boat-based SAMP surveys, and although grebes were not frequently observed in flight, those that were flew below 10 m (33 ft). Both grebe species are nocturnal migrants, and red-necked grebes flying over water tend to fly at lower altitudes during the day than at night.

Shearwaters (Procellariidae) occur in the area during summer months (Proctor and Lynch 2005). The RI Ocean SAMP study documented a total of four species of shearwater: Manx shearwater, sooty shearwater, greater shearwater, and Cory’s shearwater. Cory’s, greater, and sooty shearwaters breed in the southern hemisphere and only occur in the study area during their non-breeding “winter” (Paton, Winiarski et al. 2010). During the RI Ocean SAMP surveys, Cory’s and greater shearwaters were more abundant than Manx and sooty shearwaters. Cory’s shearwater was more likely to venture into nearshore waters and was the only shearwater species regularly detected during the land-based SAMP surveys. Paton, Winiarski et al. (2010) recorded higher densities of Cory’s and greater shearwaters in south-central Rhode Island Sound and over the Inner Continental Shelf. During the RI Ocean SAMP surveys all shearwaters were observed flying below 10 m (33 ft). Low flight altitudes are common among shearwaters because they are adapted to using air currents near the water's surface for efficient dynamic soaring flight (Sibley 2001).

Storm-petrels (Hydrobatidae) occur in the area during the summer. Two species of storm-petrel, Wilson's storm-petrel and Leach's storm-petrel, were recorded during the RI Ocean SAMP study. Wilson's was commonly observed, while observations of Leach's were less common and only happened during land-based surveys. All storm-petrels detected during the Ocean SAMP surveys were flying below 10 m (33 ft). Low flight altitudes are also common in storm-petrels because they forage by pattering on the ocean surface (Sibley 2001). Paton, Winiarski et al. (2010) estimated that, annually, tens of thousands of shearwaters and storm-petrels migrate through and forage in the area during their annual cycles. Shearwaters and storm-petrels were the most commonly observed species (following gulls) in both the NMFS and CSAP studies, though more frequent observations of species that are common in summer months would be expected because these studies conducted more surveys during summer months (Paton, Winiarski et al. 2010).

Paton, Winiarski et al. (2010) frequently encountered northern gannets in the area during winter. Paton, Winiarski et al. (2010) also found that gannets used both nearshore and offshore areas extensively in April, May, November, and December during migration. The species is entirely pelagic during the non-breeding season (Mowbray 2002). The highest gannet densities during fall and winter in the RI Ocean SAMP area were recorded 4 km (2.5 mi) off the south shore of mainland Rhode Island and around Block Island, as well as from the edge of Block Canyon extending southwest to the Inner Continental Shelf (Paton, Winiarski et al. 2010). Additionally, gannets tended to be found in waters greater than 30 m (98 ft) deep (Paton, Winiarski et al. 2010). During the RI Ocean SAMP surveys, the majority (54%) of gannets were observed flying below 10 m (33 ft), with 36% flying between 10 and 25 m (33 and 82 ft), and 10% flying between 25 and 125 m (82 and 410 ft). Gannets forage by diving from heights of up to 40 m (131 ft) to catch surface-schooling fish (Mowbray 2002). During the RI Ocean SAMP surveys this plunge-diving foraging behavior likely contributed to the variable flight altitudes recorded.

Two species of cormorants (Phalacrocoracidae) occur in the area: double-crested cormorant, which is considered common from April to October, and great-crested cormorant, which is considered less common overall and typically occurs from November to March (Paton, Winiarski et al. 2010). During the RI Ocean SAMP surveys 81% of observed cormorants flew below 10 m (33 ft). Paton, Winiarski et al. (2010) noted that cormorants tended to fly lower (<15 m [49 ft]) during local movements, and fly higher (>100 m [328 ft]) and in formation during migratory flights or over land. Both double-crested and great cormorants spend much of their time roosting and preening out of the water, are generally found less than 5 km (3 mi) from shore, and tend to forage in open water less than 8 m (26 ft) deep.

Historical datasets indicated that seaducks and diving ducks (Anatidae) were present throughout the year and were generally most abundant from November to April, although some first year and non-breeding seaducks stayed in the area during the summer (Paton, Winiarski et al. 2010). During fall migration seaducks began to arrive in the area in October and November. Spring migration showed an influx of seaducks in February with peak numbers observed in March. During the RI Ocean SAMP study, seaducks were the most commonly observed birds in winter, with the greatest densities recorded from November to March. The RI Ocean SAMP study documented a total of nine seaduck species: common eider, king eider, long-tailed duck, white-winged scoter, surf scoter, black scoter, common goldeneye, bufflehead, and red-breasted merganser. The most frequently encountered seaduck species were common eider, surf scoter, and black scoter, while observations of king eider and long-tailed duck were uncommon. Goldeneyes, buffleheads, and mergansers were rarely observed during the Ocean SAMP boat-based surveys, with most detections occurring close to shore during land-based surveys.

During the RI Ocean SAMP surveys the majority of seaduck observations occurred in nearshore and shallow water areas. Seaducks sightings were too infrequent during offshore boat-based surveys to be useful for estimating population size. Paton, Winiarski et al. (2010) also found that seaducks in the study area tend to forage and roost in different areas with offshore movements occurring around sunrise and sunset. While seaducks can roost in deeper waters, little is known about specific seaduck roosting locations in Rhode Island (Paton, Winiarski et al. 2010). Based on literature reviews, the optimum water depth for seaduck foraging was estimated to be <20 m (66 ft) (Paton, Winiarski et al. 2010). These data show that nearshore areas provide shallower waters for favorable seaduck foraging. The majority of seaducks observed during the RI Ocean SAMP study were flying below 10 m (33 ft). Seaducks generally fly below 15 m (49 ft) but are known to fly at higher altitudes during migration, over land, and to roost (Paton, Winiarski et al. 2010).

Other species of waterfowl (Anatidae) such as dabbling ducks, geese, and swans were commonly observed during migration and may be abundant seasonally during spring and fall migration in nearshore areas; these species were rarely observed during the RI Ocean SAMP boat-based surveys in offshore areas.

Shorebirds (Charadriidae and Scolopacidae) occurred in the area mainly during summer and also moved through the area during spring and fall migration. Peaks in shorebird migration occurred from August through September and again in May and June (Paton, Winiarski et al. 2010). Three species are winter residents: purple sandpiper, sanderling, and dunlin. Paton, Winiarski et al. (2010) observed relatively few shorebirds during boat-based surveys with the majority of observations occurring in nearshore, intertidal habitats. A total of 19 species of shorebirds were documented across the RI Ocean SAMP surveys; however, only six shorebird species were detected during the SAMP boat-based surveys: semipalmated plover, lesser yellowlegs, whimbrel, purple sandpiper, short-billed dowitcher, and red-necked phalarope. Red-necked phalaropes are pelagic specialists for much of their annual life cycle and are considered common in the area during late summer and early fall (Paton, Winiarski et al. 2010). Phalaropes were only documented over the Inner Continental Shelf during the offshore SAMP boat-based surveys. Most shorebird concentrations were observed in nearshore areas where there is foraging habitat in intertidal areas. During the RI Ocean SAMP study the majority of shorebirds (87%) were observed flying below 10 m (33 ft), with 9% flying 10–25 m (33–82 ft), and 4% flying 25–125 m (82–410 ft). Although detections of shorebirds offshore were too infrequent to estimate abundance, it is likely that large numbers migrate over the Ocean SAMP study area (Paton, Winiarski et al. 2010).

Three species of jaeger (Laridae, subfamily Stercorarius) were documented during the RI Ocean SAMP surveys: pomarine jaeger, parasitic jaeger, and long-tailed jaeger. Jaegers were mostly observed nearshore during land-based surveys. Only three jaegers, one of each species, were recorded during boat-based surveys. Jaegers were documented migrating through the area from May through October (Paton, Winiarski et al. 2010). During the RI Ocean SAMP surveys, jaeger flight altitudes were variable, with the majority (70%) flying <10 m (33 ft), 13% flying 10–25 m (33–82 ft), and 17% flying 25–125 m (82–410 ft).

Although there are over 15 gull species (Laridae, subfamily Larinae) that could possibly occur within the Ocean SAMP area, many are rare. Herring gull and great black-backed gull are the most common, year-round residents and were the most commonly observed species during the RI Ocean SAMP study, with peak numbers observed in March (Paton, Winiarski et al. 2010, Proctor and Lynch 2005). These species exhibited a more limited distribution in the area during the summer breeding season, with fall dispersal to offshore habitats causing lower numbers to be observed during winter. Additionally, herring and great black-backed gull distribution was often closely associated with the presence of commercial fishing vessels (Paton, Winiarski et al. 2010). Laughing gull and ring-billed gull occurred during spring and fall migration, while black-legged kittiwake and Bonaparte's gull occurred during winter. During the RI Ocean SAMP surveys observations of these species peaked in October. While gull flights varied in altitude, the majority (58%) were observed flying below 10 m (33 ft), with 30% flying 10–25 m (33–82 ft), and 12% flying 25–125 m (82–410 ft) above the water.

Terns (Laridae, subfamily Sterninae) occurred in the RI Ocean SAMP study area during summer and also moved through the area during spring and fall migration. A total of seven species of tern were documented during the Ocean SAMP during land-based surveys: Caspian tern, royal tern, common tern, Forster's tern, roseate tern, least tern, and black tern. Paton, Winiarski et al. (2010) observed relatively few terns during boat-based surveys, with the majority of observations occurring in nearshore habitats and the greatest numbers recorded during the post-breeding season in early August (Paton, Winiarski et al. 2010). Across the RI Ocean SAMP surveys 94% of terns observed in flight were flying below 25 m (82 ft). Only two of these tern species, the common and roseate tern, were detected during the SAMP boat-based surveys. A total of eight roseate terns were observed: four were seen near Pt. Judith, three were observed approximately 10 km (3.9 mi) northwest of Block Island, and one individual was recorded approximately 7 km (2.8 mi) south of Block Island. All roseate terns were recorded from mid-July to late-August (Paton, Winiarski et al. 2010), which suggests that roseate terns likely move through the area in late summer during the post-breeding season.

One species of skimmer (Laridae, subfamily Rynchopidae), black skimmer, was documented during the RI Ocean SAMP study. This species was uncommon in the area, with only three observations in September during land-based RI Ocean SAMP surveys.

Six species of alcids (Alcidae) occur off the coast of Rhode Island during winter (Proctor and Lynch 2005): razorbill, common murre, thick-billed murre, dovekie, black guillemot, and Atlantic puffin. Both the NMFS and CSAP studies rarely detected alcids, probably because their winter survey efforts were limited (Paton, Winiarski et al. 2010). However, alcids were commonly detected during the SAMP study, with all six species recorded during SAMP land-based surveys and all but one, black guillemot, detected during the boat-based surveys. Alcids occurred in the area from December to mid-March, with peak numbers recorded in January. Paton, Winiarski et al. (2010) found that alcids preferred deeper waters (>30 m [98 ft]). Razorbills, common murres, and dovekies were the most commonly observed alcid species during the RI Ocean SAMP study. Data from Paton, Winiarski et al. (2010) showed the greatest density estimates for razorbills in the northern edge of the study area and south of Block Island in shallower waters. Common murres tended to be concentrated in the middle of the RI Ocean SAMP study area in areas with slightly deeper water, with high densities estimated north of Block Island and across the middle sections of Rhode Island Sound. Dovekies occurred in deeper water sections of Rhode Island Sound and the Inner Continental Shelf, where densities can be much higher than any of the other alcids in the region (Paton, Winiarski et al. 2010). The other three species were not detected frequently enough during the RI Ocean SAMP surveys to estimate population densities. All alcids detected during the RI Ocean SAMP surveys were observed flying below 10 m (33 ft); it is common for alcids to fly low over the surface of the ocean due to the morphology of their wings (Sibley 2001).

Other avian species considered to be landbirds were rarely documented offshore during the RI Ocean SAMP boat-based surveys. These species included mourning dove, blackpoll warbler, yellow-rumped warbler, bank swallow, tree swallow, dark-eyed junco, savannah sparrow, and snow bunting. Large numbers of landbirds were observed during the RI Ocean SAMP land-based surveys, though these observations were concentrated near terrestrial and nearshore areas.

2.4.2 BAT SPECIES AND DISTRIBUTION

No publically available information was found on the distribution of bats over open water in Rhode Island Sound. The BIWF studies and the RI Ocean SAMP studies appear to be the first systematic assessments of bat occurrence on Block Island. Additionally, the offshore portion of the BIWF bat acoustic monitoring surveys were the first such surveys performed in the region.

Smith and McWilliams' (2011) avian and bat acoustic surveys, performed as part of the RI Ocean SAMP and nearly concurrent with the BIWF studies, were the first attempt at a systematic assessment of the region's bats; they provide excellent information on the relative species richness and temporal patterns of bat activity in the late-summer and early fall migration period on Block Island. Their acoustic monitoring results showed that Block Island was used by long-distance migratory tree roosting bats, including hoary bat, silver-haired bat, and eastern red bat. Other non-migratory bats, such as big brown bat and tri-colored bat, were also positively identified in the recordings. Smith and McWilliams (2011) recorded a number of potential myotis species; however, the exact species composition of these myotis call sequences is uncertain. Smith and McWilliams allude to the likelihood of eastern small-footed myotis occurrence, though there is arguably some difficulty in accurately distinguishing between myotis species in the dataset. Smith and McWilliams also allude to the possibility that Indiana bat occurs in Rhode Island. Although this is possible, it could be asserted that the habitat available in Rhode Island, and on Block Island in particular, is not suitable for Indiana bat, and that the distance from known Indiana bat hibernacula (the closest of which is in southern New York) is too great for there to be any established Indiana bat populations in the Rhode Island area. The effects of white-nosed syndrome have caused the collapse of many Indiana bat populations, which would make future range expansion unlikely.

2.5 RATIONALE FOR SELECTED SURVEY AND ANALYSIS TECHNIQUES

Survey and analysis techniques were selected to achieve each of the study objectives outlined in Section 2.3 including identification of species composition, phenology, and flight ecology of both birds and bats within the Study Area (Table 2.5.1). Modeled after studies performed in the United States and Europe the surveys offer both time-tested methods of onshore and offshore point counts, coupled with cutting edge technology like the MERLIN and VESPER radar units. This combined use of proven technology and emerging technology provided a complete image of avian and bat resources in the Study Area.

The methods chosen included standard onshore sea watch point counts, boat-based strip transects, acoustic monitoring, vertical and horizontal radar, and Next Generation Weather Radar (NEXRAD) data analysis. Point count and transect surveys enabled the identification of bird species and usage patterns, while the radar studies allowed for more in-depth counts and flight height investigations. The avian and bat acoustic monitoring provided species and/or species group identification of nocturnal migrants and bats. The NEXRAD analysis was employed to support and supplement the on-site radar study and to gain a regional perspective.

Several of the avian survey techniques implemented met similar objectives. Both point count surveys and the radar study provided information on abundance and flight heights; since radar cannot identify species and point counts overlook nocturnal movements, the two studies collectively allowed a robust measure of abundance during all time periods, including counts of individual species during the day. Both acoustic monitoring and point counts provided information on species identification, and acoustic monitoring also enabled detection of nocturnal migrants (diurnal point count surveys did not). Thus, this range of carefully selected survey methods ensured complete coverage and robust characterization of the avian community.

Table 2.5.1. Survey methods and the type of information each provided during the 2009–2011 avian and bat survey program – BIWF 2009–2011.

Survey Technique	Species Identification	Spatial Distribution	Temporal Distribution	Flight Ecology
Onshore Sea Watch Visual Surveys	X (day)	X	X	X
Onshore Raptor Migration Surveys	X	X	X	X
Bat Acoustic Monitoring	X (typically species groups or guilds)	X	X	X
Offshore Boat-Based Avian Surveys	X (day)	X	X	X
Avian Acoustic Monitoring	X (night)	X	X	
Offshore Aerial HD Videographic Survey	X	X	X	
DeTect MERLIN X-S Radar Survey		X	X	X
VESPER Vertical Fixed-beam Radar		X	X	X

The methods used to evaluate the bat community included both passive and active acoustic monitoring. Passive bat monitoring enabled a continuous sample of bat activity and provided insight on species presence and spatial and temporal distribution. Active bat monitoring allowed collection of bat data both onshore and offshore in the Study Area, and it sampled a wider range of habitats on Block Island.

The following sections (2.5.1–2.5.12) provide a more detailed overview and rationale for each survey method chosen.

2.5.1 Onshore Sea Watch Avian Surveys

The purpose of the onshore surveys was to collect data on avian species composition, abundance, and temporal and spatial distribution on both the island and within the nearshore portion of the Study Area. The onshore surveys also supported the MERLIN radar ground truthing effort by providing validation of the radar operation and species identification for targets detected.

2.5.2 Onshore Raptor Migration Surveys

Raptor surveys were conducted to provide specific information on this avian group during key migration periods. The raptor migration surveys documented species composition and temporal and spatial distribution of raptors during the fall and spring migration seasons. Because raptors are generally surveyed using a standardized protocol, the Hawk Migration Association of North America (HMANA) survey method was used for this study, which allowed for direct comparison of the raptor survey results with other regional or national hawk watch sites to evaluate the relative degree of use by these species.

2.5.3 Passive Bat Acoustic Monitoring

In spring 2009, passive bat acoustic monitoring was initiated in order to assess bat occurrence on the island and to identify the characteristics of the bat community present. Passive bat acoustic monitoring efforts continued through summer and fall 2009 and resumed in spring 2010. Results from the 2009–2010 surveys are presented in Section 4.3.1.

2.5.4 Active Bat Acoustic Monitoring

In 2009 and 2011 active onshore and offshore bat acoustic monitoring surveys were initiated to collect data on species composition and levels of activity on the island and in the offshore portion of the Study Area. Results from the summer and fall 2009 and 2010 surveys are presented in Section 4.3.2.

2.5.5 Avian Acoustic Monitoring

Though some birds are diurnal migrants, most migrate at night (Kerlinger 2009). The Neotropical passerines are the largest group of nocturnal avian migrants. Approximately 200 species of the more than 700 species of North American birds are known to give flight calls during night migration, with approximately 150 of these species' calls distinctive enough to differentiate among (Evans 2000). It is thought that calling may help birds maintain organization and spacing, minimizing collisions among themselves and with other objects (Evans 1999). These flight calls are more simplistic than territorial songs and usually consist of a single "chip" note. These "chip" notes are often species specific, and when compared to known flight call libraries, the family, genus, and even species identity of the caller is sometimes distinguishable (Evans 1994, 1999). Therefore, employing acoustic monitoring as a tool for the BIWF study enabled Deepwater to evaluate nocturnal migrants, a frequently overlooked group.

2.5.6 Offshore Boat-Based Avian Surveys

The purpose of the offshore boat-based surveys was to document avian migration patterns, diversity, flight ecology, and phenology directly within the Study Area, including at the site of the proposed turbine locations. Boat-based surveys also provided opportunities to document the occurrence of any RTE species in the offshore portion of the Study Area. This type of baseline information on migrant and resident birds can be important for assessing the potential impacts of collision, displacement, and/or barriers to movement posed by offshore wind development (Drewitt and Langston 2006).

2.5.7 Offshore Aerial High Definition Videography

Aerial high definition (HD) videography is an innovative technology with applications for wildlife assessments. Similar to traditional aerial surveys, the HD aerial surveys are intended to assess the distribution and abundance of birds within a study area, and they can also provide information on species diversity and spatial and temporal occurrence patterns. However, the technology is particularly effective at assessing avian distribution and abundance because videography can, under optimal conditions, record the presence of all birds on or above the surface of the water. In addition, aerial surveys, and HD aerial surveys in particular, are well suited to the marine environment because of the ease of canvasing large areas quickly and accurately. Aerial HD videography is in the preliminary stages of implementation; the technology has recently been applied to seabird and seaduck assessments at proposed offshore wind development sites, primarily in Europe, with limited numbers of surveys conducted in the United Kingdom (UK) by Collaborative Offshore Wind Research into the Environment Ltd (COWRIE), HiDef Aerial Surveying Ltd., and APEM Ltd. The full-scale COWRIE surveys demonstrated that the technique produced statistically significant results and accurate assessments of seabird and seaduck populations at a proposed offshore wind energy project off the UK coast. Results of these surveys also provided some initial guidelines for HD aerial videography survey techniques, which were developed over the course of a series of trial flights and full-scale surveys (Mellor et al. 2007, Mellor and Maher 2008). The COWRIE surveys provided fine-tuned camera settings and flight heights and determined optimal parameters for all aspects of the survey methodologies. These parameters were adjusted slightly to accommodate the lower airspeed of the helicopter used in the BIWF Study Area.

Aerial HD videography surveys were conducted in the BIWF Study Area because the study objectives and avian community were deemed to be similar to the COWRIE study objectives and avian community. It was determined that this survey technique would likely produce unique information pertinent to assessing the area’s baseline avian community. The objective of these surveys was to quantify avian species occurrence and distribution in the Study Area and adjacent waters. Specifically, the BIWF HD aerial surveys were designed to provide information on the spatial distribution and abundance of summer residents, fall migrants, wintering residents, and spring migrants in the offshore portions of the BIWF Study Area including where the wind turbine generators (WTGs), inter-array cable, and export cable are proposed. A secondary objective of the survey was to assess the effectiveness of the aerial HD videography technique (in comparison with boat-based visual surveys) as a viable and robust method of sampling avian populations at proposed offshore wind development sites. To meet that objective, ground truthing visual observation surveys (either onshore or offshore) were conducted concurrent to the aerial videography surveys during full-scale survey flights.

2.5.8 MERLIN Radar

The MERLIN radar surveys provided near continuous, 24-hours per day surveillance of biological target (birds and bats) movements in the Study Area. The system’s dual radars, vertical and horizontal, allowed for multiple "zones" of the Study Area to be subsampled and compared. Target passage rates (TPR), flight heights, and flight directions were extracted from the MERLIN system's database.

2.5.9 MERLIN Radar Ground Truthing

During the initial two months of MERLIN data collection in the Study Area it was deemed necessary to assess the functionality of the radar system; thus, visual ground truthing surveys were undertaken to refine the radar settings and determine the actual (opposed to the conceptual) radar coverage area. The data collected during these surveys are also useful as stand-alone information on avian activity.

2.5.10 VESPER Radar

The VESPER radar is a vertical profiling radar system that has recently been developed by DeTect, Inc. (DeTect) (Panama City, Florida). VESPER was deployed for two reasons: (1) to provide fine grained data on the movement of biological targets above Block Island, and (2) to assess the viability of the system for potential future offshore wind pre-construction monitoring surveys on offshore platforms.

2.5.11 VESPER Radar Ground Truthing

Despite confidence in the effectiveness of the radar, the VESPER system is a new technology; thus, it felt necessary to gather supplemental infrared videography data from the lower portions of the VESPER's coverage area. The infrared video and VESPER system operated concurrently.

2.5.12 NEXRAD Assessment

Tetra Tech and DeTect conducted an Avian Radar Prescreening Assessment (the assessment) of the proposed Block Island Wind Farm project site offshore the Rhode Island coast, southeasr of Block Island. The purpose of this assessment was to develop a preliminary determination of historic levels of bird activity in the area of the Northeast Atlantic coast using archived radar data. This assessment did not include a site visit and was limited to assessment of only the data sources identified in this report. Further the remote sensing and data sources utilized in this assessment provide only broad altitude distribution information and do not present bird distribution data by specific altitude levels.

2.5.13 Species Grouping

Species groups (or guilds) for avian surveys where speciation was possible (e.g., the onshore sea watch, onshore raptor migration, offshore boat-based, and offshore aerial high definition videography surveys) were based on phylogeny as well as life history. The diversity of species encountered, especially onshore, yielded a cumbersome dataset; therefore, it was decidedly more practical to focus the bulk of the analyses and discussions on species groups. To that end the species guilds employed by Paton, Winiarski et al. (2010) were incorporated into this study, with some adjustments for these analyses. The final species groups—used for each survey and found in the discussion and risk assessment sections—were determined by:

1. Abundance of the species (e.g., waterfowl were discussed separately because they were abundant and commonly observed across all surveys types)
2. Size of the species population (e.g., terns were treated as a separate group because while no roseate terns were encountered, conspecifics were, and there is likely some overlap in their phenology and ecology)

3. Relevance of each species group to various surveys (e.g., very few landbirds were observed offshore, so therefore it was not appropriate to present spatial distribution results, estimated densities, and so forth for that species group)

In general, the results of the surveys are presented in seven avian species groups: loons, waterfowl, shorebirds, gulls, terns, seabirds, and landbirds. An eighth group, raptors, is also discussed, primarily in the sections dedicated to the raptor migration surveys. Bats are treated as a separate group.

Two of the species groups, seabirds and landbirds, were not based solely on phylogeny. The seabird group included all species known to spend the majority of their lives at sea, other than waterfowl. This guild included shearwaters (*Procellariidae)*, Wilson's storm-petrel, as well as northern gannet (*Sulidae*) and all alcids (*Alcidae*). Although the grouping together of these species may initially appear awkward, the choice was made based on life history traits (i.e., all seabirds have solely pelagic and seasonal occurrence in the Study Area) as well as differences in flight behavior of the species included. The landbird group was based less on phylogeny than on ecology and spatial distribution. This guild included passerines as well as strictly terrestrial species observed during the onshore sea watch surveys, such as ring-necked pheasant.

3.0 METHODS

3.1 ONSHORE SEA WATCH AVIAN SURVEYS

Tetra Tech conducted onshore sea watch point count surveys from July 2009 through June 2010 to (1) document the occurrence of shorebirds, ducks, and seabirds, as well as passerines; and (2) assess the temporal and spatial use of coastal and nearshore waters of Block Island by avian species. The surveys also provided an opportunity to gather information on any RTE avian species that may occur in coastal and nearshore habitats of the BIWF Study Area. Federally endangered roseate terns (*Sterna dougallii*) are known to move through and forage in the nearshore and offshore waters of Rhode Island, while the federally threatened piping plover (*Charadrius melodus*) is known to nest on the north end of Block Island. Other special status species include American oystercatcher (*Haematopus palliatus*), upland sandpiper (*Bartramia longicauda*), and willet (*Tringa semipalmata*), which may use shoreline and nearshore waters for foraging and may migrate through offshore areas.

Standardized fixed-radius point count sea watch surveys were conducted from 10 point count stations (stations) on Block Island's southern and southeastern shorelines, as well as at the Great Salt Pond (Figure 3.1.1). Points were surveyed at least twice per month, and four times per month during April and September (survey effort was increased during April and September in order to more fully assess peak spring and fall migration activity along the Block Island coast). This also increased the likelihood of capturing statistically important migration events such as weather induced "fall-outs."

Although all observed species were recorded, the sea watch point counts were located in shoreline locations and designed to focus on migrant shorebirds, ducks, and seabirds. Surveys were conducted for 30 minutes at each point, during which time all birds seen or heard were recorded on standardized data sheets. Binoculars (10x42 millimeters [mm]) and spotting scopes (15–46x60 mm) were used to aid in sighting birds, and observers used field reference materials to confirm identification (Sibley 2000, Paulson 2005, Proctor and Lynch 2005, O'Brien et al. 2006). Sea watch surveys focused on the crepuscular periods of the day: dawn and dusk. During dawn surveys point counts began approximately one-half hour before sunrise, and during dusk surveys counts ended approximately one-half hour after the sunset. Points were surveyed during the morning and evening periods at an approximately equal frequency to avoid potential biases related to survey timing. Information on species, number of individuals, flight ecology, relative age (adult or juvenile), and behavior (foraging, direct flight, and perched on the ground or water) were recorded. For birds observed in flight, the vertical flight elevation above the ground or water was estimated and recorded in the following categories: <10 m (<33 ft), 10–25 m (33–82 ft), 26–125 m (85–410 ft), 126–200 m (413–656 ft), and >200 m (>656 ft). Bird observations were recorded in distance increments (bins) similar to those used in the RI Ocean SAMP sea watch surveys: 0–500 m (0–1,640 ft), 500–1,500 m (1,640–4,921 ft), and 1,500–3,000 m (4,921–9,843 ft); the maximum distance sampled was 3 km (1.9 mi) offshore, or less, as visibility permitted (Paton, Winiarski et al. 2010). Weather observations were recorded including ambient temperature, wind speed, wind direction, sea state (Douglas Sea Scale), and visibility.

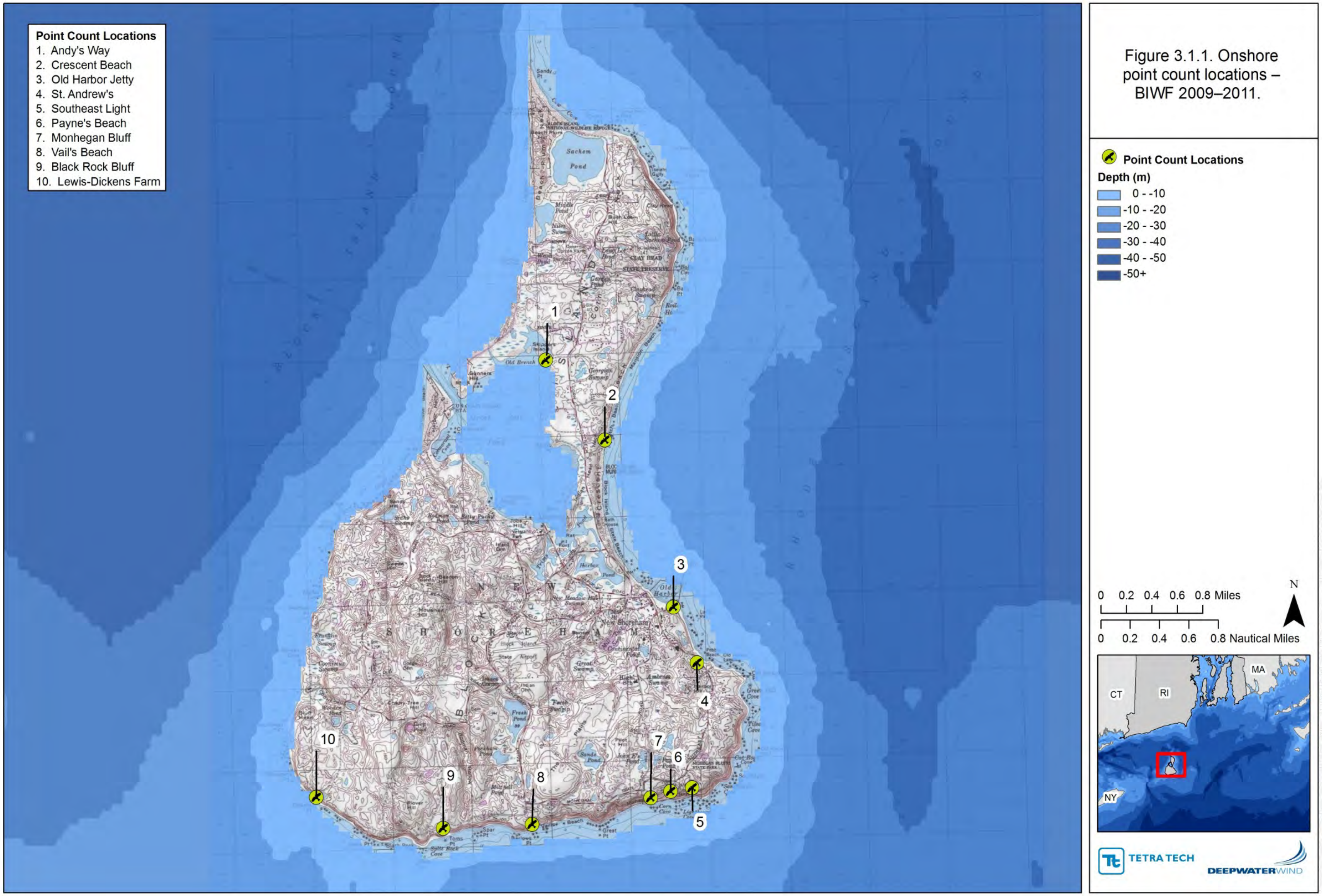


Figure 3.1.1. Onshore point count locations – BIWF 2009–2011.

In order to provide a representative sample of the coastal avian community onshore and just offshore of Block Island, point count locations were stratified spatially among available habitat types. Survey points were situated to provide an optimal amount of observable airspace. Ocean facing bluffs, sandy and rocky beaches, and tidal mudflats were surveyed. Five point count sites were located on bluff habitat stretching from Lewis-Dicken's Farm ("Point 10, Lewis Farm") on the west end of the island to the bluff near St. Andrew's parish house ("Point 4, St. Andrew's") on the eastern side of the island. Other bluff sites included Mohegan Bluff ("Point 7, Bluffs"), a bluff near Black Rock Point ("Point 9, Black Rock"), and Southeast Lighthouse Bluff ("Point 5, Southeast Light") along the southern coast (Figure 3.1.1).

Five point count sites were located in the intertidal zone and provided increased opportunities to observe shorebirds as well as seaducks and wading birds. These shoreline point count sites included Andy's Way beach on the northeast end of Great Salt Pond ("Point 1, Andy's Way"), Crescent Beach along the east central shoreline ("Point 2, Crescent Beach"), the jetty at Old Harbor ("Point 3, Old Harbor Jetty"), and points at Vail's Beach ("Point 8, Vail's Beach") and Payne's Beach ("Point 6, Payne's Beach") on the south central shoreline of the island. Panoramic photographs from each survey point are presented in Appendix A.

Tetra Tech calculated three different metrics of avian occurrence patterns: encounter rate (ER), frequency (temporal and spatial), and density. The variations among these metrics are useful for determining trends in bird activity at the proposed turbine locations and adjacent portions of the Study Area. The ER was calculated for each species and point count station. This rate was defined as the total number of individual birds observed per point count survey (birds/survey). As a metric of the number of individual birds detected per survey, the ER is not an estimate of density or population size. ER also serves as an indicator of the performance of the surveys and is an estimate of abundance during the sampling periods. Temporal frequency is the percentage of the surveys in which a bird species was observed. For example, black scoters (*Melanitta americana*) were observed during approximately one out of every three surveys; therefore the temporal frequency for black scoters was 34.4%. Spatial frequency is the percentage of transect segments (locations) at which a species was observed.

Tetra Tech calculated density (D) estimates for all observed bird species at each location, at all point count locations combined, and for each of five species groups (ducks and geese, seabirds, gulls, terns, shorebirds, and passerines). Tetra Tech recognizes that the inclusion of flying birds violates an assumption of the distance sampling methods outlined by Buckland et al. (1993); however, Tetra Tech assumed a 100% probability of detection of birds in flight (Pa = 1) within the effective point count survey area (a). The seaward portion of each point location was monitored, while the landward portion was ignored; therefore, the effective point count survey area (a) of each point count location was a semi-circle, with a maximum point count area of 14.1 square kilometers (km^2) (5.4 square miles [mi^2]) for each point count station (Figure 3.1.2). Each point count survey area was assumed to be uniform because each station was located on the shoreline at the same distance from the water, consequently providing a relatively similar view shed at each station (Figure 3.1.3). It was determined that topography and vegetation did not have a substantial effect on the view shed area of each point count station; line of sight to the sea was not obstructed at any of the 10 stations, allowing a 180 degree view of the ocean. However, to assure that estimates were accurate for each station a weighted average of the distance estimates for each bird observed (w) was used to calculate (a), the effective point count survey area.

Density estimates, for land-based point counts were thus calculated using the formula:

$$D = n / a$$

Where:

D = estimated density of birds (n/km^2)
n = number of birds observed within distance a
a = k ½ πw2 (k = total number of surveys, w = average distance of individuals observed)

This type of approach may overestimate relative densities; however, given the purpose of the surveys (i.e., to assess relative risk to avifauna from the proposed wind facility, and to provide baseline data on the existing avian community) an overestimation of density is not necessarily undesirable.

The goal was to determine relative avian density within the Study Area and along the Block Island coast in order to provide an indication and estimate of the maximum number of birds expected to occur on Block Island near each point count location and in the adjacent waters; there was no attempt to calculate regional population estimates for the species observed.

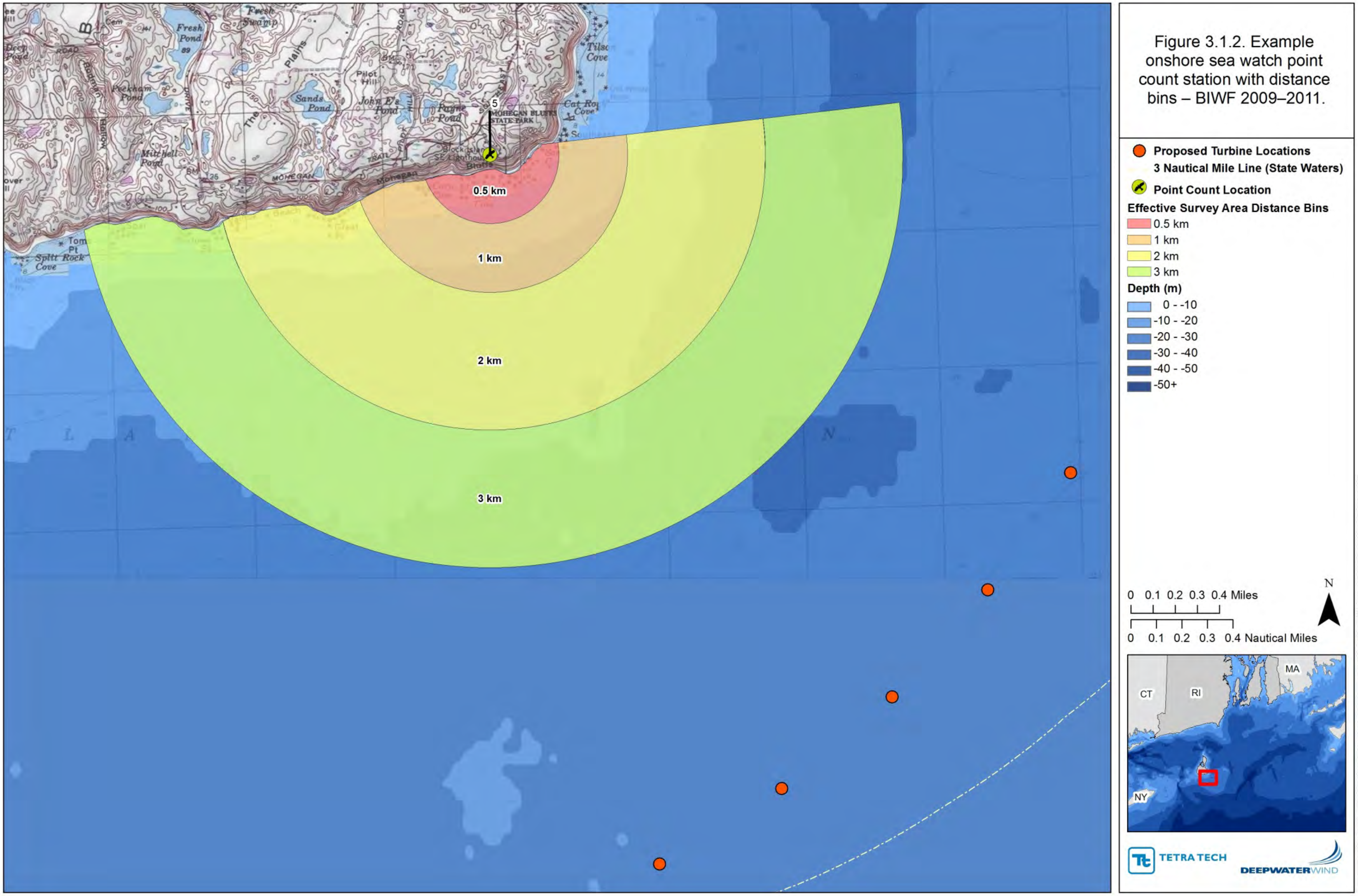


Figure 3.1.2. Example onshore sea watch point count station with distance bins – BIWF 2009–2011.

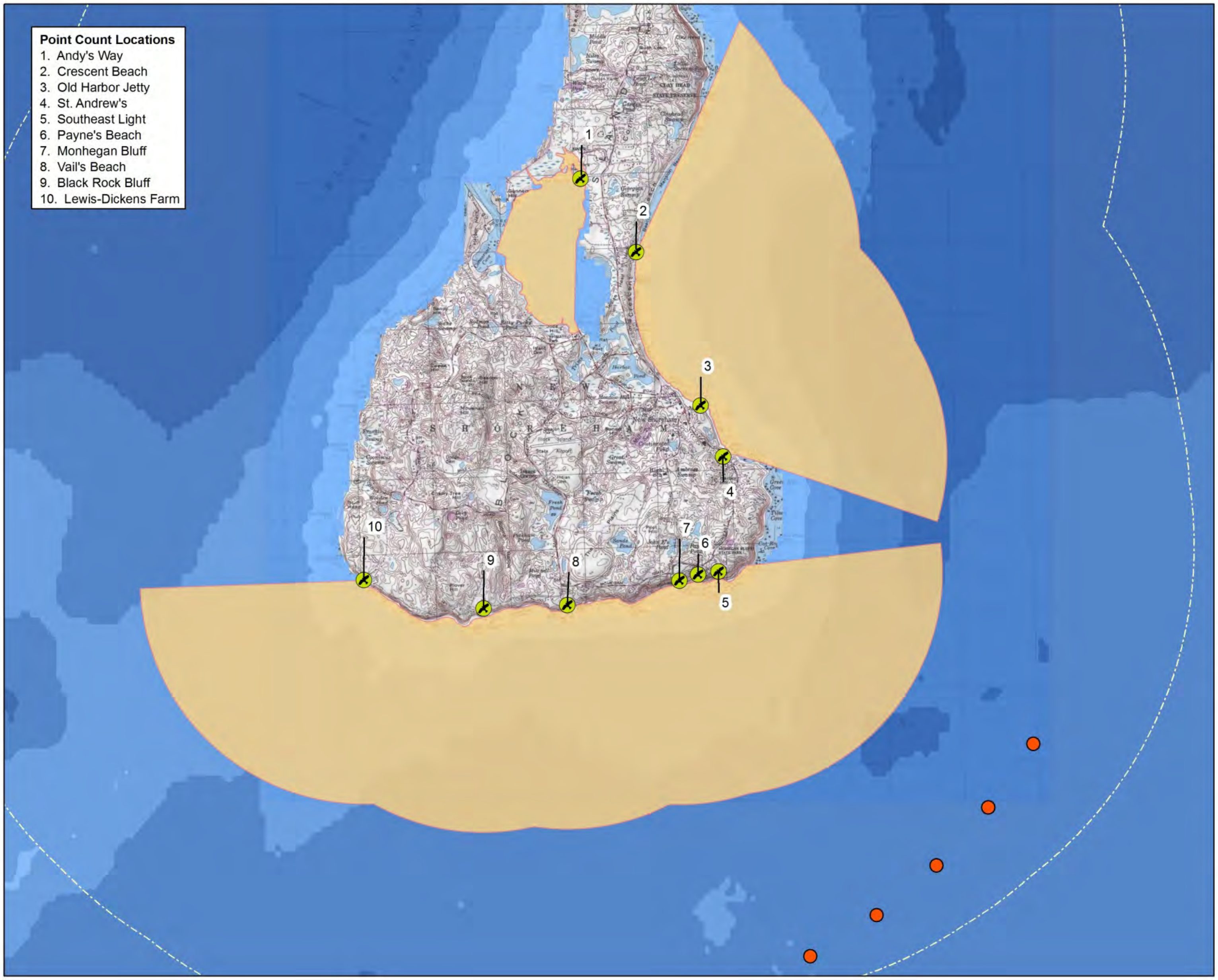


Figure 3.1.3. Effective survey area of the onshore sea watch point count stations – BIWF 2009–2011.

3.2 ONSHORE RAPTOR MIGRATION SURVEYS

Tetra Tech biologists conducted fall raptor migration surveys in 2009 using standardized visual count methods for raptors (HMANA). The primary observation point was located on the southeastern coast of Block Island at the Southeast Lighthouse. This location provided a clear vantage point of nearshore and onshore areas (Figure 3.1.1). Because the Southeast Lighthouse point location did not provide a clear vantage point to the north and the extreme west side of the offshore portion of the Study Area, additional observation locations were surveyed. Secondary observation points had improved northerly views (from where migrating raptors were expected to arrive) and improved views of western areas (where raptors were expected to be moving off Block Island toward land masses to the west and southwest). Views from the survey points are presented in the photographic record (Appendix A).

Surveys at the Southeast Lighthouse were conducted approximately each week throughout the fall raptor migration period (August 15–October 15) from 09:00 to 16:00. Additional surveys were conducted approximately once each week from late August to late October at the secondary observation points. Roving surveys were conducted for 30–60 minutes at each point from approximately 09:00 to 17:00. Raptors observed incidentally while traveling between point locations were also recorded.

Binoculars (10x42 mm) and a spotting scope (15–46x60 mm) were used to sight raptors, and field references were used to ensure accurate identification (Dunne et al. 1998, Sibley 2000, Liguori 2005). Surveys targeted optimal migration conditions with favorable winds for raptor migration. Observers recorded information on data sheets designed for the study. Data collected included survey start and end times, time of each observation, approximate flight height above ground, general behavior (i.e., direct flight, hunting, perching), and weather information (temperature, visibility, precipitation, cloud cover, wind speed, and wind direction). The flight path and direction of each raptor was recorded on topographic maps. Incidental migrant waterfowl and passerine observations were also recorded.

Raptor survey results were then compiled to provide information on species composition, passage rates and timing, predominant flight paths, and survey effort. Passage rates were determined by calculating the mean number of birds per hour during the entire survey, as well as during individual periods. Data were compared with four regional raptor survey locations on the same observation days to assess migration activity at Block Island from a regional perspective.

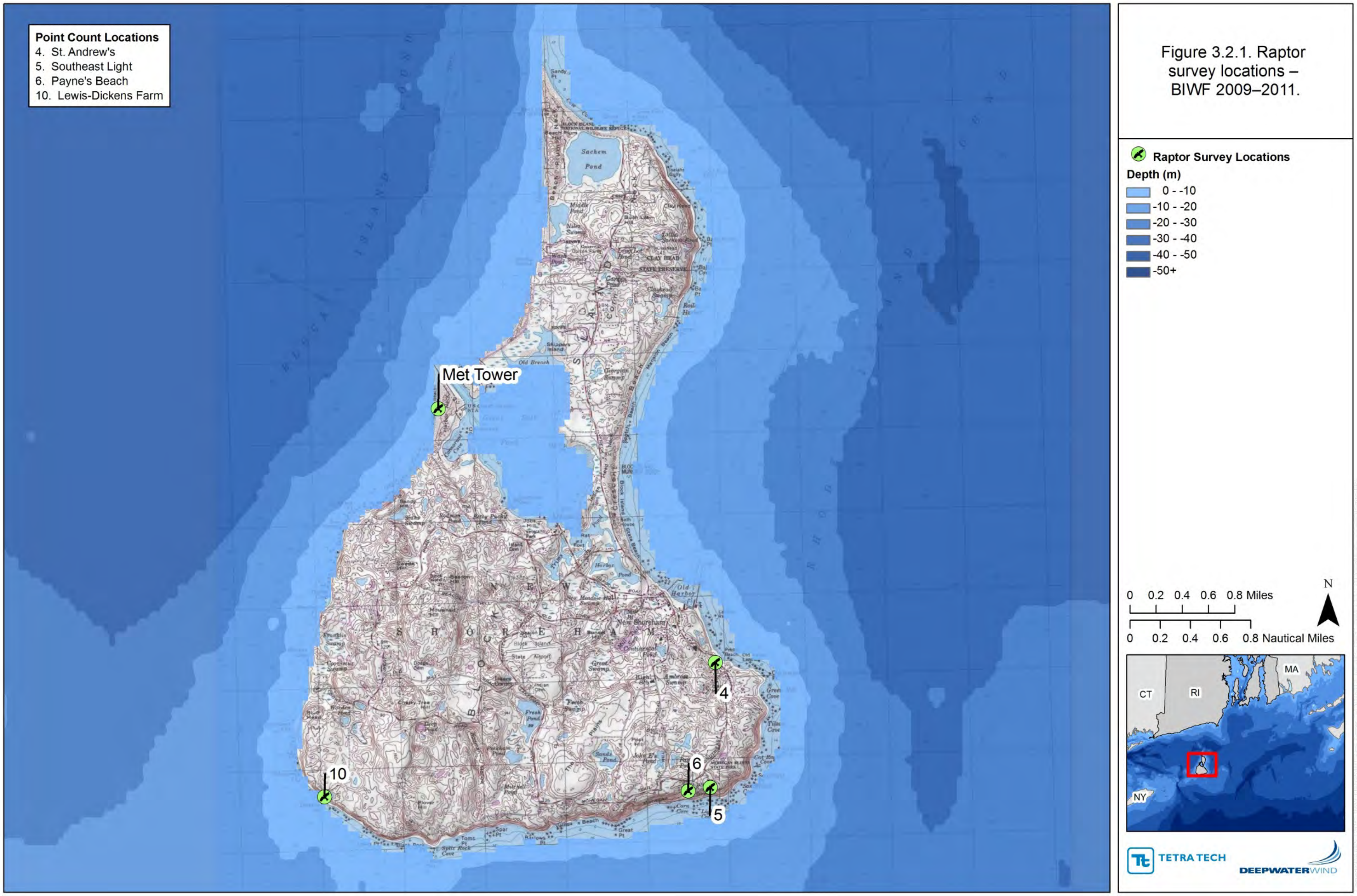


Figure 3.2.1. Raptor survey locations – BIWF 2009–2011.

3.3 BAT ACOUSTIC MONITORING

3.3.1 PASSIVE MONITORING

Passive monitoring refers to surveys where bat calls are monitored at stationary locations without a researcher present. Four bat detectors were deployed at three onshore locations and two offshore buoys during the late summer-fall 2009 and spring-early summer 2010 survey periods. Two detectors were deployed along the southern coast (one at the radar site and one at Lewis-Dicken's Farm), and two detectors were deployed in and adjacent to the meteorological measurement tower near the entrance to New Harbor: one at a height of 52 m (171 ft) and one near the base of the tower at 1 m (3.3 ft) (Appendix A). The bat acoustic surveys were initiated in June 2009 and continued until mid-November 2009. Monitoring recommenced at the same locations on April 1, 2010 and continued until July 31, 2010 (see Table 4.3.1).

Onshore Passive Sampling Methods

The onshore detectors consisted of two AR-125 and two AR-125 EXT (Binary Acoustic Technologies, Inc.) detectors housed in waterproof boxes and powered by 50-watt solar panels (Appendix A). The microphones of the detectors were set to record airspace at approximately 45 degrees above the horizontal plane and out to approximately 30 m (98 ft). The actual effective area of reception for the bat detectors may have varied with atmospheric conditions including relative humidity and temperature. Detectors were operated remotely with cellular data transfer systems, but included a secondary onsite hard disk backup system to assure no data were lost. The detectors were set to operate in "trigger mode" and recorded sounds between 18 kilohertz (kHz) in frequency and less than 90 kHz, at a sound pressure level of greater than 18 decibels. Once triggered the detectors recorded call sequences for 15 seconds before initiating a new file, with a 3 second time-out if the sound being recorded ceased. This allowed for full call sequences to be recorded in the frequency range of the bat species expected to occur on and around Block Island.

Offshore Passive Sampling Methods

In addition to the four detectors deployed on Block Island a detector was deployed on each of two buoys, at a height of 2.5 m (8.2 ft) above mean sea level (AMSL). One detector was deployed on a weather buoy anchored 5.6 km (3 nm) south of the island, and a second buoy 27.8 km (15 nm) east of Block Island (Figure 3.3.1). Anabat SD-1 detectors (Titley Electronics, Inc.) were used and weatherized for the marine environment. Each detector was set up to transmit data via a cellular connection. The detector received power from the buoy's internal solar power system. The microphone of the buoy detector was buffered from the marine environment by a 90 degree sweep section of PVC piping, with a small drain hole in the bottom (Appendix A). The PVC tube was intended to prevent sea spray from directly contacting the microphone's elements. The PVC tubing acted as a deflector for potential call sequences to be recorded by the unit, similar to the deflector plates used on the onshore passive acoustic setups (Appendix A). Sensitivity of the microphone was tested prior to deployment using a bat chirper (Tony Massena, Nevada) which produces a constant 40 kHz tone. The detectors were calibrated prior to deployment to ensure that bat calls would be detected within a maximum range of 30 m (98 ft) at 40 kHz.

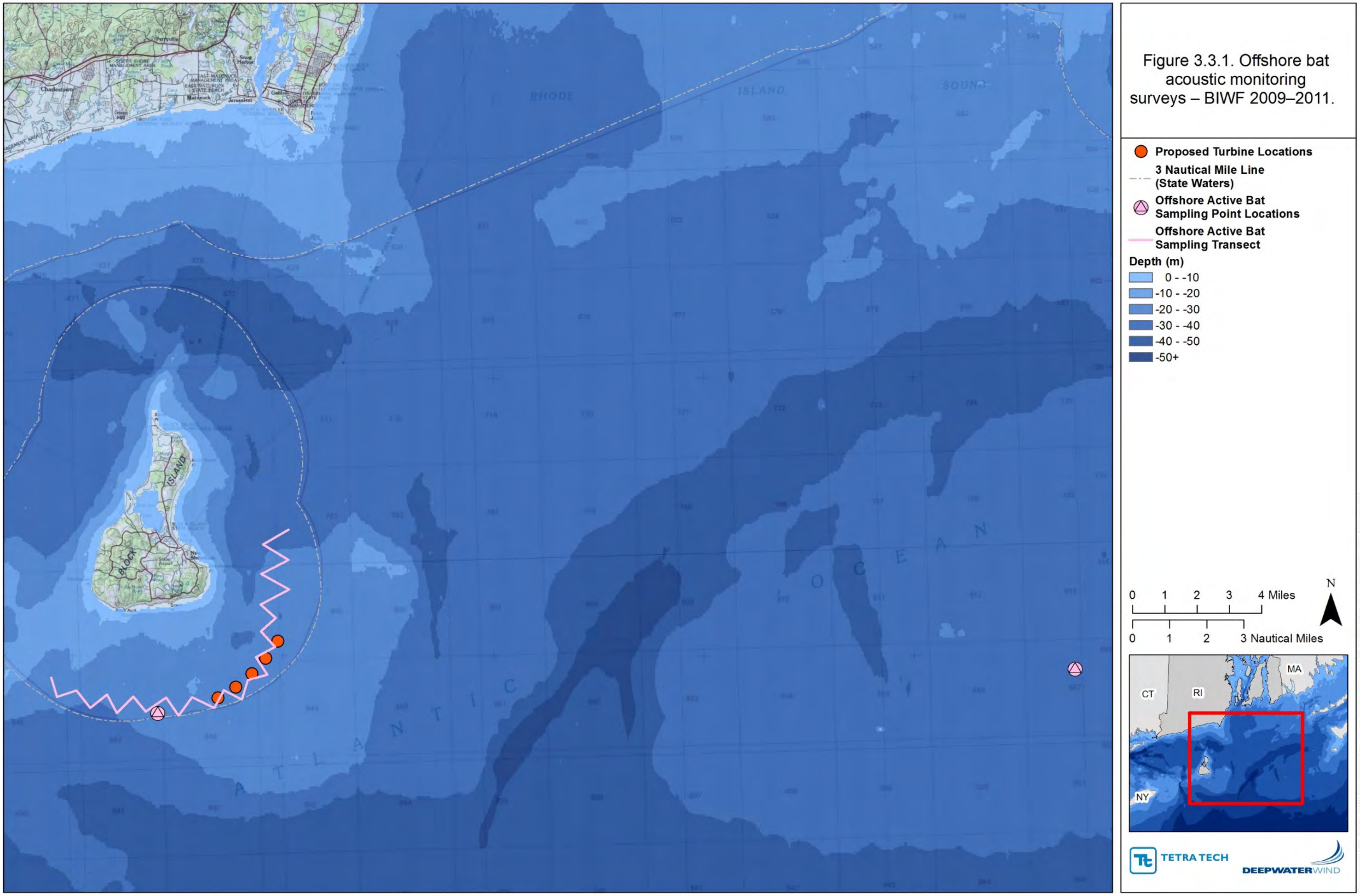


Figure 3.3.1. Offshore bat acoustic monitoring surveys – BIWF 2009–2011.

3.3.2 ACTIVE MONITORING

The occurrence of bats in the marine environment is not well understood, and much is unknown regarding the potential impacts of offshore wind energy development on bats. Tetra Tech conducted active bat acoustic monitoring surveys using hand-held detectors during the 2009 fall bat migration and swarming period (mid-July through September), both onshore and offshore of Block Island. The purpose of the surveys was to assess species composition and general foraging activity patterns of bats onshore and offshore.

Active monitoring is a mobile sampling technique that involves a researcher present during data collection and is an efficient means of locating areas of activity in a larger study area (Britzke 2004, Ellison et al. 2005). Active surveys may be useful for determining spatial occurrence patterns where bat activity is measured as the relative number of bat passes or files (Britzke 2004).

Active "roving" bat surveys were performed onshore on Block Island and within the offshore portion of the Study Area, in the area where WTGs are proposed (Project Area). Active surveys were conducted on targeted nights when ambient air temperatures were high and wind speeds low. The onshore and offshore active surveys provided supplemental data to the passive monitoring station on bat species occurrence and spatial distribution.

Prior to conducting the active surveys, Tetra Tech performed a desktop analysis of existing onshore habitat information, which included review of United States Geological Survey (USGS) 7.5-minute series topographic maps and aerial photographs. Aerial photos were used to identify general habitat types, drainages, and water sources where bats might concentrate onshore, and roving surveys were then focused on areas most likely to provide foraging or roosting habitat for bats. Linear corridors (roads and paths), wood lots, hedgerows, wetlands, ponds, and open fields were surveyed. Offshore surveys were performed along the offshore boat-based transect lines. Onshore and offshore active bat monitoring surveys were conducted using a handheld Anabat SD1 (Titley Scientific, Australia) bat detector.

Onshore Active Sampling Methods

A primary goal of the onshore portion of the active monitoring effort was to determine any potential bat roost habitat on Block Island. This mobile sampling survey was conducted on two separate evenings during the bat migration/swarming period from mid-July through the end of September along roads, trails, and in multiple habitat types throughout Block Island. Surveys were conducted at nine stationary points, one walking transect, and driving transects (between points). Habitat types at the point locations include freshwater ponds, a saltwater pond, beaches, dunes, mudflats, bluffs, shrub, meadows, scattered trees, residential lawns, and edge habitat along meadows, roads, and trails. The walking transect was located along Mansion Beach on the northeastern shore within and adjacent to beach, bluff, and shrubland habitat (Appendix A).

Surveys were conducted beginning within one hour prior to sunset, and concluded when all points and transects were surveyed. Surveys occurred during optimal weather conditions (i.e., warm nightly temperatures, low wind speeds, and no or light rain). When bat activity was detected during the driving and walking transects, surveyors stopped to record a global positioning system (GPS) point and record field notes including time, weather, and general habitat conditions on data forms. At point locations, biologists recorded Anabat data for a period of 10 minutes at each point. At walking and driving transects, the detector recorded data continuously for the entire transect length. Road transects were driven slowly (16 km/hr [10 mph]) with the detector facing out of the window.

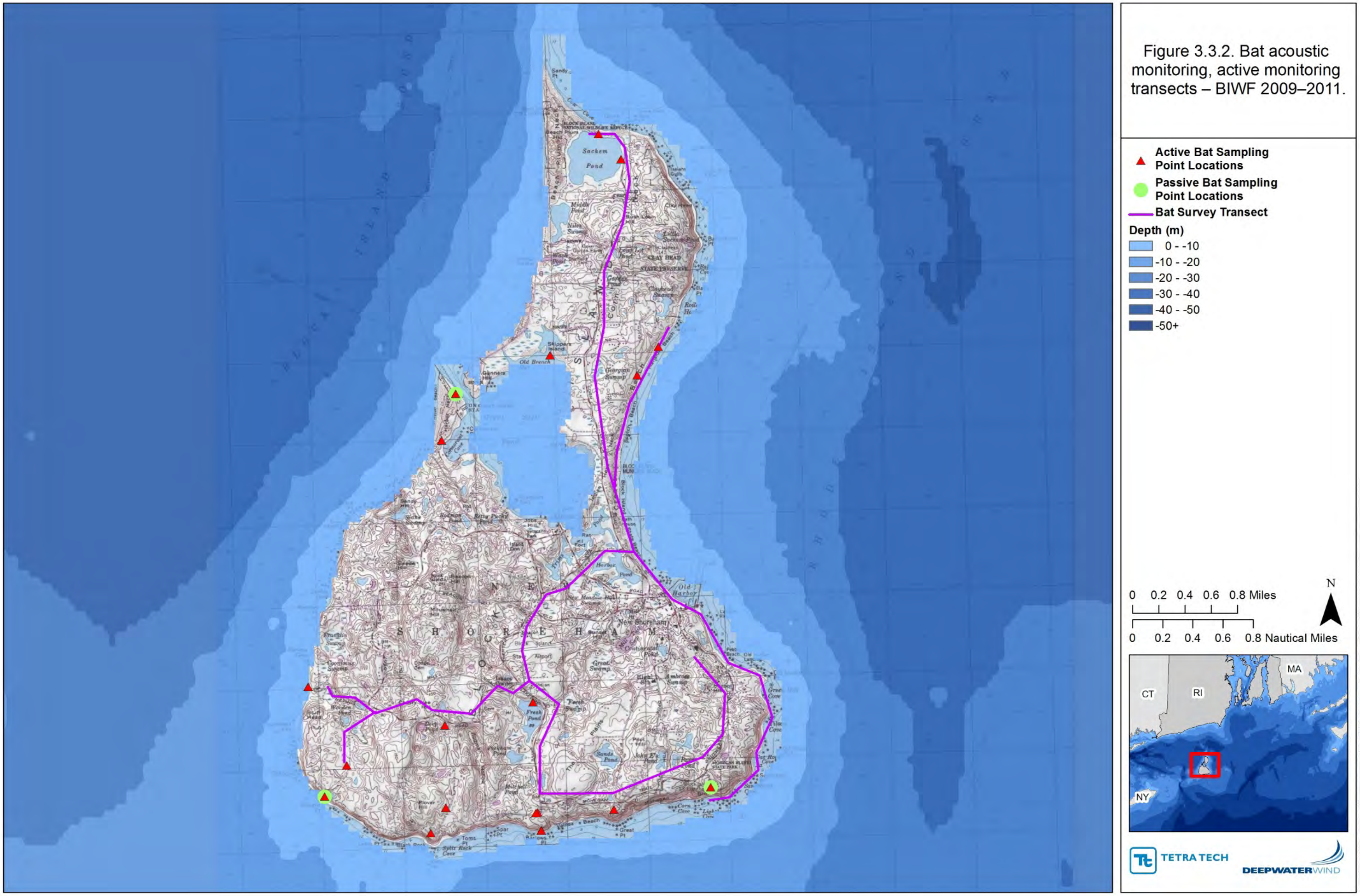


Figure 3.3.2. Bat acoustic monitoring, active monitoring transects – BIWF 2009–2011.

Offshore Active Sampling Methods

Tetra Tech biologists conducted active offshore bat monitoring surveys from a boat along two transects within the Study Area to assess species composition and relative levels of bat activity offshore during late summer and early fall 2009. Boat transect surveys were conducted during the bat migration/swarming period (mid-July through September) along Sawtooth Transect 1 and Sawtooth Transect 2, approximately 5.6 km (3 nm) offshore to the east and south of Block Island (Figure 3.3.1). Each transect is approximately 18.5 km (10 nm) in length. A total of four surveys were conducted, two surveys at each transect. Biologists gathered data using the Anabat SD1 bat detector and recorded field information on data forms including GPS location of detected bat calls, time, wind speed, temperature, wind direction, sea state (Douglas Sea Scale), and general comments on insect presence/absence. The surveys began approximately one hour prior to sunset and continued until the transect length was completed or until midnight, after which time bat activity decreases. Surveys were conducted while traveling at a constant boat speed of approximately 14.8 km/hr (8 knots) and during optimal weather conditions (low wind speed, high mean nightly temperature, and calm sea state). The starting location along each transect (i.e., north or south starting point) was alternated to avoid potential biases related to survey timing and species activity patterns.

Analysis Methods

It is important to note that two types of detectors were used during the summer and fall passive acoustic surveys. The onshore monitoring systems were time expansion detectors, and the buoy mounted detector was a frequency division/zero-cross analysis detector. These systems are not necessarily directly comparable because of their relative capacity to differentiate between interspecies call parameters. However, both types of detectors have similar cones of reception and ranges and should therefore be similarly able to record call sequences during long term monitoring.

Zero-Crossing Anabat SD-1 Detectors (Used for Onshore Active Sampling and Offshore Passive Sampling)

Potential bat call files were extracted from data files using CFCread© software. CFCread© software screens all data recorded by the bat detector and extracts call files using a filter. The default settings for the CFCread© software were used during the file extraction process to ensure comparability between datasets. These settings include a maximum time between calls (TBC) of 5 seconds, a minimum pulse fragment line length of 5 milliseconds, and a smoothing factor of 50. The smoothing factor refers to whether or not adjacent pixels can be connected with a smooth line. The higher the smoothing factor, the less restrictive the filter, resulting in more noise files and poor quality call sequences retained within the dataset. A call is defined as a single pulse of sound produced by a bat. A call sequence is defined as a combination of two or more pulses recorded in a single call file.

A qualitative visual comparison was made between recorded bat call sequences and established reference libraries of bat calls. This technique allows for relatively accurate identification of bat species (O'Farrell and Gannon 1999, O'Farrell et al. 1999). All call sequences were also run through a series of conservative filters based on call sequence characteristics outlined in Szweczak et al. (2008) and from known species call sequences (hand released and zip-line individuals) from a regional call library. A call sequence was considered of suitable quality and duration to be included in data analysis if the individual call pulse(s) exhibited the full spectrum of frequency modulation produced by a bat (i.e., consisting of sharp, distinct lines) with a minimum of 5 pulses.

In addition to the qualitative visual analysis, all bat calls recorded during the monitoring period were processed using Bat Call ID software and an Indiana bat specific call filter. The results of the Bat Call ID analysis and Indiana bat specific call filter provide an additional level of clarification of species recorded during the survey effort. It is often difficult to definitively classify call sequences due to the overlap in call pulse characteristics across species. Species such as hoary bat (*Lasiurus cinereus*) emit calls that are distinct in slope, duration, characteristic frequency, and frequency range (i.e., parameterizations). However, for other species, particularly those of the genus *Myotis,* it is difficult to accurately differentiate among species based on call sequence characteristics due to the similarities in call parameters. Nevertheless, it is often possible to make accurate classification inferences based on good quality calls of species including Indiana myotis (*Myotis sodalis*), little brown myotis (*Myotis lucifigus*), and northern myotis (*Myotis septentrionalis*). The call sequences of eastern red bat (*Lasiurus borealis*) and tri-colored bat (*Perimyotis subflavus*) are typically unique but occasionally appear similar to each other or myotis species, especially if the recording is of poor quality (Broders 2003). Classification is often complicated by the presence of static or incomplete call pulses within a recording. Fragments and poor quality calls are prevalent in recordings from passive detectors monitoring for a long duration.

Full Spectrum AR-125 Detectors (Used for Onshore Active Sampling and Offshore Passive Sampling)

AR-125 recordings were extracted from the FR-125's USB external data storage media and transferred to a desktop personal computer. Call files were placed in four different folders corresponding to the respective bat detector stations. SonoBat 3.02 North East (SonoBat, Inc. Humboldt, CA) was used for call filtering and preliminary call analysis. A final qualitative visual assessment of recorded call sequences was performed to assure accurate classifications. SonoBat 3.02 North East uses a series of algorithms based on 1,444 recordings (8,161 parameterized calls) of all eastern North American bat species to classify calls with probability rankings. The SonoBat program includes "signal quality checks" to filter out over-saturated calls and calls of poor quality due to background noise or the distance of the calling bat from the microphone unit. SonoBat takes a probabilistic approach to call classification. Species information is generated based on the quality of the call and a comparison of the recorded call parameters with established reference call parameters. SonoBat uses a decision rubric to discriminate among calls with similar parameters, and a discriminate probability (DP) of species identification is then assigned to each call. If the SonoBat algorithm determines that a call has a DP below the set threshold (DP = 0.60) for a given species but has a DP score exceeding the threshold for another species, SonoBat provides a double classification for the call. For example if a recorded call does not meet the DP threshold for matches to the call library of Indiana bat but meets or exceeds the DP threshold for a match to calls of little brown myotis, the call is classified as both species. In this circumstance SonoBat established that the call likely came from one of these two species, but the overlap in call parameters of the recorded call would not allow for a definitive classification.

To reduce the possibility of falsely identifying bat call sequences, a conservative identification grouping schematic was used. Call sequence DP thresholds were set at 0.60 to assure that all calls in the recordings were evaluated by SonoBat and were classified to some level of the decision rubric, thereby allowing species identification to be inferred. A classification rubric with three levels was used: calls with a DP of greater than 0.60 were considered first order calls, calls that did not meet the threshold of greater than or equal to a DP of 0.60 were classified as second order calls (low, middle, or high frequency unknown), and calls of poor quality were labeled as third order (high or low frequency). This layered approach to interpreting species identification was intended to be conservative. By setting a low DP threshold more calls were evaluated for potential species discrimination, thereby not excluding many of the poorer quality calls.

This report contains the results of filtered calls that were evaluated and deemed to fall below the 0.60 DP threshold; thus, all possible bat calls are presented for discussion. First order call classifications with a DP >0.60 were the most certain. Species identified from these calls are likely the most accurate, and certainty continues to increase as DP values rise. Calls with DP classification values <0.60 (second order calls) are included for discussion purposes; even though they are likely accurate, they are less definitive than calls with DP values >0.60. The least certain classifications are applied to those calls that did not pass the first and second tiers of the SonoBat decision rubric but nonetheless possessed the characteristics of bat calls. These calls were labeled as either third order, high frequency (characteristic frequency [F_c] >39 kHz), or low frequency (F_c <35 kHz). These high or low frequency calls are certainly bat calls, but species inferences would likely be inaccurate.

3.4 AVIAN ACOUSTIC MONITORING

Tetra Tech deployed avian acoustic monitoring equipment within the Study Area during the 2009 late summer–early fall migration period, and again in spring 2010. Song Meter SM-1 (Wildlife Acoustics, Inc.) recorders were deployed at three locations in the Study Area (Figure 3.4.1). The New Harbor monitoring station was deployed on August 20 and removed on October 31, 2009, near the VESPER radar at the entrance to New Harbor on Block Island. The Lewis-Dicken's Farm monitoring station was deployed on August 20 and operated until October 11, 2009. The third unit was deployed at the MERLIN radar near the Southeast Lighthouse, Block Island, and operated from August 20 to October 31, 2009. Each of the three units was redeployed in spring 2010 on April 15, and they were removed on May 31. A fourth detector was deployed on the central portion of the southern Block Island coast but did not record reliably and was therefore excluded from analysis.

The Song Meter units were set to begin recording 45 minutes before sunset and continue recording uninterrupted until 45 minutes after sunrise every night of the survey period, regardless of weather. The Song Meter SM-2 units were powered directly by a 12 volt deep-cycle marine battery and a 50 watt solar panel. The system recorded in WAC audio file format at a sampling rate of 16,000 hertz, mono. Song Meters record the full spectrum of sound frequencies from 1 to 10 kHz (the bandwidth that includes all frequencies common to avian flight calls in eastern North America). The Song Meter was connected to a sound pressure zone microphone similar to those described by Evans (1999). The maximum range of the microphone for most nocturnal migrant species was determined to be approximately 300 m (984 ft) vertically and no greater than 250 m (820 ft) horizontally (Evans 1999), although calls of some species (e.g., warblers, kinglets) with a higher frequency were not likely recorded at these distances. The estimated maximum range provides a conservative measure of the airspace sampled by the SM-1 units. Ambient noise (e.g., waves), wind noise, and other atmospheric conditions (including relative humidity) affect the maximum range of the microphone.

Data collected during the surveys were recorded in compressed WAC file format and converted into WAV files using Wildlife Acoustics, Inc. WAC to WAV file conversion software. Files were then scanned through a series of recognizers in Song Scope Version 3.3 (Wildlife Acoustics, Inc.). Recognizers were trained on known reference call libraries gathered from the Cornell Lab of Ornithology's MacAulay Library and from Evans and O'Brien (2002). All recordings were scanned against Song Scope recognizers, which were trained on all avian species regularly occurring east of 100 degrees longitude in North America. All recognizers provided cross-training matches greater than 85%, with standard error values of less than 8%. These libraries were used to train Song Scope recognizers to scan for similar sounds within the files recorded in the Study Area. The recognizers identified calls that had an 85% or greater match with those of the reference call recognizers, and a quality ranking of 85 or better. Flight calls, which were scanned and recognized by the trained Song Scope recognizers, were visually reviewed to assure similarities between recorded flight calls and reference flight calls. Additionally, some calls were also analyzed in GlassOFire software (Old Bird, Inc.) to allow for spectrogram images to be viewed in a manner consistent with reference spectrograms from Evans and O'Brien (2002). All recorded flight calls were identified to guild level: wood-warbler, thrush, and sparrow.

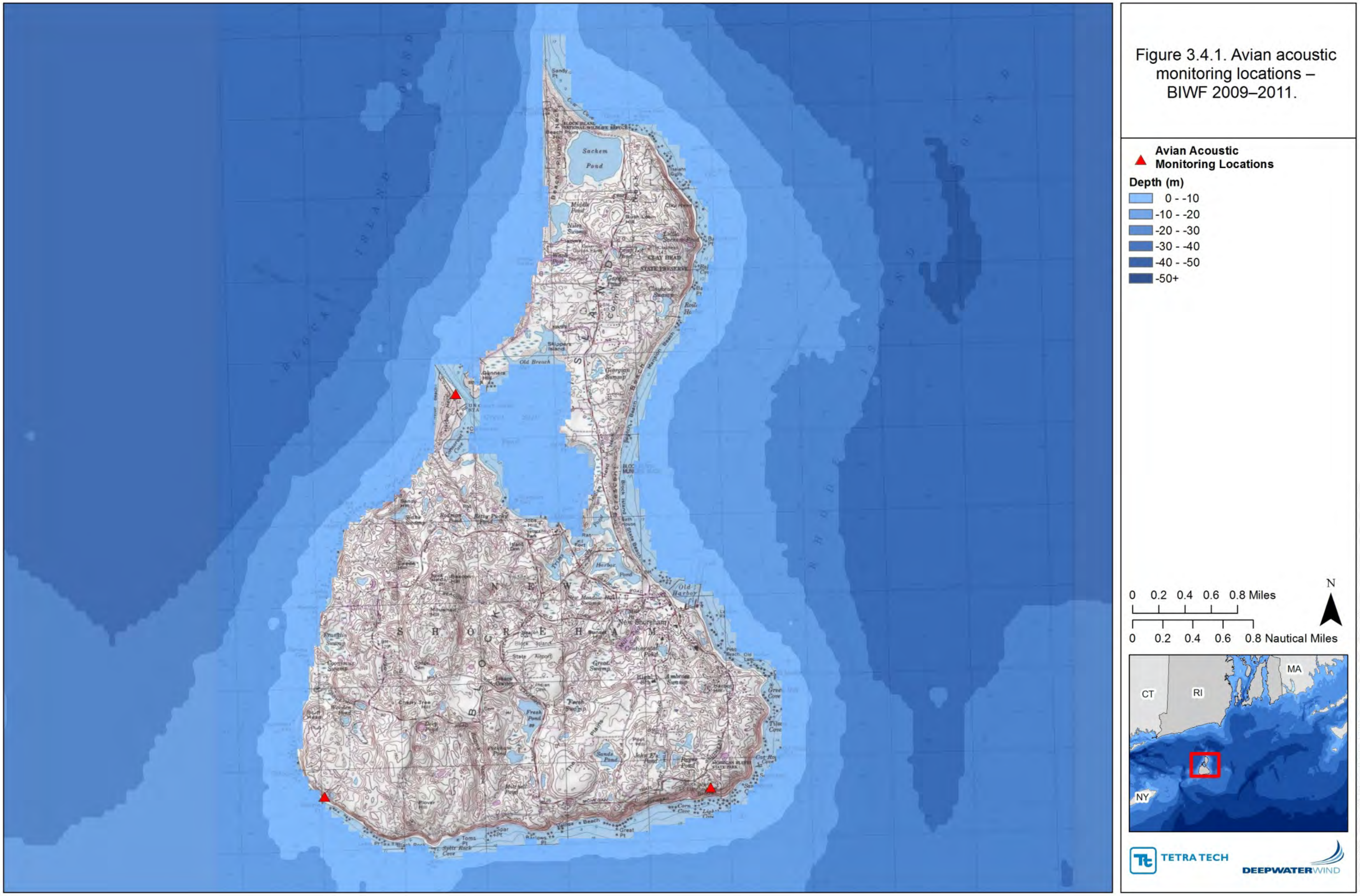


Figure 3.4.1. Avian acoustic monitoring locations – BIWF 2009–2011.

3.5 OFFSHORE BOAT-BASED AVIAN SURVEY

Tetra Tech conducted offshore boat-based avian surveys approximately twice per month from July 2009 through June 2010, and again in August and September 2011 for a total of 32 boat-based surveys during a two year and three month period. The surveys documented seasonal occurrence patterns, including the arrival and departure of summer and winter residents, and the movement of spring and fall migrants. The survey protocols were developed by Tetra Tech biologists in conjunction with the USFWS and Rhode Island Department of Environmental Management (RIDEM), and were consistent with the RI Ocean SAMP avian research group's survey efforts in Rhode Island Sound (Paton, Winiarski et al. 2010).

All surveys were performed traveling at a constant speed of 14.8 km/hr (8 knots) on the *F/V Linda and Laura*, a 10.4 m (34 ft) vessel operated by John Grant of Green Diamond Lobster, Co. (Block Island, RI). Standardized counts were performed on each of two overlapping saw-tooth transects (Transect 1 and 2) (Figure 3.5.1). Transects crisscrossed each other to provide coverage of the greatest amount of ocean surface within a standardized survey window starting or ending at civil twilight. Transects were divided into segments. Segments were positioned along each transect at the locations where the survey vessel made a turn to create the saw toothed pattern; there were 25 segments in each transect (Figure 3.5.1). Each transect was approximately 16 km (10 mi) long, and segments were 0.64 km (0.40 mi) long. The distance from the boat's track line to the shore remained generally constant from segment to segment, although some variability was inevitable due to vessel drift (Figure 3.5.1). Surveys consisted of traveling along a single transect, beginning at either segment 1 in the northeast or at segment 25 in the southwest of the Study Area. Observational data from each of the two transects were pooled by segment; therefore, spatial occurrence information is relative to each segment. The track line from each boat-based survey was averaged to calculate the actual spatial area covered by the 32 strip-transect surveys (Figure 3.5.1). Transect data were then combined and comparisons were made between segments where turbines are proposed (segments 8–14) and segments where turbines are not proposed (segments 1–7, 15–25).

Tetra Tech conducted morning and evening surveys; morning surveys started at civil twilight (approximately 30 minutes before sunrise) and ended when one transect was completed. Evening surveys began 2.5 hours before civil twilight (approximately 30 minutes after sunset) and ended at dusk. Observations were made by a qualified wildlife biologist using 10x42 magnification binoculars. When possible, distance estimates and flight heights were validated with laser range finders. All birds observed within a 300 m (984 ft) radius ahead of and perpendicular to the boat were recorded on standardized data sheets.

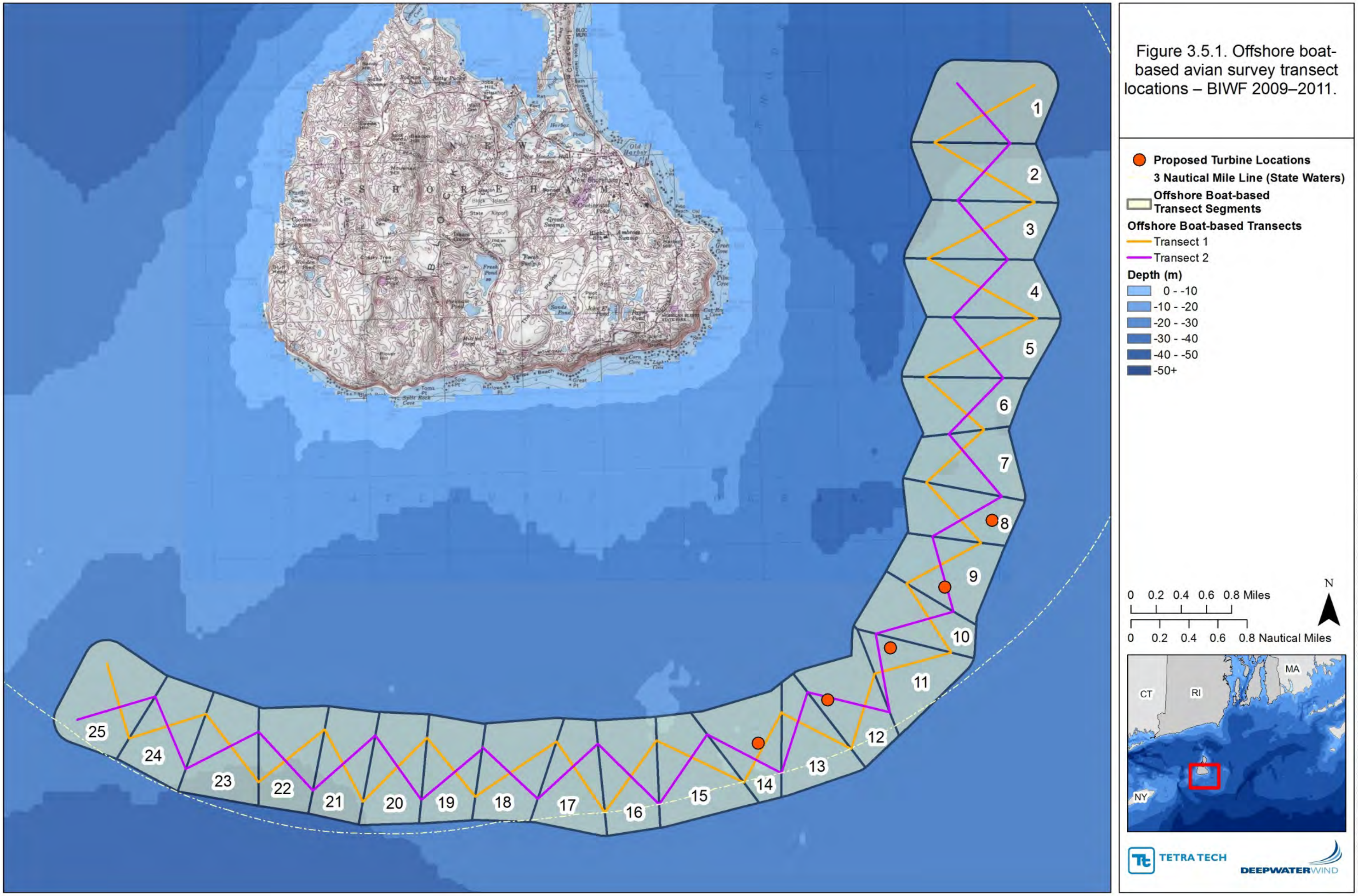


Figure 3.5.1. Offshore boat-based avian survey transect locations – BIWF 2009–2011.

Information recorded for each of the birds, or cluster of birds, encountered included the number detected, approximate age (juvenile or adult), flight height, distance from the boat, and behavior (foraging, direct flight, sitting on the water, and following). Individuals observed following the survey vessel were recorded but excluded from the analysis and summary statistics. Flight height above the water was recorded in elevation bins: <10 m (<33 ft), 10–25 m (33–82 ft), 26–125 m (85–410 ft), and 126–200 m (413–656 ft). Perpendicular distance was estimated from the boat's path to all birds using the following distance categories: <50 m (164 ft), 51–100 m (167-–328 ft), 101–200 m (331–656 ft), 201–300 m (660–984 ft). Data were recorded on standardized data sheets and entered into a Microsoft (MS) Access database. Weather information was recorded at the start of each transect using handheld thermo-anemometers (ExTech Instruments, Inc.). Surveys were conducted on a variety of weather days; however, surveys were not conducted if sea conditions were not appropriate for safe and productive vessel operation (i.e., above sea state 4).

Perpendicular distance data were used to develop density (n/km^2) estimates of all observed bird species. The inclusion of flying birds violates an assumption of the distance sampling methods outlined by Buckland, Anderson et al. (1993), though Tetra Tech did exclude birds following the boat. Detection functions were determined using program Distance 6.0 (University of St. Andrews). It was determined that the detection functions for most species followed a negative exponential or a half-normal distribution (as determined by Akaike Information Criteria [AIC] values for all possible models provided in Distance 6.0). For consistency across species a simple density function was used, assuming that the true underlying detection function was negative exponentially distributed. Individual species density estimates were calculated using the formula:

$$D = n / k\,(2LW)$$

Where:

D = estimated density of birds
n = number of birds seen
L = length of transect
W = mean perpendicular distance of birds seen
k = total number of surveys

The goal was to determine absolute density estimates within the Study Area and Project Area; there was no attempt to calculate regional population estimates for the species observed and no development of a predictive generalized additive spatial model as Paton, Winiarski et al. (2010) did for the greater RI Ocean SAMP study area. This study's density calculations provided an indication of the maximum number of birds that were expected to occur in the vicinity of the proposed project. In addition, this study's density estimates were compared with the density estimates and predictive model developed for the larger SAMP study area to gain insight into the relative density of birds occurring near the proposed turbine locations. The proposed turbine locations occurred in transect segments 8–14. Separate density estimates were made for birds observed in those segments, as well as for all other transect segments. The potential effects of the wind facility and associated risk to birds and bats are addressed in Section 6.0 of this report.

3.6 OFFSHORE AERIAL HIGH DEFINITION VIDEOGRAPHY

The BIWF HD aerial surveys were performed within the offshore portion of the BIWF avian and bat Study Area (Figure 3.6.1). There were a total of 20 transects labeled 1–20 from north to south; fifteen transects were 11.4 km (7.1 mi) long, and five were 4.8 km (3.0 mi) long (Figure 3.6.1). Easting positions along the transects were referred to as A, B, C, D, from west to east for transects 6–20, and C, D, from west to east for transects 1–5. Transects were flown alternating from west to east starting at the southwesternmost transect; consequently, even numbered transects were flown west to east, and odd numbered transects were flown east to west. For safety reasons transects were always flown south to north so that the aircraft was closest to shore (the northern portion of the Study Area) at the end of the survey effort. Transects were designed in ArcGIS and provided 10.4% (5.9 km^2) coverage of the offshore portion of the 61.4 km^2 aerial survey Study Area. The probability of detecting a flying target within the area of coverage was assumed to be 100%. Each short transect (1-5) covered an average of 0.144 km^2 and each of the long transects (6-20) surveyed an average of 0.35 km^2 of ocean. Each transect-segment (A–D) covered an average of 0.083 km^2.

Aerial HD videography methods incorporated recommendations for camera settings and flight parameters, available at the time of survey implementation from the UK COWRIE surveys (Mellor and Maher 2008). These settings and parameters were refined to maximize the effectiveness of the camera and aircraft used for the BIWF aerial surveys. Aerial surveys were conducted from a Robinson R44 Raven I helicopter based out of Newport, RI and piloted by Jeff Codman of Birds Eye View Helicopter. The HD camera was operated by Paul Cronin of White Cap Video, Jamestown, RI. A Sony XDCAM HD 422 1080p mounted on a custom gyroscopic stabilizer was used for the entire survey period. The camera was located on the side of the aircraft and orientated downward with a forward facing angle of approximately 45 degrees. The initial lens focal length was 200 mm; however, this did not provide the necessary level of detail to identify birds to species, so the focal length was changed to 275 mm. The change in magnification enhanced the quality of the video and made species identification easier. The 275 mm camera focal length permitted a 60 m (197 ft) (2,000 pixels wide) swath of ocean (centered on the transect line) to be videographed. Aircraft flight height during all surveys was 152 m (500 ft). The ground speed of the aircraft was 98 km/hr (53 knots), and it took 4.25 hours of flight time to complete all 20 transects.

Data were stored on digital media and analyzed visually on HD computer monitors. Videos were reviewed independently by a junior and senior biologist; the separate results were then compared and any discrepancies were discussed and resolved. During reviews each biologist watched the video at half speed and recorded any fauna encountered.

Following analysis of the video data, density estimates for the HD aerial surveys were calculated using the formula:

$$D = n / a$$

Where:

D = estimated density of birds (n/km^2)

n = number of birds seen within each transect

a = lwk (where l is the length of transect, w is the width of the transect, and k is the number of times the transect was surveyed)

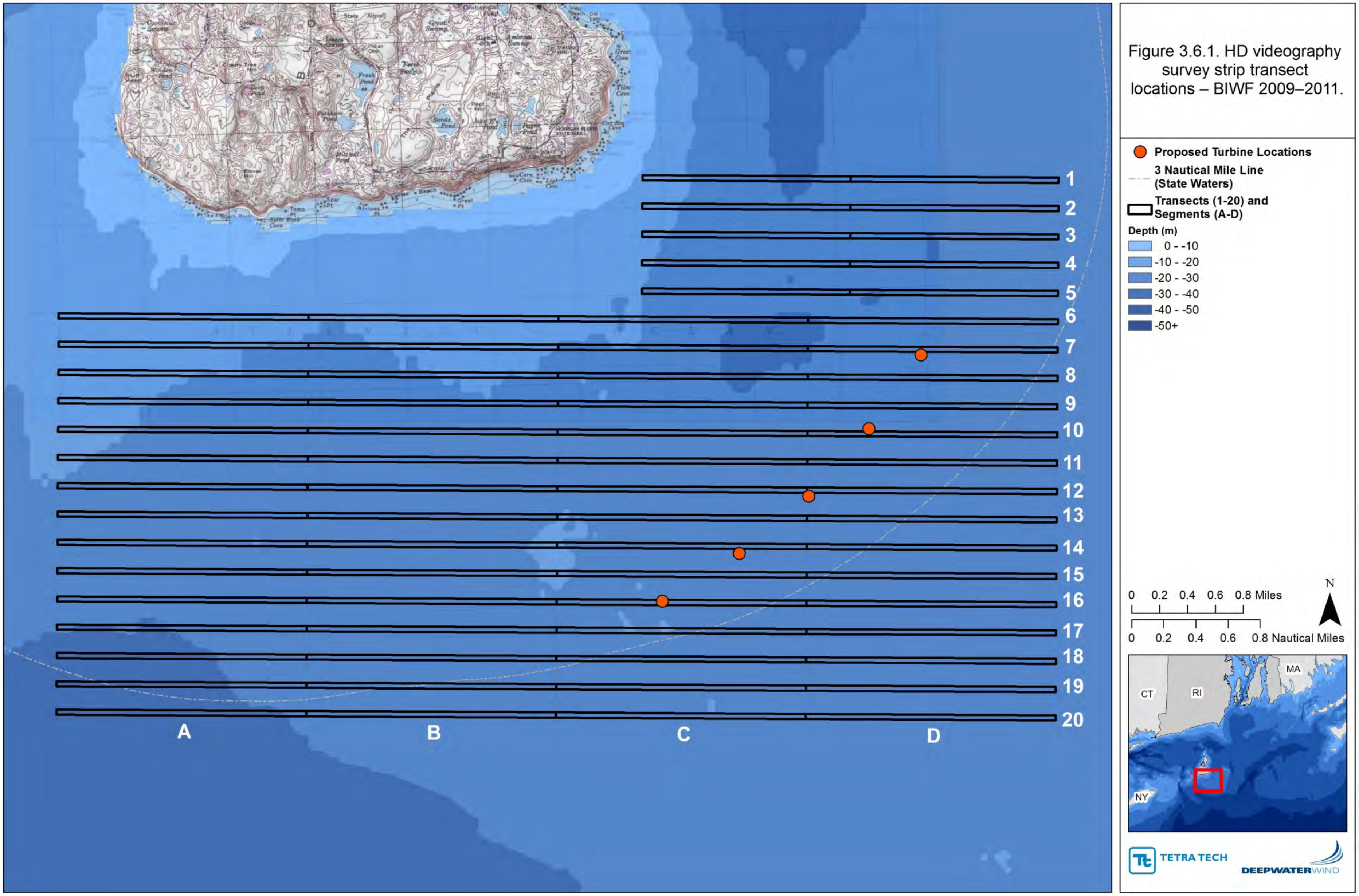


Figure 3.6.1. HD videography survey strip transect locations – BIWF 2009–2011.

3.7 MERLIN RADAR

Between February 2009 and September 2011 Tetra Tech deployed and operated a DeTect MERLIN avian radar unit near the Southeast Lighthouse on Block Island. The radar unit collected data on avian targets utilizing the coastal waters off the southeast corner of the island within the project Study Area (Figures 3.7.1 and 3.7.2). The radar system was optimized to sample targets out to 5.6 km (3 nm) from shore, and to document passage rates, flight heights, and flight directions of biological targets.

Additionally, Tetra Tech completed an intensive ground truthing effort between March and June 2009 to verify the detection capabilities of the MERLIN system and provide supplemental site specific information on avian species composition and habitat use within the Study Area. This ground truthing effort indicated that the MERLIN unit was effectively and efficiently tracking avian targets within the preferred project location and greater Study Area. The MERLIN radar survey effort continued through summer 2010.

3.7.1 RADAR EQUIPMENT AND DATA COLLECTION

MERLIN Avian Radar System

The MERLIN Avian Radar System is an advanced, automated radar system originally developed for and currently used by the U.S. Air Force (USAF) and NASA for remote detection and tracking of hazardous bird activity on and around airfields and launch facilities, in support of aviation and flight safety (bird-aircraft strike avoidance). The MERLIN system is a fully self-contained, trailer-mounted, ornithological radar system developed and manufactured by DeTect specifically for bird detection and tracking. Since 2003, the MERLIN technology has also been extensively used for collection of pre-construction survey data, risk modeling, and post-construction monitoring at proposed wind project sites in the United States, England, Scotland, The Netherlands, Poland, Norway, Turkey, and New Zealand. Agency and research users of MERLIN include the USFWS, U.S. Environmental Protection Agency (USEPA), USGS, various state natural resource agencies, the United Kingdom Central Science Lab (CSL, the UK environmental agency), and various U.S. and international universities.

A model XS2530e MERLIN Avian Radar System was used to survey the proposed BIWF project site. The MERLIN radar system precisely tracks targets within avian size ranges and displays the data in real-time (at the radar and remotely via the Internet) and records all data on targets, tracks, and system parameters to internal databases. For environmental applications, the recorded databases are queried and used to develop statistical data as well as document bird/bat movements in the Study Area.

The MERLIN system used for this project has dual marine radar sensors: a 25-kW power, X-band frequency (3 centimeter [cm] [1.2 inch] wavelength), vertical scanning radar (VSR) sensor; and a 30-kW power, S-band (10 cm [3.9 in] wavelength), horizontal surveillance radar (HSR) sensor. A remote data uplink (WiFi) allowed remote system monitoring through the Internet, access to recorded data, and system administration. DeTect and Tetra Tech biologists conducted the initial setup and maintenance visits as necessary. The system was otherwise remotely monitored via the data uplink/Internet connections.

The radar location was near the edge of a cliff overlooking the area of the Atlantic Ocean in which turbines are proposed. Once the radar was in place, the HSR was positioned to minimize ground clutter, and the VSR was oriented along a northwest-southeast axis, approximately perpendicular to the expected direction of migration. The HSR collected data at a range of 3.7 km (2.0 nm) with an offset on the radar display that effectively expanded the range from the radar location. The VSR collected data at two ranges: the standard 1.4 km (0.75 nm) and an offset range starting 2.8 km (1.5 nm) southeast of the radar and extending out to 5.6 km (3.0 nm). These range settings allowed for optimal detection of bird-sized targets (Cooper et al. 1991). The MERLIN system collected radar data continuously (24 hours a day, 7 days a week), with the exception of limited periods of system maintenance and service downtime and periods of moderate to heavy precipitation.

Vertical Scanning Radar (VSR) Operation

The VSR X-band radar operates in the vertical (y-z) plane transmitting a wedge-shaped beam from horizon to horizon using the vertical scanning technique (Harmata et al. 1999). In this configuration the radar is turned on its side so it scans a vertical slice through the atmosphere. The MERLIN software detects and tracks targets that pass through or along the vertical beam, recording target size, speed, and altitude attributes, as well as other characteristics. This radar transmits a 22°, fan-shaped beam (Figure 3.7.1) at a scan rate of approximately 2.5 seconds/scan, and can reliably detect small, bird- and bat-sized targets on either side of and above the radar. The VSR in this configuration outputs the lowest power density, but it provides high spatial resolution data with low side lobe returns to provide optimal detection of bird/bat targets as they pass through the study site. As the X-band is a short wavelength radar (3 cm), it is susceptible to interference from precipitation; radar data collected during moderate to heavy rain events are quantified and removed during post-processing. The VSR collected data both at the standard 1.4 km (0.75 nm) range as well as an offset range extending 2.8–5.6 km (1.5–3.0 nm) to the southeast of the radar (Figure 3.7.2). The VSR data are used to determine target altitudes and are also the primary dataset used to determine target counts and target passage rates.

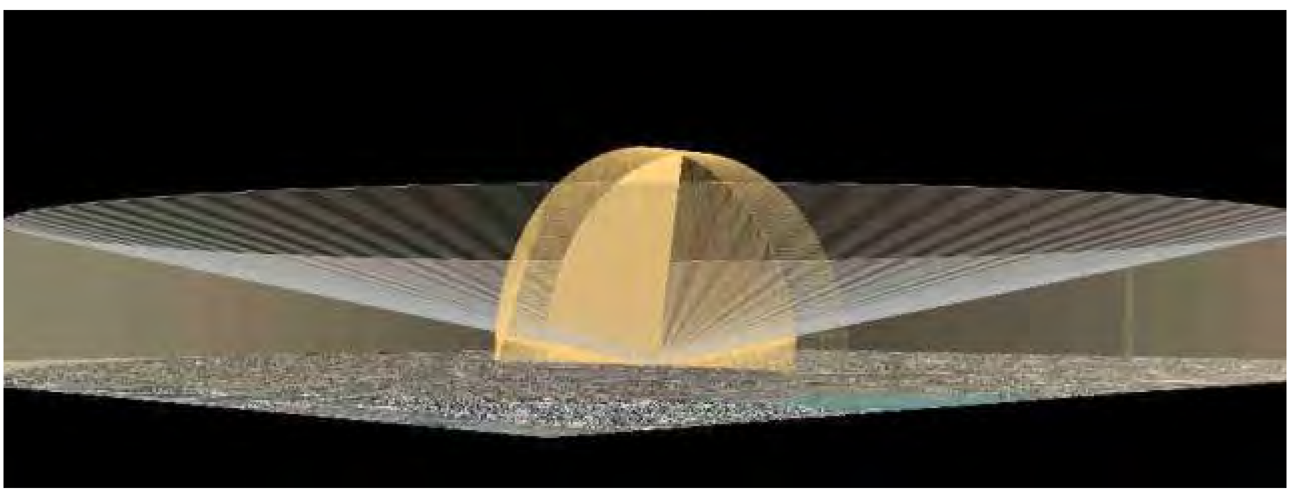


Figure 3.7.1. Illustration of standard beam coverage for the MERLIN Avian Radar System's dual horizontal surveillance radar (HSR, gray area) and the vertical scanning radar (VSR, orange area).

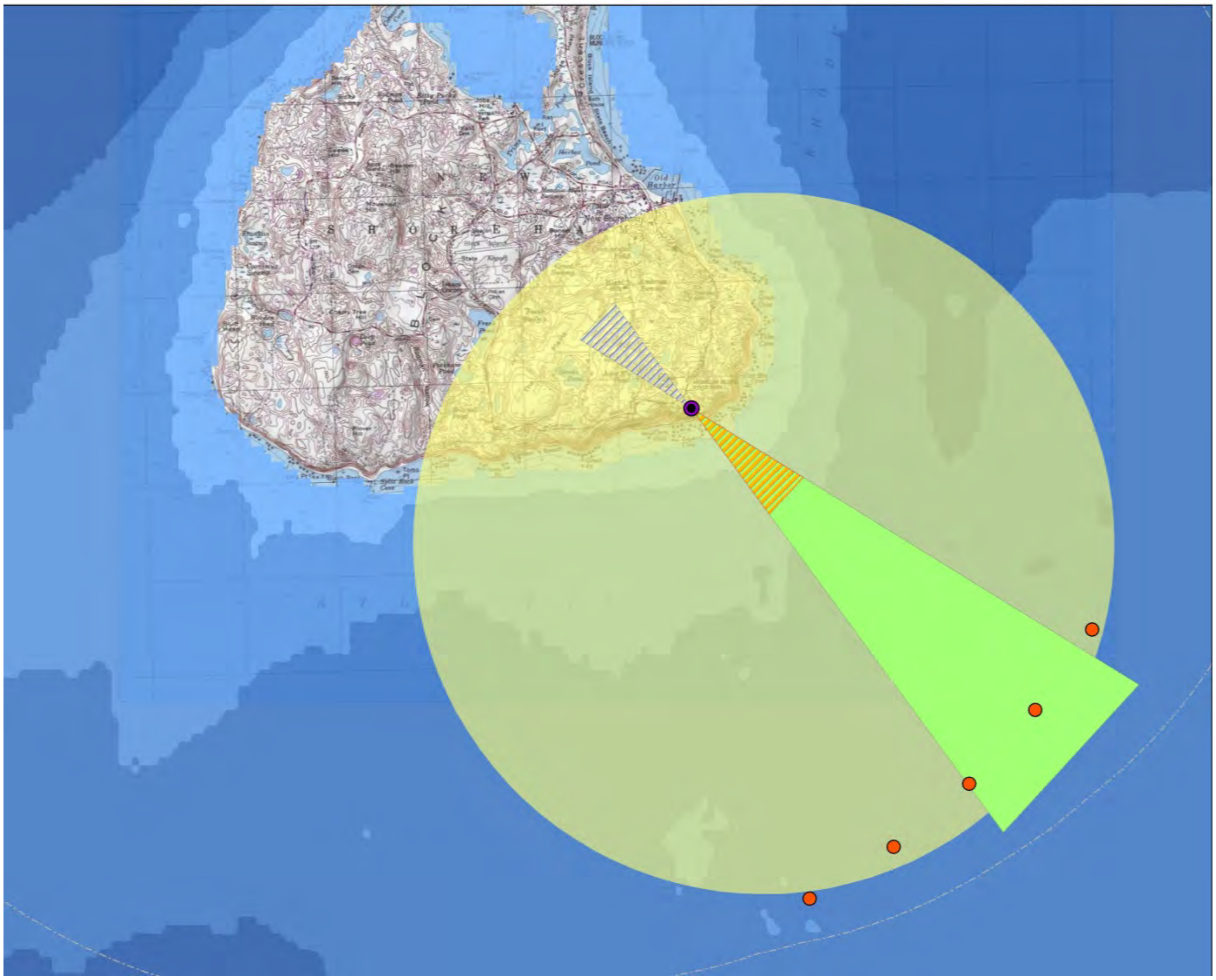


Figure 3.7.2. Illustration of the onshore, nearshore, and offshore VSR sectors, as well as the HSR coverage, of the MERLIN Avian Radar System – BIWF 2009–2011.

Horizontal Scanning Radar (HSR) Operation

The HSR S-band radar operates in the horizontal (x-y) plane transmitting a 24°, wedge-shaped beam relatively perpendicular to the VSR (Figure 3.7.1). The HSR for this survey was configured to operate with a short pulse but transmits at a longer wavelength (10 cm) of energy than the VSR. The S-band has the advantage of greater detection range and less signal attenuation (interference) from surrounding vegetation and waves (typically referred to as ground and wave clutter, respectively), as well as rain. It is also less sensitive to insect contamination. Clutter interference is additionally reduced by applying the MERLIN software clutter suppression algorithms that improve detection of small (bird- and bat-sized) targets in high clutter environments. The HSR scans 360° in the horizontal plane at a scan rate of approximately 2.5 seconds/scan and a range setting of 3.7 km (2.0 nm) radius (for this survey), detecting and tracking targets moving around the survey site. The HSR data are used to determine directional movement of targets over or through the Project Area.

MERLIN Avian Radar Data Collection and Processing

The MERLIN Avian Radar System uses modern, marine-grade radar signal processing technology to collect, process, and store 12-bit digitized radar data from both the VSR and HSR. DeTect and Tetra Tech biologists set up and maintained the MERLIN Avian Radar System as needed, but the system ran automatically and was remotely monitored for most of the data collection period. All VSR and HSR target data and system metadata processed in real-time by the MERLIN software at the radar, with all data recorded to compact, internal system databases for target and track processing, analysis, and reporting.

The MERLIN Avian Radar processing software uses automated clutter suppression in conjunction with biological target detection, tracking, and data recording to identify and track bird/bat targets in the survey area. The software also identifies noise (undesired signals such as ground clutter, insects, and interference) within a given radar environment and applies a statistical approach to suppressing the noise while still allowing targets within the noise to be detected, tracked, and recorded. This maximizes the probability of detecting moving targets in high clutter environments. The application of CFAR (constant false alarm rate) algorithms and clutter mapping techniques are also included in the MERLIN software, and provide automated, high resolution data while minimizing the amount of data lost to clutter.

The detection and tracking algorithms in the MERLIN software locate plot sequences of biological targets in the raw radar data that fit together into a sequence over time as the radar scans. When a target meeting the criteria of a bird- or bat-like target is tracked for a minimum of three out of four sequential scans or plots, it is identified as a target by the radar system, enumerated, and recorded to the system database. A target continues to track as long as it is detected in three out of the last four radar scans or plots. Although the criteria for identifying targets has been developed to only track targets that are most likely birds or bats, targets such as insects or clutter will occasionally be falsely identified and tracked as targets. However, the inclusion of non-bird/bat targets was minimized through optimization of the operational settings in the software, visual ground truthing, and application of custom database queries. Specifically, in order to filter out undesired signals, or false tracks, in both the horizontal and vertical data, targets that were only plotted once after they were defined as a target (leaving only one entry in the database) were eliminated from the database. The MERLIN software also dictated a minimum target-tracking area of 7 pixels in the VSR data and 7 pixels in the HSR data to reduce tracking of possible insects.

It must also be noted that an individual radar echo does not necessarily represent an individual bird or bat, as individuals moving in and out of the radar beam (e.g., circling) would be “counted” by the radar system multiple times. Similarly, a target that is tracked but drops out of the radar line-of-sight (e.g., drops below a tree line) is recorded as a “new” target once it “reappears” and is tracked again (within the MERLIN system, each target is assigned a unique, 64-digit identification number, which facilitates analyses for extended surveys). Therefore, an individual radar echo is referred to as a biological “target” in this study, and when counted together they represent an index of bird and bat activity or exposure level for any given period of time, and not necessarily a count of individuals.

3.7.2 Data Analysis

Radar Data

Radar data were analyzed for 32 months starting in February 2009 and ending September 15, 2011. Database analysis of the radar data was conducted in DeTect’s Data Lab in Panama City, Florida. The Data Lab uses MS Windows® based computer systems, networks, and SQL (structured query language) servers for database processing and analysis. This database query development and analysis is conducted by DeTect staff programmers, radar ornithologists, and biologists.

The HSR data required extra processing to remove wave clutter. Data from each 15-minute increment containing wave clutter was flagged as containing wave clutter and underwent further filtering to remove as much of that clutter as possible. The SQL server analysis data mining technique was employed to extract targets in offshore areas during sea clutter periods. This approach involved building a cluster algorithm data mining model trained with data collected for offshore targets tracked in non-sea clutter periods. This mining model was queried utilizing clusters offering the highest density and probability indexes to extract target data embedded in offshore spatial extents during sea clutter periods. The full MERLIN output for Block Island is provided in Appendix B.

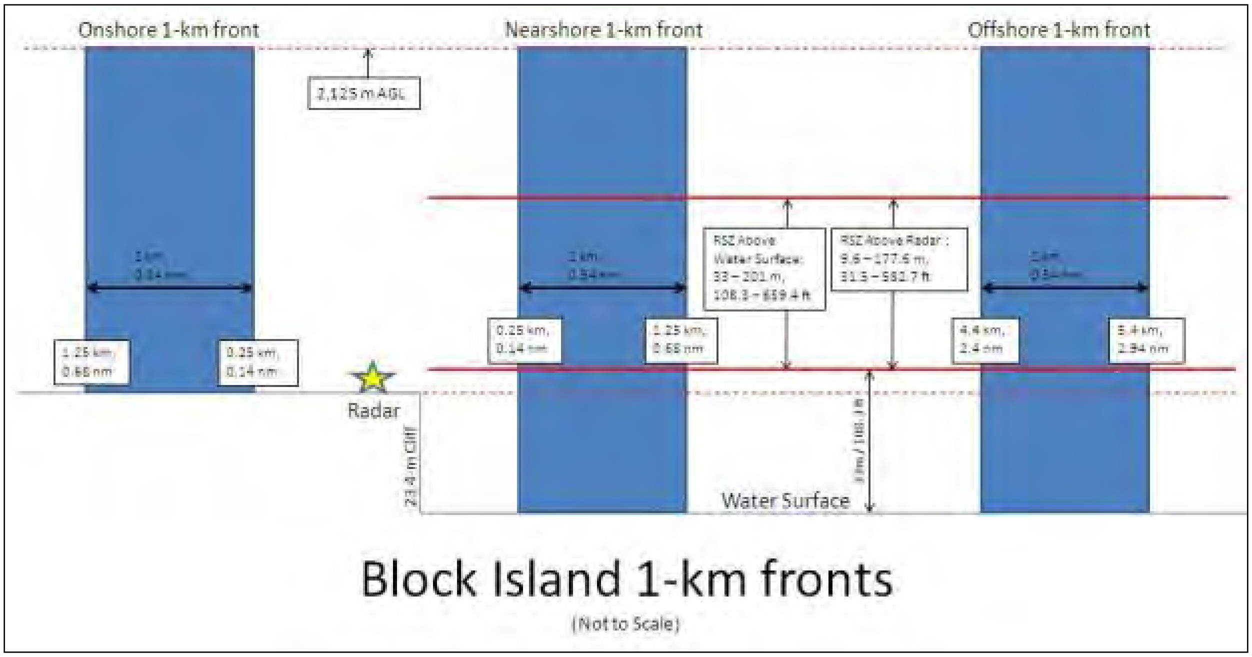
Vertical Radar Data – Target Counts and Altitudes

As targets passed along or through the VSR beam, the altitude of the target was recorded with each scan (rotation) of the radar, approximately every 2.5 seconds. The average altitude of each target above ground level (AGL) was generated and used to derive mean and median target heights, as well as to group targets into one of three categories: below rotor swept zone (RSZ), in RSZ, or above RSZ to a maximum height of approximately 2,125 m (6,972 ft) AGL. Some migrating birds fly even higher than this altitude, but 2,800 m (9,186 ft) was the threshold for which bird-sized targets could be consistently detected by the radar. Intermittent interference between 2,125 and 2,800 m (6,972 and 9,186 ft) established a new upper threshold, and birds flying higher than 2,125 m (6,972 ft) are not documented in this radar study.

The turbine dimensions used for the altitude analyses included a RSZ ranging from 23 to 201 m (108 to 659 ft) above the mean low water level. As the radar was situated on a 23.4 m (76.8 ft) cliff above the water's surface, this RSZ translates to 9.6–177.6 m (31.5–582.7 ft) AGL and above the radar.

The VSR data queries were standardized to a 1-km (0.6-mi) front per hour, generally the industry standard for most migratory and wind energy avian studies and risk analyses. For this report, target passage rates are further defined as the number of targets detected during a one hour period within three different 1-km fronts (Figure 3.7.3). The "Onshore 1-km front" extended from 0.25 to 1.25 km (0.16 to 0.78 mi) over land to the northwest of the radar. The "Nearshore 1-km front" was over water and extended from 0.25 to 1.25 km (0.16 to 0.78 mi) to the southeast of the radar. The "Offshore 1-km front" was also over water, extending from 4.4 to 5.4 km (2.7 to 3.4 mi) to the southeast of the radar. VSR data information was derived from the standard VSR data for both the Onshore and Nearshore 1-km fronts; VSR data information for the Offshore 1-km front used the offset VSR data.

Both the standard and offset VSR data have the same resolution and target detection probability at equal distances from the preset "center" location for the nearshore and onshore VSR data collected with a 1.4 km (0.75 nm) range setting. Offshore VSR operated independent of the effects of ground clutter and beam blockage caused by obstructions. VSR data collection was conducted with an offset at 5.45 km (2.94 nm) to the southeast while running at a 2.78 km (1.50 nm) range setting.



Note: Onshore 1-km Front: -1,250 km to -250 km; Nearshore 1-km Front: 250 km to 1250 km; Offshore 1-km Front: 4,444 km to 5,444 km. Rotor swept zone for VSR data processed: -9.6 m to 177.6 m altitude.

Figure 3.7.3. Illustration of the three 1-km fronts used for the Block Island VSR data.

Passage rates were standardized using the number of minutes with radar data within a given time period (minus any time with rain or time when no targets were tracking) and collated for each dawn (30 minutes before sunrise to 30 minutes after sunrise), day (30 minutes after sunrise to 30 minutes before sunset), dusk (30 minutes before sunset to 30 minutes after sunset), and night (30 minutes after sunset to 30 minutes before sunrise the next day), as well as for the entire season. The average target passage rates and mean and median target heights were calculated for dawns, days, dusks, and nights, as well as hourly during this survey. For the Nearshore and Offshore 1-km fronts, target passage rates were further calculated for below, within, and above the RSZ, as well as total (they were only calculated for the total area for the Onshore 1-km front).

Two other filters were applied to the VSR data. For all fall reporting periods data were eliminated > 900 m (> 2,953 ft) and < 0 m due to unidentified clutter/contamination above 900 m (2,953 ft) and the standard approach not to count VSR track data below ground level. In addition, for the reporting period summer 2010 (July 1–September 15, 2010) data were eliminated > 762 m (2,430 ft) due to additional contamination.

Horizontal Radar Data – Target Directions

The horizontal radar data collected was used to develop information on the directional movement of targets throughout the Study Area. As targets were detected by the HSR, their bearings were recorded during each scan (rotation) of the radar, approximately every 2.5 seconds. The average bearing of each target was then generated from all the scans as the target passed through the HSR beam.

The horizontal radar data were queried and the average target directions were generated for dawn, day, dusk, and night. The overall distribution target directions was also plotted for all dawns, days, dusks, and nights in each season in MS Excel by developing a frequency table of target counts occurring in 45° increments: eight groups centered on north, northeast, east, southeast, south, southwest, west, and northwest. This provided a directional assessment of the target movements throughout the survey area.

Mean direction and angular concentration (*r*) for these time periods were calculated using SQL and formulas based on Zar (1999). The value of *r* is a measure of concentration; it has no units and varies from 0 (no concentration, all values very dispersed) to 1.0 (all data concentrated in the same direction), whereas 1-*r* is a measure of angular dispersion (Zar 1999).

3.7.3 MERLIN Radar Ground Truthing Methods

Both onshore and offshore point count surveys were conducted concurrent with the first few month of radar operation to validate the radar's detection capabilities and to provide supplemental species information. Onshore avian surveys were performed at a total of 15 point count sites. Observations were conducted for 30 minutes per point once per week for ten weeks from March 26 to May 27, 2009. During the onshore point counts all birds seen or heard were recorded on standardized data sheets. Information on species, relative abundance, and flight height (ground, low, medium, and high) was recorded, as well as age and behavior (foraging, direct flight, soaring, and sitting). Weather observations were also recorded on standardized data sheets and included wind speed, ambient temperature, wind direction, sea state (Douglas sea scale) and visibility.

Onshore point count locations were stratified spatially across habitat and terrain types to provide a representative sample of the island's southern coastal avian community as well as the passage of migrants through nearshore waters. Point count sites were selected based on the amount of airspace observable both from the site as well as over the site by the radar system. The majority of onshore point count sites (n = 13) were within the airspace sampled by the horizontal beam of the MERLIN Avian Radar System. Ocean facing bluffs, sandy shorelines, freshwater ponds, and terrestrial ecosystems were sampled throughout the survey period. Five point count sites were located on island bluffs, which provided excellent views over the open ocean out to 3 km (1.9 mi) and allowed for detection of birds over the water, the primary focus of the radar survey. Pelagic species and migrant seaducks were best seen from the bluff point count sites. On average bluffs were a maximum of 52 m (170 ft) above mean sea level (AMSL), though most bluffs were less than 30 m (100 ft). Five point count sites were located on the shoreline, in the intertidal zone; these points provided opportunities for observing shorebirds, seaducks, and wading birds. Shore point count sites included Andy's Way beach on the north end of Great Salt Pond, the jetty at Old Harbor, as well as Vail's Beach and Payne's Beach on the south central shoreline of the island (Appendix A).

Offshore boat-based avian surveys were conducted at 15 point count locations for a total of 15 minutes per point, once per week, for ten weeks from March 26 to May 27, 2009. As with the onshore survey, information on bird species, abundance, and flight height (ground, low, medium, and high) was recorded, as well as age and behavior (foraging, direct flight, soaring, and sitting). During transit (steaming) from port, between points, and back to port, all birds seen or heard were tallied to provide supplemental observations. The 15 point count sites were located in coastal waters approximately 4.6 km (2.5 nm) east, southeast, and south of Block Island.

The MERLIN Avian Radar System located at the Southeast Lighthouse operated in three modes during the spring 2009 surveys: horizontal, short-range vertical, and long-range vertical. The horizontal radar was tracking avian targets moving through a 3.7 km (2 nm) radius circle centered on the Southeast

Lighthouse (Figure 3.7.2). The vertical radar was tracking targets in a 2.8 km (1.5 nm) "bow-tie" shaped swath of airspace and a 5.6 km (3 nm) "pie" slice swath of airspace originating from the radar located at the Southeast Lighthouse (Figure 3.7.2).

During both the onshore and offshore avian point count surveys a radar operator was stationed in the MERLIN radar unit. Constant VHF radio communication allowed the radar operator to ground truth the radar system's tracking abilities based on direct visual observations of avian targets made by the field observer. In addition, a GIS layer (as depicted in Figure 3.7.2) was added to the horizontal radar to allow for more accurate ground truthing by providing geospatial references for biological targets seen on the radar display. Landscape features, such as a communication tower onshore and passing vessels offshore, provided additional geospatial references for accurate identification and correlation between biological targets seen on the radar display and birds observed visually by the boat or shore based observer.

Following confirmation of a biological target by the field observer the target was marked in the radar system using the ground truthing function in the MERLIN software. The ground truthing function allowed individual targets or groups of targets on the radar displays to be tagged with a species name and the number of birds observed. When a target was tagged with the ground truthing function, the target's unique ID number, which was automatically assigned by the MERLIN software, was recorded in the ground truthing database. All records of that target before and after the ground truthing tag were retained in the database and provide more than 40 parameters of data on target size, shape, radar reflectivity, speed, heading, flight height, and target location.

The radar operator monitored the MERLIN radar display during all point count surveys. During point counts avian target locations were relayed from the radar unit to the field observer when the targets approached the expected field of view of the observer. Conversely, when a bird was spotted by the field observer the location of the bird was relayed to the radar operator, where the bird was confirmed or denied as a target being tracked by the MERLIN software. This process of back-and-forth ground truthing can be best described as "MERLIN Initiated Observations" and "Field Observer Initiated Observations," with observations resulting in either a confirmation of the target by the radar operator, or a confirmation of the target by the field observer. The field observer recorded the confirmation of targets when instructed by the radar operator. During periods of down time when the field observer was in transit between points, the radar operator conducted self-initiated ground truthing from the radar station with a spotting scope and binoculars over the Southeast Lighthouse bluff (onshore point count station 5).

3.8 VESPER RADAR

In fall 2009 and spring 2010, Tetra Tech deployed a DeTect VESPER vertical profiling radar on the western side of Block Island. VESPER radar utilizes new technology and analysis techniques to sample a vertical column of air. VESPER is capable of differentiating between biological organisms and, under some conditions, species. DeTect will be providing the analysis and results from the VESPER radar unit upon completion of the study.

Data were collected at Block Island off the coast of Rhode Island from September 3 to October 21, 2009 and from March 17 to June 9, 2010 with a DeTect-owned prototype VESPER radar system. The primary data collection system for the site was the MERLIN Radar System; the VESPER was deployed in conjunction to provide additional insight into the type of activity occurring at the site and help identify those activities that may be relevant to collision risk with wind turbines.

Current radar survey techniques attempt to eliminate insect targets in radar data to prevent overstating bird counts. However, by rejecting insect data rather than classifying it, important data are lost. The vertical distribution of insects is likely to have a significant effect on the height distribution of bats and subsequently the probability of a collision with a wind turbine. At a wind turbine site, if insects occur at the highest densities below the rotor-swept height it is likely that foraging bats would adopt a strategy that would place them below the RSZ. Many studies to date have suggested that most large bat kills occur during the fall migratory season. It is important to understand, however, that during migration bats must still actively seek food. A radar system that can effectively discriminate birds, bats, and insects can provide important information on bat migration relative to insect rich layers in the atmosphere. Insects typically stratify into layers in the atmosphere where the temperature is optimal for flight. Insects also can only modulate their flight muscles efficiently in a narrow temperature range: if it is too cold, they must metabolize energy to warm the flight muscles; too warm and they overheat and die. It is possible that bat mortality with respect to wind turbines is highest where these insect layers intersect with the RSZ of the turbine. This VESPER technology is being developed to aid in defining this relationship.

3.8.1 Radar Equipment and Data Collection

The VESPER radar system is a fixed-beam radar (non-scanning) that is directed vertically. When a target passes over the radar antenna, the height above ground and signal strength of the radar return is collected for every pulse of the radar while the target remains in the beam. The amplitude (reflectivity) of each radar pulse for each range bin was recorded to a data file and post-processed with the VESPER software developed by DeTect. The radar beam was from a parabolic dish with a beam width of approximately 7°; the larger the target, the larger the effective beam width becomes.

The VESPER software takes 4,096 pulses of the radar and integrates (averages) the pulses to make a single detection value. Pulse integration is an average of the return strength in each range bin over many pulses. Random events like noise and interference will not occur in every pulse, and therefore, when averaged, will have a reduced effect on the output of the processed signal when compared to actual targets that will be in every pulse. In this way noise in the radar signal is reduced and the contrast with real targets is enhanced. This is particularly important when trying to image small targets with low radar cross section such as insects.

3.8.2 Data Analysis

The integrated values were plotted onto a graph, and this data output from the software was then reviewed by DeTect staff who noted any significant events (the full VESPER output for Block Island is provided in Appendix C). The graphs have a vertical axis of height above the radar and a horizontal axis of time (Figure 3.8.1). Each of the successive 4,096 pulses were placed into a new column on the graph with the oldest time to the left of the graph and the newest time to the right. Data are displayed as time series data and the targets are birds, bats, and insects. Dark blue targets are the weaker, less reflective targets such as insects or particulates in the atmosphere, while larger targets are more reflective and show up as brighter yellows and whites.

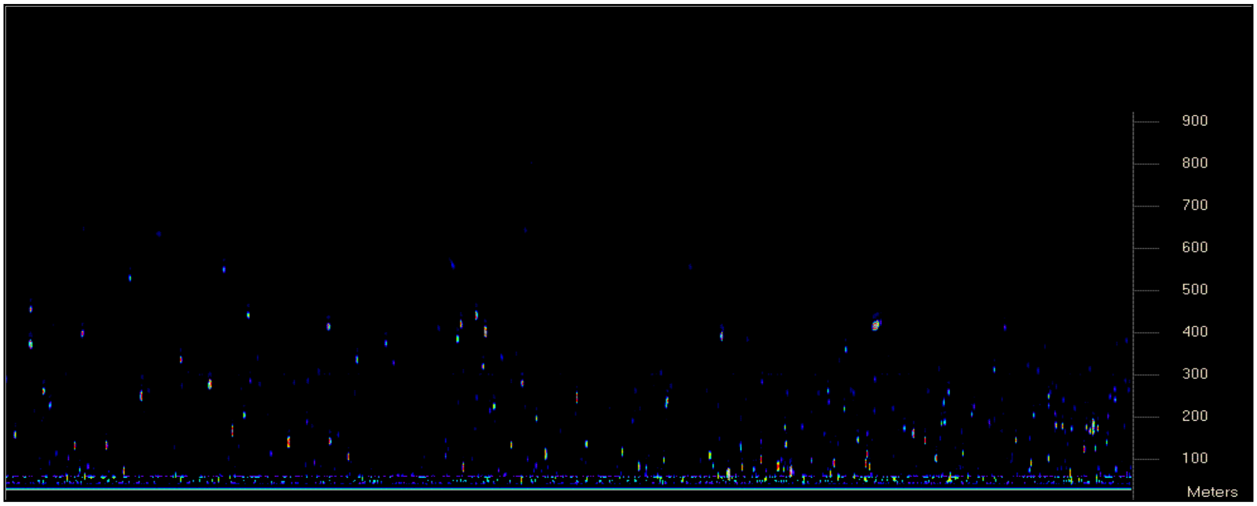


Figure 3.8.1. Example of low activity in the VESPER radar output.

The VESPER radar with its narrow field of view will generally observe fewer targets per unit time than a MERLIN radar system's vertical scanning radar, which has a much larger field of view. The net result is that during low activity times the VESPER radar plots appear to be very quiet with very few targets observed, but as activity picks up they can quickly appear "busy" (Figure 3.8.2). For this reason the MERLIN radar data provide a better quantitative estimate of the activity of migrant birds and bats. However, the narrow field of view and pulse integration of the VESPER makes it much more sensitive to insects, and the graphed data output makes layers of insects or migrant birds or bats more readily discerned.

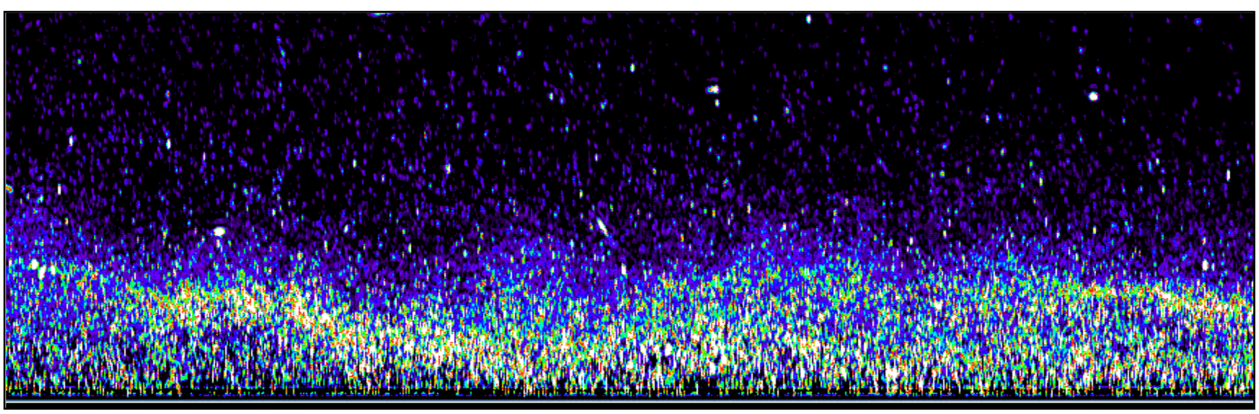


Figure 3.8.2. Example of high activity in the VESPER radar output.

When activity increases the plots illustrate some interesting things such as layering during portions of nights. Within layers of dark blue targets (insects) one sees brighter, larger targets embedding, which are likely bats foraging on these concentrations of insects (Figure 3.8.2). This would be particularly useful information at a wind farm because the occurrence of this layer, especially within the RSZs, provides a better understanding of when bats and birds are at the greatest risk for strikes. This type of data can be easily matched up with other time series data, such as weather, temperature, visibility, and so forth, and correlation of the insect and bat layering with weather time series data may provide the conditions under which high risk occurs.

Insects to a large extent are "aerial plankton," the term used to describe the tiny life forms that float and drift in the air carried by the current of the wind; it is the atmospheric analogue to oceanic plankton. The life forms can vary from microbes to spores, pollen, and wind-scattered seeds, to a large number of invertebrates, mainly arthropods (such as insects and spiders) that are carried upwards into the atmosphere by air currents and may be found floating several thousand feet up. The smallest of the insects are weak fliers; they can do little to direct the trajectory of their flight except to stop flying and allow gravity to cause them to sink more rapidly in the air column. The larger and more powerful insects can alter altitude or flight direction through powered flight, but to minimize energetic losses they will frequently do as little powered flight as possible to overcome the air currents. Similarly, while they are able to expend energy to maintain body temperature and hence optimal flight muscle performance, it is more energy efficient to select flight altitudes where they are thermo neutral. Therefore, layers or multiple layers of insects seeking the same thermo neutral band can form.

Layering is not confined to insects; bats foraging on insects will likely employ optimal foraging strategies that select for these insect layers. The steeply ascending and descending tracks sometimes observed on radar are suspected of representing one strategy adopted by insectivorous birds and bats to quickly locate the insect layers (Figures 3.8.3 and 3.8.4). When bats and birds are hawking insects in the atmosphere, it has been previously noted by DeTect staff using MERLIN (Figure 3.8.3) and VESPER (Figure 3.8.4) radars that they at times make steeply ascending and descending movements as they prospect the atmosphere searching for the location of the insects.

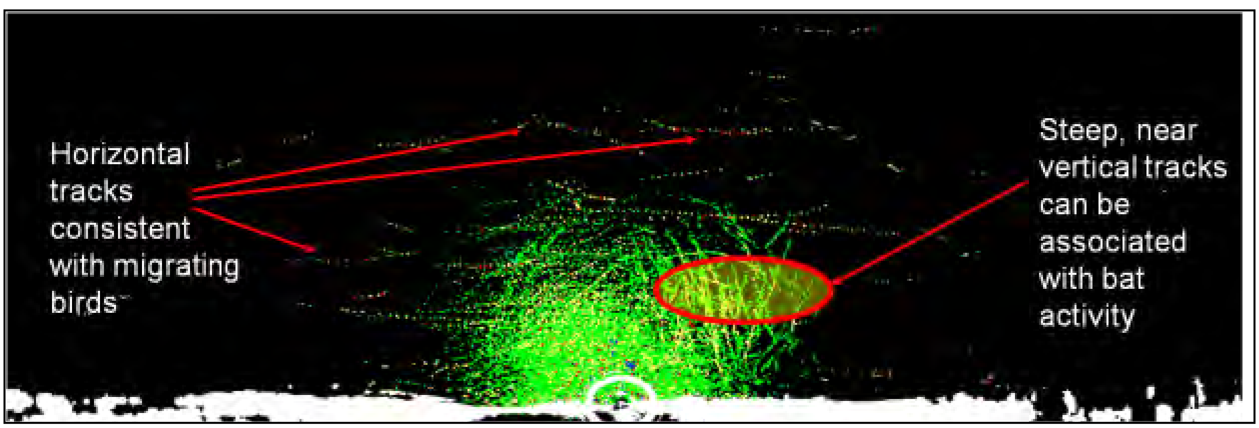


Figure 3.8.3. Example of bat activity in MERLIN radar.

Similar patterns can be visible on the VESPER images as birds and bats change altitude within the beam of the radar (Figure 3.8.4).

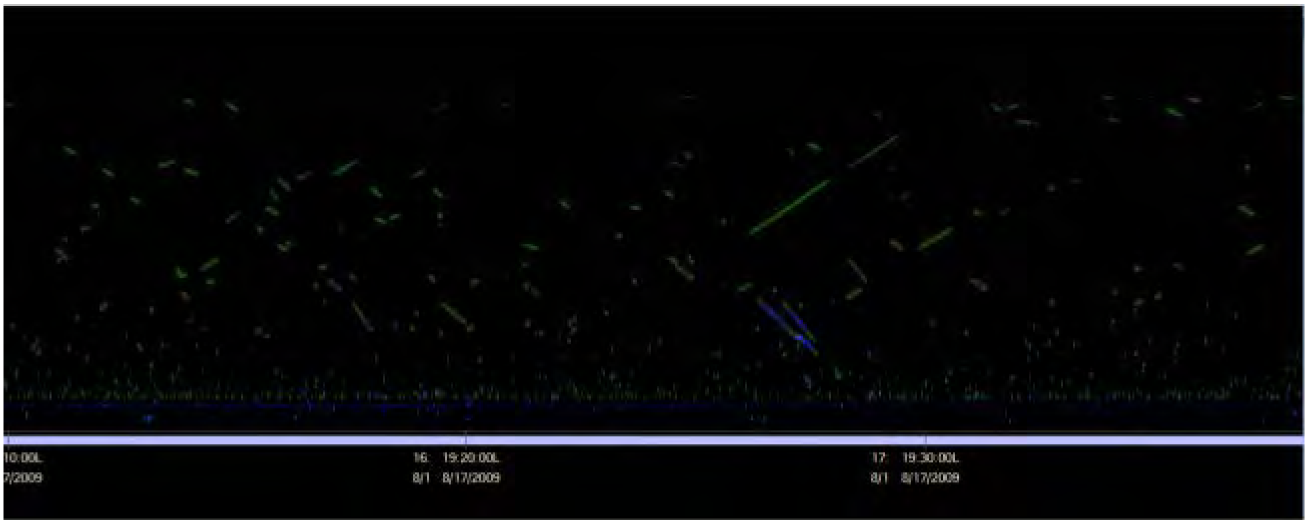


Figure 3.8.4. Example of bat activity in VESPER radar.

3.9 NEXRAD ASSESSMENT METHODS

NEXRAD (Next-Generation Radar) data were accessed, processed, and analyzed to evaluate the seasonal level of bird activity in the Study Area. The nationwide NEXRAD network includes 148 Doppler radars arrayed across the continental United States that provide near-real-time (updated approximately every 6 minutes) information on weather activity. In the early 1980s it was determined that these radars also detected biological targets in the atmosphere (such as birds and bats), and by late 1998 techniques were available to collect and process this information to develop regional bird density information. The radar data can be processed to remove weather, identify biological targets, and conduct spatial analyses to determine daily and seasonal trends of biological targets.

NEXRAD reflectivity is recorded by the system in dBZ (decibels of “Z”) values, which are logarithmic measurements of the energy returned to the radar. High dBZ values represent high amounts of energy return. When weather is not present, biological targets typically range from less than 1 to approximately 35 dBZ. Higher dBZ values are generally correlated with higher levels of biological activity for that period.

3.9.1 Description of Data Sources

The radar remote sensing data used for this assessment was from the National Weather Service (NWS) WSR 88-D NEXRAD weather radar located near Boston, Massachusetts (denoted as KBOX) and New York City (denoted as KOKX). Additionally, regional NWS Surface Area Observations (SAO) visibility databases were used to eliminate radar returns that were associated with weather. This assessment did not include site visits and was limited to a review and evaluation of the data sources identified in this report.

3.9.2 Data Limitations and Bias

DeTect developed, operates, and maintains a NEXRAD-based Avian Radar System that continuously processes data from all 148 NEXRAD stations 24 hours a day, 7 days a week, 365 days a year. The core system is the Avian Hazard Advisory System (AHAS) that provides bird strike risk advisory risks to the

U.S. military flying units (USAF, Navy, Air Guard, NASA) and the Federal Aviation Administration (FAA). In the case of the USAF, all flying units make flight safety decisions using the AHAS web interface (www.usAHAS.com), which allows users to select any flight route, range, or operating area and receive the current or future risk (projected based on over eight years of archived data). The system is a neural network of over 20 computers located in DeTect's Florida offices that continually processes the NEXRAD data feed and uses a complex set of algorithms to determine specific risk based on a number of variables that include current NEXRAD density and weather conditions. The validity of the system is relied upon by the USAF, and its use has been credited with significantly reducing the number of bird-aircraft strikes on low level flying routes across the United States. DeTect's NEXRAD methodology takes into consideration the specific limitations and bias inherent in the NEXRAD data that includes spatial resolution, data pre-processing, radar range and sampling accuracy at low altitudes, and insect contamination, each outlined below.

Spatial Resolution

NEXRAD data in their native format have a spatial resolution of 1 km (0.6 mi) by 1°, or one data point for each 1 km of range and each degree in azimuth. Each 1 km range bin sample is composed of four 250 m (820 ft) range bins, which are integrated to create a single 1 km value. DeTect's automated NEXRAD data system takes this range/azimuth polar format data and transforms it into raster Cartesian data with a resolution of 1 km by 1 km. The raster format is much more easily handled in a Geographic Information System (GIS) within the NEXRAD system for analysis.

Pre-Processing

All data formats available to any end user of NEXRAD data undergo signal processing before being distributed to end users. Post-processing of the raw NEXRAD radar data involves specialized, highly redundant processing, such as point target censoring and signal thresholding, prior to the integration of the four 250 m (820 ft) range bins into a 1 km (0.6 mi) data value.

It is important to note that weather surveillance radar such as NEXRAD are not designed to monitor single or "point" targets, but rather multiple targets (such as rain drops) distributed throughout a volume of space known as a pulse volume. For example, NEXRAD does not show aircraft (a point target) and does not detect individual vultures or gulls soaring over the landscape, nor any other spatially limited point source. It only detects biological targets distributed in such a manner that they bypass the point target censoring and signal thresholding process built into the NEXRAD system.

Radar Range and Sampling Accuracy at Low Altitudes

It has been suggested that NEXRAD data samples taken at a distance (up to 119 km [64 nm]) from the radar (as used in the USAF protocol) may not reflect the numbers of biological targets active in the RSZ of a turbine, as the calculated theoretical radar beam bottom height will be too high (above the RSZ). The effect of atmospheric conditions on calculated beam height and super-refractive conditions are more common than in a standard atmosphere when most birds are active, particularly in coastal areas. Therefore, beam height charts overestimate the height of the beam and are not useful for this analysis.

Additionally, the numbers of birds moving at the lower altitudes are generally proportional to the numbers of birds moving aloft, and higher altitude data can provide a useful gauge of level of activity in a NEXRAD screening assessment analysis. There is generally an autocorrelation between the trend in bird target numbers aloft and the trend in bird target numbers at lower altitudes. Stratification of bird targets has been seen where dense layers of targets can be observed, but even so, the general trend of more bird targets occurring above than below them holds true.

This auto correlation of bird target numbers aloft with bird target numbers near the surface can also be demonstrated from analysis of NEXRAD data. If stratification and altitude correlation does not occur, then once bird migration is underway and birds have reached the optimal flight altitudes (i.e., 2–3 hours after sunset), NEXRAD should show no targets at low altitudes and high activity aloft (at higher altitudes). If this were true, one should be able to identify "donut-like" regions of no targets immediately around each NEXRAD extending out to the point where the beam intersects the higher altitudes at which the targets are migrating. This is not typically observed. If the target numbers decrease significantly at any location in the radar coverage area, the NEXRAD point target censoring algorithm will eliminate those targets. In over 10 years of continuously analyzing year-round NEXRAD data from all 148 NEXRAD stations in the lower 48 states, this condition has yet to be observed with biological targets; the condition has only been observed one time with virga, a form of precipitation whereby the rain or snow evaporates or sublimates before it reaches the ground. While the NEXRAD beam from the lower tilt at the Boston and New York City radars for the Block Island site may not always sample the RSZ, data collected from the airspace above remain a viable indicator of biological activity in the sample area.

Insect Contamination

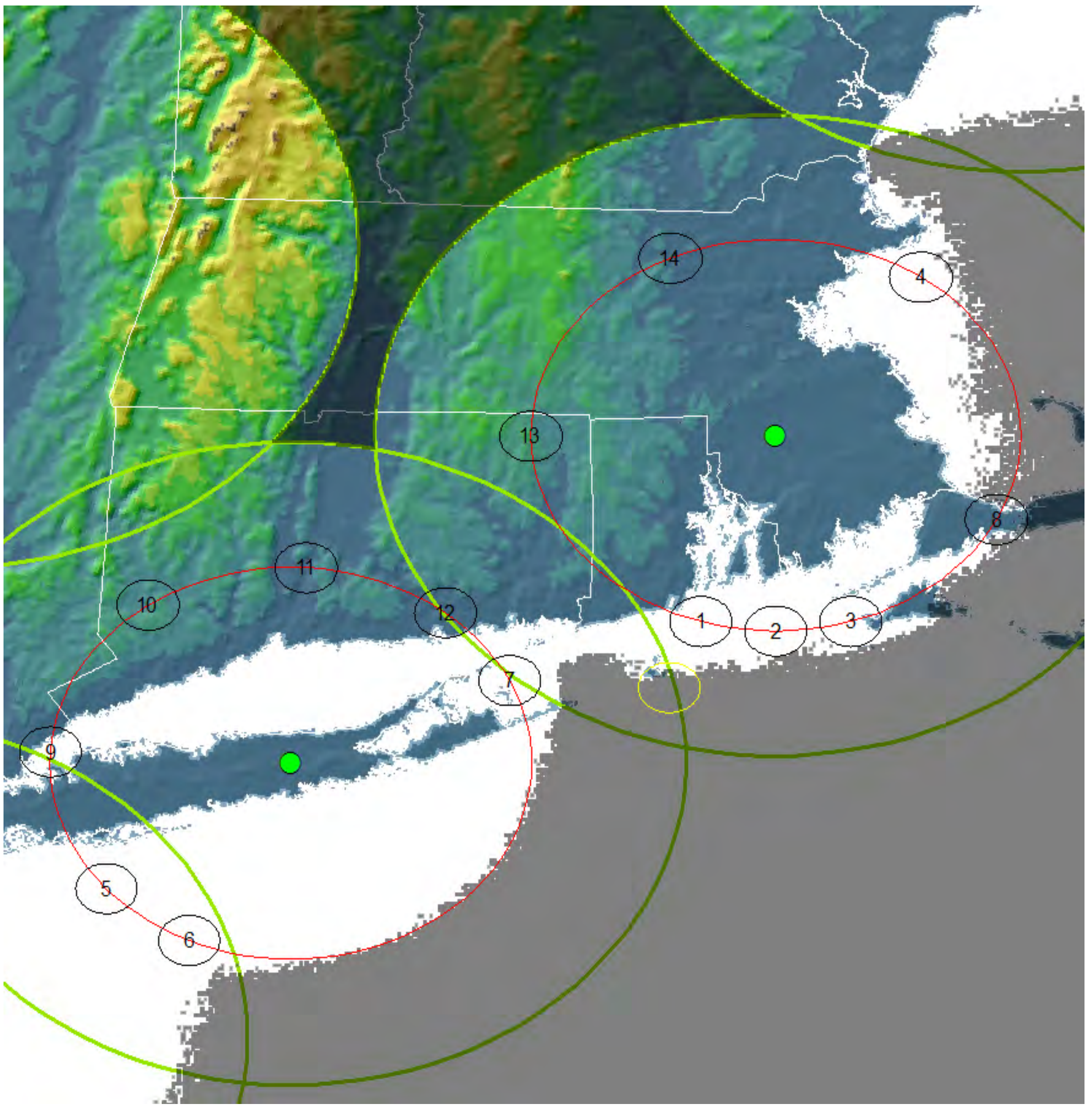
It has been suggested that because NEXRAD data include returns from insects, then steps should be taken to exclude insects from the data. The debate should be not *if* NEXRAD data contain insects, but rather *when* the data are mostly insects, can they (1) be identified, and (2) removed without falsely removing bird data when birds may be the majority of the radar returns. In developing AHAS, the USAF and DeTect staff carefully considered the published or reported methodologies for elimination of insects from NEXRAD data and concluded that the assumptions of each resulted in unreliable removal of those targets. Additionally, on days when insects aloft are abundant and widespread, it is highly likely that there will be large numbers of active insectivorous birds and bats exploiting the resource. On the occasions when only insects could be present in the atmosphere, the benefit of any uncertainty in an analysis is, accordingly, to the resource (birds and bats).

3.9.3 Surface Area Observations

Historical visibility information was accessed from airport Automated Surface Observing System (ASOS) and Automated Weather Observing System (AWOS) databases available for the Study Area. ASOS data are available at both towered airports and major non-towered facilities, and AWOS is available at most towered airports. Both systems are a collection of electronic sensors providing data to a computer system that creates visibility information for the current period. Data are archived and can be used to develop a visibility history profile for specific areas by time of day. Current reportable ASOS values of visibility in statute miles are: <1/4, 1/4, 1/2, 3/4, 1, 11/4, 11/2, 13/4, 2, 21/2, 3, 4, 5, 6, 7, 8, 9, and 10+. For avian risk assessment, low visibility resulting in bird strike risk is generally defined as visibility of less than one third of a mile. As a more conservative estimate of low visibility, DeTect uses a half mile as the threshold value for low visibility.

3.9.4 Assessment Methodology

As previously noted, this assessment analyzed archived radar data that were processed from the NWS NEXRAD installations located near Boston and New York City. The actual proposed location of the turbines is outside of the coverage area for the NEXRAD system (Figure 3.9.1). The closest location to this coordinate that had coverage (to the northeast of the proposed wind farm) was selected as the test site (site 1). As illustrated in Figure 3.9.1, the KBOX radar is located 72.2 km (44.9 mi) from the analysis point within site 1. A major factor determining the probability of detection of a target by radar is the distance from the radar to the target. Thirteen additional sites with the same coverage area and at the same distance from the NEXRAD radar, at either Boston or the New York City (KOKX) installations, were also sampled (sites 2–14). Sites 1–7 are all offshore locations, and sites 8–14 are onshore sites for comparison purposes. NEXRAD reflectivity data (dBZ) are archived approximately every 6 minutes in 1 km^2 areas.



Note: The small yellow circle represents the proposed location of the BIWF turbines; green dots indicate the locations of the New York City (KOKX) and Boston (KBOX) NWS NEXRAD installations; NEXRAD sample sites are numbered black circles 1–14; grey areas are zones of non-coverage.

Figure 3.9.1. Approximate location of the NEXRAD sample sites.

NEXRAD data were converted to "Z" values, and the hourly averages were calculated for each survey site. A great deal of work has been done over the past decade in an effort to convert dBZ values to an estimator of bird densities. A wide range of variables may influence these calculations; however, Black (2000) reported that a simple estimation of density could be determined by converting the logarithmic dBZ value to "Z" values (Z = antilog [dBZ/10.0]). At a given location the value of "Z" should be equal to the average value of the density times the average value of the radar cross-section of the birds in the volume of airspace times a constant of 28.0. However in most cases the average cross-section of the birds in the volume of airspace is unknown. Additionally, the mix of bird species in the airspace volume may include both large and small birds. Black (2000) suggests that an average density can be determined by multiplying the Z value times 3 to estimate birds/km^2/hr. The multiplier can range from 2 (landing density), to 3 (beam density at 46km), to 100 (migration traffic rate). For statistical comparison and ranking of the proposed site to other sites in the area no adjustment to the Z values was used.

Recent updates to the USAF AHAS have included a new operational risk management calculation that not only includes the level of reflectivity (estimate of density) but also the percentage of the sample area that has returns (estimate of probability of encountering a target in a given sample area). This analysis of radar data uses this concept of operational risk (average Z values times the percentage of the area covered) as the variable used to compare activity at each of the fourteen sample sites.

3.9.5 Data Queries

Processed NEXRAD data from the fourteen sample sites along the Northeast U.S. Atlantic coast were extracted from the NEXRAD data archives (KBOX and KOKX) covering the period from January 2006 through December 2010. The initial data set accessed included over 4 million radar records. Records that occurred during periods of precipitation (defined by SAO data and NEXRAD precipitation mode) were excluded from the analysis.

3.9.6 Radar Coverage

Data extracted for the analysis was processed from the lowest tilt of the NEXRAD radars. The NEXRAD system has a one degree beam angle and is aligned to cover from ground level to an altitude that is dependent upon the distance from the radar. At a distance of 72.23 km (44.88 mi), the theoretical beam coverage of the Boston and New York City radars at the sample sites would be between 410 m (1,345 ft) and 1,675 m (5,495 ft) above surface level. This geometric coverage is based upon a standard atmosphere, which is rarely the case, and the beam will frequently cover airspace lower to the ground through atmospheric beam bending effect. Viewshed analysis of both radar locations shows no blockage of the beam at this altitude (Appendix G).

4.0 RESULTS

4.1 ONSHORE SEA WATCH AVIAN SURVEYS

A total of 274 onshore avian point count surveys were conducted at the 10 designated stations at the southern end of Block Island between July 14, 2009 and June 24, 2010. Each point count station was surveyed for 30 minutes, resulting in 137 hours of total observation time. While the original survey effort called for a total of 280 surveys over the 12 month period, sampling at certain stations could not take place on several occasions due to weather conditions and beach closures; therefore, the onshore sea watch survey effort was not consistent across all point count stations, with sampling at each station ranging between 23 and 29 times over the entire survey period (Tables 4.1.1 and 4.1.2).

Table 4.1.1. Summary of level of effort of the onshore sea watch surveys – BIWF 2009–2011.

Point Count Station	Survey Frequency	Survey Effort (Hrs)
1	28	14.0
2	29	14.5
3	29	14.5
4	29	14.5
5	28	14.0
6	29	14.5
7	26	13.0
8	27	13.5
9	26	13.0
10	23	11.5
Total	**274**	**137**

Table 4.1.2. Onshore sea watch surveys performed, by date and location – BIWF 2009–2011.

Date	1. Andy's Way	2. Crescent Beach	3. Old Harbor Jetty	4. St. Andrew's	5. Southeast Light	6. Payne's Beach	7. Monhegan Bluff	8. Vail's Beach	9. Black Rock Bluff	10. Lewis-Dicken's Farm	Total Count of Surveys
14-Jul-09	X	X									2
15-Jul-09			X	X	X	X	X	X	X	X	8
21-Jul-09		X	X	X	X						4
22-Jul-09						X	X	X			3
11-Aug-09						X	X	X	X	X	5
13-Aug-09	X	X	X	X	X						5
25-Aug-09				X							1
26-Aug-09	X				X	X					3
27-Aug-09		X	X			X			X	X	5
7-Sep-09						X	X	X			3
8-Sep-09	X	X									2
9-Sep-09			X	X	X						3
16-Sep-09	X	X	X	X	X		X	X	X	X	9
23-Sep-09						X	X		X	X	4
24-Sep-09	X	X	X	X	X			X			6
28-Sep-09		X	X	X							3
29-Sep-09						X	X	X	X		4
30-Sep-09	X				X	X				X	4
13-Oct-09	X	X	X	X	X	X		X	X		8
15-Oct-09										X	1
27-Oct-09	X	X	X	X	X	X	X	X	X	X	10
9-Nov-09	X			X			X	X		X	5
10-Nov-09		X	X		X	X			X		5
18-Nov-09		X	X	X						X	4
19-Nov-09	X				X		X				3

Date	1. Andy's Way	2. Crescent Beach	3. Old Harbor Jetty	4. St. Andrew's	5. Southeast Light	6. Payne's Beach	7. Monhegan Bluff	8. Vail's Beach	9. Black Rock Bluff	10. Lewis-Dicken's Farm	Total Count of Surveys
20-Nov-09						X		X	X		3
8-Dec-09	X	X	X	X	X	X	X	X	X	X	10
15-Dec-09	X	X	X	X	X						5
16-Dec-09						X	X	X	X	X	5
13-Jan-10						X	X	X	X		4
14-Jan-10	X									X	2
15-Jan-10		X	X	X	X						4
27-Jan-10	X	X	X	X	X						5
28-Jan-10						X	X	X	X	X	5
3-Feb-10			X	X	X	X	X	X	X	X	8
4-Feb-10	X	X									2
18-Feb-10	X	X	X	X		X					5
19-Feb-10	X	X	X	X	X		X	X	X	X	9
2-Mar-10	X	X					X		X	X	5
3-Mar-10			X	X	X	X		X			5
16-Mar-10			X	X	X						3
17-Mar-10	X	X					X			X	4
18-Mar-10								X	X		2
19-Mar-10						X					1
6-Apr-10			X								1
7-Apr-10	X					X	X	X	X		5
9-Apr-10		X		X	X						3
13-Apr-10				X			X				2
14-Apr-10	X	X	X			X		X	X		6
15-Apr-10					X						1
19-Apr-10							X		X		2
20-Apr-10	X	X	X	X	X	X					6

Date	1. Andy's Way	2. Crescent Beach	3. Old Harbor Jetty	4. St. Andrew's	5. Southeast Light	6. Payne's Beach	7. Monhegan Bluff	8. Vail's Beach	9. Black Rock Bluff	10. Lewis-Dicken's Farm	Total Count of Surveys
21-Apr-10								X			1
27-Apr-10				X	X						2
28-Apr-10	X	X	X				X	X	X	X	7
29-Apr-10						X					1
10-May-10										X	1
11-May-10						X	X	X	X		4
13-May-10	X	X	X	X	X						5
26-May-10	X	X	X	X						X	5
27-May-10					X	X	X	X	X		5
8-Jun-10										X	1
9-Jun-10	X	X		X	X	X	X	X	X		8
10-Jun-10			X								1
23-Jun-10						X	X	X	X	X	5
24-Jun-10	X	X	X	X	X						5
Total	**28**	**29**	**29**	**29**	**28**	**29**	**26**	**27**	**26**	**23**	**274**

4.1.1 Observation Totals and Overall Species Abundance, Richness, and Composition

A total of 25,507 bird observations representing ninety seven (97) species were recorded during the sea watch surveys (Tables 4.1.3 and 4.1.4). Landbirds, including passerines and raptors, accounted for much of the species richness (46 species) during the onshore point count surveys (Table 4.1.4). However, there were not as many species of landbirds encountered as might have been expected given the passerine species diversity observed elsewhere on Block Island, especially during fall migration mist-net surveys (ASRI 2003). Landbirds may have been under-represented because the focus of the onshore sea watch surveys was to catalog seabird and shorebird activity. Shorebirds were the next most diverse group following landbirds with 20 species observed, followed by waterfowl with 16 species. Two species of loon and two grebes were observed during the BIWF sea watch survey. One shearwater and one storm-petrel species were encountered (Table 4.1.3). Four species of wading bird were noted: great blue heron, great egret, snowy egret, and black-crowned night-heron.

Three of the species observed during the sea watch survey are listed as endangered by the state of Rhode Island and include barn owl, peregrine falcon, and northern harrier (RIDEM 2006). Ten of the species observed are listed as species of special concern in Rhode Island including osprey, Cooper's hawk, great-blue heron, great egret, snowy egret, black-crowned night-heron, blue-winged teal, American oystercatcher, willet, dark-eyed junco, and least tern. The federally threatened piping plover was observed on two occasions during the onshore sea watch survey at Andy's Way (Point 1) (ER = 0.007, *n* = 2); the federally endangered roseate tern was not observed during the onshore sea watch surveys.

Overall Abundance/Relative Abundance – Bird Counts

Of the 25,507 detections 9,914 (38.9%) were gulls and 7,720 (30.2%) were waterfowl. Seabirds, terns, and shorebirds accounted for 6.5% (*n* = 1,666), 5.7% (*n* = 1,465), and 5.2% (n = 1,333) of all bird detections, respectively. Approximately 5.1% (*n* = 1,294) were landbirds. Loon observations accounted for 2% (*n* = 555) of the total (Table 4.1.3).

Of the gulls counted, the species with the greatest number of observations were herring gull (17.9%, n = 4,587) and great black-backed gull (13.8%, *n* = 3,512) (Table 4.1.4). Of the waterfowl, common eider had the greatest number of observations at 2,586 (10.1%) followed by black scoter at 1,885 observations (7.4%) (Table 4.1.4).

Table 4.1.3. Summary statistics for the onshore sea watch surveys, by species group – BIWF 2009–2011.

Species Group	Species Richness	Total Count of Encounters	Percentage of Total Count	Overall Encounter Rate (birds/survey)	Temporal Frequency (percentage of surveys during which the group was observed)	Spatial Frequency (percentage of point count locations at which the group was observed)
Loons	2	555	2.2%	8.41	43.4%	100.0%
Waterfowl	16	7,720	30.3%	116.97	86.9%	100.0%
Shorebirds	20	1,333	5.2%	20.20	30.7%	70.0%
Gulls	5	9,914	38.9%	150.21	100.0%	100.0%
Terns	1	1,465	5.7%	22.20	8.0%	90.0%
Seabirds	4	1,666	6.5%	25.24	42.3%	90.0%
Landbirds	46	1,294	5.1%	19.61	85.4%	100.0%

Table 4.1.4. Summary of species observed during the onshore sea watch surveys – BIWF 2009–2011.

Common Name	Genus/Species	Total # Birds Observed	Encounter Rate (birds observed per survey)
Loons			
Common loon	*Gavia immer*	535	1.953
Red-throated loon	*Gavia stellata*	17	0.062
Unidentified loon		3	0.011
Grebes			
Horned grebe	*Podiceps auritus*	130	0.474
Red-necked grebe	*Podiceps grisegena*	4	0.015
Shearwaters and Petrels			
Great shearwater	*Puffinus gravis*	29	0.106
Wilson's storm-petrel	*Oceanites oceanicus*	3	0.011
Unidentified shearwater		147	0.536
Gannets			
Northern gannet	*Morus bassanus*	1,482	5.409
Cormorants			
Double-crested cormorant	*Phalacrocorax auritus*	602	2.197
Great cormorant	*Phalacrocorax carbo*	616	2.248
Unidentified cormorant		10	0.036
Herons and Allies			
Great blue heron	*Ardea herodias*	20	0.073
Great egret	*Ardea alba*	56	0.204
Snowy egret	*Egretta thula*	37	0.135
Black-crowned night-heron	*Nycticorax nycticorax*	13	0.047
Ducks and Geese			
Canada goose	*Branta canadensis*	336	1.226
Brant	*Branta bernicla*	1	0.004
Mallard	*Anas platyrhynchos*	88	0.321
American black duck	*Anas rubripes*	73	0.266
American black duck X Mallard hybrid		1	0.004
Blue-winged teal	*Anas discors*	4	0.015
Redhead	*Aythya americana*	8	0.029
Greater scaup	*Aythya marila*	1	0.004
Common eider	*Somateria mollissima*	2,586	9.438
Harlequin duck	*Histrionicus histrionicus*	11	0.040
Long-tailed duck	*Clangula hyemalis*	5	0.018
White-winged scoter	*Melanitta fusca*	103	0.376
Surf scoter	*Melanitta perspicillata*	57	0.208
Black scoter	*Melanitta nigra*	1,885	6.880

Common Name	Genus/Species	Total # Birds Observed	Encounter Rate (birds observed per survey)
Common goldeneye	*Bucephala clangula*	474	1.730
Bufflehead	*Bucephala albeola*	287	1.047
Red-breasted merganser	*Mergus serrator*	1,253	4.573
Unidentified scoter		365	1.332
Unidentified duck		182	0.664
Hawks and Allies			
Osprey	*Pandion haliaetus*	2	0.007
Sharp-shinned hawk	*Accipiter striatus*	1	0.004
Cooper's Hawk	*Accipiter cooperii*	2	0.007
Unidentified accipiter		1	0.004
Northern harrier	*Circus cyaneus*	6	0.022
Falcons			
MERLIN	*Falco columarius*	5	0.018
Peregrine falcon	*Falco peregrinus*	14	0.051
Unidentified falcon		2	0.007
Pheasant			
Ring-necked pheasant	*Phasianus colchicus*	28	0.102
Plovers			
Black-bellied plover	*Pluvialis squatarola*	314	1.146
American golden-plover	*Pluvialis dominica*	92	0.336
Semipalmated plover	*Charadrius semipalmatus*	56	0.204
Piping plover	*Charadrius melodus*	2	0.007
Oystercatchers			
American oystercatcher	*Haematopus palliatus*	22	0.080
Sandpipers and Allies			
Greater yellowlegs	*Tringa melanoleuca*	29	0.106
Solitary sandpiper	*Tringa solitaria*	3	0.011
Willet	*Catoptrophorus semipalmatus*	2	0.007
Whimbrel	*Numenius phaeopus*	1	0.004
Ruddy turnstone	*Arenaria interpres*	13	0.047
Purple sandpiper	*Calidris maritima*	12	0.044
Sanderling	*Calidris alba*	391	1.427
Pectoral sandpiper	*Calidris melanotos*	1	0.004
White-rumped sandpiper	*Calidris fuscicollis*	8	0.029
Semipalmated sandpiper	*Calidris pusilla*	101	0.369
Western sandpiper	*Calidris mauri*	3	0.011
Unidentified sandpiper		27	0.099
Spotted sandpiper	*Actitis macularia*	3	0.011
Dunlin	*Calidris alpina*	179	0.653

Common Name	Genus/Species	Total # Birds Observed	Encounter Rate (birds observed per survey)
Unidentified shorebird		67	0.245
Short-billed dowitcher	*Limnodromus griseus*	7	0.026
American woodcock	*Scolopax minor*	1	0.004
Gulls and Terns			
Bonaparte's gull	*Larus philadelphia*	1	0.004
Laughing gull	*Larus atricilla*	35	0.128
Ring-billed gull	*Larus delawarensis*	43	0.157
Herring gull	*Larus canus*	4,587	16.741
Great black-backed gull	*Larus marinus*	3,512	12.818
Unidentified Larus gull		1,736	6.336
Common tern	*Sterna hirundo*	572	2.088
Unidentified tern		893	3.259
Alcids			
Razorbill	*Alca torda*	2	0.007
Unidentified alcid		3	0.011
Doves			
Mourning dove	*Zenaida macroura*	20	0.073
Kingfishers			
Belted kingfisher	*Ceryle alcyon*	9	0.033
Woodpeckers and Allies			
Northern flicker	*Colaptes auratus*	1	0.004
Jays and Crows			
Blue jay	*Cyanocitta cristata*	2	0.007
American crow	*Corvus brachyrhynchos*	334	1.219
Fish crow	*Corvus ossifragus*	96	0.350
Unidentified crow		3	0.011
Swallows			
Barn swallow	*Hirundo rustica*	71	0.259
Northern rough-winged swallow	*Stelgidopteryx serripennis*	3	0.011
Bank swallow	*Riparia riparia*	81	0.296
Tree swallow	*Tachycineta bicolor*	53	0.193
Unidentified swallow		45	0.164
Chickadees			
Black-capped chickadee	*Poecile atricapilla*	4	0.015
Wrens			
Carolina wren	*Thryothorus ludovicianus*	45	0.164
Thrushes			
American robin	*Turdus migratorius*	149	0.544
Mockingbirds and Thrashers			

Common Name	Genus/Species	Total # Birds Observed	Encounter Rate (birds observed per survey)
Gray catbird	*Dumetella carolinensis*	5	0.018
Northern mockingbird	*Mimus polyglottos*	1	0.004
Wood-Warblers			
Yellow warbler	*Dendroica petechia*	6	0.022
Common yellowthroat	*Geothylypis thrichas*	40	0.146
Cardinals			
Northern cardinal	*Cardinalis cardinalis*	2	0.007
Emberizids			
Eastern towhee	*Pipilo erythrophthalmus*	54	0.197
Song sparrow	*Melospiza melodia*	110	0.401
White-throated sparrow	*Zonotrichia albicollis*	1	0.004
Unidentified sparrow		4	0.015
Dark-eyed junco	*Junco hyemalis*	3	0.011
Blackbirds			
Red-winged blackbird	*Agwlaius phoeniceus*	96	0.350
Common grackle	*Quiscalus quiscula*	24	0.088
Brown-headed cowbird	*Molothrus ater*	1	0.004
Old World Sparrows			
House sparrow	*Passer domesticus*	11	0.040
Finches			
American goldfinch	*Carduelis tristis*	29	0.106
Unidentified			
Unidentified bird		1	0.004
Total # Birds Observed		**25,507**	**93.091**

Overall Encounter Rates

Using ER as a measure of abundance (average number of observations of a given species or species group per survey effort) the most abundant species group was gulls (overall gull ER = 150.21 birds/survey), particularly herring gull and great black-backed gull, which were encountered at rates of 16.7 and 12.8 birds/survey, respectively (Tables 4.1.3 and 4.1.4). Waterfowl were also abundant (ER = 116.97 birds/survey), although they occurred at a lower ER than gulls. Common eider (ER = 9.4 birds/survey) and black scoter (ER = 6.8 birds/survey) were the most abundant waterfowl species.

Seabirds, terns, shorebirds, and landbirds occurred at similar abundances with ERs of approximately 20 birds/survey, while loons had the lowest overall abundance (ER = 8.0 birds/survey) (Table 4.1.4). Northern gannet was observed at a rate of 5.4 birds/survey, more so than any other seabird including alcids and shearwaters. Common tern had an ER of 2.1 birds/survey. The most abundant passerine was American crow (ER = 1.22 birds/survey). Common loon was the most abundant loon species (ER = 1.95 birds/survey), while red-throated loon detections were less abundant (ER = 0.1 birds/survey). Encounter rates for all species groups may be found in Table 4.1.3 and for all species in Table 4.1.4.

4.1.2 Temporal Distribution

Counts by Time Period

The total count of birds observed varied across survey periods. The greatest number of bird observations was made on February 3, 2010 (*n* = 1,465), and the fewest detections were recorded on August 25, 2009 (*n* = 13). In general more birds were observed during the winter than during the fall and spring surveys, and even fewer were observed in the summer (Figure 4.1.1.). There were definitive increases in the number of birds observed during the fall and spring migration periods, but this is likely a result of increased survey effort; therefore ER values maybe more descriptive. There was also an increase in count totals during the month of August, which may be attributable to early fall tern and shorebird migration.

The largest percentage of loon observations was made in April (*n* = 315, 57%) as were most seabird observations (*n* = 768, 57%). Most waterfowl observations were noted in March (*n* = 2,263, 29%). Counts of gulls were less variable, although 15% of gull detections were made in April and 16% in September. Nearly all terns (*n* = 1,464, 99%) were encountered in August. Most landbirds were recorded from April to July (*n* = 794, 66%). Most shorebirds were observed from February to May (*n* = 681, 51%), and again in August (*n* =169, 13%).

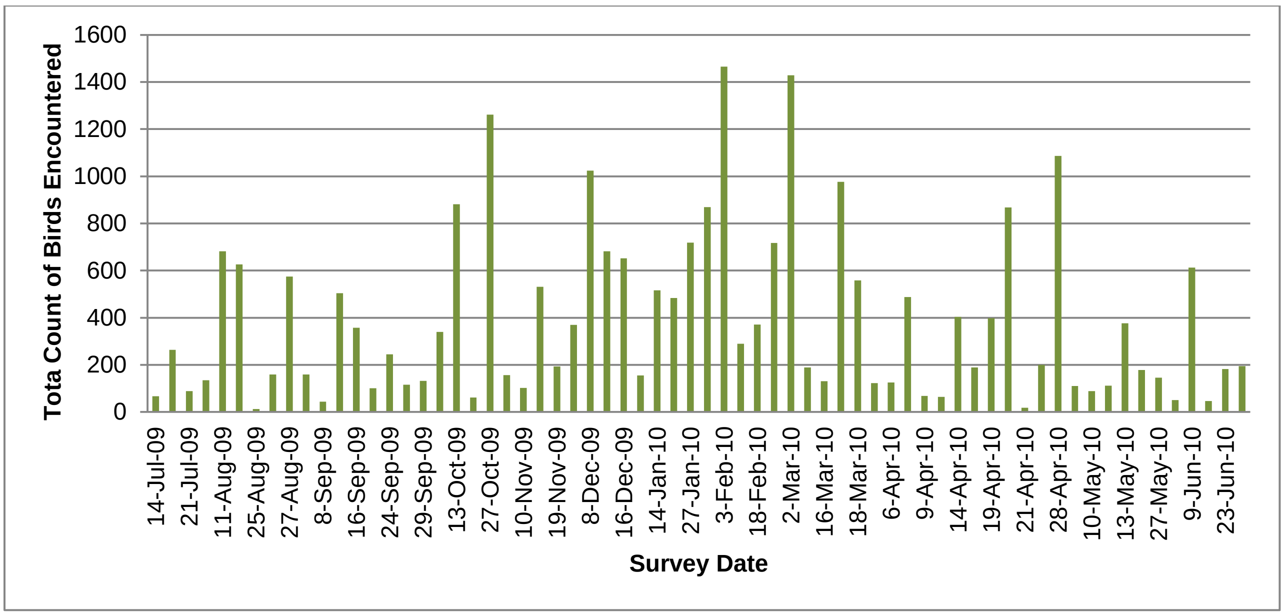


Figure 4.1.1. Count of total birds observed by survey date across all point count stations – BIWF 2009–2011.

Frequency During the Survey Period

There was some variability in the presence of each species group across survey dates. Gulls were observed during every survey and thus had a frequency rate of 100% over the entire survey period (Table 4.1.4). Waterfowl were also observed frequently and were detected in 86.9% of surveys. Similarly, landbirds were present during nearly every point count (85.4% of surveys). Shorebirds and terns had relatively low frequencies of observations at 30.7% and 8.0%, respectively.

Encounter Rates by Time Period

Distinct seasonal variations in encounter rates were observed among different species groups during the year-long survey period. Overall abundance, as measured by ER, was greatest in the month of March, followed by January and February (Table 4.1.5 and Figure 4.1.2). A relatively significant decrease in the overall ERs was observed during May, June, and July.

Waterfowl were the most abundant species in March, with an ER of 113.15 birds/survey (Table 4.1.5 and 4.1.6). Waterfowl became less abundant in spring with an ER between 25.14 birds/survey and 3.20 birds/survey in April and May, and they were present only in low numbers in the summer with an ER of 1.07 in June, July, and August combined. Loon abundance increased from January through April (loons had a combined ER of 4.58 birds/survey during this time period). Loons were most frequently observed in April, with an ER of 8.51 birds/survey (Table 4.1.6). Loons were not observed in June, July, or August. Shorebirds were most abundant in May and August, which corresponds with the expected shorebird spring and fall migration periods (Figure 4.1.2). Gull abundance was generally constant throughout the year, although their abundance increased slightly in December and October (Figure 4.1.2). Terns were observed only in August and September during the onshore sea watch surveys, with the highest ER in August. Seabirds as a group (e.g., northern gannets, shearwaters, and alcids) were detected at relatively consistent rates throughout the year, with peak observations in April. Landbirds were present year-round, with peak abundance in late spring and summer (Figure 4.1.2).

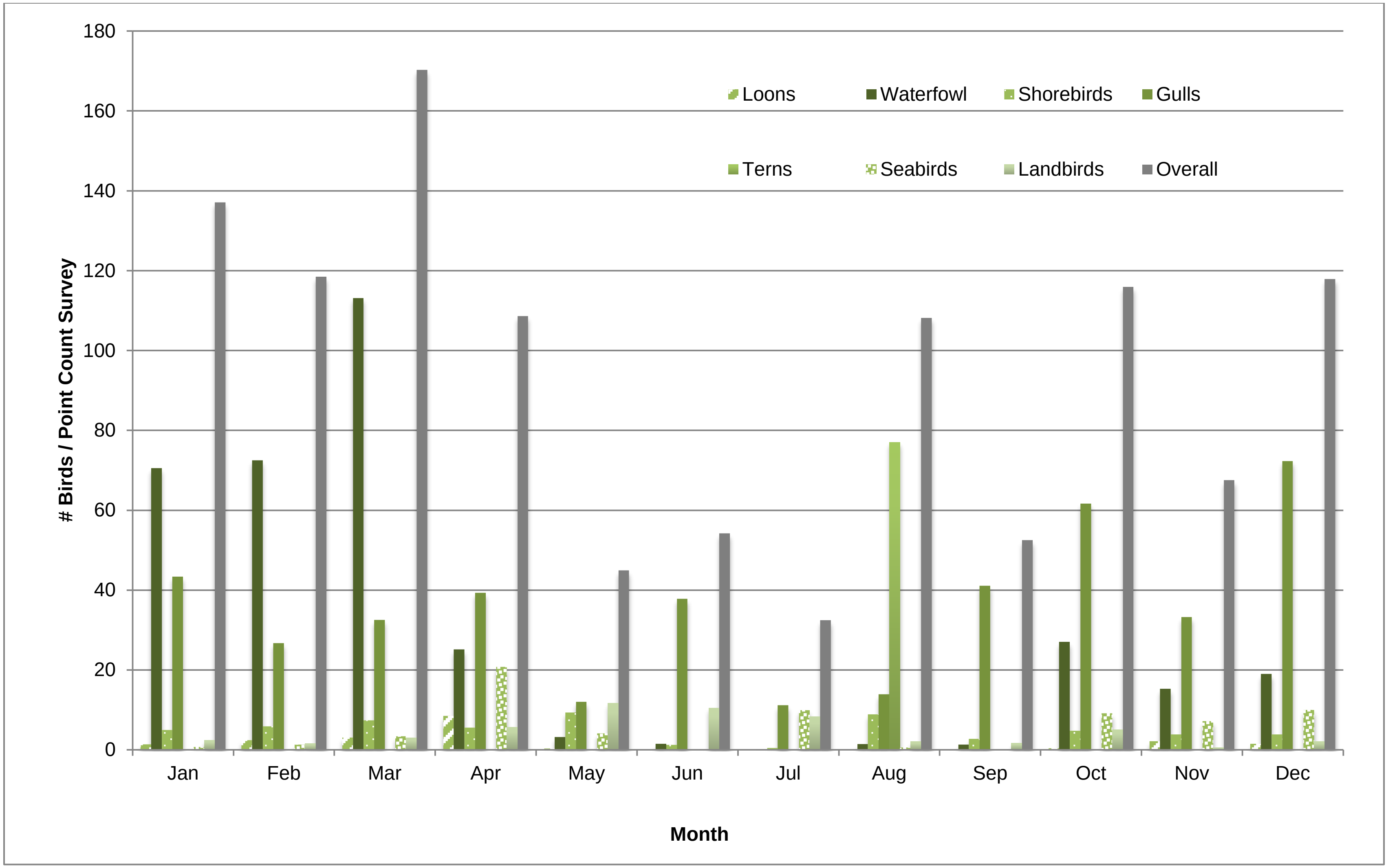


Figure 4.1.2. Encounter rate of species groups by month across all point count stations during the onshore sea watch surveys – BIWF 2009–2011.

Table 4.1.5. Abundance of birds observed per survey (encounter rate), by species and month, during the onshore sea watch surveys – BIWF 2009–2011.

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Loons												
Common loon	1.250	2.375	3.000	8.216	0.350	–	–	–	0.526	0.422	2.200	1.400
Red-throated loon	0.100	0.417	0.100	0.297	–	–	–	–	–	–	–	0.500
Unidentified loon	0.500	–	–	–	–	–	–	–	–	–	–	0.100
Grebes												
Horned grebe	0.500	1.792	3.300	0.297	–	–	–	–	–	–	–	–
Red-necked grebe	–	–	–	0.182	–	–	–	–	–	–	–	–
Shearwaters and Petrels												
Great shearwater	–	–	–	–	–	–	1.759	–	–	–	–	–
Wilson's storm-petrel	–	–	–	–	–	–	0.176	–	–	–	–	–
Unidentified shearwater	–	–	–	–	–	–	7.941	0.632	–	–	–	–
Gannets												
Northern gannet	0.750	1.292	3.150	2.757	4.100	0.150	0.118	–	–	9.158	7.200	1.000
Cormorants												
Double-crested cormorant	–	–	–	1.892	2.950	2.000	0.765	2.000	3.474	5.895	2.950	3.950
Great cormorant	12.500	5.667	4.150	0.351	–	–	–	–	0.526	0.526	1.950	4.600
Unidentified cormorant	0.150	–	–	–	–	–	–	–	–	–	0.500	0.300
Herons and Allies												
Great blue heron	0.500	–	–	0.273	0.500		0.588	0.526	0.237	0.263	0.500	–
Great egret	–	–	–	0.135	0.500	0.250	0.476	0.474	0.422	0.632	–	–
Snowy egret	–	–	–	0.273	0.500	0.100	0.588	0.215	0.653	0.263	–	–
Black-crowned night-heron	–	–	–	0.545	0.150	0.250	0.118	0.526	–	–	–	
Ducks and Geese												
Canada goose	2.950	1.283	4.800	2.000	0.700	–	0.118	1.000	–	0.474		1.700
Brant	–	0.417	–	–	–	–	–	–	–	–	–	–
Mallard	1.150	–	0.200	0.676	0.500	–	–	–	0.395	–	–	0.550
American black duck	0.450	1.833	0.200	0.162		0.500	–	–	–	–	–	–
American black duck X Mallard hybrid	–	–	–	–	0.500	–	–	–	–	–	–	–
Blue-winged teal	–	–	–	–	–	–	–	–	0.526	–	–	0.100

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Redhead	–	–	–	0.216	–	–	–	–	–	–	–	–
Greater scaup	–	–	–	–	–	–	–	–	–	–	0.500	–
Common eider	1.200	32.667	42.650	3.273	1.600	0.900		0.263	0.737	1.000	8.350	9.650
Harlequin duck	0.500	–	–	–	–	–	–	–	–	0.526	0.450	–
Long-tailed duck	–	–	0.500	–	–	–	–	–	–	–	–	0.200
White-winged scoter	2.900	0.167	–	–	–	–	–	–	0.263	1.215	0.600	0.250
Surf scoter	1.150	0.958	–	0.297	–	–	–	–	–	–	–	–
Black scoter	22.550	8.792	33.250	8.324	–	–	–			12.579	0.350	0.200
Common goldeneye	11.500	7.875	1.850	–	–	–	–	–	–	–	0.100	1.250
Bufflehead	5.300	5.458	1.800	–	–	–	–	–	–	–	–	0.700
Red-breasted merganser	12.650	12.333	14.200	5.273	0.250	0.100	–	–	–	1.316	5.350	4.300
Unidentified scoter	–	–	1.000	4.545	–	–	–	–	–	0.789	–	–
Unidentified duck	0.150	1.167	4.150	1.182	0.100	–	–	0.215	0.132	0.632	0.500	0.150
Hawks and Allies												
Osprey	–	–	–		0.500	–	–	–	–	–	0.500	–
Sharp-shinned hawk		0.417	–	–	–	–	–	–	–	–	–	–
Cooper's Hawk	–	–	–	–	–	–	–	–	0.526	–	–	–
Unidentified accipiter		–	–	–	–	–	–		0.263	–	–	–
Northern harrier	0.500	–	–	–		0.100	0.588	0.526	–	–	0.500	
Falcons	–	–	–	–	–	–	–	–	–	–	–	–
MERLIN	–	–	–	0.545	–	0.500	–	–	0.526	–	–	–
Peregrine falcon	0.500	–	–	–	–	–	–		0.184	0.215		0.100
Unidentified falcon	–	0.833	–	–	–	–	–	–	–	–	–	–
Pheasant												
Ring-necked pheasant	–	0.417	0.150	0.216	0.500	0.200	–	–	–	0.526	–	0.500
Plovers												
Black-bellied plover	1.100	0.667	0.800	2.273	2.900	0.250	–	2.263	0.447	1.474	0.900	0.800
American golden-plover	–	–	–	0.892	2.250	–	–	0.153	0.184	–	0.250	–
Semipalmated plover	–	–	–	–	–	–	–	1.684	0.316	0.632	–	–
Piping plover	–	–	–	0.545	–	–	–	–	–	–	–	–
Oystercatchers	–	–	–	–	–	–	–	–	–	–	–	–

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
American oystercatcher	–	–	0.500	0.818	0.150	0.300	0.118	0.153	0.132	–	–	–
Sandpipers and Allies												
Greater yellowlegs	–	–	–	–	0.100	0.500	0.235	1.153	–	–	0.500	–
Solitary sandpiper	–	–	–	–	–	–	–	0.158	–	–	–	–
Willet	–	–	–			0.500	–	0.526	–	–	–	–
Whimbrel	–	–	–	–	–	–	–	0.526	–	–	–	–
Ruddy turnstone	–	–	–		0.200	0.350	–	–	–	–	0.100	–
Purple sandpiper		0.167	–	–	–	–	–	–	–	–	0.400	–
Sanderling	1.550	3.542	4.900	1.351	1.000				0.153	0.684	1.850	2.650
Pectoral sandpiper	–	–	–	–	–	–	–	–	0.263	–	–	–
White-rumped sandpiper	–	–	–	–	–	–	–	–	0.789	0.263	–	–
Semipalmated sandpiper	–	–	–	0.297	0.200	0.500	0.588	2.632	0.263	1.737	–	–
Western sandpiper	–	–	–	–	–	–	–	0.158	–	–	–	
Unidentified sandpiper	–	–	–	0.455	0.500	–	–	–	0.153	–	–	0.350
Spotted sandpiper	–	–	–	–	–	0.500	–	0.526	0.263	–	–	–
Dunlin	2.000	1.500	1.650	0.378	2.400	–	–	–	–	–	0.350	0.500
Unidentified shorebird	0.300	–	–	–	–	–	0.588	0.526	1.316	–	–	–
Short-billed dowitcher	–	–	–	0.545	0.100	0.150	–	–	–	–	–	–
American woodcock	–	–	–	0.273	–	–	–	–	–	–	–	–
Gulls and Terns												
Bonaparte's gull	0.500	–	–	–	–	–	–	–	–	–	–	–
Laughing gull	–	0.458	–	–	0.150	0.200	–	0.422	0.237	–	–	–
Ring-billed gull	–	–	–	0.189	0.250	–	1.588	0.158	0.158	–	0.200	–
Herring gull	23.950	1.542	16.100	2.595	3.550	19.250	1.588	4.158	24.974	24.316	19.850	2.500
Great black-backed gull	18.200	4.667	13.900	18.455	7.000	17.300	3.765	3.316	11.789	21.947	4.600	25.350
Unidentified larus gull	1.200	11.833	2.550	0.162	1.100	1.100	4.765	5.895	3.922	15.422	8.600	26.900
Common tern	–	–	–	–	–	–	–	3.153	–	–	–	–
Unidentified tern	–	–	–	–	–	–	–	46.947	0.263	–	–	–
Auks, Murres, and Puffins												
Razorbill	–	–	0.100	–	–	–	–	–	–	–	–	–
Unidentified alcid	–	–	0.150	–	–	–	–	–	–	–	–	–

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Doves												
Mourning dove	–	–	0.500	0.189	0.100	0.150	0.588	0.526	0.132	–	–	–
Kingfishers												
Belted kingfisher	–	–	–	–	–	–	–	–	0.132	0.158	–	0.500
Woodpeckers and Allies												
Northern flicker	–	–	–	–	–	–	–	–	–	–	–	0.500
Jays and Crows												
Blue jay	–	–	–	–	–	–	–	–	0.526	–	–	–
American crow	1.950	1.417	1.300	1.189	0.700	0.950	0.476	0.158	1.132	2.947	0.500	1.900
Fish crow	0.300	0.375	0.500	0.486	0.400	0.100	0.759	1.263	0.316	0.215	–	–
Unidentified crow	–	–	–	–	–	–	0.176	–	–	–	–	–
Swallows												
Barn swallow	–	–	–	0.545	1.000	1.750	0.294	0.474	–	–	–	–
Northern rough-winged swallow	–	–	–	–	0.150	–	–	–	–	–	–	–
Bank swallow	–	–	–	–	1.500	0.550	1.588	0.422	0.132	–	–	–
Tree swallow	–	–	–	0.545	0.600	1.750	0.176	–	0.263	–	–	–
Unidentified swallow	–	–	–	–	0.900	0.100	1.412	–	0.263	–	–	–
Chickadees												
Black-capped chickadee	0.100	–	–	–	–	–	0.588	–	–	–	0.500	–
Wrens												
Carolina wren	0.500	0.417	0.350	0.324	0.450	0.300	0.118	0.526	0.526	0.158	–	0.500
Thrushes												
American robin	0.200	0.417	–	1.649	1.500	1.100	0.476	0.526	–	1.579	0.500	–
Mockingbirds and Thrashers	–	–	–	–	–	–	–	–	–	–	–	–
Gray catbird	–	–	–	–	0.100	0.500	–	0.526	–	0.526	–	–
Northern mockingbird	–	–	–	–	–	–	–	–	0.263	–	–	–
Wood-Warblers	–	–	–	–	–	–	–	–	–	–	–	–
Yellow warbler	–	–	–	–	0.200	0.100	–	–	–	–	–	–
Common yellowthroat	–	–	–	–	1.150	0.350	0.529	–	–	0.526	–	–
Cardinals	–	–	–	–	–	–	–	–	–	–	–	–
Northern cardinal	–	–	–	–	0.500	0.500	–	–	–	–	–	–

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Emberizids												
Eastern towhee	–	–	–	0.324	0.800	0.600	0.759	0.526	0.263	–	–	–
Song sparrow	–	–	0.350	0.818	0.900	0.950	1.412	0.153	0.789	0.263		0.100
White-throated sparrow	–	–	–	0.273	–	–	–	–	–	–	–	–
Unidentified sparrow	–	0.417	–		0.500		0.588	–	–	0.526	–	–
Dark-eyed junco	0.150	–	–	–	–	–	–	–	–	–	–	–
Blackbirds												
Red-winged blackbird	–	–	0.950	0.818	0.900	0.950	0.412	0.158	–	–	–	–
Common grackle	–	–	–	–	0.900	0.250	0.588	–	–	–	–	–
Brown-headed cowbird	–	–	–	–	0.500	–	–	–	–	–	–	–
Old World Sparrows												
House sparrow	–	–	–	–	–	0.350	0.588	0.158	–	–	–	–
Finches												
American goldfinch	–	0.417	–	0.216	0.150	0.150	0.476	0.316	–	–	–	–
Unidentified	–	–	–	–	–	–	–	–	–	–	–	–
Unidentified bird	–	0.417	–	–	–	–	–	–	–	–	–	–
Total	**137.100**	**118.458**	**170.250**	**108.622**	**44.950**	**54.250**	**32.471**	**108.158**	**52.500**	**115.947**	**67.550**	**117.900**

Table 4.1.6. Abundance of birds observed per survey (encounter rate), by species group and month, during the onshore sea watch surveys – BIWF 2009–2011.

Species Group	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Loons	1.40	2.42	3.10	8.51	0.35	0.00	0.00	0.00	0.05	0.42	2.20	1.55	2.03
Waterfowl	70.55	72.50	113.15	25.14	3.20	1.50	0.12	1.47	1.34	27.05	15.30	19.05	28.18
Gull	43.40	26.75	32.55	39.35	12.05	37.85	11.18	13.95	41.08	61.68	33.25	72.30	36.18
Terns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	77.05	0.03	0.00	0.00	0.00	5.35
Seabirds	0.75	1.29	3.40	20.76	4.10	0.15	9.94	0.63	0.00	9.16	7.20	10.00	6.08
Shorebirds	4.95	5.88	7.40	5.54	9.35	1.25	0.47	8.89	2.76	4.79	3.90	3.85	4.86
Passerine	2.45	1.58	3.00	5.65	11.70	10.45	8.35	2.05	1.68	5.11	0.60	2.10	4.36
Total	**137.10**	**118.46**	**170.25**	**108.62**	**44.95**	**54.25**	**32.47**	**108.16**	**52.50**	**115.95**	**67.55**	**117.90**	**93.09**

Species Richness and Presence by Time Period

Species richness changed throughout the survey period. Overall richness was greatest in May (*n* = 55 species) and April (*n* = 54 species). During the summer the total number of species declined slightly, likely because spring migrants had dispersed from the area (Figure 4.1.3). Species richness increased again in early fall, and then declined again in early winter. More species were encountered in January and February than in November and December (Figure 4.1.3).

Gulls were ubiquitous year-round, as were shorebirds and landbirds (Table 4.1.5). Terns were observed during the onshore sea watches in August and September. Individual seabird species exhibited more variability in temporal distribution patterns than when pooled as the seabird group. For example, northern gannets were observed from October through April, but shearwaters were observed only in July and August and storm-petrels only in July. Alcids were observed only in March (Table 4.1.5, Figure 4.1.2). Landbirds were present year round, but raptors were most frequently encountered during fall migration, especially in September and October. Only two raptor species, sharp-shinned hawk and northern harrier, were observed in the winter (Table 4.1.3).

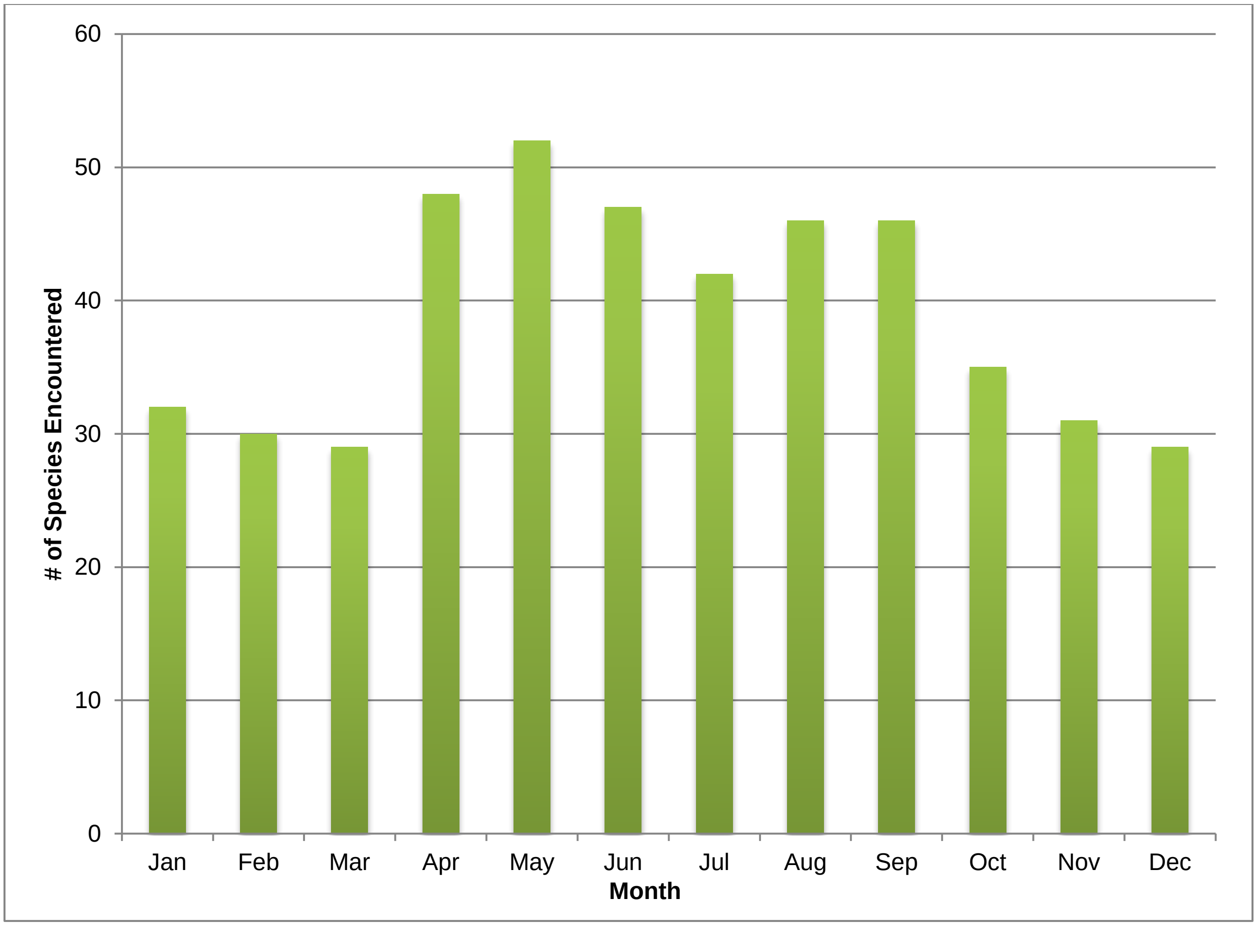


Figure 4.1.3. Seasonal variability in overall species richness observed during the onshore sea watch surveys – BIWF 2009–2011.

4.1.3 Spatial Distribution and Flight Ecology

Counts by Location

The total number of birds recorded at point count stations varied from a low of 1,322 at Southeast Light (Station 5) to a high count of 4,109 birds at Lewis-Dicken's Farm (Station 10) (Figure 4.1.4). The second greatest number of birds was observed at Andy's Way (Station 1). In general the southern coastal sites (Stations 4, 5, 6, 7, and 8) yielded lower total observations than the interior coastal site (Station 1) and the southwest site (Station 10).

Most loon observations were recorded at Stations 7 and 9 (24.5% and 27.9%, respectively). Nearly 30% of all waterfowl detections were made from Station 10 (Lewis-Dicken's Farm) (*n* = 2,228). Most gulls were observed at Station 3 (*n* = 2,617, 26.4%). The vast majority (*n* = 1,094, 82.1%) of shorebirds were encountered at Station 1 (Andy's Way), although it should be noted that this station was specifically chosen to provide a representative sample of shorebirds occurring in the Great Salt Pond. More seabirds were detected at Station 5 (Southeast Light) (*n* = 391, 23.5%) than at any other station, although Stations 6, 8, and 9 each accounted for over 15% of all seabird observations. Landbirds were encountered uniformly across most survey locations, although Stations 1 and 5 each yielded over 15% of all landbird detections.

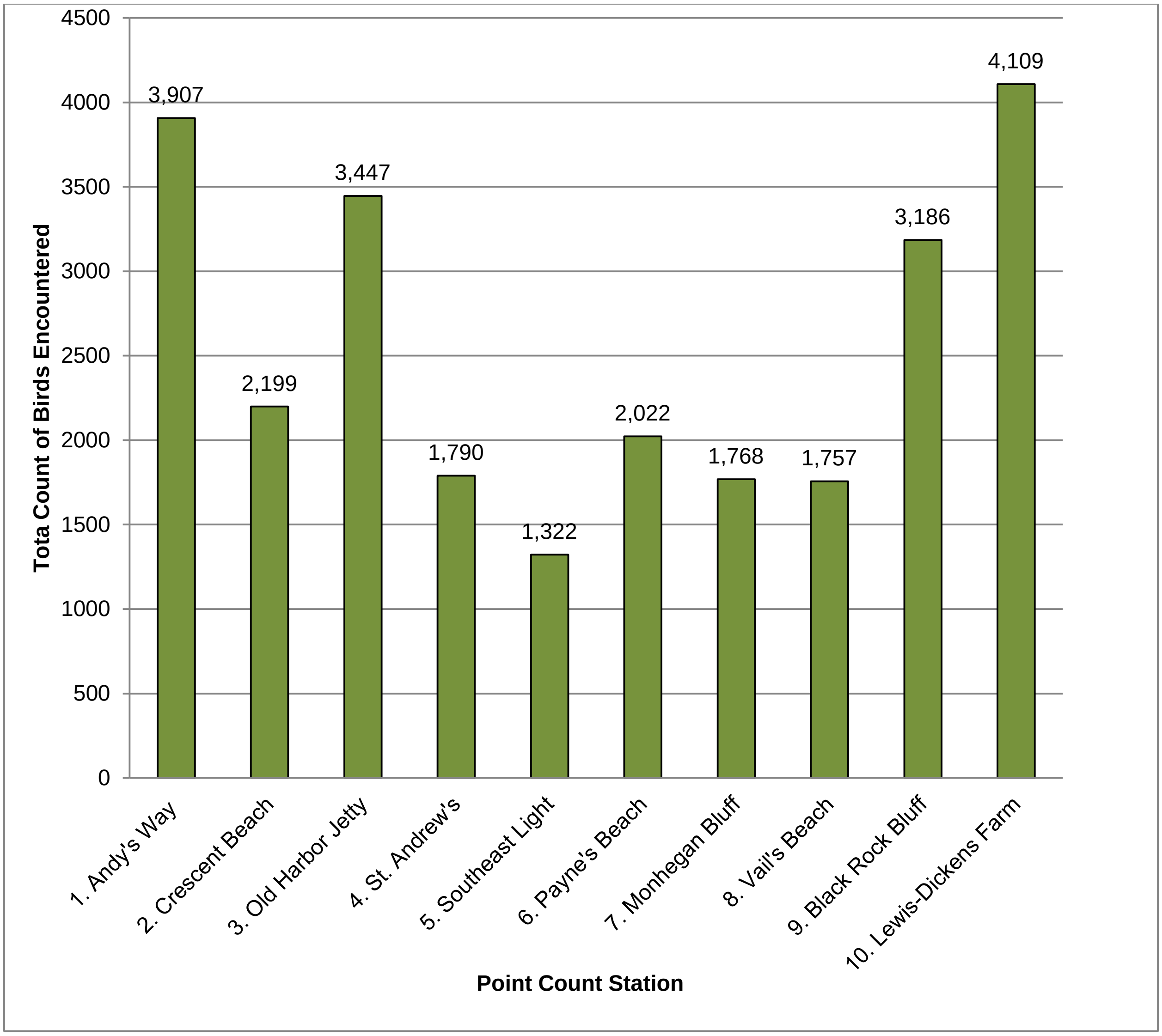


Figure 4.1.4.Total count of bird observations at onshore point count stations – BIWF 2009–2011.

Frequency by Location

There was less variability in the frequency of each species group's occurrence across point count stations (spatial) than there was between survey dates (temporal) (Table 4.1.3). Four of the seven species groups had a frequency of 100% and were present at all 10 point count stations during the BIWF study. Terns and seabirds occurred at 90% or 9 of 10 stations. Terns were not observed from Station 5 (Southeast Light), and seabirds were not observed at Point 3 (Old Harbor Jetty). Shorebirds were only present at 7 of the 10 stations.

Encounter Rates by Location

The abundance of birds (as indicated by encounter rate) varied across point count stations (Tables 4.1.7 and 4.1.8, Figure 4.1.5). The ER was highest at Lewis-Dicken's Farm (Station 10) (ER = 178.65 birds/survey), and lowest at the Southeast Light (Station 5) (ER = 47.21 birds/survey). Abundances were generally similar at Stations 4 (St. Andrew's), 5 (Southeast Light), 6 (Payne's Beach), 7 (Monhegan Bluff), and 7 (Vail's Beach).

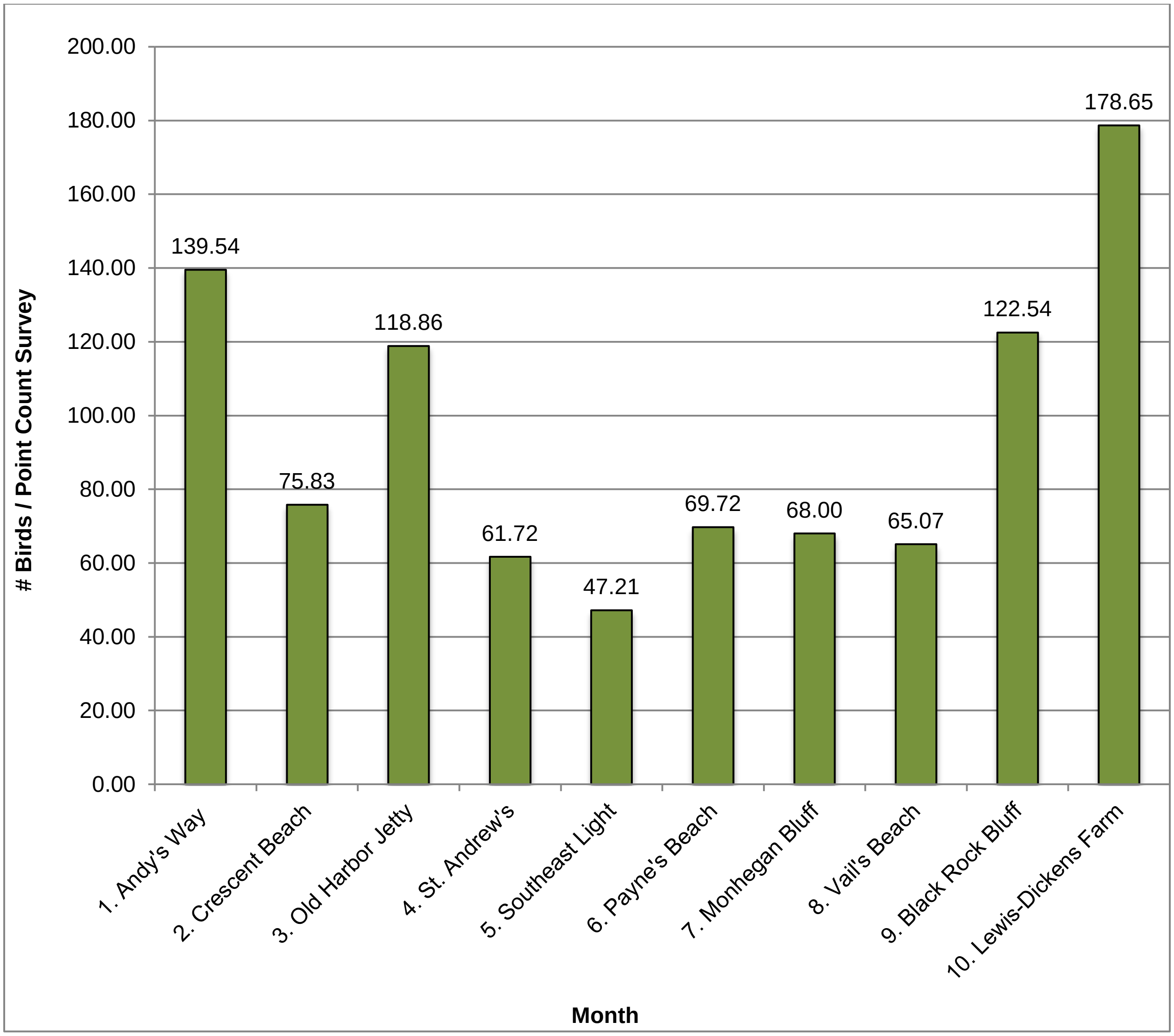


Figure 4.1.5. Spatial variability in encounter rates during the onshore sea watch surveys – BIWF 2009–2011.

Table 4.1.7. Encounter rate of birds observed per survey, by species and point count station, during the onshore sea watch surveys – BIWF 2009–2011.

Common Name	Genus/ Species	1. Andy's Way	2. Crescent Beach	3. Old Harbor Jetty	4. St. Andrew's	5. South-east Light	6. Payne's Beach	7. Monhe-gan Bluff	8. Vail's Beach	9. Black Rock Bluff	10. Lewis-Dicken's Farm	Overall Observation Rate (Birds Per Point Count Survey)
Loons												
Common loon	*Gavia immer*	0.393	0.345	0.690	0.690	1.429	1.586	5.769	1.475	5.877	2.913	1.953
Red-throated loon	*Gavia stellata*	–	–	–	–	–	–	0.385	0.333	0.154	0.134	0.624
Unidentified loon		–	–	–	–	–	–	0.115	–	–	–	0.195
Grebes												
Horned grebe	*Podiceps auritus*	0.143	1.138	–	–	0.143	0.690	0.385	1.815	0.238	1.348	0.474
Red-necked grebe	*Podiceps grisegena*	–	–	–	–	–	–	–	0.374	0.115	–	0.146
Shearwaters and Petrels												
Great shearwater	*Puffinus gravis*	–	–	–	–	–	0.138	0.962	–	–	–	0.158
Wilson's storm-petrel	*Oceanites oceanicus*	–	–	–	–	–	0.134	–	–	–	–	0.195
Unidentified shearwater		–	–	–	–	–	1.345	1.154	2.778	0.269	0.217	0.536
Gannets												
Northern gannet	*Morus bassanus*	0.429	1.276	–	2.793	13.964	7.655	2.462	7.778	9.500	9.478	5.488
Cormorants												
Double-crested cormorant	*Phalacrocorax auritus*	2.750	0.724	6.724	3.241	0.643	0.759	0.424	0.747	0.962	5.174	2.198
Great cormorant	*Phalacrocorax carbo*		0.345	6.690	0.690	2.000	1.483	1.000	0.481	0.346	11.435	2.248
Unidentified cormorant		–	0.690	–	–	–	–	–	0.111	0.385	0.174	0.365
Herons and Allies												

Common Name	Genus/ Species	1. Andy's Way	2. Crescent Beach	3. Old Harbor Jetty	4. St. Andrew's	5. South-east Light	6. Payne's Beach	7. Monhe-gan Bluff	8. Vail's Beach	9. Black Rock Bluff	10. Lewis-Dicken's Farm	Overall Observation Rate (Birds Per Point Count Survey)
Great blue heron	*Ardea herodias*	0.429	–	0.690	–	–	–	–	0.374	0.385	0.174	0.730
Great egret	*Ardea alba*	1.679	–	0.138	0.345	–	0.690	–	0.747	–	–	0.244
Snowy egret	*Egretta thula*	1.321	–	–	–	–	–	–	–	–	–	0.135
Black-crowned night-heron	*Nycticorax nycticorax*	0.286	–	0.138	–	–	–	–	0.374	–	–	0.474
Ducks and Geese												
Canada goose	*Branta canadensis*	4.821	0.759	0.931	0.172	1.000	0.828	1.738	0.667	0.385	1.348	1.226
Brant	*Branta bernicla*	–	–	0.345	–	–	–	–	–	–	–	0.365
Mallard	*Anas platyrhynchos*	1.536	0.134	0.586	0.448	0.714	–	–	0.111	0.269	–	0.321
American black duck	*Anas rubripes*	2.714	–	0.134	0.690	–	0.134	0.769	0.148	–	0.435	0.266
American black duck X Mallard hybrid		0.357	–	–	–	–	–	–	–	–	–	0.365
Blue-winged teal	*Anas discors*	0.143	–	–	–	–	–	–	–	–	–	0.146
Redhead	*Aythya americana*	–	–	–	–	–	–	–	–	0.377	–	0.292
Greater scaup	*Aythya marila*	–	0.345	–	–	–	–	–	–	–	–	0.365
Common eider	*Somateria mollissima*	5.714	9.931	3.414	3.627	1.171	4.793	8.877	6.778	17.154	39.391	9.438
Harlequin duck	*Histrionicus histrionicus*	–	0.345	–	0.134	–	0.134	0.385	0.374	0.385	0.435	0.415
Long-tailed duck	*Clangula hyemalis*	–	0.138	–	0.345	–	–	–	–	–	–	0.182
White-winged scoter	*Melanitta fusca*	–	0.345	–	0.345	0.143	0.134	0.238	1.747	0.885	1.174	0.376
Surf scoter	*Melanitta perspicillata*	–	0.586	–	–	–	–	–	–	–	1.739	0.283
Black scoter	*Melanitta nigra*	–	–	0.690	0.241	0.393	7.552	7.238	6.222	21.385	31.913	6.880

Common Name	Genus/ Species	1. Andy's Way	2. Crescent Beach	3. Old Harbor Jetty	4. St. Andrew's	5. South-east Light	6. Payne's Beach	7. Monhe-gan Bluff	8. Vail's Beach	9. Black Rock Bluff	10. Lewis-Dicken's Farm	Overall Observation Rate (Birds Per Point Count Survey)
Common goldeneye	*Bucephala clangula*	3.286	1.724	–	7.931	–	–	0.154	0.475	1.577	2.000	1.730
Bufflehead	*Bucephala albeola*	1.286	5.276	0.134	0.345	0.714	0.345	0.769	0.185	2.538	–	1.474
Red-breasted merganser	*Mergus serrator*	9.171	0.966	1.172	8.241	2.357	3.134	5.769	2.630	4.385	1.134	4.573
Unidentified scoter		–	–	–	–	5.357	0.517	–	–	–	8.696	1.332
Unidentified duck		–	0.138	0.172	0.269	0.429	1.414	1.462	0.630	1.924	0.391	0.664
Hawks and Allies												
Osprey	*Pandion haliaetus*	–	–	0.345	–	–	–	–	0.374	–	–	0.730
Sharp-shinned hawk	*Accipiter striatus*	0.357	–	–	–	–	–	–	–	–	–	0.365
Cooper's Hawk	*Accipiter cooperii*	–	–	–	–	–	–		0.747	–	–	0.730
Unidentified accipiter		–	–	–	–	–	–	0.385	–	–	–	0.365
Northern harrier	*Circus cyaneus*	0.357	–	–	–	–	–	–	0.111	0.769	–	0.219
Falcons												
MERLIN	*Falco columarius*	–	–	–	–	0.357	–	–	0.374	–	0.134	0.182
Peregrine falcon	*Falco peregrinus*	–	–	–	–	0.357	0.269	–	0.747	0.115	0.870	0.519
Unidentified falcon		–	–	–	–	–	0.690	–	–	–	–	0.730
Pheasant												
Ring-necked pheasant	*Phasianus colchicus*	0.171	–	–	0.690	0.393	0.345	0.238	–	0.115	0.870	0.122
Plovers												
Black-bellied plover	*Pluvialis squatarola*	1.964	0.241	–	–	–	–	–	–	–	–	1.146
American golden-plover	*Pluvialis dominica*	3.286	–	–	–	–	–	–	–	–	–	0.336

Common Name	Genus/ Species	1. Andy's Way	2. Crescent Beach	3. Old Harbor Jetty	4. St. Andrew's	5. South-east Light	6. Payne's Beach	7. Monhe-gan Bluff	8. Vail's Beach	9. Black Rock Bluff	10. Lewis-Dicken's Farm	Overall Observation Rate (Birds Per Point Count Survey)
Semipalmated plover	*Charadrius semipalmatus*	1.500	0.134	0.379	–	–	–	–	–	–	–	0.244
Piping plover	*Charadrius melodus*	0.714	–	–	–	–	–	–	–	–	–	0.730
Oystercatchers												
American oystercatcher	*Haematopus palliatus*	0.786	–	–	–	–	–	–	–	–	–	0.829
Sandpipers and Allies												
Greater yellowlegs	*Tringa melanoleuca*	1.357	–	–	–	–	–	–	–	–	–	0.158
Solitary sandpiper	*Tringa solitaria*	0.357	0.345	–	–	–	–	–	–	–	0.435	0.195
Willet	*Catoptrophorus semipalmatus*	0.714	–	–	–	–	–	–	–	–	–	0.730
Whimbrel	*Numenius phaeopus*	0.357	–	–	–	–	–	–	–	–	–	0.365
Ruddy turnstone	*Arenaria interpres*	0.393	–	–	0.690	–	–	–	–	–	–	0.474
Purple sandpiper	*Calidris maritima*	–	–	0.414	–	–	–	–	–	–	–	0.438
Sanderling	*Calidris alba*	9.179	4.586	0.345	–	–	–	–	–	–	–	1.428
Pectoral sandpiper	*Calidris melanotos*	0.357	–	–	–	–	–	–	–	–	–	0.365
White-rumped sandpiper	*Calidris fuscicollis*	0.286	–	–	–	–	–	–	–	–	–	0.292
Semipalmated sandpiper	*Calidris pusilla*	2.000	1.448	0.690	0.345	–	–	–	–	–	–	0.369
Western sandpiper	*Calidris mauri*	–	0.134	–	–	–	–	–	–	–	–	0.195
Unidentified sandpiper		0.893	–	0.690	–	–	–	–	–	–	–	0.985
Spotted sandpiper	*Actitis macularia*	0.357	–	–	0.345	–	0.345	–	–	–	–	0.195
Dunlin	*Calidris alpina*	6.393	–	–	–	–	–	–	–	–	–	0.653
Unidentified shorebird		1.821	–	0.241	–	–	–	–	–	0.769	0.343	0.245

Common Name	Genus/ Species	1. Andy's Way	2. Crescent Beach	3. Old Harbor Jetty	4. St. Andrew's	5. South-east Light	6. Payne's Beach	7. Monhe-gan Bluff	8. Vail's Beach	9. Black Rock Bluff	10. Lewis-Dicken's Farm	Overall Observation Rate (Birds Per Point Count Survey)
Short-billed dowitcher	*Limnodromus griseus*	0.250	–	–	–	–	–	–	–	–	–	0.255
American woodcock	*Scolopax minor*	–	–	–	–	–	–	0.385	–	–	–	0.365
Gulls and Terns												
Bonaparte's gull	*Larus philadelphia*	0.357	–	–	–	–	–	–	–	–	–	0.365
Laughing gull	*Larus atricilla*	0.214	0.269	0.379	0.138	–	0.345	–	0.259	–	–	0.128
Ring-billed gull	*Larus delawarensis*	0.171	0.172	0.138	0.345	–	0.690	0.154	0.374	0.154	0.827	0.157
Herring gull	*Larus canus*	23.393	9.138	43.863	12.138	3.393	13.448	1.738	14.333	25.385	1.870	16.749
Great black-backed gull	*Larus marinus*	23.643	7.897	33.345	9.966	4.357	7.517	1.115	6.148	15.877	8.435	12.818
Unidentified Larus gull		0.321	11.313	12.517	4.483	2.750	12.724	4.269	6.556	5.738	1.000	6.336
Common tern	*Sterna hirundo*	8.929	6.966	0.586	1.724	–	0.379	–	0.222	0.924	0.522	2.876
Unidentified tern		0.464	6.931	1.724	–	–	0.759	0.769	1.148	1.846	22.870	3.259
Alcids												
Razorbill	*Alca torda*	–	–	–	–	–	–	–	–	–	0.870	0.730
Unidentified alcid		–	–	–	–	–	–	–	–	–	0.134	0.195
Doves												
Mourning dove	*Zenaida macroura*	0.357	0.138	0.134	0.134	0.714	0.690	0.385	–	0.385	0.134	0.730
Kingfishers												
Belted kingfisher	*Ceryle alcyon*	0.214	–	0.134	–	–	–	–	–	–	–	0.328
Woodpeckers and Allies												
Northern flicker	*Colaptes auratus*	–	–	–	–	0.357	–	–	–	–	–	0.365

Common Name	Genus/ Species	1. Andy's Way	2. Crescent Beach	3. Old Harbor Jetty	4. St. Andrew's	5. South-east Light	6. Payne's Beach	7. Monhe-gan Bluff	8. Vail's Beach	9. Black Rock Bluff	10. Lewis-Dicken's Farm	Overall Observation Rate (Birds Per Point Count Survey)
												Jays and Crows
Blue jay	*Cyanocitta cristata*	–	–	–	0.690	–	–	–	–	–	–	0.730
American crow	*Corvus brachyrhynchos*	4.357	0.793	0.313	0.379	2.571	0.759	0.538	0.259	1.500	1.435	1.219
Fish crow	*Corvus ossifragus*	0.536	0.627	1.138	0.690	0.179	0.269	0.769	–	0.577	–	0.354
Unidentified crow		0.171	–	–	–	–	–	–	–	–	–	0.195
Swallows												
Barn swallow	*Hirundo rustica*	0.821	0.269	0.627	0.690	0.179	–	0.269	–	0.269	0.134	0.259
Northern rough-winged swallow	*Stelgidopteryx serripennis*	–	–	–	–	0.171	–	–	–	–	–	0.195
Bank swallow	*Riparia riparia*	0.214	0.379	0.241	0.134	0.179	–	0.385	0.737	0.769	0.783	0.296
Tree swallow	*Tachycineta bicolor*	0.171	–	–	0.241	0.821	0.172	0.115	0.747	0.192	0.217	0.193
Unidentified swallow		–	0.134	–	0.345	–	0.690	0.846	–	0.769	0.652	0.164
Chickadees												
Black-capped chickadee	*Poecile atricapilla*	–	–	–	–	–	–	0.769	–	0.769	–	0.146
Wrens												
Carolina wren	*Thryothorus ludovicianus*	0.250	0.134	0.269	0.241	0.357	0.345	–	0.374	0.115	0.343	0.164
Thrushes												
American robin	*Turdus migratorius*	0.671	0.241	0.313	0.690	1.250	0.241	1.846	0.374	0.115	0.870	0.544
Mockingbirds and Thrashers												
Gray catbird	*Dumetella carolinensis*	0.357	–	–	0.345	0.357	0.345	–	–	–	0.435	0.182
Northern mockingbird	*Mimus polyglottos*	0.357	–	–	–	–	–	–	–	–	–	0.365

Common Name	Genus/ Species	1. Andy's Way	2. Crescent Beach	3. Old Harbor Jetty	4. St. Andrew's	5. South-east Light	6. Payne's Beach	7. Monhe-gan Bluff	8. Vail's Beach	9. Black Rock Bluff	10. Lewis-Dicken's Farm	Overall Observation Rate (Birds Per Point Count Survey)
Wood-Warblers												
Yellow warbler	*Dendroica petechia*	0.171	0.345	–	–	0.714	–	–	–	–	–	0.219
Common yellowthroat	*Geothylypis thrichas*	0.171	0.134	0.172	0.138	0.179	0.241	0.238	–	0.192	0.870	0.146
Cardinals												
Northern cardinal	*Cardinalis cardinalis*	–	–	0.345	–	–	–	–	–	0.385	–	0.730
Emberizids												
Eastern towhee	*Pipilo erythrophthalm us*	0.179	0.269	–	0.134	0.464	0.172	0.424	0.374	0.154	0.269	0.198
Song sparrow	*Melospiza melodia*	0.214	0.313	0.269	0.448	0.679	0.379	0.692	0.296	0.238	0.687	0.415
White-throated sparrow	*Zonotrichia albicollis*	–	–	–	0.345	–	–	–	–	–	–	0.365
Unidentified sparrow		0.357	–	0.345	0.345	–	–	0.385	–	–	–	0.146
Dark-eyed junco	*Junco hyemalis*	–	–	–	–	–	–	0.115	–	–	–	0.195
Blackbirds												
Red-winged blackbird	*Agwlaius phoeniceus*	0.171	0.690		0.414	0.464	–	0.346	0.374	0.269	2.134	0.354
Common grackle	*Quiscalus quiscula*	–	–	0.172	0.379	–	0.276	–	–	–	–	0.876
Brown-headed cowbird	*Molothrus ater*	–	–	–	–	0.357	–	–	–	–	–	0.365
Old World Sparrows												
House sparrow	*Passer domesticus*	–	–	0.379	–	–	–	–	–	–	–	0.415
Finches												
American goldfinch	*Carduelis tristis*	–	0.690	–	0.241	0.714	0.345	0.154	0.374	0.424	0.435	0.158

Common Name	Genus/ Species	1. Andy's Way	2. Crescent Beach	3. Old Harbor Jetty	4. St. Andrew's	5. South-east Light	6. Payne's Beach	7. Monhe-gan Bluff	8. Vail's Beach	9. Black Rock Bluff	10. Lewis-Dicken's Farm	Overall Observation Rate (Birds Per Point Count Survey)
Unidentified												
Unidentified bird		–	–	–	–	0.357	–	–	–	–	–	0.365
Overall ER		**139.536**	**75.828**	**118.863**	**61.724**	**47.214**	**69.724**	**68.000**	**65.747**	**122.538**	**178.652**	**93.912**
Number of Species		**65.000**	**45.000**	**43.000**	**46.000**	**39.000**	**43.000**	**43.000**	**44.000**	**47.000**	**47.000**	**91.000**

Encounter rates for each species group were generally dissimilar across point count stations (Table 4.1.8, Figure 4.1.6). Waterfowl were most abundant at Lewis-Dicken's Farm (Station 10) and Black Rock Bluff (Station 9). Gulls were substantially more abundant at Old Harbor Jetty (Station 3) than elsewhere, but were present at each point count station. Seabirds were detected at most point count stations, but were not encountered at Andy's Way (Station 1) or at Old Harbor Jetty (Station 3), and were most abundant at Southeast Light (Station 5).

Table 4.1.8. Encounter rate of birds observed per survey, by species group and point count station, during the onshore sea watch surveys – BIWF 2009–2011.

Species Group	Point Count Station										Total
	1	2	3	4	5	6	7	8	9	10	
Loons	0.39	0.34	0.69	0.69	1.43	1.59	5.23	1.74	5.96	3.04	2.03
Waterfowl	28.00	19.72	6.59	21.76	10.61	18.86	24.88	18.89	50.50	96.87	28.18
Gull	47.71	28.72	90.24	26.76	10.18	33.79	25.27	27.33	47.08	20.35	36.18
Terns	9.39	13.90	2.31	1.72	0.00	1.14	0.08	1.37	2.77	23.39	5.35
Seabirds	0.43	1.28	0.00	2.79	13.96	8.93	4.58	10.56	9.77	9.91	6.08
Shorebirds	39.07	6.52	1.21	0.14	0.00	0.03	0.00	0.00	0.08	0.35	4.86
Landbirds	6.89	2.76	2.79	3.76	7.57	2.48	6.12	1.52	3.77	6.52	4.36
Total	**139.54**	**75.83**	**118.86**	**61.72**	**47.21**	**69.72**	**68.00**	**65.07**	**122.54**	**178.65**	**93.09**

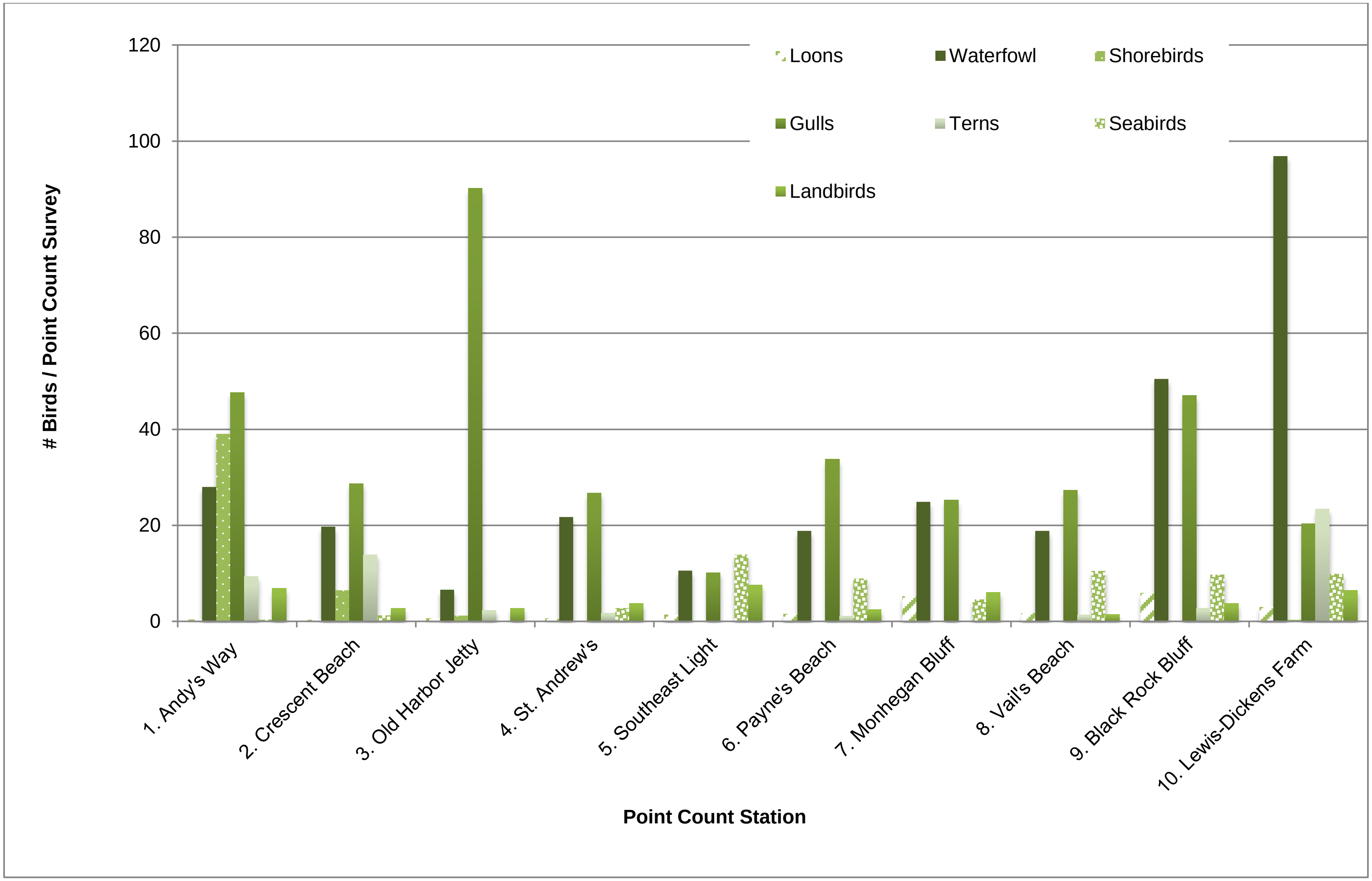


Figure 4.1.6. Spatial variability in encounter rates, by species group, during the onshore sea watch surveys – BIWF 2009–2011.

Variability in the spatial distribution of species was especially evident during the late summer-fall migration period (August 15–December 15). During August terns were most abundant at the southern coastal site Lewis-Dicken's Farm (Station 10), and at Andy's Way (Station 1). In late-summer shorebirds were much more plentiful at Andy's Way (Station 1) and Crescent Beach (Station 2). Cormorants exhibited higher encounter rates at Lewis-Dicken's Farm during this period (Station 10). Seabird species were more common along the southern coast in fall. Similarly, more loon observations were recorded along the southern coast during late summer and early fall. Overall, during fall migration abundance patterns shifted slightly towards the south and southwestern point count stations, which is perhaps evidence of the existence of a migration corridor towards the west and southwest via Montauk and Long Island, New York.

Species Richness by Location

Overall species richness was generally similar across point count stations with the exception of Andy's Way (Station 1), which exhibited the most diverse avian assemblage of any point (n = 65) (Figure 4.1.7). At the remaining nine points richness ranged from 39 (Station 5) to 47 (Station 5 and Station 10). Species group richness was dissimilar across point count stations, with the exception of loon diversity, which was low at all stations (Figure 4.1.7). Waterfowl diversity was highest at Stations 2 and 4, but varied little across all points, from a minimum of 8 species to a maximum of 12 species. Shorebirds were substantially more diverse at Andy's Way (Station 1) than at any other station, although this was expected given the extensive intertidal habitat available at the station. Though highest at Station 1, gull diversity varied less across stations than other species group. The total number of landbird species encountered was higher than all other species groups at each of the 10 stations.

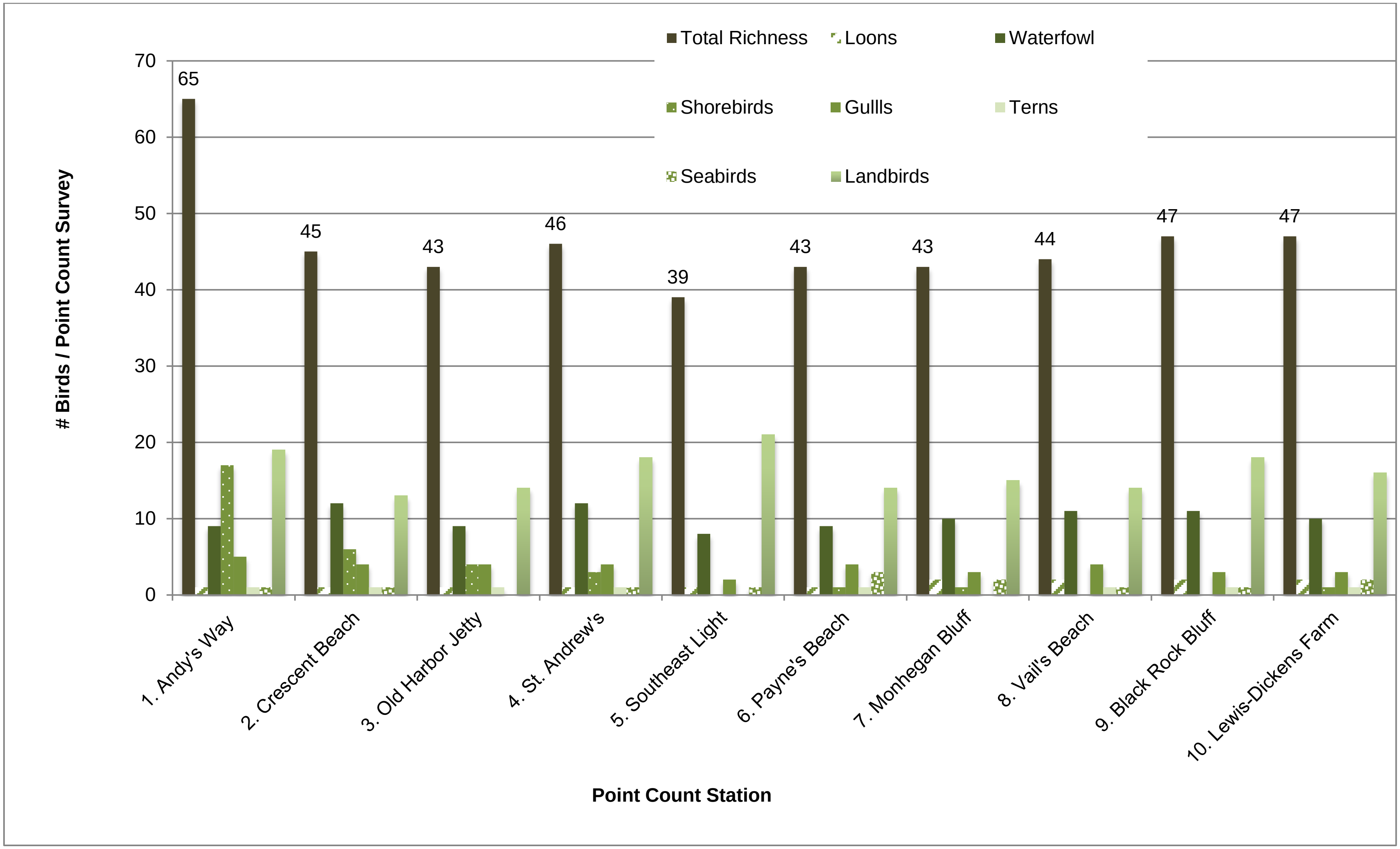


Figure 4.1.7. Total number of species per species group and overall species richness at each point count location – BIWF 2009–2011.

Density

Encounter rates are an index of abundance at each of the sea watch stations. However, ERs are not a metric of density [birds (n)/km^2] of birds observed. Density values are an estimate of the number of birds that occurred per square kilometer of effective survey area at each count station. Density estimates take into account the distance between observed birds and the station, and therefore may not necessarily correlate with encounter rates.

Density for all species pooled ranged from 30.24 birds/km^2 at Southeast Light (Station 5) to 389.99 birds/km^2 at Old Harbor Jetty (Station 3) (Table 4.1.9 and Figures 4.1.8–4.1.15). Species guild density ranged from 281.52 gulls/km^2 at Old Harbor Jetty (Station 3) to 0 shorebirds/km^2 at Southeast Light (Station 5), Monhegan Bluff (Station 7), and Vail's Beach (Station 8) (Figures 4.1.11). Loon relative density was greatest at Old Harbor Jetty (Station 3) and lowest at Andy's Way (Station 1) (Figure 4.1.9). Waterfowl (ducks) exhibited comparatively higher densities across all point stations, with the exception of Southeast Light (Station 5) where estimates were lowest (2.47 birds/km^2) (Figure 4.1.10). Shorebird densities were highest at Andy's Way (Station 1) followed by Crescent Beach (Station 2), and were generally low elsewhere (Figure 4.1.11). Gull densities were higher than any other species guild at 9 of the 10 points (Figure 4.1.12). Landbird density was greater than gull density at Southeast Light (Station 5) (Figure 4.1.15). Seabirds (pelagics) were less abundant than most of the other species guilds; seabird density was greatest at Southeast Light (Station 5) and lowest at Old Harbor Jetty (Station 3) (Figure 4.1.14). Landbird (passerine) density was consistent across point stations and highest at Southeast Light (Station 5), and lowest at Vail's Beach (Station 8) (Figure 4.1.15).

Table 4.1.9. Estimated density of birds observed per survey, by species group and point count station, during the onshore sea watch surveys – BIWF 2009–2011.

Point	Loon Density (n/km^2)	Waterfowl Density (n/km^2)	Gull Density (n/km^2)	Tern Density (n/km^2)	Shorebird Density (n/km^2)	Seabird Density (n/km^2)	Passerine Density (n/km^2)	Overall Density (n/km^2)
1. Andy's Way	0.15	21.07	30.09	18.27	30.24	0.27	22.50	116.01
2. Crescent Beach	0.56	11.16	26.21	46.15	16.87	0.58	22.71	81.17
3. Old Harbor Jetty	7.03	20.10	281.52	23.54	3.57	0.00	28.46	389.99
4. St. Andrew's	0.61	27.74	37.41	17.57	1.41	1.86	31.08	94.02
5. Southeast Light	0.72	2.47	8.81	0.00	0.00	7.62	50.14	30.24
6. Payne's Beach	0.92	12.14	24.58	0.97	0.35	4.88	21.56	51.70
7. Monhegan Bluff	3.32	17.49	40.68	0.01	0.00	4.96	33.77	74.92
8. Vail's Beach	1.92	17.02	38.04	1.13	0.00	3.22	15.48	60.50
9. Black Rock Bluff	2.38	33.81	92.01	6.01	0.78	3.86	27.42	117.22
10. Lewis-Dicken's Farm	2.51	29.07	79.26	3.24	0.27	4.33	39.33	70.43

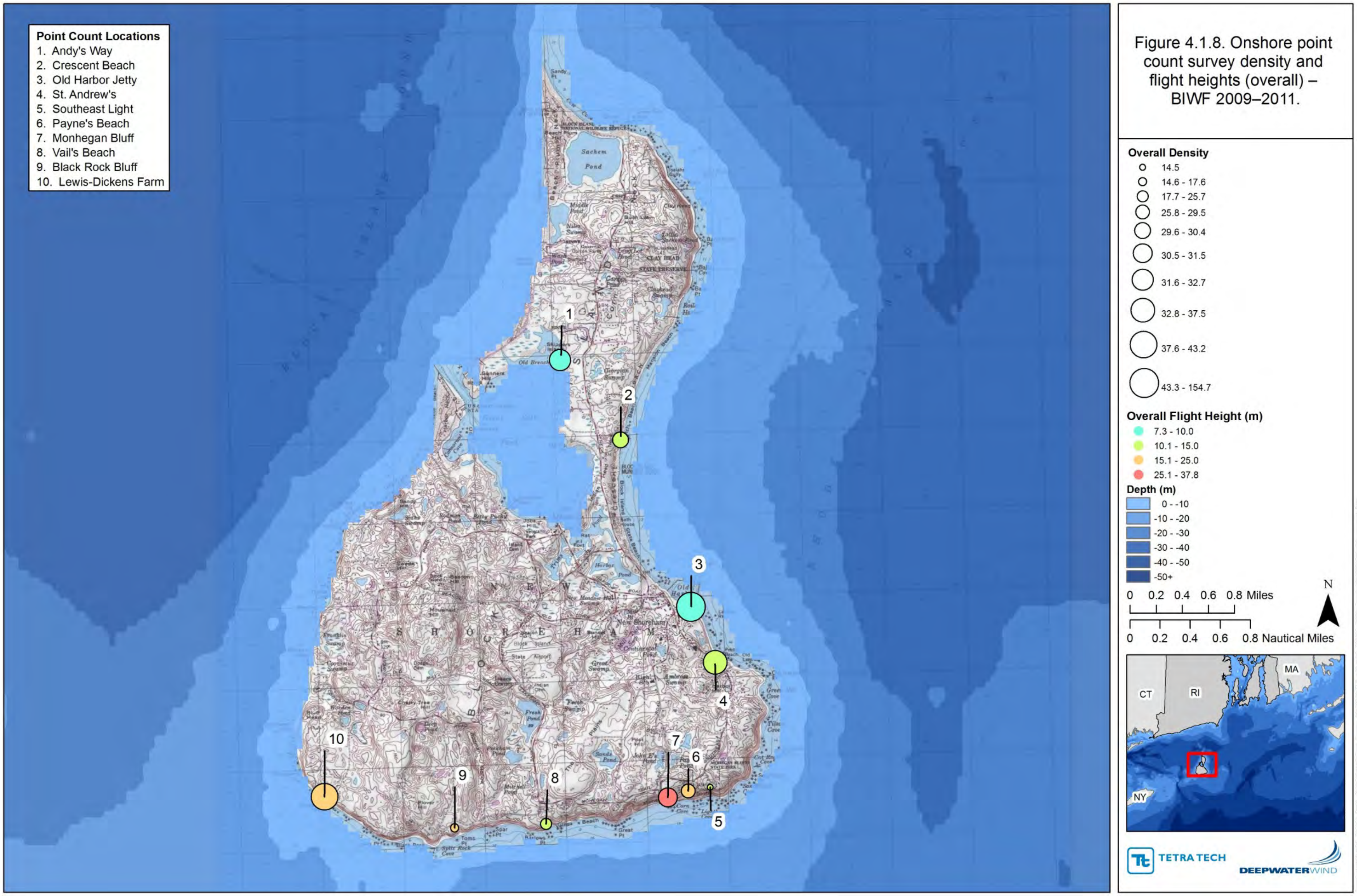


Figure 4.1.8. Onshore point count survey density and flight heights (overall) – BIWF 2009–2011.

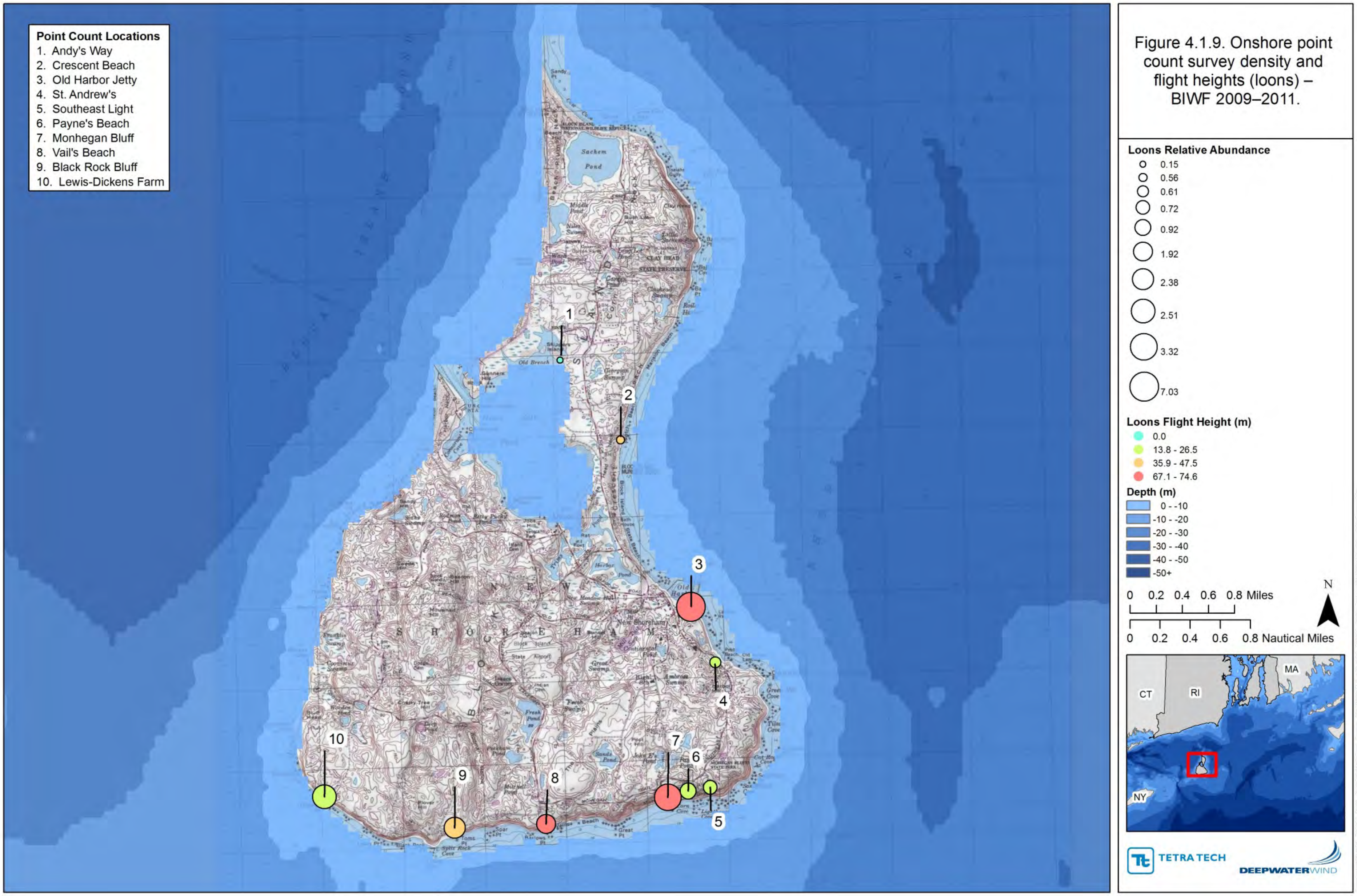


Figure 4.1.9. Onshore point count survey density and flight heights (loons) – BIWF 2009–2011.

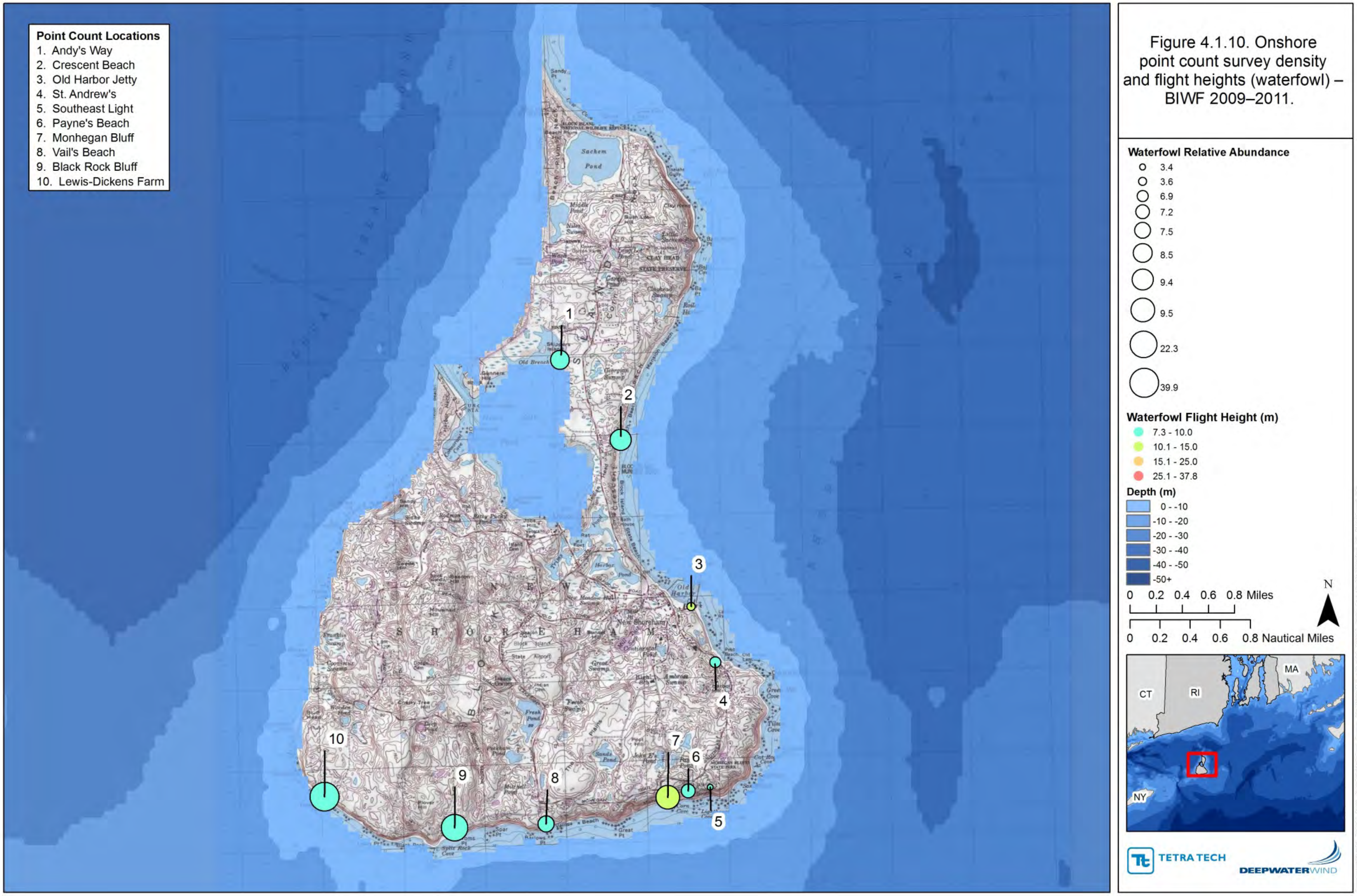


Figure 4.1.10. Onshore point count survey density and flight heights (waterfowl) – BIWF 2009–2011.

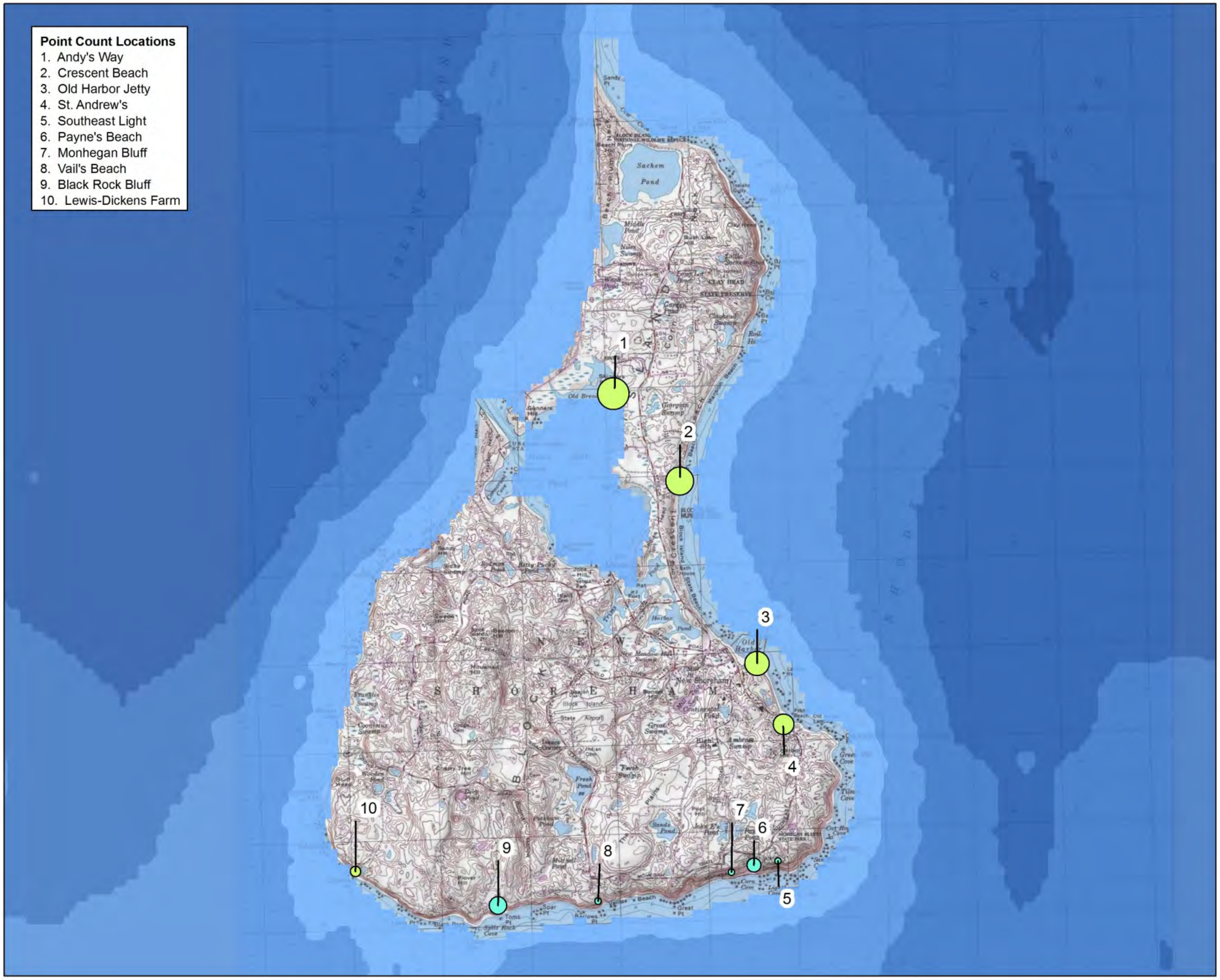


Figure 4.1.11. Onshore point count survey density and flight heights (shorebirds) – BIWF 2009–2011.

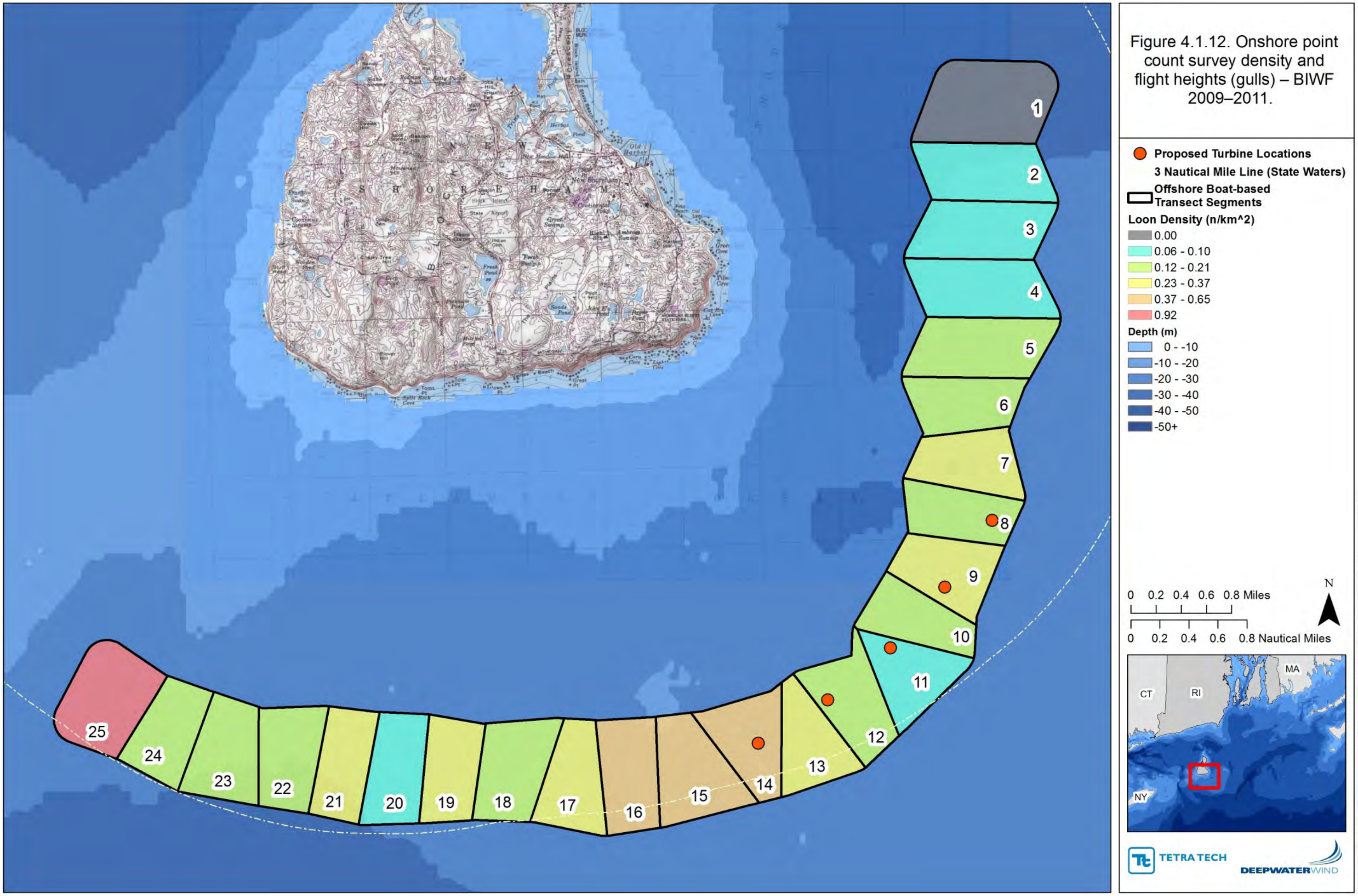


Figure 4.1.12. Onshore point count survey density and flight heights (gulls) – BIWF 2009–2011.

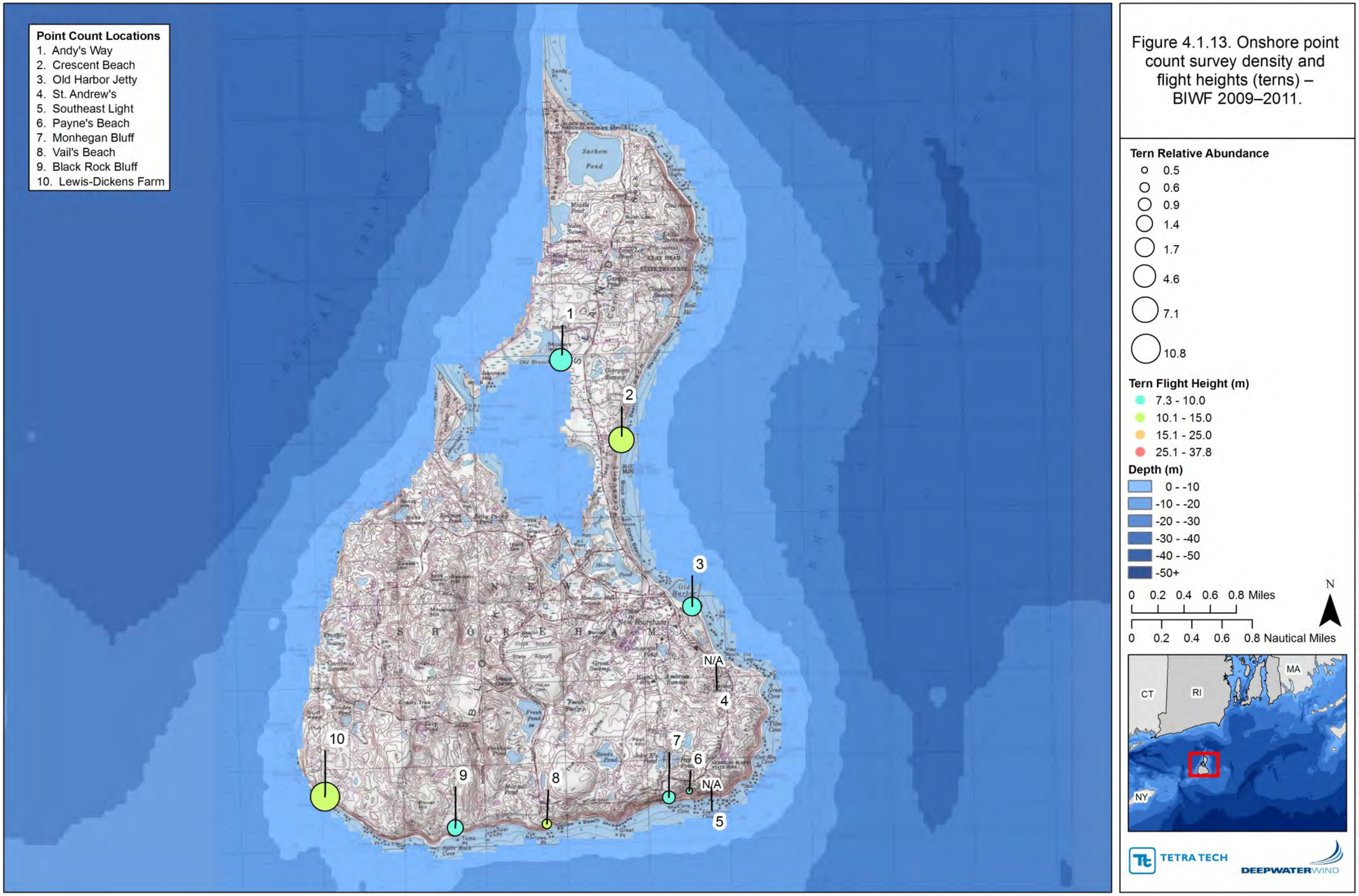


Figure 4.1.13. Onshore point count survey density and flight heights (terns) – BIWF 2009–2011.

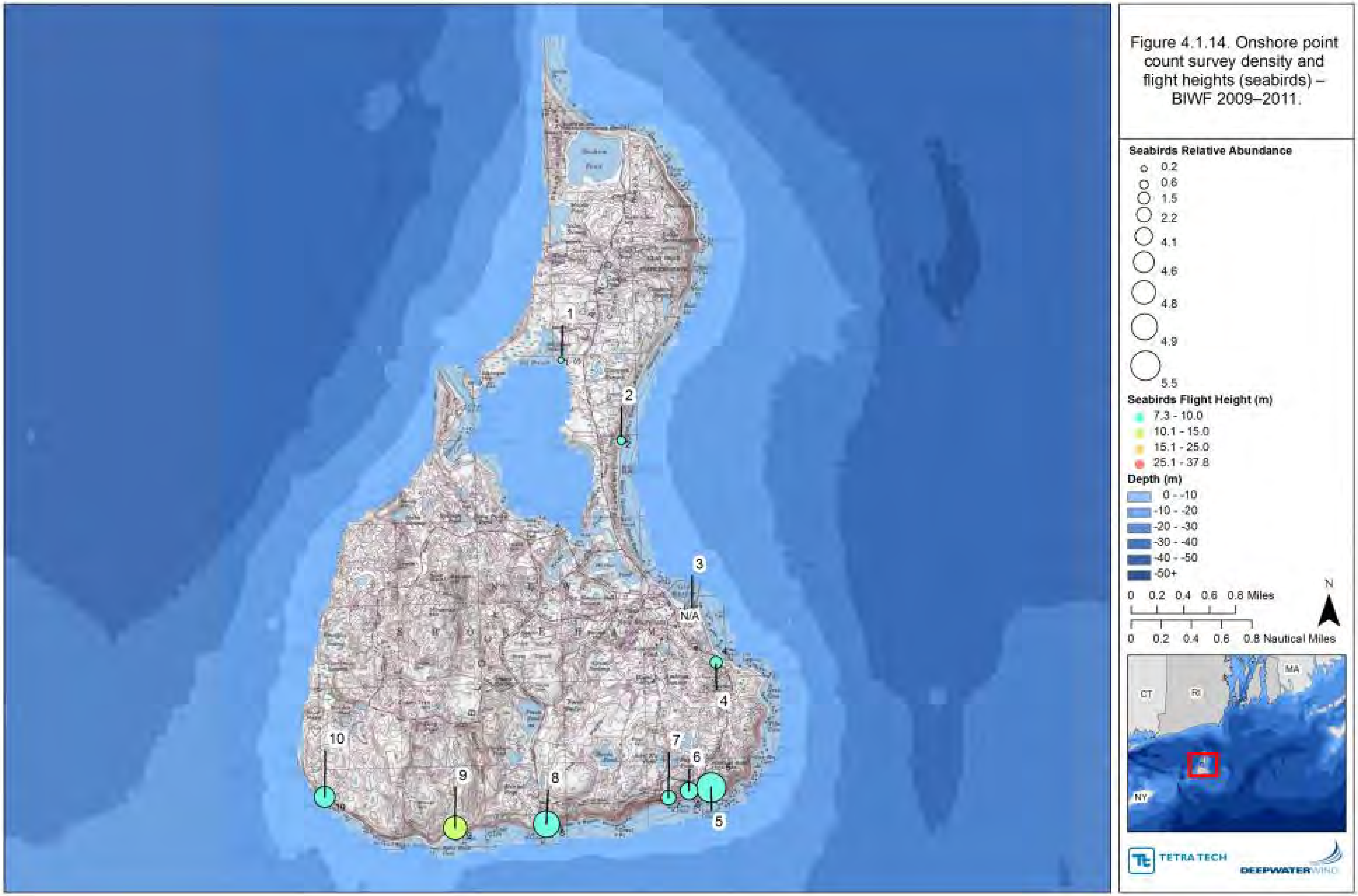


Figure 4.1.14. Onshore point count survey density and flight heights (seabirds) – BIWF 2009–2011.

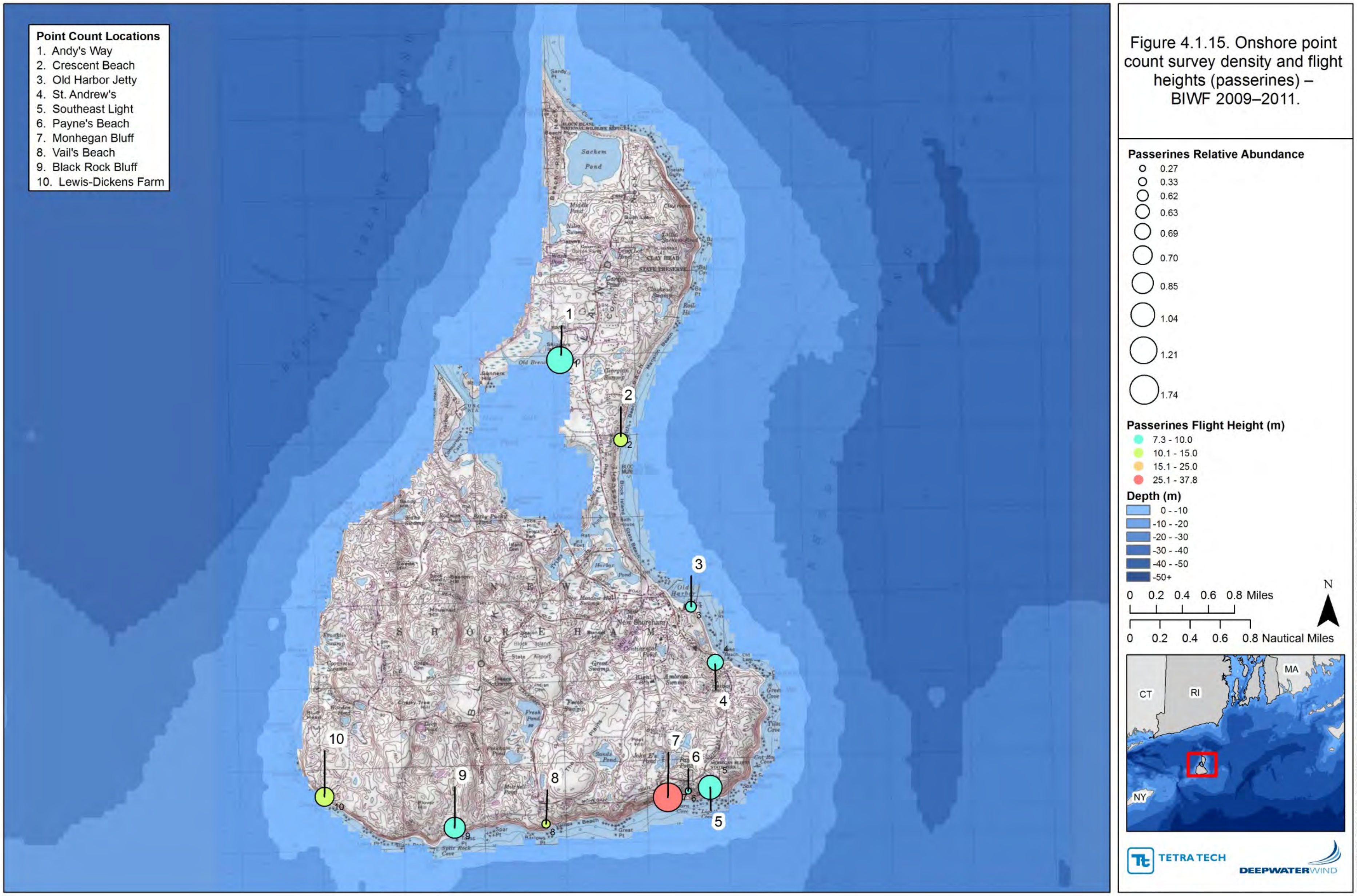


Figure 4.1.15. Onshore point count survey density and flight heights (passerines) – BIWF 2009–2011.

Flight Height/Ecology

Bird behavior was categorized into one of four bins: “Direct Flight,” “Foraging,” “Sitting on Ground,” and “Sitting on Water.” Most birds were observed sitting on the water (26.4%), although many were also seen in direct flight (26.2%). For birds observed in flight (*n* = 10,652) most flew below 10 m (33 ft) above water and/or ground level (*n* = 5,604, 52.6%), 37.4% flew between 10 m (33 ft) and 25 m (82 ft) (*n* = 3,988), 9.8% flew between 26 m (85 ft) and 125 m (410 ft) (*n* = 14), and 0.1% flew between 126 m (413 ft) and 200 m (656 ft) (*n* = 14) (Table 4.1.10). Flight heights were lowest at Old Harbor Jetty (Station 3) and highest at Monhegan Bluff (Station 7) (Table 4.1.11, Figure 4.1.8).

Table 4.1.10. Flight height distribution of birds observed per survey, by species group and point count station, during the onshore sea watch surveys – BIWF 2009–2011.

Species	<10 m	10–25 m	26–125 m	126–200 m
Loons				
Common loon	2.2%	9.5%	26.2%	0.0%
Red-throated loon	5.9%	0.0%	0.0%	0.0%
Unidentified loon	66.7%	0.0%	0.0%	0.0%
Grebes				
Horned grebe	0.0%	0.0%	0.0%	0.0%
Red-necked grebe	0.0%	0.0%	0.0%	0.0%
Shearwaters and Petrels				
Greater shearwater	100.0%	0.0%	0.0%	0.0%
Wilson's storm-petrel	100.0%	0.0%	0.0%	0.0%
Unidentified shearwater	49.0%	51.0%	0.0%	0.0%
Gannets				
Northern gannet	53.6%	38.9%	0.7%	0.0%
Cormorants				
Double-crested cormorant	30.1%	17.6%	2.0%	0.5%
Great cormorant	15.7%	13.8%	6.0%	0.0%
Unidentified cormorant	80.0%	10.0%	0.0%	0.0%
Herons and Allies				
Great blue heron	15.0%	10.0%	15.0%	0.0%
Great egret	5.4%	3.6%	0.0%	0.0%
Snowy egret	5.4%	27.0%	0.0%	0.0%
Black-crowned night-heron	7.7%	0.0%	0.0%	0.0%
Ducks and Geese				
Canada goose	20.8%	34.8%	17.9%	0.0%
Brant	0.0%	0.0%	0.0%	0.0%
Mallard	18.2%	13.6%	0.0%	0.0%
American black duck	0.0%	0.0%	0.0%	0.0%
American black duck X Mallard hybrid	0.0%	0.0%	0.0%	0.0%
Blue-winged teal	50.0%	0.0%	0.0%	0.0%
Redhead	0.0%	0.0%	0.0%	0.0%

Species	<10 m	10–25 m	26–125 m	126–200 m
Greater scaup	0.0%	0.0%	0.0%	0.0%
Common eider	4.8%	0.0%	0.0%	0.0%
Harlequin duck	27.3%	0.0%	0.0%	0.0%
Long-tailed duck	20.0%	0.0%	0.0%	0.0%
White-winged scoter	62.1%	0.0%	0.0%	0.0%
Surf scoter	0.0%	0.0%	0.0%	0.0%
Black scoter	32.5%	0.4%	0.0%	0.0%
Common goldeneye	0.6%	3.2%	0.0%	0.0%
Bufflehead	5.9%	0.0%	0.0%	0.0%
Red-breasted merganser	8.3%	0.0%	0.0%	0.0%
Unidentified scoter	45.2%	0.0%	0.0%	0.0%
Unidentified duck	43.4%	4.9%	0.0%	0.0%
Hawks and Allies				
Osprey	0.0%	0.0%	50.0%	0.0%
Sharp-shinned hawk	0.0%	100.0%	0.0%	0.0%
Cooper's Hawk	100.0%	0.0%	0.0%	0.0%
Unidentified accipiter	100.0%	0.0%	0.0%	0.0%
Northern harrier	66.7%	33.3%	0.0%	0.0%
Falcons				
MERLIN	60.0%	20.0%	0.0%	0.0%
Peregrine falcon	85.7%	0.0%	0.0%	0.0%
Unidentified falcon	0.0%	100.0%	0.0%	0.0%
Pheasant				
Ring-necked pheasant	3.6%	0.0%	0.0%	0.0%
Plovers				
Black-bellied plover	6.7%	0.0%	0.0%	0.0%
American golden-plover	7.6%	0.0%	0.0%	0.0%
Semipalmated plover	16.1%	0.0%	0.0%	0.0%
Piping plover	0.0%	0.0%	0.0%	0.0%
Oystercatchers				
American oystercatcher	13.6%	0.0%	0.0%	0.0%
Sandpiper and Allies				
Greater yellowlegs	0.0%	0.0%	0.0%	0.0%
Solitary sandpiper	0.0%	0.0%	0.0%	0.0%
Willet	0.0%	0.0%	0.0%	0.0%
Whimbrel	0.0%	0.0%	0.0%	0.0%
Ruddy turnstone	15.4%	0.0%	0.0%	0.0%
Purple sandpiper	0.0%	0.0%	0.0%	0.0%
Sanderling	2.8%	0.0%	0.0%	0.0%
Pectoral sandpiper	100.0%	0.0%	0.0%	0.0%
White-rumped sandpiper	0.0%	0.0%	0.0%	0.0%

Species	<10 m	10–25 m	26–125 m	126–200 m
Semipalmated sandpiper	0.0%	0.0%	0.0%	0.0%
Western sandpiper	0.0%	0.0%	0.0%	0.0%
Unidentified sandpiper	7.4%	0.0%	0.0%	0.0%
Spotted sandpiper	0.0%	0.0%	0.0%	0.0%
Dunlin	0.0%	0.0%	0.0%	0.0%
Unidentified shorebird	98.5%	0.0%	0.0%	0.0%
Short-billed dowitcher	0.0%	0.0%	0.0%	0.0%
American woodcock	0.0%	0.0%	0.0%	0.0%
Gulls and Terns				
Bonaparte's gull	0.0%	0.0%	0.0%	0.0%
Laughing gull	60.0%	0.0%	2.9%	0.0%
Ring-billed gull	18.6%	16.3%	2.3%	0.0%
Herring gull	13.3%	15.6%	8.8%	0.1%
Great black-backed gull	14.3%	17.4%	7.2%	0.0%
Unidentified Larus gull	42.3%	42.5%	5.3%	0.2%
Common tern	89.3%	1.0%	0.0%	0.0%
Unidentified tern	23.1%	76.1%	0.1%	0.0%
Alcids				
Razorbill	0.0%	0.0%	0.0%	0.0%
Unidentified alcid	0.0%	0.0%	0.0%	0.0%
Doves				
Mourning dove	70.0%	0.0%	0.0%	0.0%
Kingfishers				
Belted kingfisher	44.4%	11.1%	0.0%	0.0%
Woodpecker and Allies				
Northern flicker	100.0%	0.0%	0.0%	0.0%
Jays and Crows				
Blue jay	0.0%	0.0%	0.0%	0.0%
American crow	38.6%	15.0%	0.3%	0.0%
Fish crow	18.8%	6.3%	0.0%	0.0%
Unidentified crow	0.0%	0.0%	0.0%	0.0%
Swallows				
Barn swallow	93.0%	7.0%	0.0%	0.0%
Northern rough-winged swallow	100.0%	0.0%	0.0%	0.0%
Bank swallow	56.8%	30.9%	8.6%	3.7%
Tree swallow	98.1%	1.9%	0.0%	0.0%
Unidentified swallow	6.7%	44.4%	48.9%	0.0%
Chickadees				
Black-capped chickadee	0.0%	0.0%	0.0%	0.0%
Wrens				
Carolina wren	0.0%	0.0%	0.0%	0.0%

Species	<10 m	10–25 m	26–125 m	126–200 m
Thrushes				
American robin	2.7%	20.8%	0.0%	0.0%
Mockingbirds and Thrashers				
Gray catbird	0.0%	0.0%	0.0%	0.0%
Northern mockingbird	0.0%	0.0%	0.0%	0.0%
Wood-Warblers				
Yellow warbler	0.0%	0.0%	0.0%	0.0%
Common yellowthroat	0.0%	0.0%	0.0%	0.0%
Cardinals				
Northern cardinal	0.0%	0.0%	0.0%	0.0%
Emberizids				
Eastern towhee	1.9%	0.0%	0.0%	0.0%
Song sparrow	3.6%	0.0%	0.0%	0.0%
White-throated sparrow	0.0%	0.0%	0.0%	0.0%
Unidentified sparrow	0.0%	0.0%	0.0%	0.0%
Dark-eyed junco	0.0%	0.0%	0.0%	0.0%
Blackbirds				
Red-winged blackbird	14.6%	11.5%	0.0%	0.0%
Common grackle	58.3%	0.0%	0.0%	0.0%
Brown-headed cowbird	0.0%	0.0%	0.0%	0.0%
Old World Sparrows				
House sparrow	9.1%	0.0%	0.0%	0.0%
Finches				
American goldfinch	75.9%	13.8%	0.0%	0.0%
Unidentified				
Unidentified bird	100.0%	0.0%	0.0%	0.0%
Overall	**52.6%**	**37.4%**	**9.8%**	**0.1%**

The average flight heights of species guilds were more variable across count stations than were the overall flight heights (Table 4.1.11, Figures 4.1.8–4.1.15). Loons had the highest average flight heights, followed by gulls, landbirds, waterfowl, seabirds, terns, and then shorebirds. Average loon flight heights were greater than all other species guilds at 5 of the 10 stations. Mean gull flight heights were highest at 3 of the 10 count stations, and waterfowl flight heights were greatest, overall, at one station.

Table 4.1.11. Weighted average flight heights of birds observed per survey, by species group and point count station, during the onshore sea watch surveys – BIWF 2009–2011.

Point	Loon Average Flight Height (m)	Water-fowl Average Flight Height (m)	Gull Average Flight Height(m)	Tern Average Flight Height (m)	Shore-bird Average Flight Height (m)	Passerine Average Flight Height (m)	Seabird Average Flight Height (m)	Overall Average Flight Height (m)
1. Andy's Way	0.00	16.26	12.90	5.74	5.00	5.00	5.00	8.94
2. Crescent Beach	35.88	11.20	16.27	9.52	5.00	9.38	5.00	12.92
3. Old Harbor Jetty	67.08	16.38	7.68	5.00	5.00	5.00	0.00	8.05
4. St. Andrew's	13.75	5.43	15.00	0.00	5.00	5.00	9.32	12.74
5. Southeast Light	26.10	5.18	28.71	0.00	0.00	11.70	9.52	14.84
6. Payne's Beach	26.45	11.01	33.05	10.43	0.00	9.96	13.01	23.30
7. Monhegan Bluff	74.58	10.90	53.17	5.00	0.00	41.51	5.00	39.04
8. Vail's Beach	68.11	10.23	18.56	19.66	0.00	14.66	16.05	16.74
9. Black Rock Bluff	47.50	7.59	22.01	7.35	5.00	7.08	16.34	18.65
10. Lewis-Dicken's Farm	18.13	7.50	23.26	22.11	5.00	11.34	19.23	20.33

4.1.4 Weather

During the 2009–2010 shore-based surveys the mean temperature was 11.2°C (52°F) (Table 4.1.12). Temperatures ranged from -2.2 to 32.7°C (28 to 91°F). Wind speeds during surveys were generally moderate with a survey period average of 3.4 m/s (7.6 mph). Wind speeds ranged from 0 m/s to 11.2 m/s (0 mph to 25 mph). Sky conditions were generally clear although surveys were also conducted during days with cloudy, partly cloudy, rain, snow, and fog conditions.

Table 4.1.12. Summary of weather observations made during the 2009–2010 onshore avian surveys – BIWF 2009–2011.

Period	Average Wind Speed (m/s)	Average Temperature (ºC)	Average Sea State
Winter (December 16–March 15)	5.0	3.0	3
Spring (March 16–June 30)	2.6	13.9	3
Summer (July 1–September 15)	3.1	21.4	3
Fall (September 16–December 15)	3.08	9.3	3
Overall	**3.4**	**11.2**	**3**

4.2 ONSHORE RAPTOR MIGRATION SURVEYS

Tetra Tech biologists conducted raptor surveys to document the presence of migrating raptors through the Block Island Study Area during the fall 2009 migration season. The following sections summarize and discuss raptor observations on and adjacent to Block Island including data on species composition, behavior, passage rates, seasonal timing, flight direction and height. Data from the Block Island surveys were also compared to raptor count sites on the Atlantic coast for a regional perspective on migration.

4.2.1 OBSERVATION TOTALS, DIVERSITY AND ABUNDANCE

Seven raptor migration surveys were performed during the 2009 fall migration season resulting in 59 total hours of observation between August 27 and October 23, 2009 (Table 4.2.1). During the spring six raptor surveys were performed totaling 40 hours of additional observation. Overall 94 raptors were detected, representing six species including peregrine falcon, Cooper's hawk, merlin, northern harrier, American kestrel, and bald eagle (Table 4.2.1). The passage rate for the entire fall and spring survey periods, pooled, was 0.95 birds/hr (Table 4.2.1). The species with the greatest number of detections over the entire survey was peregrine falcon (*n* = 76). The second most abundant species was Cooper's hawk (*n* = 8) followed by merlin (*n* = 6) and northern harrier (*n* = 2) (Table 4.2.1). American kestrel and bald eagle were both only observed on one occasion. The vast majority of peregrine falcons were sub-adult birds (83%). More than half of the Cooper's hawks observed were sub-adults while the remainder were either undetermined or adult birds. Also, nearly half the merlins detected were juvenile birds. One of the two northern harriers observed was a juvenile while the other was an adult. The single bald eagle detected was a sub-adult, as was the single American kestrel observed.

Table 4.2.1. Summary of raptor migration surveys fall 2009, and spring 2010, by species and date – BIWF 2009–2011.

Species	Genus / Species	27-Aug-09	28-Aug-09	9-Sep-09	16-Sep-09	29-Sep-09	30-Sep-09	9-Oct-09	13-Oct-09	14-Oct-09	23-Oct-09	18-Mar-10	8-Apr-10	15-Apr-10	21-Apr-10	29-Apr-10	11-May-10	Over-all
Cooper's hawk	*Accipiter cooperii*	–	–	1	1	–	–	–	–	1		1	1	1	1	1		8
Northern harrier	*Circus cyaneus*	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–	2
Bald eagle	*Haliaeetus leucocephalus*	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1
American kestrel	*Falco sparverius*	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1
MERLIN	*Falco columbarius*	–	1	–	–	–	3	1	–	–	–	–	–	–	1	–	–	6
Peregrine falcon	*Falco peregrinus*	–	1	–	–	22	10	10	28	5	–	–	–	–	–	–	–	76
Total		0	2	1	2	22	13	13	28	7	0	1	1	1	2	1	0	94
Survey Effort (hour)		6.0	4.8	7.0	7.0	7.0	4.5	6.5	3.5	7.0	5.5	5.5	7.0	7.0	6.5	7.0	7.0	98.8
Encounter Rate (# / hour)		0.00	0.42	0.14	0.29	3.14	2.89	2.00	8.00	1.00	0.00	0.18	0.14	0.14	0.31	0.14	0.00	0.95

Of the six species observed during the fall raptor surveys on Block Island, two are listed as endangered by the Rhode Island Endangered Species Program: northern harrier and peregrine falcon (Enser 2006). Only two northern harriers were detected during the Block Island raptor surveys, and both were hunting over the field near Southeast Lighthouse. No northern harriers were seen flying over the sea. Seventy-six peregrine falcons were observed during the surveys, none of which were seen flying greater than 0.5 km (0.26 nm) over the ocean. Only Cooper's hawk and merlin were seen during the spring survey; therefore, no RTE species were observed during this time of year.

4.2.2 Temporal Distribution

Substantially more raptors were encountered during the fall 2009 migration surveys (*n* = 88) than in spring 2010 (*n* = 6). Despite relatively similar levels of survey effort—59 hours in fall and 40 hours in spring—the overall observation rate in fall was 90% higher than in spring: 1.49 birds/hr and 0.15 birds/hr, respectively (Table 4.2.1).

Raptors were first observed on August 28, 2009 (Figure 4.2.1). Passage rates were low during the first four surveys, and did not increase until late September, and then decreased again in late October. Peregrine falcon migration peaked on October 13 when 8.0 observations per hour were recorded (Table 4.2.1). Peregrine falcons were encountered during surveys on October 14 but were absent during the October 23, 2009 survey. In general, the majority of fall raptor migration was observed between September 16 and October 14, 2010. Migration surveys were reinitiated in spring 2010; however, only six birds were observed during the spring effort. Two species were noted in the spring, Cooper's hawk and northern harrier, both of which are known to breed on Block Island (Audubon et al. 2003).

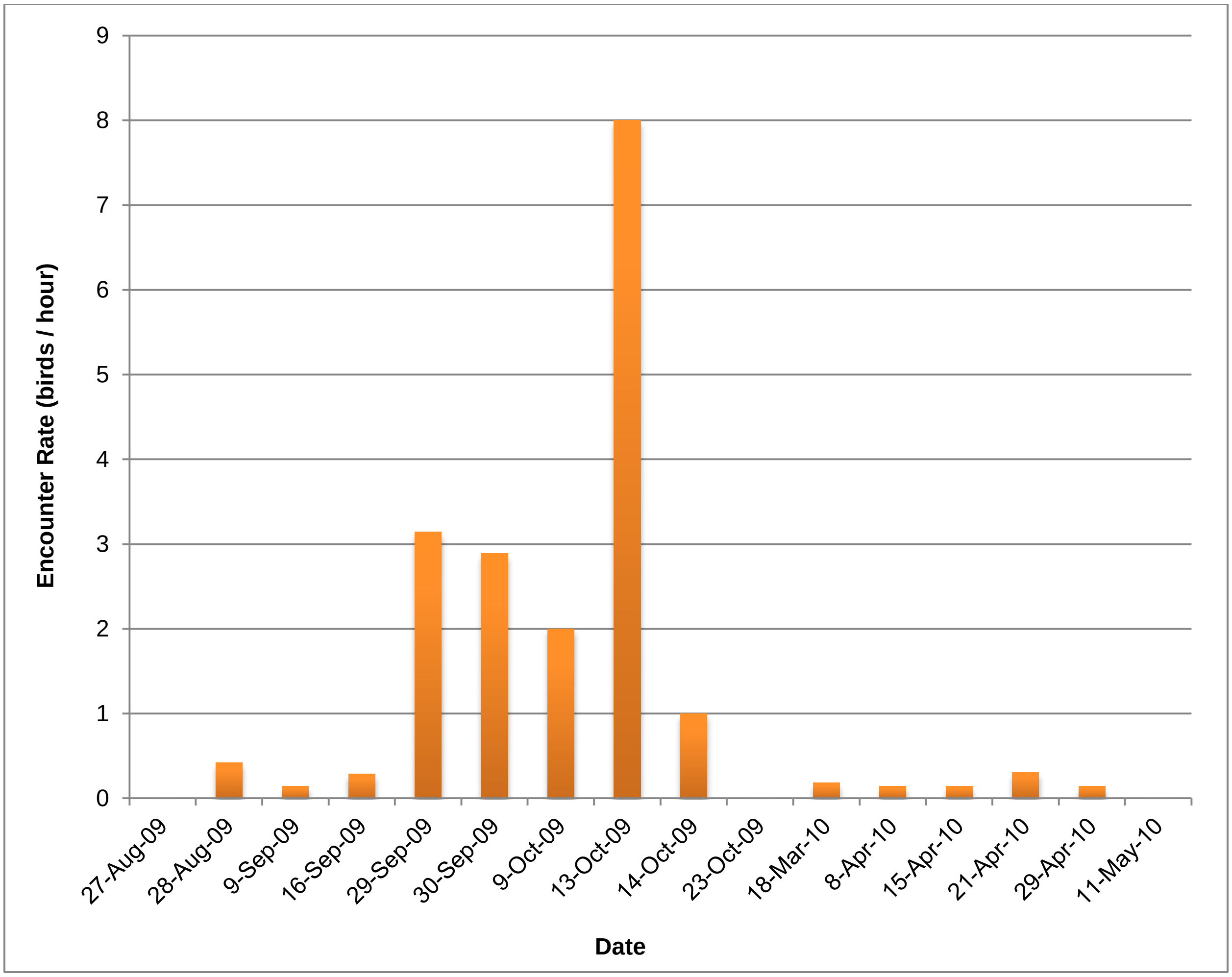


Figure 4.2.1. Temporal variation in raptor encounter rates during the 2009 and 2010 onshore raptor migration surveys – BIWF 2009–2011.

Observation rates of raptors differed between surveys days and throughout the survey period. Daily observation totals ranged from 0 to 8 birds/hr (Figure 4.2.1). Daily count totals also varied throughout the surveys and ranged from 0 to 28 raptors per day. The highest raptor count occurred on October 13, 2009 when 28 peregrine falcons were detected. The second highest daily count occurred on September 29, 2009 with 23 peregrine falcons (Table 4.2.1). Ninety-four percent of observations were made during the last week of September and the first two weeks of October. No raptors were observed on two survey days (August 27 and October 23, 2009). Only six birds were observed during the spring surveys. In general it appears that most raptor migration on Block Island occurs in the fall. However, due to the low sample size and encounter rate during the spring 2010 surveys it is likely not appropriate to make conjectures about raptor migration or flight ecology on Block Island during spring migration.

4.2.3 SPATIAL DISTRIBUTION AND FLIGHT ECOLOGY

Raptor surveys were performed at four locations, which corresponded with the onshore sea watch survey points St. Andrew's (Station 4), Southeast Light (Station 5), Payne's Beach (Station 6), and Lewis-Dicken's Farm (Station 10) (Figure 4.2.2). Most raptors were observed at Southeast Light since the majority of survey effort was focused there. Results for all survey locations were pooled and as such were considered representative of the southern coastal portion of Block Island only.

Flight directions were also recorded and provide some indication of the most likely migration corridor for raptors, especially sub-adult peregrines, on Block Island. Peregrine falcons observed on the southern coast moved almost exclusively towards the west along the bluff line. Upon arriving at the southwestern extremity of the island birds would then move out to sea towards the west and southwest.

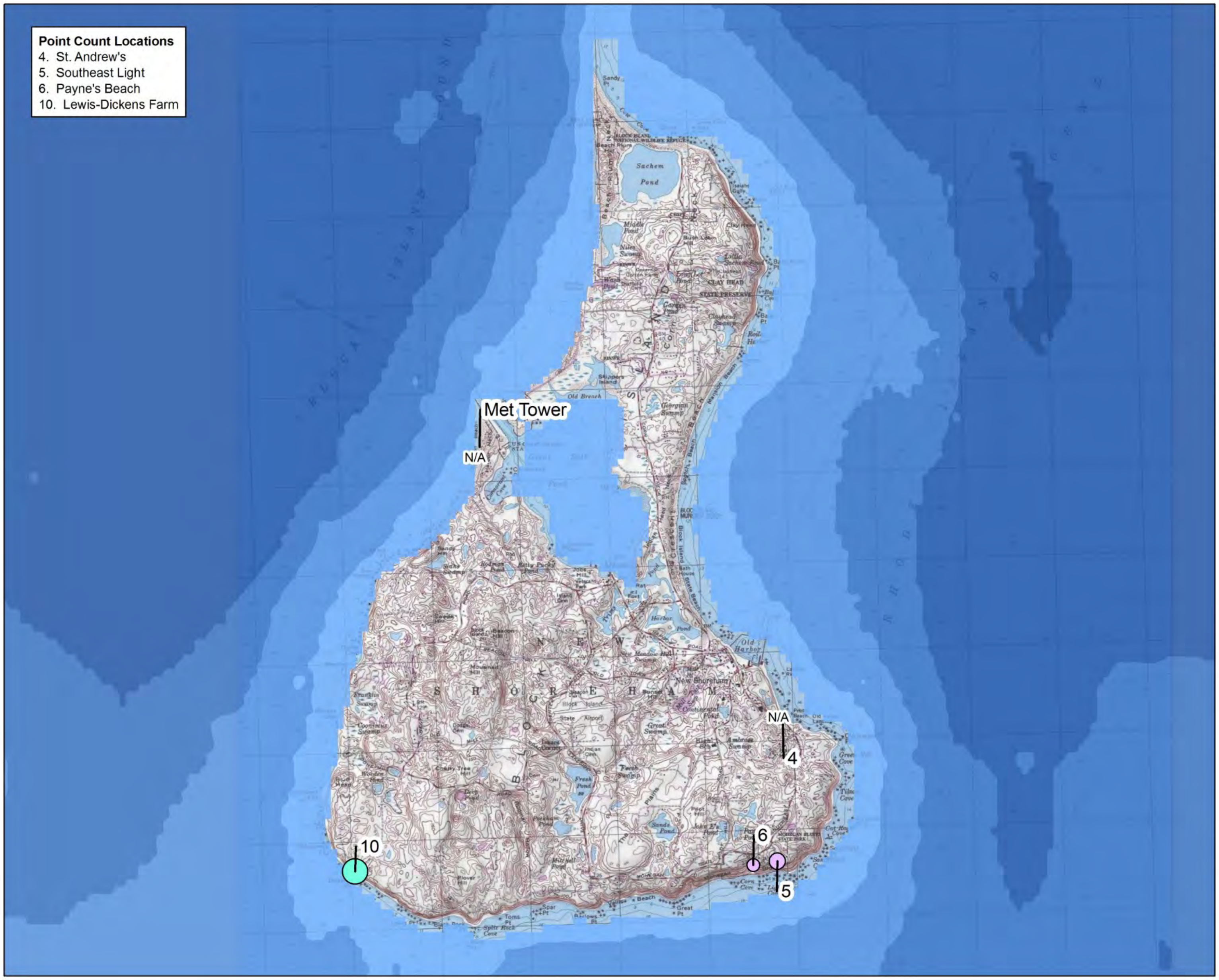


Figure 4.2.2. Raptor Survey Results - Density and Flight Heights - BIWF 2009-2011.

Flight Ecology

Raptor behavior observed during surveys included direct flight, hunting, and perching. A total of 89 raptors were observed in flight, and the remaining five were perched. Raptors were primarily observed hunting along the bluffs and over fields on the island. Cooper's hawk, American kestrel, and northern harrier were seen foraging over open habitats and near bluffs. Tetra Tech observed the majority of peregrine falcons actively hunting while in flight, closely following the topography searching for prey along the contours of the bluffs. One peregrine falcon was observed aggressively making dives at a smaller unidentified bird approximately 0.5 km (0.26 nm) out to sea from the south coast of Block Island; this was the farthest offshore a raptor was observed during the surveys. Perched raptors were infrequently observed but included a bald eagle (the only bald eagle observed during all surveys) perched on a tree across the channel from the met tower at the entrance to New Harbor. One merlin and two peregrine falcons were observed perched on the bluffs at the southern end of the island.

A majority of raptors (65%) were observed flying lower than 10 m (30 ft) above the island. Twenty-one percent flew between 10 and 25 m (30 and 82 ft). Four peregrine falcons were seen flying below 10 m (30 ft) and then increasing in altitude to approximately 125 m (410 ft). A total of four birds flew between 26 and 125 m (85 and 410 ft). The weighted average flight height for all observations of raptors in flight was 10.8 m (35.4 ft) (Figure 4.2.3). With the exception of the single bald eagle observation all raptors had an average flight height of below 20 m (66 ft).

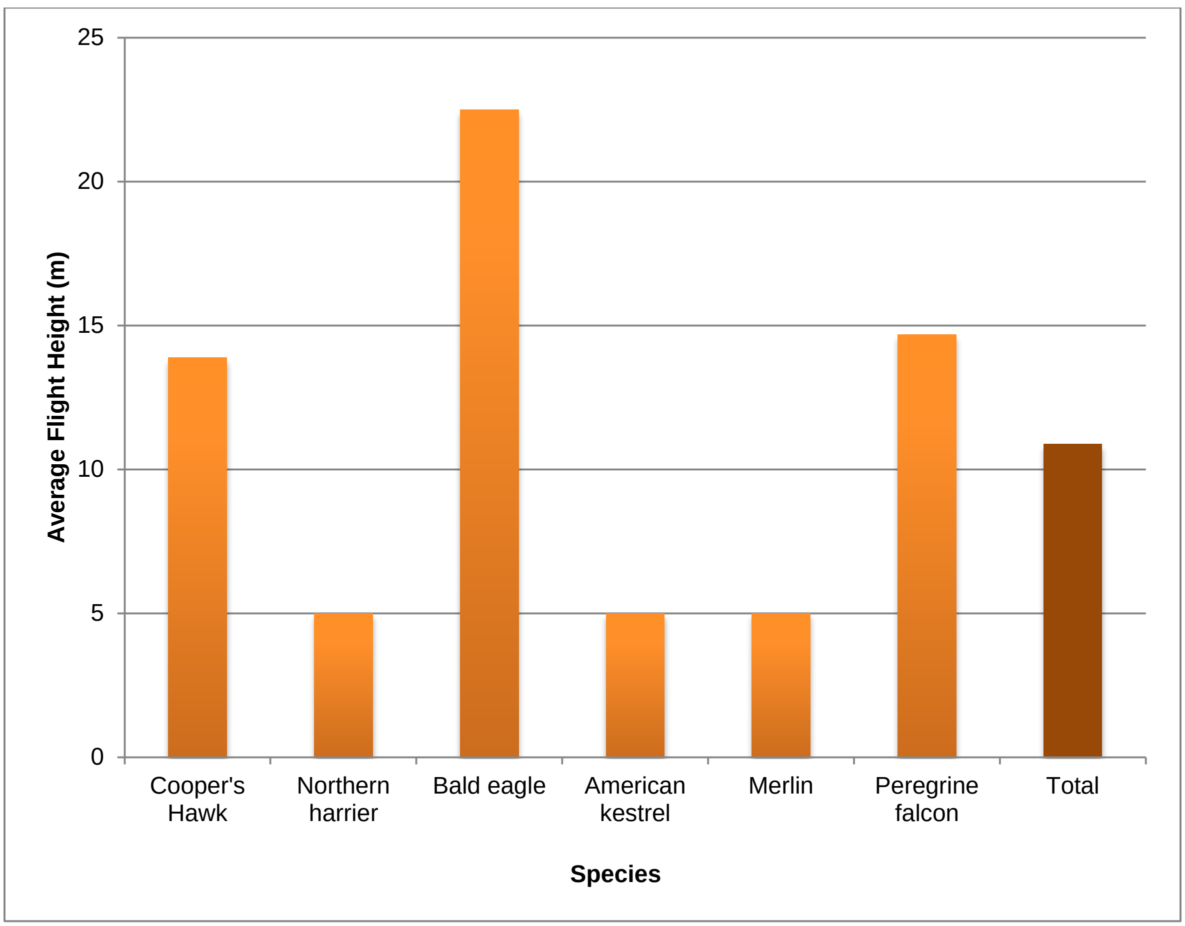


Figure 4.2.3. Average flight height of raptors encountered during the 2009 and 2010 onshore raptor migration surveys – BIWF 2009–2011.

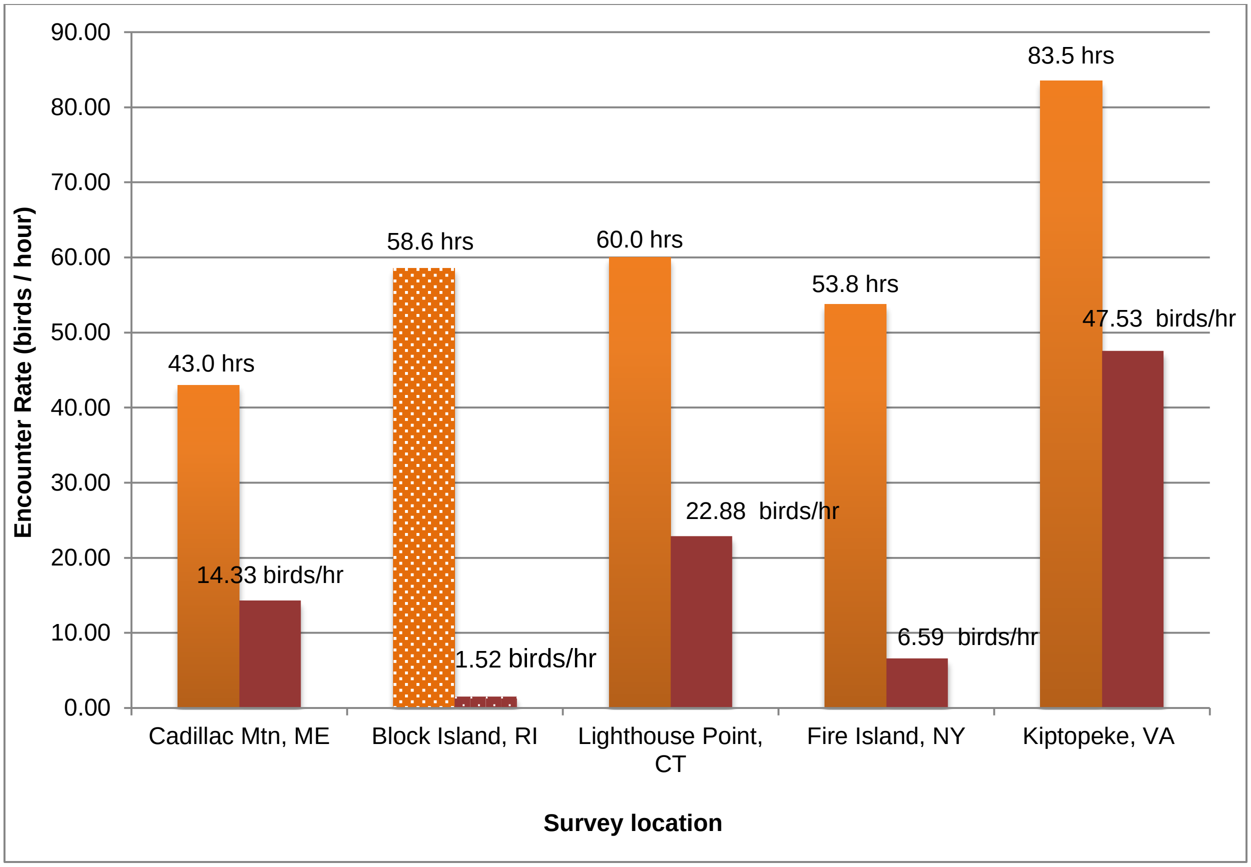
Regional Comparison

Survey results from the Block Island raptor surveys were compared to regional hawk count data collected on the identical survey days. Regional comparison sites included Lighthouse Point (Connecticut), Fire Island (New York), Cadillac Mountain (Maine), and Kiptopeke State Park (Virginia). Lighthouse Point is located on the mainland in New Haven, Connecticut approximately 112 km (70 mi) west of Block Island and on a coastal plain with a clear view of Long Island Sound. Fire Island is located on a barrier beach on the south shore of Long Island approximately 137 km (85 mi) southwest of Block Island. Cadillac Mountain is located on Mt. Desert Island in Bar Harbor, Maine, approximately 451 km (280 mi) northeast of Block Island. The Kiptopeke Hawkwatch is conducted from Kiptopeke State Park on the tip of Virginia's eastern shore on Chesapeake Bay, approximately 595 km (370 mi) southwest of Block Island. These sites were selected because of their similarity in geography, distance from the coast, and general ecological condition, and are presumed to be within the same migratory flyway as Block Island; therefore, a comparison of the data collected from Block Island with data collected at these four hawk watch sites is assumed to provide an indication of the relative importance of Block Island to migrating raptors.

During fall 2009 raptor migration activity was higher at the four regional hawk count sites than at Block Island (Figure 4.2.4). A total of 1,373 raptors were recorded at Lighthouse Point, 378 at Fire Island, 616 at Cadillac Mountain, and 3,969 at Kiptopeke, compared to 89 raptors at Block Island over the same survey days in fall 2009. The four regional hawk count sites recorded between 4 (Fire Island) and 44 (Kiptopeke) times the overall number of raptors over the same survey period.

The Kiptopeke Hawkwatch recorded almost twice the number of peregrine falcons than those recorded at Block Island. However, peregrine falcons were recorded at higher numbers on Block Island than at the Cadillac Mountain, Fire Island, and Lighthouse Point sites during the same 10 survey days. Block Island and Fire Island had similar numbers of peregrine observed, 77 and 65 respectively.

Hourly passage rates were 22.88 birds/hr at Lighthouse Point, 6.59 birds/hr at Fire Island, 14.33 birds/hr at Cadillac Mountain, and 83.5 birds/hr at Kiptopeke as compared with 1.52 birds/hr at Block Island (Figure 4.2.4). During the same ten days, the Lighthouse Point survey effort was 60.0 hours, Fire Island surveyed for 53.75 hours, Cadillac Mountain surveyed for 43.0 hours, Kiptopeke 83.5 survey hours, and the Block Island survey effort was 58.6 hours. Thirteen species were recorded at both Lighthouse Point and Cadillac Mountain, while Kiptopeke recorded twelve species, Fire Island eight species, and Block Island recorded six species.



Note: Orange bars represent survey effort (number of total hours) and red bars represent encounter rate (birds/hour).

Figure 4.2.4. Encounter rate and survey effort at BIWF Study Area during fall migration 2009 and at four hawk watch sites on the same survey days – BIWF 2009–2011.

4.2.4 Weather

During the fall 2009 raptor migration surveys the mean temperature was approximately 16.6°C (62°F), and in spring 2010 the average temperature during surveys was 12.8°C (55°F). Temperatures ranged from 10.8° to 22.2°C (51.5° to 72°F) in fall, and from 11.1° to 14.4°C (52°to 58°F) in spring. Wind speeds during the surveys were generally moderate with a fall survey average of 4.7 m/s (10.6 mph), and 2.9 m/s (6.5 mph) in spring. During observation periods conditions were generally partly cloudy although surveys were also conducted on days with clear and mostly cloudy conditions. Wind directions were northerly and westerly during fall survey days, and southerly and easterly in spring.

4.3 BAT ACOUSTIC MONITORING

Block Island supports a diversity of habitats (Nature Conservancy 2009) with a mosaic of open meadows, shrub land edges, wetlands, and agricultural fields that can provide foraging, roosting, and migratory stopover habitat for bats. Upland habitats include maritime shrubland, maritime grassland, bluffs, dunes, and beach strands (Enser and Lundgren 2006). Other habitats include emergent and interdunal swale wetlands, ponds and lakes, coastal salt ponds, streams, beach, mudflats, disturbed grasslands, hayfields, and other agricultural fields.

Tree habitat available for foraging or roosting bats is generally limited on Block Island, with trees occurring in scattered patches within the more common shrublands, or in association with residential development. Typical shrubland vegetation includes northern bayberry (*Morella pensylvanica*), beach plum (*Prunus maritima*), wild rose (*Rosa virginiana*), shadbush (*Amelanchier* spp.), arrowwood (*Viburnum dentatum*), eastern red cedar (*Juniperus virginiana*), black cherry (*Prunus serotina*), and highbush blueberry (*Vaccinium corymbosum*). Non-native invasive species include honeysuckles (*Lonicera* spp.), oriental bittersweet (*Celastrus orbiculatus*), rugosa rose (*Rosa rugosa*), and multiflora rose (*Rosa multiflora*). Grassland habitat occurs on rolling morainal topography, generally exposed to periodic wind and salt spray. Typical vegetation includes little bluestem (*Schizachyrium scoparium*), grass-leaved goldenrods (*Euthamia graminifolia* and *E. tenuifolia*), bitter milkwort (*Polygala polygama*), white-topped Aster (*Sericocarpus asteroides*), rush (*Juncus greenei*), and grasses. Representative plants of the bluffs habitat include common horsetail (*Equisetum arvense*), orach (*Atriplex patula*), poison ivy (*Toxicodendron radicans*), and Virginia creeper (*Parthenocissus quinquefolia*). The dune community is dominated by grasses and low shrubs where vegetation is patchy due to disturbances such as erosion, sand deposition, and dune migration. Beach strand habitat is a sparsely-vegetated community on unstable sand, gravel or cobble beaches above mean high tide. Characteristic plants include sea-rocket (*Cakile edentula*), orach, seabeach sandwort (*Honkenya peploides* var. *robusta*), common saltwort (*Salsola kali*), and seabeach knotweed (*Polygonum glaucum*).

Land use on Block Island includes commercial and community development, tourism, roads, trails, rural residential with manicured lawns, agriculture, and open space. Protected conservation areas, such as Rodman's Hollow, Fresh Swamp Preserve, Hodge Family Wildlife Preserve, and the USFWS Block Island National Wildlife Refuge provide wildlife habitat (The Nature Conservancy 2009). This varied land use provides potential foraging and roosting habitat for some bat species. For example, species may use buildings as roosts, forage at street lights, use trails as flyways, and forage over freshwater ponds and along edge habitats.

Rhode Island is within the range of nine northeastern bat species that includes big brown bat, eastern red bat, eastern small-footed myotis, hoary bat, little brown bat, northern myotis, silver-haired bat, tri-colored bat (formerly known as the eastern pipistrelle), and Indiana bat[1] (*Myotis sodalis*) (Harvey et al. 1999, RIDEM 2005, BCI 2009). The most common of these species in Rhode Island are the little brown bat, big brown bat, eastern red bat, and tri-colored bat (Rhode Island Department of Health and Department of Environmental Management 2009). In Rhode Island, insufficient data exists for bats and all bat species except the big brown bat are considered species of Greatest Conservation Need (RIDEM 2005).

Based on literature review, the available habitat communities, and Block Island's offshore location, not all bat species that occur in Rhode Island are likely to occur on Block Island. During the summer, four bat species are possible residents on Block Island. These include the big brown bat, little brown bat, eastern red bat, and hoary bat. The eastern small-footed myotis, northern myotis, and silver-haired bat are unlikely summer residents on Block Island because the large, dense forest stands, old growth forest, or more mountainous areas preferred by these species are not present. The tri-colored bat is unlikely to

[1] The federally endangered Indiana bat is included as a species of Greatest Conservation Need in *Rhode Island's Comprehensive Wildlife Conservation Strategy* (RIDEM 2005) though its occurrence is listed as **hypothetical** for the state. The *Indiana Bat (Myotis sodalis) Draft Recovery Plan: First Revision* (USFWS 2007) does not include Rhode Island as within the range of the Indiana bat.

occur on Block Island or the surrounding waters during summer or migration because it is generally incapable of lengthy migration (Tuttle 1991) and thus may not fly over the ocean. The Indiana bat is a hypothetical species in Rhode Island and is highly unlikely to occur on Block Island. During migration, species that are likely to be found on Block Island and the surrounding waters include the big brown bat, little brown bat, hoary bat, silver-haired bat, and eastern red bat. In particular, the migratory tree roosting bats (eastern red bat, hoary bat, and silver-haired bat) are known to migrate long distances (BCI 2009). Also, hoary bats (Cryan and Brown 2007) and eastern red bats (Texas Parks and Wildlife 2009) have been documented flying over the open ocean. The northern myotis and eastern small-footed myotis are possible migrants in the vicinity of the Study Area.

4.3.1 Passive Monitoring

This section contains the results of the 920 detector-nights of onshore passive acoustic bat monitoring and 227 detector-nights of offshore passive acoustic monitoring (Table 4.3.1). Results are provided for the four ultrasonic acoustic detectors deployed on Block Island (AR-125-EXT, Binary Acoustic Technologies, Inc.) and for one detector (Anabat SD-1, Titley Scientific, Inc.) deployed on an offshore buoy 5.5 km (3 nm) south of the island. A second offshore bat detector was deployed on a buoy 16.5 km (15 nm) east of Block Island. This unit did not record any bats, although it appeared to have functioned properly during the late-fall migration period from October 8 to November 5, 2009. The 16.5 km (15 nm) detector did record static and generated status files that indicated that it was operational during the fall 2009 monitoring period. Unfortunately, Tetra Tech was unable to perform a spring 2010 survey from the 16.5 km (15 nm) buoy due to issues with the buoy's power system.

Passive Monitoring Onshore

A total of 157 bat call sequences representing at least three bat species and the genus *Myotis* were recorded during the summer-fall 2009 and spring 2010 monitoring periods (Tables 4.3.1 and 4.3.2). The combined detection rate was 0.17 call sequences per detector-night (call sequences/detector-night) for the four onshore detectors pooled. The Southeast Lighthouse detector recorded the highest detection rate (0.34 call sequences/detector-night) in fall 2009. The Met Tower Low detector recorded the highest detection rate (0.34 call sequences/detector-night) in spring 2010.

Bat calls were identified to the lowest possible taxonomic level (Table 4.3.2). Of the 157 call sequences recorded at onshore monitoring stations, 42 were identified to species level (27%); the remaining call sequences were classified to a genus or a mean characteristic frequency (Fc) guild. Species were then combined into four "Known Species Groups" (Low Frequency Species, Middle Frequency Species, and High Frequency Species) based on similarities in call sequence structure. Call sequences that did not meet the parameters required for species level identification (*n* = 115) were grouped into "Unknown Species Groups." These Unknown Species Groups consisted of bat call sequences with insufficient quality to allow classification to species or a Known Species Group level, and they were therefore labeled either as Low Frequency Unknown, Middle Frequency Unknown and/or High Frequency Unknown.

The Low Frequency Unknown category was used to label call sequences of poor quality but with a characteristic frequency of around 20 kHz. This group contained poor quality calls only from hoary bat. The Middle Frequency Unknown category was used to label call sequences of poor quality but with a characteristic frequency of around 30 kHz. This category includes species such as silver-haired bat (*Lasionycteris noctivagans*) and big brown bat (*Eptesicus fuscus*). The High Frequency Unknown category could potentially contain call sequences of tri-colored bat, eastern red bat, eastern small-footed myotis

(*Myotis leibii*), little brown myotis, and/or northern long-eared myotis (*Myotis septentrionalis*). Few of the onshore calls recorded were identified as myotis species (*n* = 9, 5.7%). It is highly unlikely that Indiana bat occurs on Block Island for reasons elaborated on in Section 6.7 of this report.

Table 4.3.1. Summary of passive bat acoustic survey effort and results performed onshore and offshore – BIWF 2009–2011.

Detector		Deployment Dates	# Detector Nights	Total # Call Sequences	Call Sequences/ Night
South Coast	Southeast Lighthouse MERLIN Radar	June 6 through November 18, 2009	165	56	0.34
		April 1–June 30, 2010	91	13	0.14
	Southwest Point	June 6 through November 18, 2009	165	14	0.08
		April 1–June 30, 2010	91	11	0.12
Met Tower	High	July 27 -August 24, August 26–November 18, 2009	113	5	0.04
		April 1–June 30, 2010	91	19	0.21
	Low	July 27 -August 24, August 26–November 18, 2009	113	8	0.07
		April 1–June 30, 2010	91	31	0.34
Onshore Total			**920**	**157**	**0.17**
Buoy	Offshore (3 nm south of Block Island)	October 8 through November 5, 2009	29	0	0.00
		April 1–October 15, 2010	198	16	0.08
Offshore Total			**227**	**16**	**0.07**

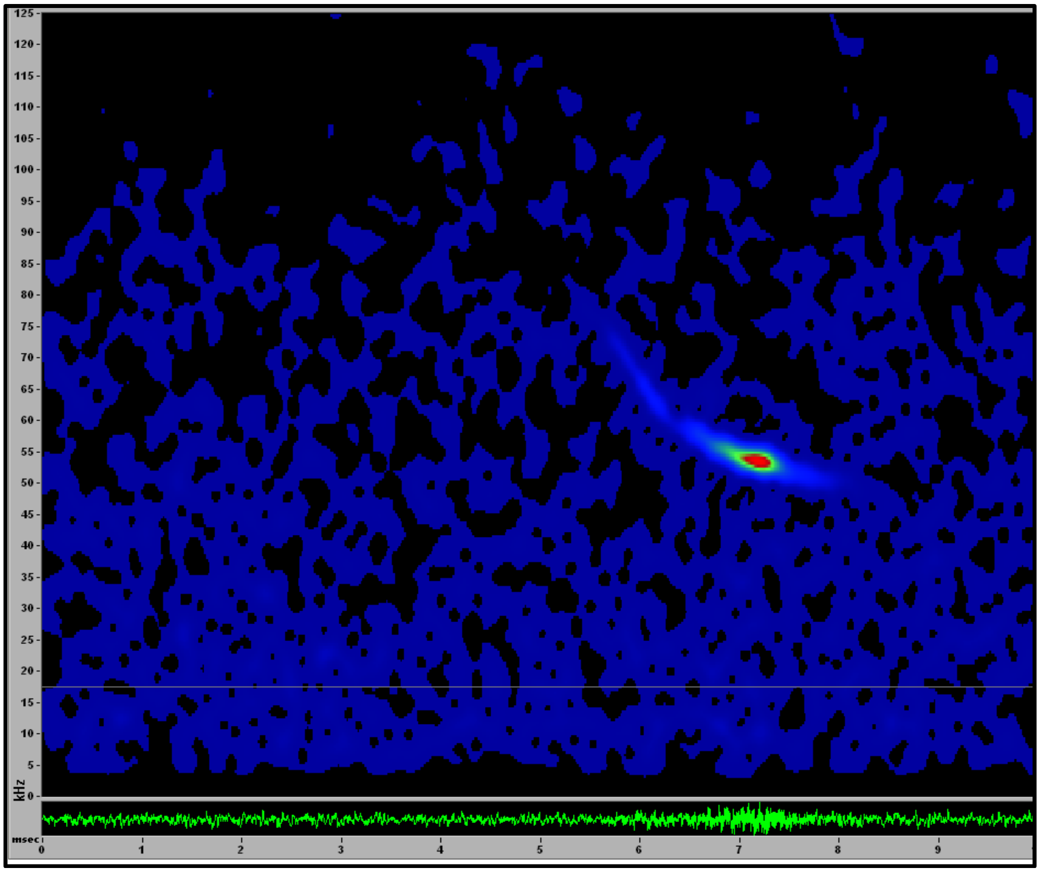
Table 4.3.2. Passive bat acoustic monitoring survey results including species per detector locations – BIWF 2009–2011.

Known Species Group	Characteristic Frequencies[1]	Species	South Coast		Met Tower		Buoy	Total
			Southeast Lighthouse MERLIN Radar	Southwest Point	High	Low	Offshore (3 nm south of Block Island)	
Low Frequency	12 kHz to 24 kHz	Unknown low frequency call seq.	18	11	13	15	–	**57**
	12 kHz to 24 kHz	Hoary bat	12	1	–	–	2	**15**
Middle Frequency	24 kHz to 38 kHz	Silver-haired bat	13	2	1	4	3	**23**
		Unknown middle frequency call seq.	6	1	–	2	–	**9**
High Frequency	39-45 kHz	Eastern red bat	7	–	–	2	–	**9**
		Unknown Myotis species	5	4	–	–	–	**9**
		Unknown high frequency call seq.	8	6	10	16	11	**51**
Total			**69**	**25**	**24**	**39**	**16**	**173**

[1]Characteristic frequency (Fc) is generally defined as the frequency of the call pulse at the lowest slope, or the lowest frequency of the consistent frequency modulation sweeps. Fc represents the single most useful parameter for species identification.

The Southeast Lighthouse detector recorded the greatest number of bat species (three species and unknown myotis calls). The majority of silver-haired bat and hoary bat calls were recorded at the Southeast Lighthouse. Eastern red bat calls were only recorded at the Southeast Lighthouse and the Met Tower Low detector (Figure 4.3.1). High frequency call sequences and/or myotis species call sequences were recorded at all detector locations.

During the late-summer fall monitoring period no call sequences were recorded prior to July 24 and after October 21, 2009 (Figure 4.3.3). The earliest that call sequences were recorded in the spring was on May 19, and the latest calls recorded were on June 2, 2010 (Figure 4.3.4). The overall peak in recorded calls onshore occurred on August 28, 2009 at the Southeast Lighthouse detector.



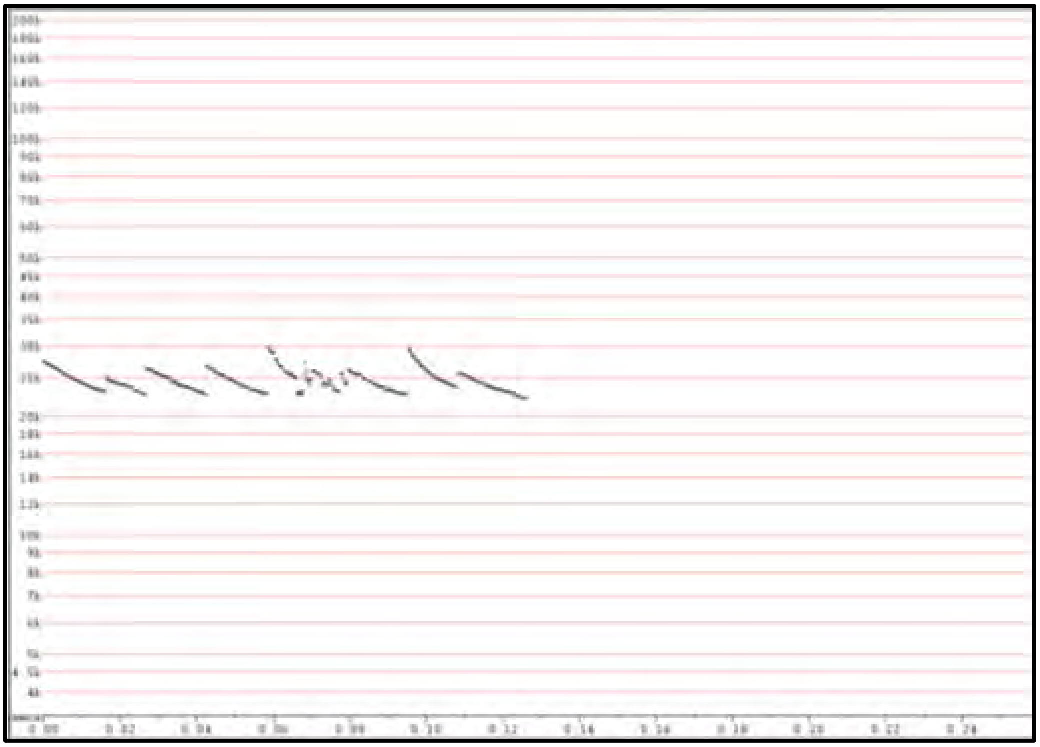
*Note the high Fc frequency and slope of the pulse, both characteristics indicative of the eastern red bat.

Figure 4.3.1. Spectrogram of eastern red bat call pulse recorded at the Southeast Lighthouse detector – BIWF 2009–2011.

Passive Monitoring Offshore

The Anabat detector at the 5.5 km (3 nm) buoy off the south coast of Block Island collected data for 29 detector-nights in fall 2009, and 198 detector-nights in 2010 (Table 4.3.1). No call sequences were recorded in fall 2009. Sixteen call sequences were recorded by the 5.5 km (3.0 nm) buoy detector in 2010. Of the 16 call sequences recorded during passive monitoring offshore, 69% were High Frequency Unknown (*n* = 11). Two calls were classified as hoary bat and three as silver-haired bat (Figure 4.3.2).

It is uncertain which species were responsible for the 11 High Frequency Unknown calls recorded offshore. It is possible that myotis species were responsible for many of the calls, and indeed eight of the call sequences appeared to be fragments of myotis call sequences. The three remaining calls may also have been myotis species, although there was insufficient information in the recordings to distinguish these calls from "feeding buzz" phase calls of other species. The myotis calls recorded were most similar to little brown myotis and northern long-eared myotis, two common species in southern New England. Some of the unknown high frequency calls also resembled fragments of eastern red bat calls.



*Note the low Fc frequency and relatively constant frequency (lack of frequency modulation) in each pulse, both characteristics indicative of the hoary bat.

Figure 4.3.2. Spectrogram of a hoary bat call sequence recorded at the 5.5 km (3 nm) buoy detector – BIWF 2009–2011.

All of the 16 call sequences recorded during offshore passive acoustic monitoring were detected on three nights: June 23, June 24, and July 22, 2010. On June 23 two High Frequency Unknown calls were recorded. Two hoary bat, three silver-haired bat, and five High Frequency Unknown calls were recorded on June 24, 2010. During the entire deployment period, June 24 was the most active day at the 5.5 km (3.0 nm) offshore passive monitoring station. On July 22, four High Frequency Unknown calls were recorded.

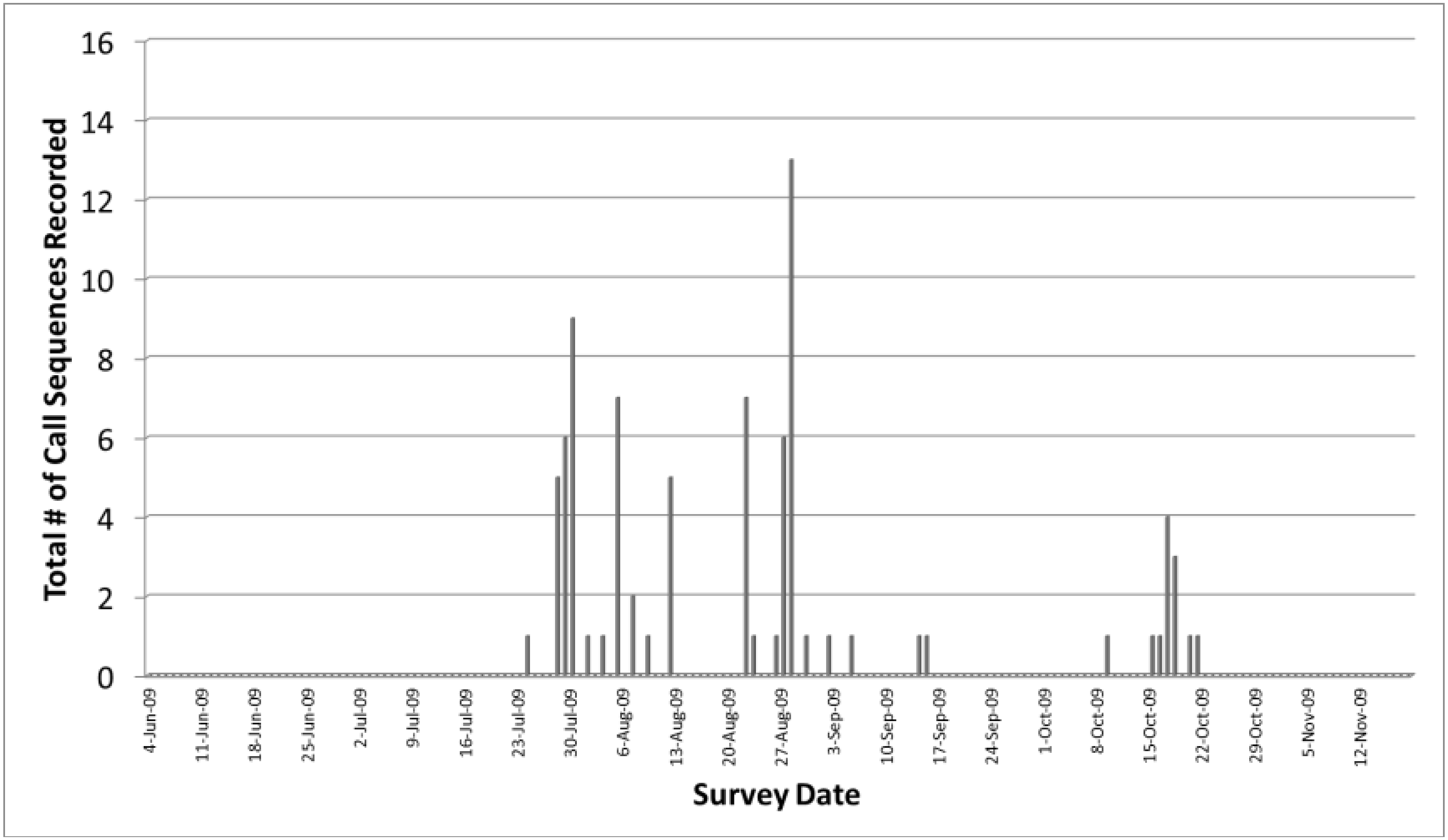


Figure 4.3.3. Temporal distribution of call sequences recorded during the late-summer/fall 2009 passive acoustic onshore bat monitoring surveys – BIWF 2009–2011.

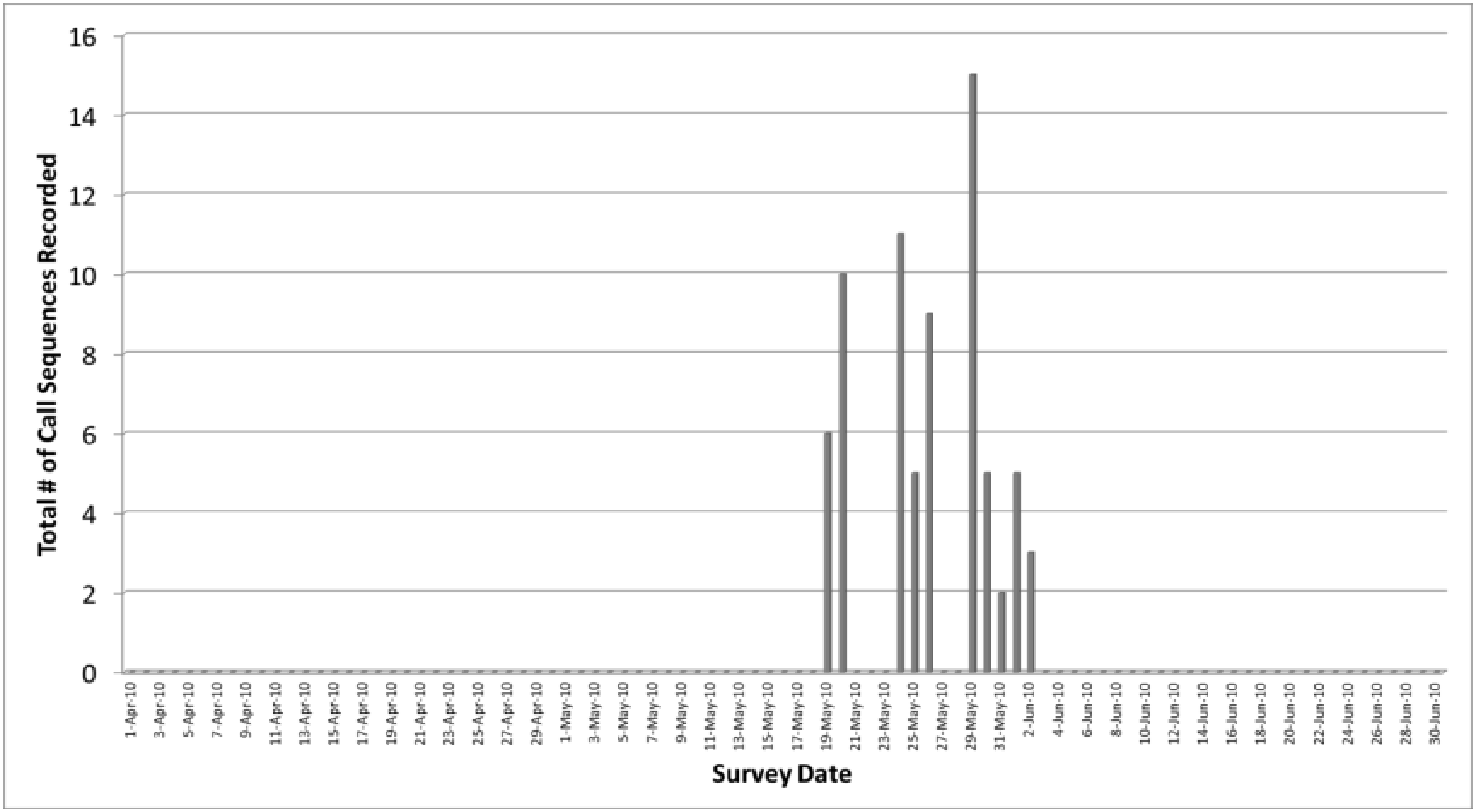


Figure 4.3.4. Temporal distribution of call sequences recorded during the spring 2010 passive acoustic onshore bat monitoring surveys – BIWF 2009–2011.

4.3.2 Active Monitoring

Three nights of active monitoring were performed onshore, and five nights offshore. Combined, these surveys yielded 48 hours of "roving" monitoring. Only seven call sequences were recorded onshore during these roving surveys, and one call sequence was recorded offshore (Table 4.3.3).

Table 4.3.3. Summary of level of effort and results of the active acoustic monitoring surveys for bats – BIWF 2009–2011.

Survey Location	Survey Dates	# Detector Nights	# Detector Hours	Total # Call Sequences	Call Sequences/ Night
Onshore	August 26 and September 4, 2009, and August 31, 2011,	3	18	7	2.33
Offshore	July 22, August 25, August 27, September 3, 2009, and September 13, 2011	5	30	1	0.20
Total		**8**	**48**	**8**	**1**

Table 4.3.4. Call sequences recorded, by species, during active monitoring surveys offshore and onshore – BIWF 2009–2011.

Location	Species	Recording Night	Recording Time
Offshore	Silver-haired bat (*Lasionycteris noctivagans*)	8/27/2009	21:08
Onshore	Eastern red bat (*Lasirius borealis*)	9/4/2009	19:46
		9/4/2009	19:53
		9/4/2009	19:58
	Little brown myotis (*Myotis lucifigus*)	8/26/2009	19:56
		8/26/2009	21:37
	Unknown *Myotis* species	9/4/2009	19:57
	High frequency species unknown	9/4/2009	19:56

Table 4.3.5. Summary of bat call sequences and probable species recorded during onshore and offshore active acoustic surveys, July to September, 2009 – BIWF 2009–2011

Known Species Group	Characteristic Frequencies[1]	Species	Total
Low Frequency	12 kHz to 24 kHz	Hoary bat	–
Middle Frequency	24 kHz to 38 kHz	Big brown bat	–
		Silver-haired bat	**1**
		Silver-haired bat/ Big brown bat	–
		Unknown middle frequency call seq.	–
High Frequency	39-45 kHz	Eastern red bat	**3**
		Northern myotis	–
		Eastern small-footed myotis	–
		Little brown myotis	**2**
		Unknown *Myotis* species	**1**
		Unknown high frequency call seq.	**1**

[1] Characteristic frequency (Fc) is generally defined as the frequency of the call pulse at the lowest slope, or the lowest frequency of the consistent frequency modulation sweeps. Fc represents the single most useful parameter for species identification.

Active Monitoring Onshore

Onshore active acoustic bat surveys were conducted at a total of nine points, one walking transect, and along driving transects on August 26 and September 4, 2009 between 19:00 to 00:37 and 19:30 to 01:40, respectively. Surveys were performed again on August 31, 2011 from 19:30 to 0:37. The walking transect along Mansion Beach included a total of 0.97 survey km (0.6 survey mi) each night. Approximately 29 km (18 mi) of road transects were surveyed each night and included the following roads: Corn Neck Road, Water Street, Spring Street, Mohegan Trail, Lakeside Drive, Cooneymus Road, Champlin Road, Center Road, Beach Avenue, Andy's Way, and Mansion Road. The monitoring effort for this three-night period resulted in three detector-nights (number of detectors multiplied by the number of nights deployed) of recordings. Detectors monitored bat echolocation calls for approximately 6 hours per night, resulting in a total of 18 detector-hours and a mean of 2.3 call sequences/detector-night (Table 4.3.3).

During the onshore surveys the temperature on August 26 was 21°C (70°F), and on September 4 the temperature was 20°C (68°F) (mean = 20.5°C [69°F]). Wind speeds were moderate, with a survey period average of 5.4 m/s (12 mph) and ranged from 3.1 to 7.6 m/s (7 to 17 mph). Wind direction was generally from the west-southwest. Light but steady rain occurred during the August 26 survey night.

A total of seven bat call sequences representing two identified species, one unknown myotis species, and one Unknown High Frequency species were recorded during the onshore active monitoring surveys (Table 4.3.3). Most (71%) of the recorded calls were identified to species level (*n* = 5); a total of three calls (43%) were eastern red bats and two calls (28%) were little brown bats. The myotis species group was more frequently recorded (57%), though eastern red bats were not uncommon (43%). No calls of federally listed bat species were identified during the onshore survey. For both survey nights when calls were recorded, call sequences were first detected approximately one-half hour after sunset, and recorded activity occurred between 19:46 and 21:37 for both surveys combined (Table 4.3.5). No calls were detected during active monitoring on August 31, 2011.

The three eastern red bat calls and one Unknown High Frequency detection were all recorded in the vicinity of points 6 and 7 along the west side of Cormorant Cove and the Inlet of Great Salt Pond on September 4, 2009 (Table 4.3.6). Myotis species were detected in the northern survey area on each survey night. One little brown bat was recorded on August 26, and one unknown myotis species was recorded on September 4, both just north of point 5 at the intersection of Corn Neck Road and Clayhead Trail. Habitat in this area includes a freshwater pond with surrounding shrubs and trees, and rural residential yards. One little brown bat was recorded along the Mansion Beach bluff habitat on August 26. No bats were recorded in the southern portion of the survey area. Observations indicated that general insect activity was spatially and temporally variable during each survey, ranging from many insects present to none observed.

Table 4.3.6. Onshore active bat acoustic monitoring locations and habitat descriptions – BIWF 2009–2011.

Label[a]	Name	GPS Location[b]		Habitat Description
		Latitude	Longitude	
P1	Fresh Pond	41° 09.728	-71° 34.686	Large freshwater pond; tree and shrub edge, lawn and meadow adjacent
P2	Vaill Beach Trailhead	41° 08.992	-71° 34.619	Small, shallow pond; tree/shrub/meadow mosaic
P3	Southwest Point	41° 09.830	-71° 36.658	Beach, grass dunes, tree/shrub/meadow mosaic, residential lawns
P4	Mohegan Trail Pond	41° 09.016	-71° 33.974	Small open water pond, tree/shrub/meadow/residential mosaic
P5	Great Salt Pond (East Side)	41° 12.030	-71° 34.537	Large salt pond, beach, tree/shrub/meadow/residential lawn mosaic
P6	Cormorant Cove	41° 11.465	-71° 35.489	Beach, shrub/residential area
P7	Great Salt Pond Inlet	41° 11.774	-71° 35.365	Beach, shrub
P8	Sachem Pond (North)	41° 13.499	-71° 34.115	Beach, dunes, shrub, open freshwater pond
P9	Sachem Pond (East)	41° 13.333	-71° 33.918	Open freshwater pond, shrub/meadow/residential
T1	Mansion Beach	41° 12.132[c]	-71° 33.607[c]	Beach, bluffs, shrublands

[a] P = Point location: timed stationary observation; T = Walking Transect: continuous detector recording along transect
[b] Datum WGS 84
[c] Transect start location

Active Monitoring Offshore

Offshore active acoustic bat surveys were conducted along the same two offshore transects that were used for boat-based avian surveys. A total of four surveys were performed during the 2009 summer and fall monitoring period, and a single survey was performed in September 2011. Surveys were started between 19:30 and 20:38 and were completed between 21:30 and 23:10. During the offshore surveys the mean temperature was 19°C (67°F); temperatures ranged from 18° to 21°C (63° to 70°F). Surveys were conducted on evenings with generally calm seas and light wind speeds averaging 2.9 m/s (6.5 mph). Wind direction varied among south, east, and southwest.

One bat call sequence was recorded during the offshore active monitoring surveys (Table 4.3.3). The single bat call was a silver-haired bat recorded on August 27 at 21:08 near the north end of Sawtooth Transect 1. The monitoring effort for this five-night period resulted in five detector-nights of recordings. Detectors monitored bat echolocation calls for approximately 2 hours per night, resulting in a total of 8.5 detector-hours and a mean of 0.20 call sequences/detector-night. No insects were observed offshore during surveys.

4.4 AVIAN ACOUSTIC MONITORING

4.4.1 OBSERVATION TOTALS AND DIVERSITY

Avian acoustic monitoring surveys were performed on Block Island during fall 2009 and spring 2010. Wildlife Acoustic SM-1 units recorded data at three locations: Lewis-Dicken's Farm, Southeast Light, and the entrance to Old Harbor (Table 4.4.1).

Table 4.4.1. Summary of the avian acoustic monitoring results including species guilds, survey periods, and total number of calls recorded – BIWF 2009–2011.

Location	Season	Survey Period	Wood-warblers	Thrushes	Sparrows	TOTAL
Southeast Light	Fall	Aug. 20–Oct. 11, 2009.	–	8	2	10
	Spring	April 15–May, 31, 2010	–	–	–	–
Lewis-Dicken's Farm	Fall	Aug. 20–Oct. 11, 2009.	–	–	–	–
	Spring	April 15–May, 31, 2010	695	658	918	2,271
New Harbor	Fall	Aug. 20–Oct. 31, 2009.	221	57	142	420
	Spring	April 15–May, 31, 2010	–	–	–	–
		TOTAL	**916**	**723**	**1,062**	**2,701**

Each of the three monitoring locations recorded nocturnal avian flight calls, although the detection rate (calls/monitor-night) varied at each station. The Lewis-Dicken's Farm station yielded the highest detection rate (48.32 calls/monitor-night), in spring 2010. The Old Harbor station produced the second highest rate (5.75 calls/monitor-night) (Table 4.4.2).

Table 4.4.2. Detection rate by monitoring station and season during the fall 2009 and spring 2010 sampling periods – BIWF 2009–2011.

Location	Season	Detector-Nights	Calls	Calls/Monitor-Night
Southeast Light	Fall	53	10	0.19
	Spring	47	0	0.00
Lewis-Dicken's Farm	Fall	53	0	0.00
	Spring	47	2,271	48.32
Entrance to Old Harbor	Fall	73	420	5.75
	Spring	47	0	0.00

Recorded calls were attributed to three species guilds: wood-warblers, thrushes, and sparrows (Figure 4.4.1). Most calls (*n* = 2,271, 84%) were recorded at the Lewis-Dicken's Farm monitoring station, in spring 2010 (Figure 4.4.2). The New Harbor station recorded 420 calls (15.6%), and the monitor at Southeast Light recorded 10 calls (0.4%). Each of the three stations recorded calls only during a single season. Southeast Light and New Harbor only recorded calls during fall 2009, and Lewis-Dicken's Farm only recorded calls in 2010. The cause of this discrepancy in uncertain, though it is known that birds were migrating through the area during the periods when no calls were recorded (see Section 4.7). It is likely that the quality of any avian recordings during those time periods was too poor to be picked up by the SongScope recognizer employed during analysis. Poor quality call recordings can be caused by excessive background noise, the distance between the bird and microphone, or a combination of multiple factors including atmospheric conditions such as high humidity. Unfortunately, a large number of calls were not consistently recorded during the survey period, it is inappropriate to make any specific conclusions about nocturnal passerine migration based on the avian acoustic monitoring survey results. These data are useful when studied in comparison with the results of other surveys types employed in the Study Area, such as the onshore sea watch avian surveys and the MERLIN radar surveys (Sections 4.1 and 4.7).

The monitoring stations recorded 430 calls during fall 2009. In spring 2010, the monitoring stations recorded 2,271 calls. The earliest fall flight call was recorded on September 12 (*n* = 8). The greatest number of calls recorded in fall was on November 2, 2009; no calls were recorded after this date. The earliest spring calls were recorded on May 13 (*n* = 82). The peak number of calls in spring was recorded on May 16, and the monitoring stations recorded the last spring calls on May 21, 2010.

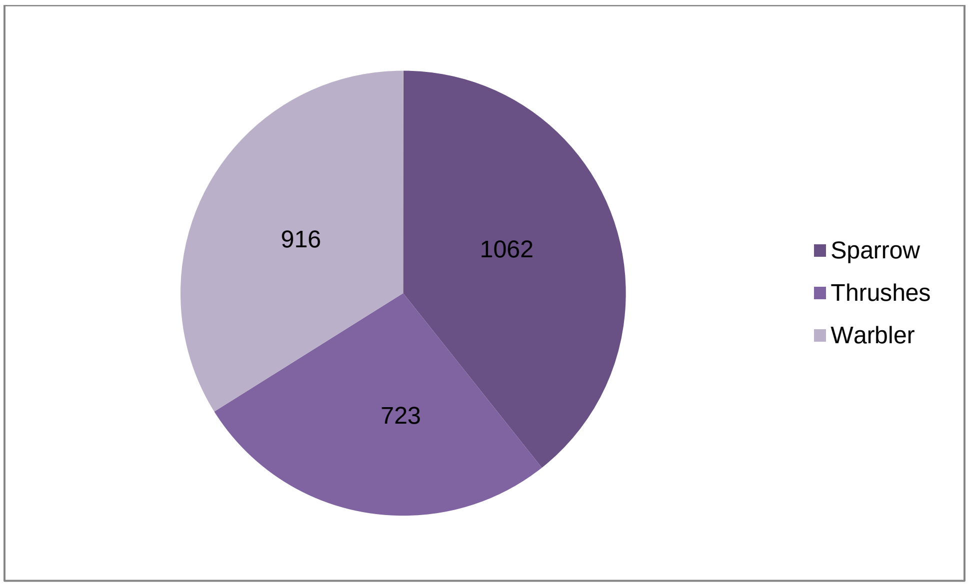


Figure 4.4.1. Composition of flight calls recorded during the fall and spring monitoring periods, pooled – BIWF 2009–2011.

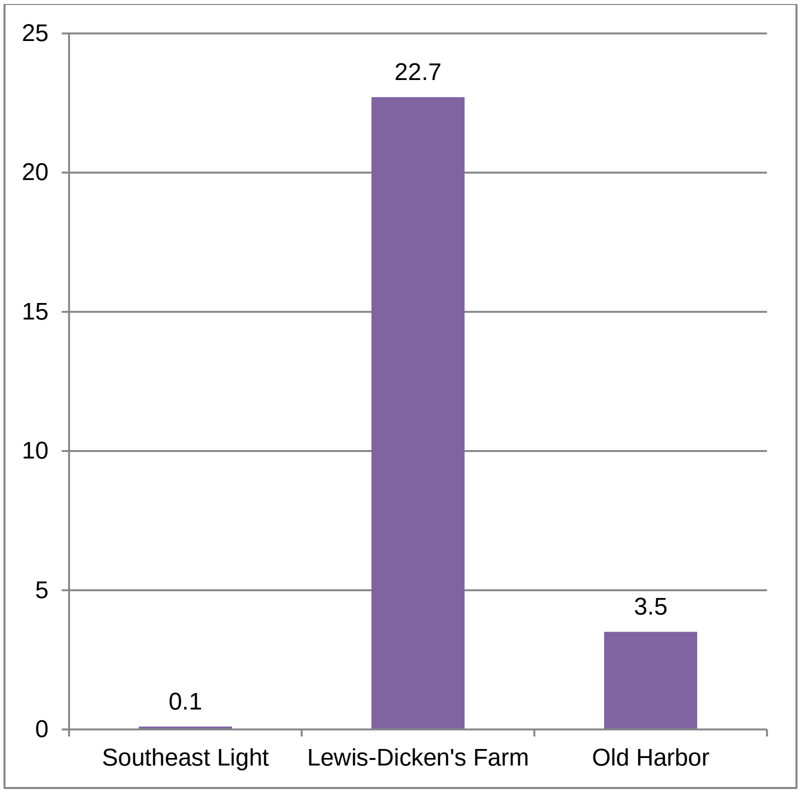


Figure 4.4.2. Detection rate by monitoring station during the fall and spring survey efforts, pooled – BIWF 2009–2011.

4.5 OFFSHORE BOAT-BASED AVIAN SURVEYS

4.5.1 OBSERVATION TOTALS, DIVERSITY, AND ABUNDANCE

Offshore boat-based surveys were performed on 32 different days during a 366 day survey period from July 16, 2009 to June 24, 2010, and again from August 31, 2011 to September 21, 2011 (Table 4.5.1). (Surveys were suspended from June 24, 2010 and August 31, 2011 because of uncertainties in the viability of the BIWF, once confidence in the project was reestablished surveys were finished.) Transects 1 and 2 were sampled 16 times each. Transect data were then combined and comparisons were made between segments where turbines are proposed (segments 8–14) and segments where turbines are not proposed (segments 1–7, 15–25).

A total of 6,971 birds were recorded during the 2009, 2010, and 2011 boat-based surveys, representing 32 bird species; all species observed are listed in Table 4.5.2, which also includes their respective scientific names. Nine of the 32 species were seabirds, six were waterfowl, and five were gulls (Table 4.5.3). Also, three species of tern, two species of gull, two species of cormorant, and one species each of shorebird, gannet, and passerine (landbird) were recorded during the survey.

Of the total 6,971 birds recorded, 27.4% were waterfowl (*n* = 1,910), 20.3% (*n* = 1,415) were seabirds and 14.4% were gulls (*n* = 1,006) (Table 4.5.3). Approximately 8.3% (*n* = 578) of the birds observed were loons, while 1% of the birds recorded (*n* = 67) were terns. Cormorants, least tern, and Forester’s tern were observed very infrequently, and overall tern observations accounted for only 1.0% of all individual birds detected. Shorebirds were observed even less frequently, and accounted for a mere 0.19% of observations.

No federally listed threatened or endangered species were observed during the boat-based surveys. Two species listed under the ESA, the piping plover and roseate tern, have potential to occur in the Study Area, primarily during migration periods, but were not observed during the field investigation. Red knot (*Calidris canutus*) a candidate species for ESA listing also has potential to occur in the Study Area, but was likewise not observed.

Some of the species encountered are considered Birds of Conservation Concern (BCC) by the USFWS (USFWS 2008). BCC are species that may be at risk from habitat loss or other natural and/or anthropogenic factors, and whose populations are thought to be in decline (USFWS 2008). Block Island is part of Bird Conservation Region (BCR) 30, which includes New England and the Mid-Atlantic Coast. In BCR 30 there are 45 BCC species. Of these, a total of four BCC species were observed during boat-based surveys: red-throated loon, great shearwater, Audubon's shearwater, and least tern. Least tern is also listed as a threatened species by RIDEM (RIDEM 2006).

Table 4.5.1. Summary of boat-based avian surveys performed in 2009, 2010, and 2011 – BIWF 2009–2011.

Date	Transect 1 (Segment 1–25)	Transect 2 (Segments 1–25)
7/16/2009	X	
7/22/2009		X
7/31/2009	X	
8/12/2009		X
8/18/2009	X	
9/8/2009		X
9/15/2009	X	
9/24/2009		X
10/1/2009	X	
10/14/2009		X
11/9/2009	X	
11/18/2009		X
11/19/2009	X	
11/21/2009		X
12/7/2009	X	
12/15/2009		X
1/14/2010	X	
2/2/2010		X
2/3/2010	X	
3/2/2010		X
3/19/2010	X	
3/20/2010		X
4/7/2010	X	
4/14/2010		X
4/21/2010	X	
5/11/2010		X
5/26/2010	X	
6/9/2010		X
6/24/2010	X	
8/31/2011	X	
9/20/2011		X
9/21/2011	X	X

Table 4.5.2. Encounter rate and frequency for species observed during the boat-based transect surveys conducted from 2009 to 2011 – BIWF 2009–2011.

Species (Common Name)	Scientific Name	Total # observed (n)	Encounter rate (bird per survey)
Loons			
Common loon	*Gavia immer*	552	17.25
Red-throated loon	*Gavia stellata*	26	0.81
Shearwaters and Allies			
Manx's shearwater	*Puffinus puffinus*	18	0.56
Audubon's shearwater	*Puffinus iherminieri*	16	0.50
Great shearwater	*Puffinus gravis*	100	3.13
Sooty shearwater	*Puffinus griseus*	29	0.91
Cory's shearwater	*Calonectris diomedea*	29	0.91
Unidentified shearwater		26	0.81
Wilson's storm-petrel	*Oceanites oceanicus*	103	3.22
Unidentified storm-petrel		12	0.38
Gannets			
Northern gannet	*Morus bassanus*	865	27.03
Cormorants			
Double-crested cormorant	*Phalacrocorax auritus*	35	1.09
Great cormorant	*Phalacrocorax carbo*	14	0.44
Unidentified cormorant		44	1.38
Waterfowl			
Common eider	*Somateria mollissima*	215	6.72
Long-tailed duck	*Clangula hyemalis*	6	0.19
White-winged scoter	*Melanitta fusca*	693	21.66
Surf scoter	*Melanitta perspicillata*	28	0.88
Black scoter	*Melanitta nigra*	948	29.63
Unidentified scoter		382	11.94
Red-breasted merganser	*Mergus serrator*	20	0.63
Unidentified duck		353	11.03
Shorebirds			
Sanderling	*Calidris alba*	5	0.16
Unidentified shorebird		8	0.25
Gulls			
Bonaparte's gull	*Larus philadelphia*	6	0.19
Laughing gull	*Larus atricilla*	15	0.47
Ring-billed gull	*Larus delawarensis*	17	0.53
Herring gull	*Larus argentatus*	491	15.34

Species (Common Name)	Scientific Name	Total # observed (n)	Encounter rate (bird per survey)
Great black-backed gull	*Larus Marinus*	477	14.9%
Unidentified Larus gull		828	25.88
Black-legged kittiwake	*Rissa tridactyla*	14	0.44
Terns			
Common tern	*Sterna hirundo*	65	2.03
Forster's tern	*Sterna forsteri*	1	0.03
Least tern	*Sterna antillarum*	1	0.03
Unidentified tern		35	1.09
Seabirds			
Razorbill	*Alca torda*	257	8.03
Thick-billed murre	*Uria lomvia*	10	0.31
Unidentified murre		82	2.56
Dovekie	*Alle alle*	20	0.63
Black guillemot	*Cepphus grylle*	2	0.06
Unidentified alcid		88	2.75
Passerines			
Bank swallow	*Riparia riparia*	2	0.06
Unidentified swallow		5	0.16
Unidentified bird		28	0.88
Overall		**6,971**	**217.84**

Table 4.5.3. Encounter rate and frequency for five species groups observed during the boat-based transect surveys conducted from 2009 to 2011 – BIWF 2009–2011.

Species Group	Species Richness	Total Count of Encounters	Percentage of Total Count	Overall Encounter Rate (birds/survey)	Temporal Frequency (% of surveys group was observed during)	Spatial Frequency (% of transect segments where group was observed)
Loons	2	578	8.3%	18.06	63%	96%
Waterfowl	6	1910	27.4%	59.69	50%	100%
Gulls	5	1006	14.4%	31.44	100%	100%
Terns	3	67	1.0%	2.09	18%	68%
Seabirds	9	1415	20.3%	44.22	100%	100%

4.5.2 OVERALL ENCOUNTER RATES

Abundance, as measured by encounter rate, was variable across survey dates, species, and species groups (Table 4.5.2). The overall avian abundance for all transect segments combined was 217.8 birds per survey. Black scoter were the most abundant species per survey effort (ER = 29.6 birds/survey), followed by northern gannet as the second most abundant species (ER = 27.0 birds/survey). All gulls, both those identified to species and those not identifiable to the species level (*Larus* spp.), accounted for 26% (*n* = 1,828) of all bird encounters; *Larus* gull species were particularly prominent in the Study Area (ER = 25.9 birds/survey). White-winged scoters had an overall ER of 21.7 birds/survey and common loon, the fifth most abundant species, had an ER of 17.3 birds/survey. The most abundant species group was waterfowl (ER = 59.69), followed by seabirds (ER = 44.22), gulls (ER = 31.44), and loons (ER = 18.06) (Table 4.5.3). Overall, terns were less abundant than other species (overall ER = 2.09), and unidentified tern ER (1.09 birds/survey) was lower than the common tern ER (2.03 birds/survey).

Overall Species Richness and Composition

As noted previously, 32 species were observed in the Study Area. Many of these species were seabirds and gulls; only one landbird (bank swallow) was definitively identified offshore. Two species of cormorant, double-crested and great, were observed. Sanderling was the only shorebird species identified to species level during the boat-based surveys; other shorebirds were observed but could not be classified.

Seabirds were represented by nine species, and were thus the most diverse species group detected during the boat-based surveys (Tables 4.5.2 and 4.5.3). Waterfowl were also diverse, with six species, followed by gulls with five species.

4.5.3 TEMPORAL DISTRIBUTION

Counts by Time Period

The number of birds observed during each survey effort varied. Observation counts were highest in early spring, and late fall, and lowest in June, July, August, and early fall. Bird counts were highest in early spring between March and late April (Figure 4.5.1). The highest bird count was at the beginning of this period on March 2, 2010 (*n* = 774). Bird counts then gradually declined through the spring period until May 2, 2010 when only 69 birds were recorded. Bird counts then remained relatively low, averaging around 100 bird counts per survey through May, June, July, August, and September, with the fewest number of detections being recorded on September 24, 2009.

Bird counts began to climb again around October 14, 2009 when 224 birds were observed, and then climbed to a late fall/early winter peak on December 7, 2009 when 467 birds were recorded. Bird counts then gradually declined through the remainder of December and January, generally remaining above 100 bird counts per survey into February.

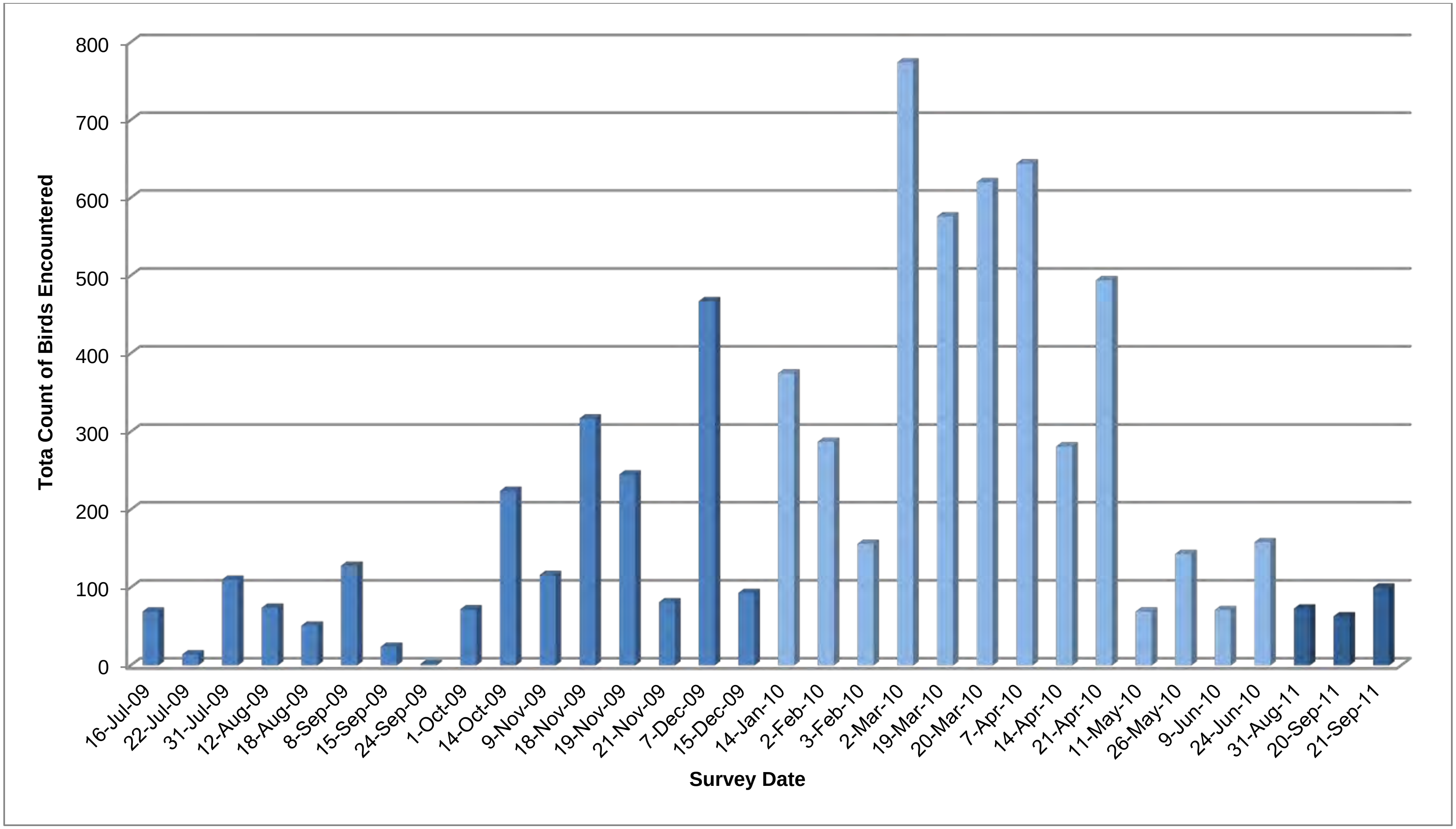


Figure 4.5.1. Total number of birds encountered by date during the boat-based transect surveys conducted from 2009 to 2011– BIWF 2009–2011.

Encounter Rates by Time Period

Abundance for all species pooled was highest in March, followed by April, and January (Table 4.5.4). Loon and waterfowl species ER values trended with the overall ER values in late winter and early spring, that is they were highest in March and April, and were either absent or only scarcely observed in late summer and fall. Loons were most abundant in March and April, and were noted at lower abundances from September to December, as were most waterfowl species. Some gull species were abundant year-round (herring and great black-backed gull); others, such as Bonaparte's gull, were absent much of the year and occurred only at low abundances in February. Overall tern abundances were low but were highest in August. Seabirds were most abundant in April, when northern gannets were encountered at a rate of 84.67 birds/survey.

Table 4.5.4. Species encounter rates by month during the boat-based transect surveys conducted from 2009 to 2011 – BIWF 2009–2011.

Guild and Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Loons												
Common loon	20.00	11.00	84.33	53.33	26.00	0.00	0.00	0.00	0.40	0.50	8.50	4.00
Red-throated loon	0.00	9.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.25	0.00
Shearwaters and Allies												
Manx shearwater	0.00	0.00	0.00	0.00	0.00	8.50	0.00	0.00	0.20	0.00	0.00	0.00
Audubon's shearwater	0.00	0.00	0.00	0.00	0.00	1.00	4.67	0.00	0.00	0.00	0.00	0.00
Great shearwater	0.00	0.00	0.00	0.00	0.00	38.00	7.00	1.00	0.00	0.00	0.00	0.00
Sooty shearwater	0.00	0.00	0.00	0.00	6.50	5.00	2.00	0.00	0.00	0.00	0.00	0.00
Cory's shearwater	0.00	0.00	0.00	0.00	0.00	1.00	5.00	2.33	1.00	0.00	0.00	0.00
Unidentified shearwater	0.00	0.00	0.00	0.00	2.50	0.00	4.33	2.00	0.40	0.00	0.00	0.00
Wilson's storm-petrel	0.00	0.00	0.00	0.00	0.00	6.00	10.33	14.67	3.20	0.00	0.00	0.00
Unidentified storm-petrel	0.00	0.00	0.00	0.00	0.00	0.00	0.67	2.33	0.60	0.00	0.00	0.00
Gannets												
Northern gannet	14.00	5.00	39.33	84.67	21.50	15.00	1.33	0.67	7.40	6.50	61.00	48.00
Cormorants												
Double-crested cormorant	1.00	0.00	0.00	0.00	0.00	1.50	0.00	10.00	0.00	0.00	0.00	0.50
Great cormorant	5.00	1.50	1.67	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unidentified cormorant	0.00	0.50	0.00	11.67	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00
Waterfowl												
Common eider	54.00	7.50	37.33	0.00	0.00	0.00	0.00	0.00	0.00	5.50	3.75	4.00
Long-tailed duck	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
White-winged scoter	15.00	4.50	199.67	5.67	0.00	0.00	0.00	0.00	0.00	0.00	8.50	9.50
Surf scoter	0.00	0.00	1.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	2.50	0.00
Black scoter	6.00	5.50	169.67	73.00	0.00	0.00	0.00	0.00	0.00	92.50	4.00	1.00
Unidentified scoter	100.00	0.00	0.00	87.33	0.00	0.00	0.00	0.00	0.00	4.00	3.00	0.00

Guild and Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Red-breasted merganser	0.00	8.50	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unidentified duck	8.00	6.50	14.67	91.67	0.00	0.00	0.00	0.00	0.00	2.00	1.00	2.50
Shorebirds												
Sanderling	0.00	0.00	0.00	0.00	0.00	0.00	1.67	0.00	0.00	0.00	0.00	0.00
Unidentified shorebird	0.00	0.00	0.00	0.00	0.00	0.00	2.67	0.00	0.00	0.00	0.00	0.00
Gulls												
Bonaparte's gull	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laughing gull	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.67	2.40	0.00	0.00	0.00
Ring-billed gull	0.00	0.00	0.33	0.00	0.00	0.00	0.00	4.33	0.00	0.00	0.75	0.00
Herring gull	15.00	32.00	11.00	9.33	14.00	8.50	0.67	9.33	20.80	22.00	22.50	19.00
Great black-backed gull	19.00	14.00	24.67	17.33	22.50	26.50	10.00	2.00	3.80	10.00	18.75	28.00
Black-legged kittiwake	1.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.50
Unidentified Larus gull	18.00	28.00	12.67	25.33	11.50	3.50	1.00	4.00	11.60	1.00	54.25	159.00
Terns												
Common tern	0.00	0.00	0.00	0.00	0.00	0.00	3.00	7.67	6.60	0.00	0.00	0.00
Forster's tern	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00
Least tern	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00
Unidentified tern	0.00	0.00	0.00	0.00	0.00	0.00	1.67	2.00	4.80	0.00	0.00	0.00
Seabirds												
Razorbill	0.00	80.50	31.67	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thick-billed murre	9.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
Unidentified murre	74.00	0.50	0.00	2.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dovekie	14.00	0.00	0.67	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black guillemot	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unidentified alcid	0.00	0.00	26.00	3.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Passerines												
Bank swallow	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00
Unidentified swallow	0.00	0.00	0.00	0.00	1.00	0.00	0.33	0.33	0.20	0.00	0.00	0.00
Unidentified bird	0.00	0.00	0.00	0.00	0.00	0.00	7.00	2.33	0.00	0.00	0.00	0.00

Frequency

As expected resident species (primarily gulls) were observed throughout the year during all surveys, with a survey frequency of 100% (Tables 4.5.2 and 4.5.3). Seabirds were also observed during each of the 32 surveys and had a frequency of 100%. The remaining species/species groups have known seasonal occurrence patterns in the Study Area, such as being present primarily during the summer or winter months, and were observed with lower frequency. Loons were observed during 63% of surveys and waterfowl during 50%. Terns and shorebirds, observed on only 18% and 8% of the survey dates, respectively, had the lowest frequency. Shorebirds were encountered offshore only in June.

During the summer surveys, resident species and early fall migrants, such as shearwaters, storm-petrels, and terns, were present. Later, during the fall surveys, summer residents emigrated and migrants moved through the Study Area. Late in the fall, winter residents, including loons, alcids, seaducks, and adult gannets began arriving; these birds were documented consistently throughout the winter surveys. During late spring surveys, winter residents left the area, and some migrants moved north or northeast through the Study Area. For example, seaduck diversity was highest in the winter months, primarily February and March (five species), while during the summer months no seaducks were observed. Summer residents returned in spring and were monitored throughout the breeding season.

Observation rates of shearwaters were highest in July and declined in subsequent surveys with the last shearwater observation on September 15, 2009. Shearwaters were observed again during the late May 2010 surveys. Five shearwater species were observed including Audubon's shearwater (*Puffinus lherminieri*), Cory's shearwater (*Calonectris diomedea*), greater shearwater (*Puffinus gravis*), Manx shearwater (*Puffinus puffinus*), and sooty shearwater (*Puffinus griseus*). There were also unidentified shearwaters that could not be identified to species due to lighting conditions and the species' tendency to fly low over waves and in and out of visibility. A single species of storm-petrel, Wilson's storm-petrel, was observed during the surveys, most frequently during the June, July, and August surveys. A secondary peak of storm-petrel observations occurred in early September with the last observation occurring on September 8, 2009. Storm-petrels were observed again during the late June 2010 survey.

Species Richness by Time Period

The overall abundance and composition of the avian community moving through and foraging in the effective area of the boat-based survey transects shifted temporally; however, species richness did not fluctuate dramatically across months (e.g., similar numbers of species occurred in each season, despite fluctuations in ER and species composition). Despite the lower total abundance, overall richness was greater during the summer and early fall (Figure 4.5.2).

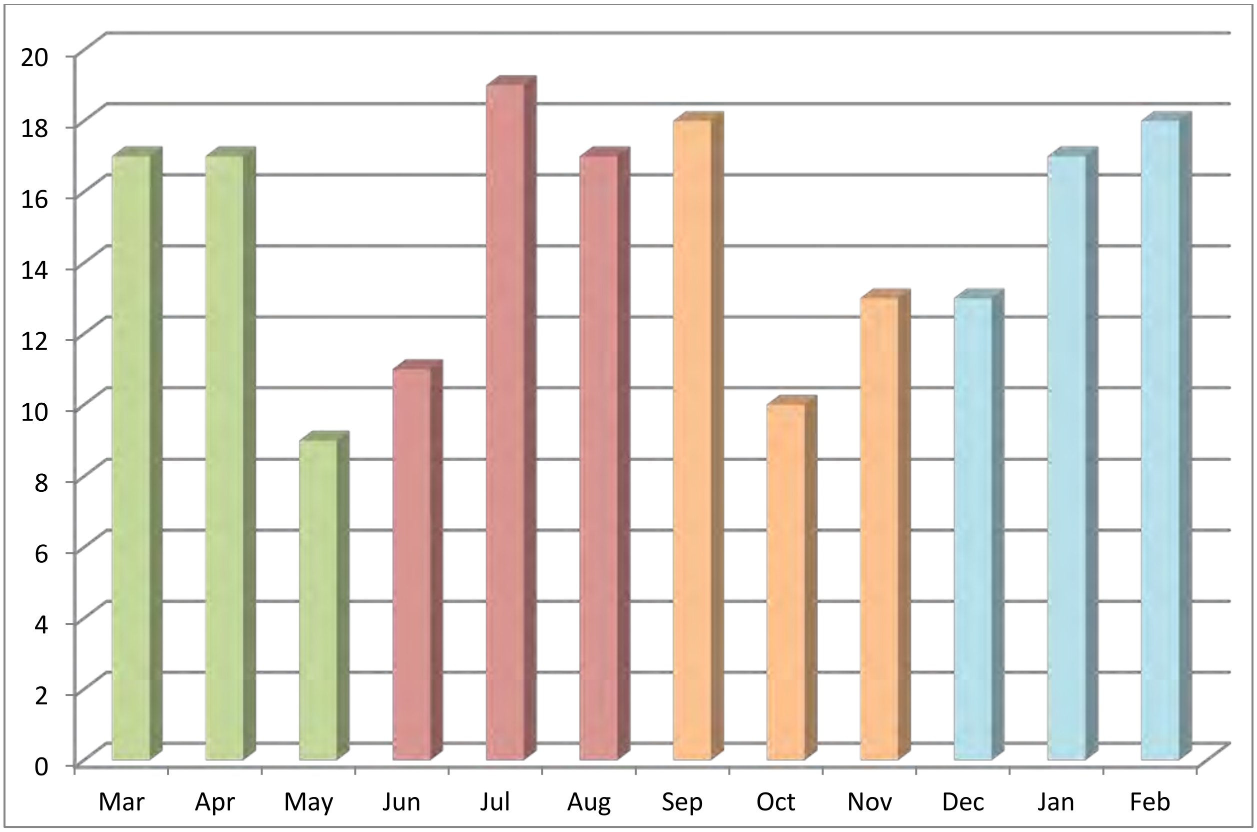


Figure 4.5.2. Species richness, by month during the boat-based transect surveys conducted from 2009 to 2011 – BIWF 2009–2011.

Two loon species (common loon and red-throated loon) were encountered during the 2009–2011 surveys. Common loons were present in the Study Area from September through the winter to May, occurring in the Study Area for a longer duration than red-throated loon, which was observed only in February, early March, and November (Table 4.5.4).

Observations of cormorants were fairly consistent throughout the surveys. Double-crested cormorants were present primarily in the summer (June and July), while great cormorant was present in winter and early spring.

Seabirds were observed year-round, but the species that were present shifted temporally. For example, northern gannet were seen in the Study Area year-round, but alcids were observed only in the winter and spring (December to April). Shearwaters were observed primarily in the summer, but also in late spring and early fall. Overall, four alcid species were observed during the surveys: black guillemot, dovekie, razorbill, and thick-billed murre. There were also unidentified alcids that could not be identified to species, so it is possible (but unlikely) that other species were present. Alcids were first observed during mid-December surveys and encounter rates peaked in early February and early March. The last alcids observations were recorded in the spring on April 21, 2010.

Gull species diversity changed very little across seasons (between two and four species occurred each month), and two species, great black-backed and herring gull, occurred year-round. Black-legged kittiwake was seen only in the winter (Table 4.5.4). Other gull species observed included Bonaparte's gull, laughing gull, and ring-billed gull. Bonaparte's gull was documented in early February and laughing gull in early May. Many gulls were unidentifiable during periods of poor visibility, unpredictable boat movements, or inadequate light conditions. Also because gulls are highly visible at sea (because of their size and coloration), a large proportion of gulls were observed in the outer limits of the distance sampling bands, which undoubtedly contributed to the higher percentage of unidentified individuals compared with other species groups. Terns were encountered only in July, August, and September. Tern species observed included common tern, Forster's tern, and least tern.

A total of eight seaduck species were observed including black scoter, common eider, long-tailed duck, red-breasted merganser, surf scoter, and white-winged scoter. There were also numerous ducks and scoters that could not be classified to species level. Seaducks began arriving in the Study Area in October and were observed during every survey until late April, after which there were no seaduck observations. Large scoter rafts numbering in the hundreds were observed during the winter residency period.

4.5.4 Spatial Distribution and Flight Ecology

Counts by Location

As mentioned previously, the greatest number of observations for a single species, across all transect segments pooled (1–25), were of black scoter. This was also true for those areas where turbines are not proposed (segments 1–7 and 14–25). However, for areas where WTGs are proposed (segments 8–14), there was a larger number of northern gannet (*n* = 192) observations than of black scoter (*n* = 155). Nonetheless, it should be noted that substantially more observations were made at transect segments 1–7 and 14–25 than at segments 8–14 (Table 4.5.5).

Of the 6,971 total birds recorded over the entire transect length during the survey, 19% (1,292) were recorded in transect segments 8–14 where WTGs are currently proposed (Table 4.5.5). The remaining 81% (5,679) of birds were recorded between segments 1–7 (18%; 1,233) and 14–25. Segments 14–25, in the southwestern portion of the Study Area, had by far the greatest number of observations, accounting for 64% (4,446) of the total 6,971 birds recorded. This was considerably greater than the 2,252 observations (36%) recorded in segments 1–14 combined.

At individual transect segments for all species pooled, there was less variability in total counts and percentage of total counts made in each area. The total percentage of all counts made per segment ranged from 1% at segments 1 and 10, to 8% at segment 19.

The greatest number of loon encounters was in segment 25 (12% of all loons). The highest percentage of waterfowl observations (16% of all waterfowl) were encountered in segment 19. Counts of gulls per segment were more uniform than some other species groups, but were greatest in segment 24 (18% of gulls). Terns were counted primarily in segments 14 and 20 (25% and 22% of terns, respectively). The greatest number of seabirds (12%) was counted in segment 15. Landbirds were encountered only in segment 11.

Table 4.5.5. Count and percentage of total counts by species group for each transect segment – BIWF 2009–2011.

Segment	Loons (Count)	Loons (%)	Waterfowl (Count)	Waterfowl (%)	Gulls (Count)	Gulls (%)	Terns (Count)	Terns (%)	Seabirds (Count)	Seabirds (%)	Overall Count	Overall %
1	–	0%	20	1%	44	2%	–	0%	8	0%	77	1%
2	8	1%	36	1%	115	6%	5	5%	14	1%	178	3%
3	9	2%	12	0%	90	5%	2	2%	29	2%	147	2%
4	11	2%	152	6%	54	3%	6	6%	29	2%	252	4%
5	23	4%	57	2%	87	5%	3	3%	49	3%	219	3%
6	10	2%	45	2%	47	3%	2	2%	43	3%	155	2%
7	17	3%	47	2%	50	3%	7	7%	49	3%	205	3%
8	27	5%	17	1%	55	3%	1	1%	36	2%	136	2%
9	34	6%	123	5%	43	2%	–	0%	33	2%	233	3%
10	14	2%	15	1%	34	2%	–	0%	28	2%	91	1%
11	13	2%	32	1%	96	5%	–	0%	61	4%	204	3%
12	9	2%	21	1%	49	3%	–	0%	51	3%	130	2%
13	21	4%	91	3%	57	3%	1	1%	44	3%	216	3%
14	32	6%	101	4%	44	2%	25	25%	75	5%	282	4%
15	51	9%	20	1%	61	3%	–	0%	193	12%	325	5%
16	55	10%	333	13%	67	4%	–	0%	84	5%	540	8%
17	28	5%	70	3%	76	4%	3	3%	124	7%	306	4%
18	21	4%	322	12%	95	5%	–	0%	80	5%	518	7%
19	19	3%	426	16%	17	1%	2	2%	86	5%	550	8%
20	9	2%	94	4%	42	2%	22	22%	97	6%	266	4%
21	36	6%	151	6%	85	5%	8	8%	126	8%	411	6%
22	15	3%	34	1%	109	6%	1	1%	62	4%	257	4%
23	34	6%	231	9%	48	3%	5	5%	83	5%	424	6%
24	11	2%	10	0%	334	18%	4	4%	118	7%	478	7%
25	71	12%	185	7%	49	3%	5	5%	55	3%	371	5%
Segments 1 to 7	**78**	**13%**	**369**	**14%**	**487**	**26%**	**25**	**25%**	**221**	**13%**	**1233**	**18%**
Segments 8 to 14	**150**	**26%**	**400**	**15%**	**378**	**20%**	**27**	**26%**	**328**	**20%**	**1292**	**19%**
Segments 15 to 25	**350**	**61%**	**1876**	**71%**	**983**	**53%**	**50**	**49%**	**1108**	**67%**	**4446**	**64%**
Overall	**578**	**100%**	**2645**	**100%**	**1848**	**100%**	**102**	**100%**	**1657**	**100%**	**6971**	**100%**

Frequency by Location

The frequency of occurrence by transect segment for species groups was less variable than temporal frequency (Tables 4.5.3 and 4.5.5). Most species groups occurred at most transect segments. Waterfowl, gulls, and seabirds were encountered at 100% of the transect segments (Table 4.5.5). Loons were observed at nearly all transect segments (96%), and terns at most segments (68%).

Encounter Rates by Location

The overall encounter rate for all species pooled, across all transect segments, was 217.84 birds/survey (Table 4.5.6). The ER was lowest for segments 1–7 pooled, and greatest for transects 8–14 pooled. Species group abundance also varied by location. Loons were more abundant in segments 15–25, with peak ER at segment 16 (Table 4.5.6). Waterfowl were also most abundant in transects 15–25, with peak abundance in segment 24. Gulls were less variable in spatial distribution between segments; peak ER was noted in segment 24. Terns occurred at low abundances in 18 of the 25 segments, but were most abundant in segment 14. Seabirds, as a group, had less uniformity in spatial distribution than did all other groups. ER values for individual segments ranged from 0.25 (segment 1) to 6.03 (segment 15) (Table 4.5.6).

Table 4.5.6. Encounter rate by species group for each of the transect segments – BIWF 2009–2011.

Segment	Loons	Waterfowl	Gulls	Terns	Seabirds	Total
1	0.00	0.63	1.38	0.00	0.25	2.41
2	0.25	1.13	3.59	0.16	0.44	5.56
3	0.28	0.38	2.81	0.06	0.91	4.59
4	0.34	4.75	1.69	0.19	0.91	7.88
5	0.72	1.78	2.72	0.09	1.53	6.84
6	0.31	1.41	1.47	0.06	1.34	4.84
7	0.53	1.47	1.56	0.22	1.53	6.41
8	0.84	0.53	1.72	0.03	1.13	4.25
9	1.06	3.84	1.34	0.00	1.03	7.28
10	0.44	0.47	1.06	0.00	0.88	2.84
11	0.41	1.00	3.00	0.00	1.91	6.38
12	0.28	0.66	1.53	0.00	1.59	4.06
13	0.66	2.84	1.78	0.03	1.38	6.75
14	1.00	3.16	1.38	0.78	2.34	8.81
15	1.59	0.63	1.91	0.00	6.03	10.16
16	1.72	10.41	2.09	0.00	2.63	16.88
17	0.88	2.19	2.38	0.09	3.88	9.56
18	0.66	10.06	2.97	0.00	2.50	16.19
19	0.59	13.31	0.53	0.06	2.69	17.19
20	0.28	2.94	1.31	0.69	3.03	8.31
21	1.13	4.72	2.66	0.25	3.94	12.84
22	0.47	1.06	3.41	0.03	1.94	8.03
23	1.06	7.22	1.50	0.16	2.59	13.25
24	0.34	0.31	10.44	0.13	3.69	14.94
25	2.22	5.78	1.53	0.16	1.72	11.59
Segments 1 to 7	**2.44**	**11.53**	**15.22**	**0.78**	**6.91**	**38.53**
Segments 8 to 14	**4.69**	**12.50**	**11.81**	**0.84**	**10.25**	**40.38**
Segments 15 to 25	**10.94**	**58.63**	**30.72**	**1.56**	**34.63**	**138.94**
Overall	**18.06**	**82.66**	**57.75**	**3.19**	**51.78**	**217.84**

Species Richness by Location

Species richness (total number of species observed) per transect segment was highest at segment 21 and lowest at segment 1 (Figure 4.5.3). In general species richness was not highly variable across segments.

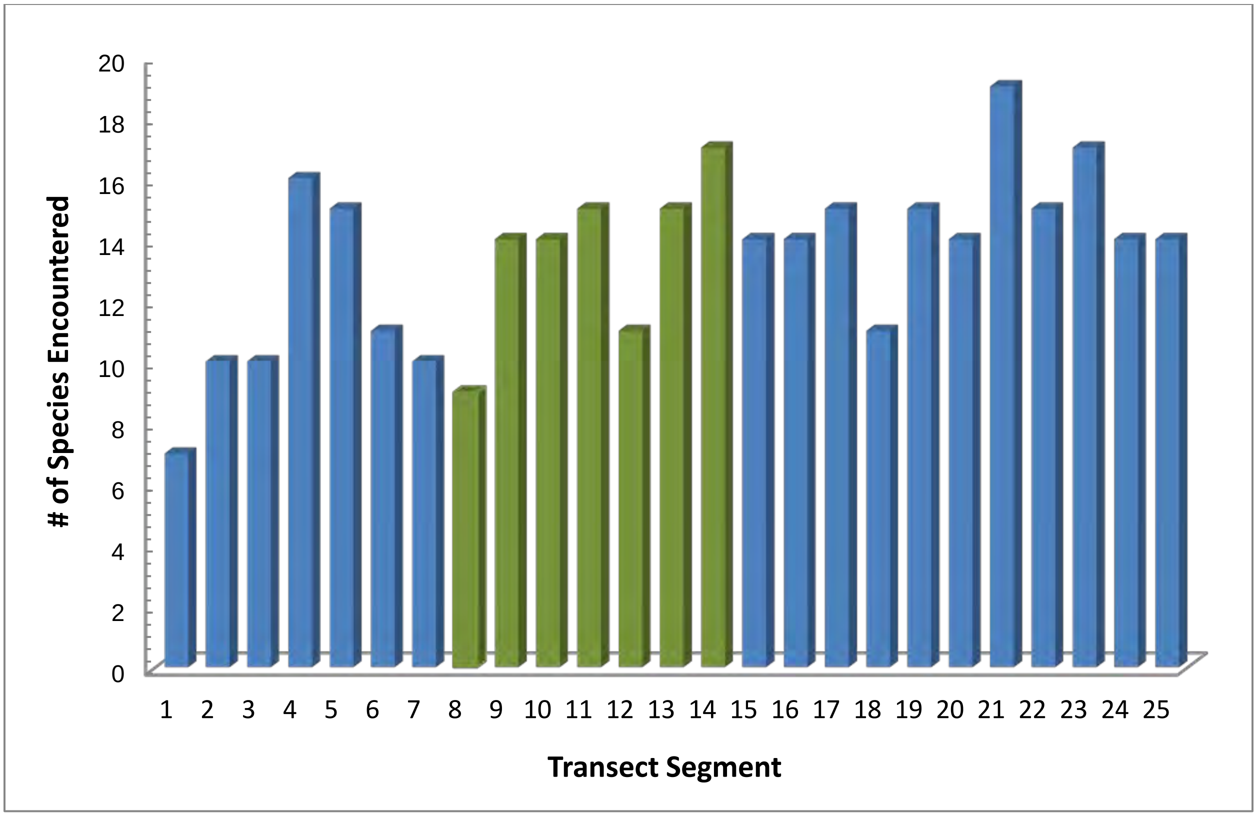


Figure 4.5.3. Overall species richness by transect segment, all species pooled (green bars indicate segments where turbines are proposed) – BIWF 2009–2011.

Density

Density (birds/km^2) was estimated for individual species (Table 4.5.7) and each of five species guilds (Table 4.5.8) across all transect segments, as well as for each individual segment (Figure 4.5.4). Individual species density estimates ranged from 0.006 birds/km^2 for black guillemot to 7.3 birds/km^2 for black scoter. The top five most abundant species, as a function of estimated density were black scoter, northern gannet, common loon, great black-back gull, and white-winged scoter. Table 4.5.7 includes density estimates for all observed species.

Common loon density was higher (6.3 birds/km^2) than red-throated loon density (0.339 birds/km^2). Shearwaters were not particularly abundant, with density estimates ranging from 0.197 birds/km^2 for Audubon's shearwater to 1.11 birds/km^2 for greater shearwater. Northern gannets were abundant (6.67 birds/km^2) and frequently observed. Waterfowl were abundant, particularly black scoter (7.31 birds/km^2), white-winged scoter (4.63 birds/km^2), and common eider (3.18 birds/km^2). Long-tailed duck (0.09 birds/km^2) and red-breasted merganser (0.234 birds/km^2) were observed at lower densities than other species of waterfowl. A single shorebird species, sanderling (0.21 birds/km^2), was identified during the boat-based surveys. Some gull species occurred at high densities (great black-backed gull and herring gull), other gulls were less abundant (Bonaparte's, laughing, and ring-billed gulls). Tern densities were very low (least tern and Forster's tern were each estimated to occur at densities of less than 0.03 birds/km^2 each), although common tern was estimated at 0.41 birds/km^2, which was similar to the estimated density of ring-billed gull (0.51 birds/km^2). In general alcid species were not abundant, though razorbill density in the offshore portion of the Study Area was 1.64 birds/km^2.

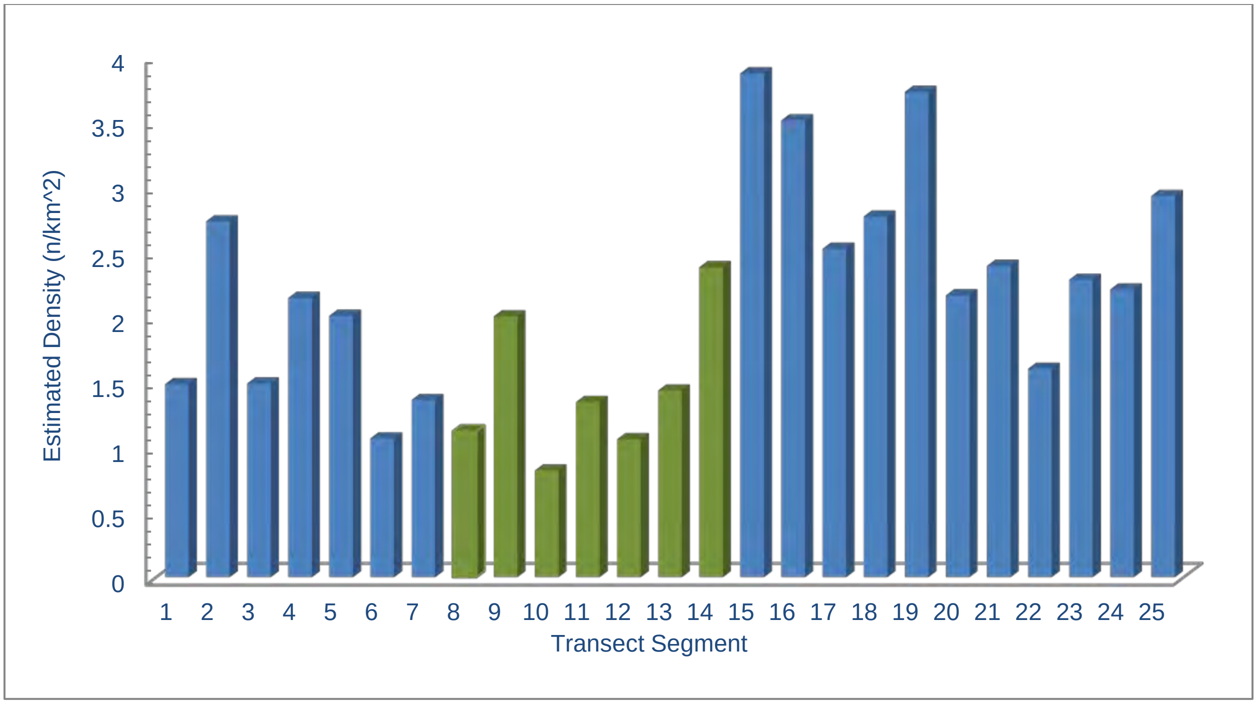
Table 4.5.7. Density estimates for all encountered species during boat-based surveys – BIWF 2009–2011.

Species	Common Names	Total # observed (n)	Estimated Density (birds/km^2)
Loons			
Common loon	*Gavia immer*	552	6.300
Red-throated loon	*Gavia stellata*	26	0.339
Manx shearwater	*Puffinus puffinus*	18	0.221
Shearwaters and Allies			
Audubon's shearwater	*Puffinus iherminieri*	16	0.197
Great shearwater	*Puffinus gravis*	100	1.114
Sooty shearwater	*Puffinus griseus*	29	0.261
Cory's shearwater	*Calonectris diomedea*	29	0.316
Unidentified shearwater		26	0.146
Wilson's storm-petrel	*Oceanites oceanicus*	103	1.550
Unidentified storm-petrel		12	0.122
Gannets			
Northern gannet	*Morus bassanus*	865	6.670
Cormorants			
Double-crested cormorant	*Phalacrocorax auritus*	35	0.245
Great cormorant	*Phalacrocorax carbo*	14	0.130
Unidentified cormorant		44	0.401
Waterfowl			
Common eider	*Somateria mollissima*	215	3.175
Long-tailed duck	*Clangula hyemalis*	6	0.094
White-winged scoter	*Melanitta fusca*	693	4.626
Surf scoter	*Melanitta perspicillata*	28	0.859
Black scoter	*Melanitta nigra*	948	7.308
Unidentified scoter		382	1.397
Red-breasted merganser	*Mergus serrator*	20	0.234
Unidentified duck		353	1.464
Shorebirds			
Sanderling	*Calidris alba*	5	0.209
Unidentified shorebird		8	0.126
Gulls			
Bonaparte's gull	*Larus philadelphia*	6	0.123
Laughing gull	*Larus atricilla*	15	0.274
Ring-billed gull	*Larus delawarensis*	17	0.510
Herring gull	*Larus argentatus*	491	4.368
Great black-backed gull	*Larus marinus*	477	5.132
Unidentified Larus gull		828	5.258
Black-legged kittiwake	*Rissa tridactyla*	14	0.227
Terns			
Common tern	*Sterna hirundo*	65	0.406
Forster's tern	*Sterna forsteri*	1	0.039

Species	Common Names	Total # observed (n)	Estimated Density (birds/km^2)
Least tern	*Sterna antillarum*	1	0.026
Unidentified tern		35	0.321
Seabirds			
Razorbill	*Alca torda*	257	1.636
Thick-billed murre	*Uria lomvia*	10	0.195
Unidentified murre		82	0.573
Dovekie	*Alle alle*	20	0.134
Black guillemot	*Cepphus grylle*	2	0.006
Unidentified alcid		88	0.172
Passerines			
Bank swallow	*Riparia riparia*	2	0.032
Unidentified swallow		5	0.078
Unidentified bird		28	0.313

Table 4.5.8. Density estimates for species guilds during boat-based survey – BIWF 2009–2011.

Segment	Loon Density (n/km2)	Waterfowl Density (n/km2)	Gull Density (n/km2)	Tern Density (n/km2)	Seabird Density (n/km2)	Overall Density (n/km2)
1	0.00	0.78	0.77	0.00	0.31	1.48
2	0.10	0.62	1.75	0.07	0.21	2.73
3	0.08	0.06	0.92	0.03	0.42	1.49
4	0.06	1.04	0.92	0.08	0.50	2.14
5	0.15	0.46	0.80	0.12	0.64	2.00
6	0.12	0.21	0.44	0.08	0.37	1.07
7	0.23	0.21	0.56	0.09	0.46	1.36
8	0.19	0.09	0.57	0.01	0.33	1.12
9	0.25	0.99	0.44	0.00	0.36	2.00
10	0.15	0.07	0.32	0.00	0.37	0.82
11	0.09	0.19	0.55	0.00	0.56	1.35
12	0.12	0.12	0.48	0.00	0.41	1.06
13	0.26	0.39	0.60	0.01	0.48	1.43
14	0.53	0.61	0.46	0.33	0.66	2.38
15	0.37	0.19	0.86	0.00	2.67	3.86
16	0.65	1.68	0.63	0.00	1.35	3.50
17	0.25	0.50	0.75	0.02	0.96	2.52
18	0.21	1.32	0.92	0.00	0.95	2.77
19	0.26	2.48	0.28	0.03	1.33	3.72
20	0.08	0.93	0.61	0.10	0.67	2.16
21	0.33	0.83	0.53	0.10	0.64	2.39
22	0.16	0.29	0.55	0.01	0.60	1.60
23	0.18	1.14	0.43	0.05	0.40	2.28
24	0.14	0.07	1.42	0.10	0.62	2.21
25	0.92	1.19	0.34	0.08	0.71	2.92
Average 1 to 7	**0.12**	**0.48**	**0.88**	**0.08**	**0.42**	***1.75***
Average 8 to 14	**0.23**	**0.35**	**0.49**	**0.12**	**0.45**	***1.45***
Average 15 to 25	**0.32**	**0.97**	**0.67**	**0.06**	**0.99**	***2.72***
Overall Average	**0.24**	**0.66**	**0.68**	**0.08**	**0.68**	***2.09***



Note: Green bars indicate segments where turbines are proposed.

Figure 4.5.4. Overall density by transect segment – BIWF 2009–2011.

Average density estimates for each species guild, across all transect segments, were compared (Figure 4.5.5). The overall average density of the five species guilds pooled across segments 1–25 was 2.09 birds/km^2. Average density was highest across segments 15–25 and lowest in segments 8–14, where the WTGs are proposed. The average density across just the segments where turbines are proposed (8–14) was estimated as 1.45 birds/km^2, and 2.34 birds/km^2 in segments where no turbines are proposed (Table 4.5.8, Figure 4.5.4).

Waterfowl, gulls, and seabirds demonstrated similar densities. Two species guilds, waterfowl and seabirds, had substantially higher average segment density in the westernmost portion of the offshore Study Area, segments 15–25 (Figure 4.5.5). Waterfowl densities were lowest in segments 8–14. Gulls were disproportionately dense in segments 1–7, less abundant in 15–25, and the lowest in 8–14. Terns were the only guild with higher densities in segments 8–14, where the WTGs are proposed, although tern densities overall were much lower than most other species. Seabirds were most abundant in the western segments (15–25) and least in the northeastern segments (1–7). Average loon density was greatest in the western segments (15–25) and lowest in the northeastern segments (1–7).

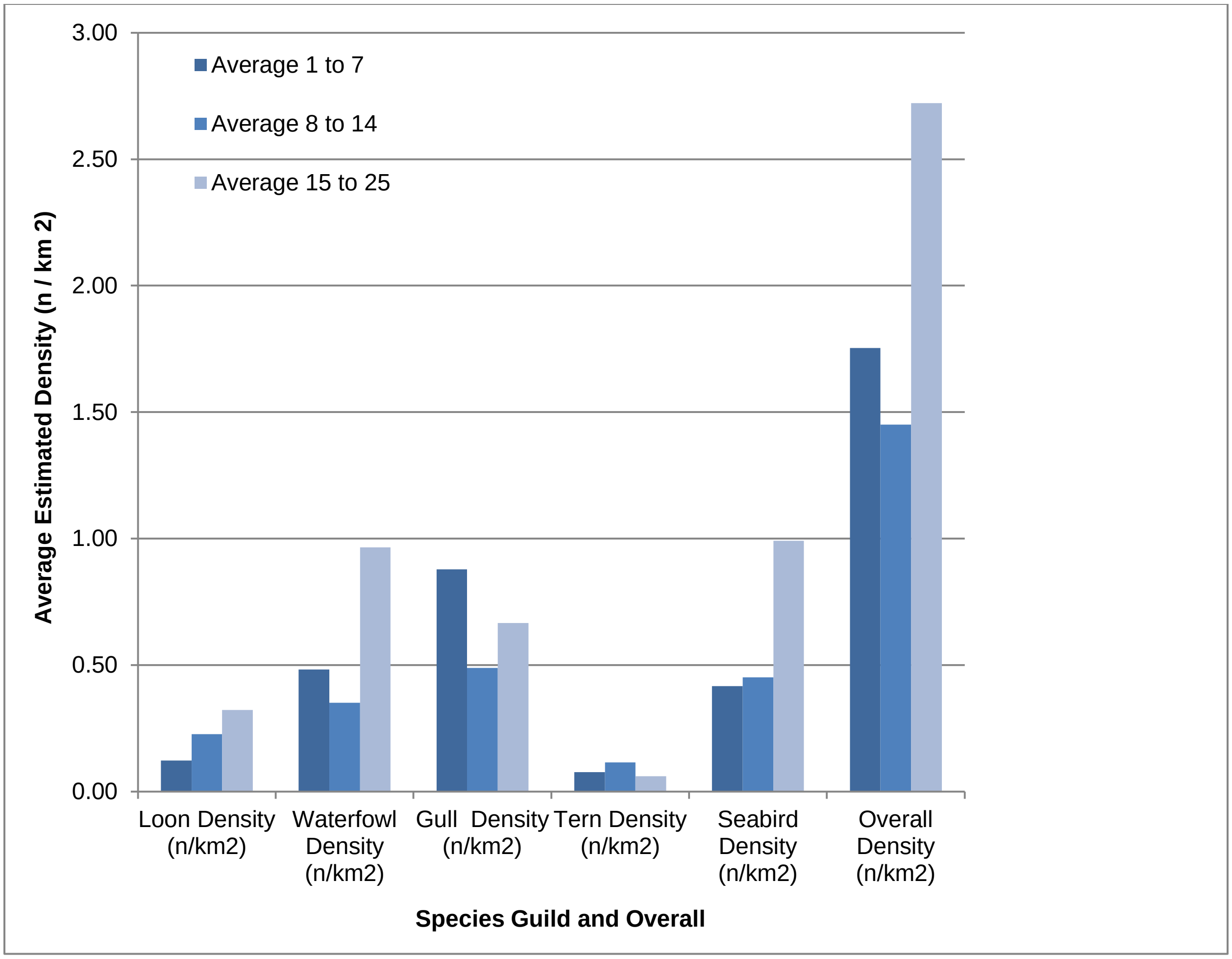


Figure 4.5.5. Average estimated density of species groups in each of three transect segment areas: 1–7, 8–14 (where turbines are proposed), and 15–25 – BIWF 2009–2011.

The five most frequently encountered species were great black-backed gull, herring gull, northern gannet, common loon, and white-winged scoter (*Melanitta deglandi*). Great black-backed gulls were observed on the majority of surveys days, but had only the third highest estimated density in all segments (5.13 birds/km^2) (Table 4.5.7). Great black-backed gull, the largest gull species in the world, breeds on Block Island. The occurrence of this species at a high density was not unexpected; moreover, the large size of the species may make it more “detectable” than others. Great black-backed gull density in the turbine segments (8–14) was slightly lower (4.1 birds/km^2) than in the other segments (183.4 birds/km^2). Across all segments, the top five most frequently encountered species each had lower estimated densities within the segments where turbines are proposed than for all segments pooled and segments where turbines are not proposed (Table 4.5.8).

Flight Ecology

The flight height of birds was recorded and sorted into one of four bins: <10 m (<33 ft), 10–25 m (33–82 ft), 26–125 m (83–410 ft), and 126–200 m (411–656 ft) (Table 4.5.9 presents the percentage of observations for all species detected, sorted by flight height bin; Table 4.5.10 presents average flight heights for each species guild by transect segment). The majority of birds (72.8%) flew less than 10 m (33 ft) above the water, many (20%) flew between 10 and 25 m (33 and 82 ft), 6.9% flew between 26 and 125 m (83 and 410 ft), and 0.3% flew between 126 and 200 m (411 and 656 ft) (Figure 4.5.7). Only gull species were observed flying between 126 and 200 m (411–656 ft). Few species (n = 11) flew within the 26–125 m (83–410 ft) bin. Cormorants flew primarily within the 10–25 m (33–82 ft) flight height band, as did common terns and common loons. Some species flew lower than others; for example Wilson's storm petrel flew <10 m (<33 ft) above the water during nearly 100% of observations, as did 18 other species. Birds were also frequently seen sitting on the water (n = 1,099, 15.8%).

Table 4.5.9. Flight heights of species observed during the boat-based transect survey – BIWF 2009–2011.

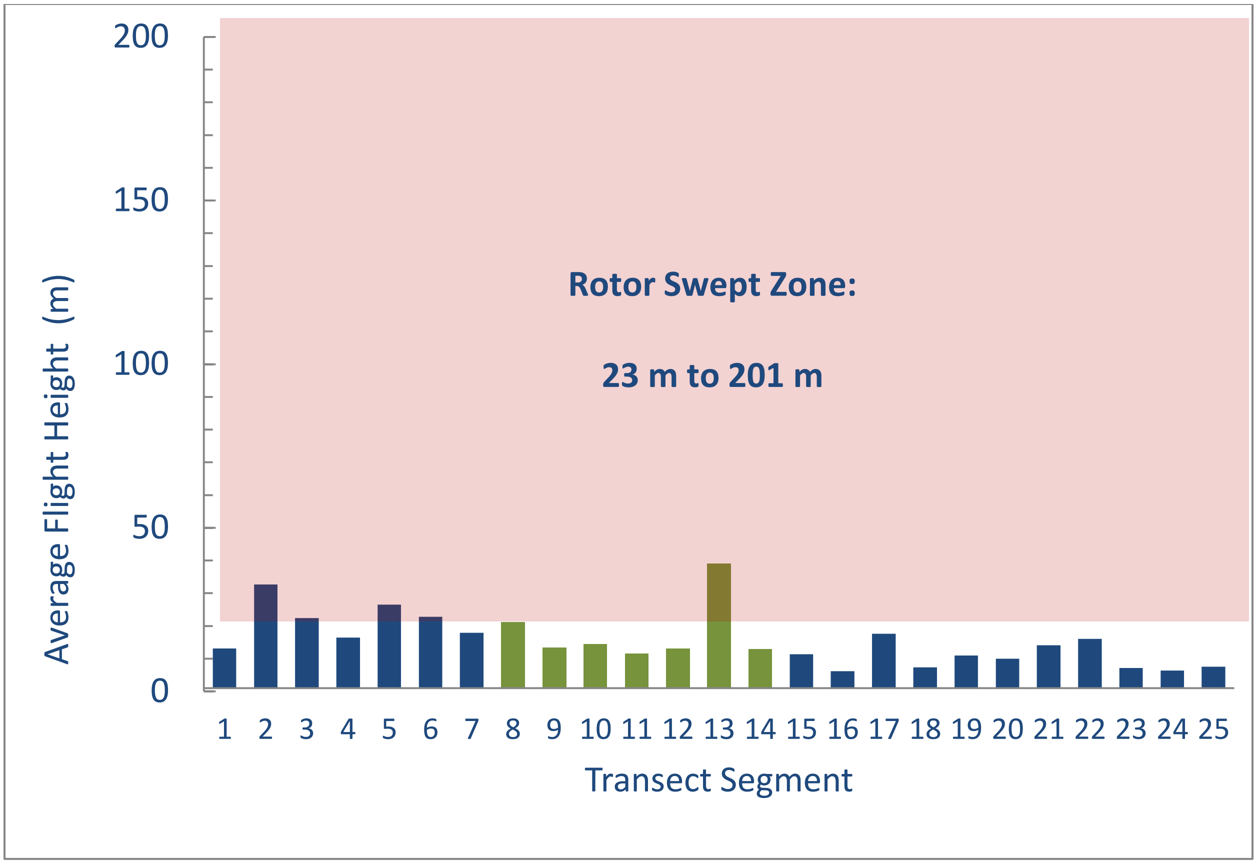
Species	<10 m	10–25 m	26–125 m	126–200 m
Common loon	30.4%	67.0%	2.7%	0.0%
Red-throated loon	68.8%	31.3%	0.0%	0.0%
Manx's shearwater	100.0%	0.0%	0.0%	0.0%
Audubon's shearwater	100.0%	0.0%	0.0%	0.0%
Great shearwater	92.2%	7.8%	0.0%	0.0%
Sooty shearwater	100.0%	0.0%	0.0%	0.0%
Cory's shearwater	100.0%	0.0%	0.0%	0.0%
Unidentified shearwater	92.3%	7.7%	0.0%	0.0%
Wilson's storm-petrel	99.0%	1.0%	0.0%	0.0%
Unidentified storm-petrel	100.0%	0.0%	0.0%	0.0%
Northern gannet	78.4%	20.2%	1.4%	0.0%
Double-crested cormorant	5.7%	8.6%	85.7%	0.0%
Great cormorant	100.0%	0.0%	0.0%	0.0%
Unidentified cormorant	2.3%	97.7%	0.0%	0.0%
Common eider	100.0%	0.0%	0.0%	0.0%
Long-tailed duck	83.3%	16.7%	0.0%	0.0%
White-winged scoter	100.0%	0.0%	0.0%	0.0%
Surf scoter	100.0%	0.0%	0.0%	0.0%
Black scoter	97.2%	2.8%	0.0%	0.0%
Unidentified scoter	69.9%	30.1%	0.0%	0.0%
Red-breasted merganser	100.0%	0.0%	0.0%	0.0%
Unidentified duck	48.2%	30.6%	21.2%	0.0%
Sanderling	100.0%	0.0%	0.0%	0.0%
Unidentified shorebird	50.0%	50.0%	0.0%	0.0%
Bonaparte's gull	100.0%	0.0%	0.0%	0.0%
Laughing gull	86.7%	0.0%	13.3%	0.0%
Ring-billed gull	41.2%	23.5%	35.3%	0.0%
Herring gull	36.9%	40.1%	22.7%	0.2%
Great black-backed gull	42.0%	41.5%	15.6%	1.0%
Unidentified Larus gull	65.1%	18.7%	14.3%	1.9%
Black-legged kittiwake	100.0%	0.0%	0.0%	0.0%
Common tern	29.2%	67.7%	3.1%	0.0%
Forster's tern	100.0%	0.0%	0.0%	0.0%
Least tern	0.0%	100.0%	0.0%	0.0%
Unidentified tern	68.6%	28.6%	2.9%	0.0%
Razorbill	100.0%	0.0%	0.0%	0.0%

Species	<10 m	10–25 m	26–125 m	126–200 m
Thick-billed murre	100.0%	0.0%	0.0%	0.0%
Unidentified murre	100.0%	0.0%	0.0%	0.0%
Dovekie	100.0%	0.0%	0.0%	0.0%
Black guillemot	100.0%	0.0%	0.0%	0.0%
Unidentified alcid	100.0%	0.0%	0.0%	0.0%
Bank swallow	0.0%	100.0%	0.0%	0.0%
Unidentified swallow	80.0%	20.0%	0.0%	0.0%
Unidentified bird	96.4%	3.6%	0.0%	0.0%
Overall	**72.8%**	**20.0%**	**6.9%**	**0.3%**
Species richness (n)	**42**	**23**	**11**	**3**

The mean height of birds observed in flight, across all transect segments, was 12.9 m (42 ft) (*n* = 5,872, 84.2%) (Table 4.5.10). Within segments where turbines are proposed (8–14) the mean flight height (17.2 m [56.4 ft]) was slightly lower than the overall. In segments 1–7 the mean flight height (20.6 m [67.6 ft]) was higher than the overall flight height, and in segments 15–25 it was lower (9 m [29.5 ft]). Birds encountered in two transect segments, 2 and 13, exhibited average flights within the rotor swept zone (RSZ) of the proposed WTGs (RSZ = 23 m–201 m [75 ft– 659 ft]) (Table 4.5.10 and Figure 4.5.6). Weighted average flight heights for each of the five species guilds (loons, waterfowl, gulls, terns, and seabirds) are provided in map Figures 4.5.8 through 4.5.12.

Table 4.5.10. Average flights for each species group at each transect segment – BIWF 2009–2011.

Segment	Loon Average Flight Height (m)	Waterfowl Average Flight Height (m)	Gull Average Flight Height(m)	Tern Average Flight Height (m)	Seabird Average Flight Height (m)	Overall Average Flight Height (m)
1	n/a	5.0	18.3	n/a	7.2	13.2
2	22.5	5.0	45.5	55.7	5.0	32.7
3	13.8	5.0	30.9	33.4	5.7	22.4
4	22.5	11.9	28.9	47.6	14.9	16.4
5	22.5	6.8	56.0	18.3	6.5	26.5
6	64.2	10.8	39.3	16.1	14.1	22.8
7	25.6	5.0	46.4	13.8	7.5	18.0
8	14.2	7.1	38.7	6.9	6.9	21.1
9	16.7	5.0	53.9	n/a	8.3	13.4
10	16.7	9.7	23.2	n/a	5.6	14.4
11	16.7	5.0	14.8	n/a	8.4	11.5
12	10.0	6.7	25.2	n/a	5.9	13.0
13	19.2	63.5	28.0	6.3	12.2	39.1
14	17.6	5.0	28.8	50.5	11.6	13.0
15	15.9	5.0	26.5	n/a	6.6	11.4
16	13.8	5.0	12.1	n/a	5.0	6.2
17	12.0	11.5	42.2	7.6	9.4	17.6
18	12.5	5.0	21.7	n/a	5.0	7.4
19	19.0	10.6	16.7	22.2	6.6	11.0
20	19.0	10.7	21.2	19.2	5.2	10.0
21	19.3	12.4	19.8	17.2	9.2	14.1
22	18.6	10.1	7.3	5.8	6.1	16.1
23	5.0	5.0	19.7	17.7	6.8	7.2
24	9.4	5.0	6.4	13.2	6.0	6.4
25	22.5	5.0	21.9	11.5	10.5	7.5
Average 1–7	**25.1**	**7.7**	**36.7**	**12.5**	**8.7**	**20.6**
Average 8–14	**13.1**	**18.6**	**25.4**	**16.6**	**7.8**	**17.2**
Average 15–25	**12.8**	**6.3**	**13.7**	**13.0**	**6.4**	**9.0**
Overall Average	**14.8**	**8.7**	**22.6**	**13.8**	**7.1**	**12.9**



Note: Green bars indicate segments where turbines are proposed.

Figure 4.5.6. Average flight heights and rotor swept zone for birds observed in each transect segment – BIWF 2009–2011.

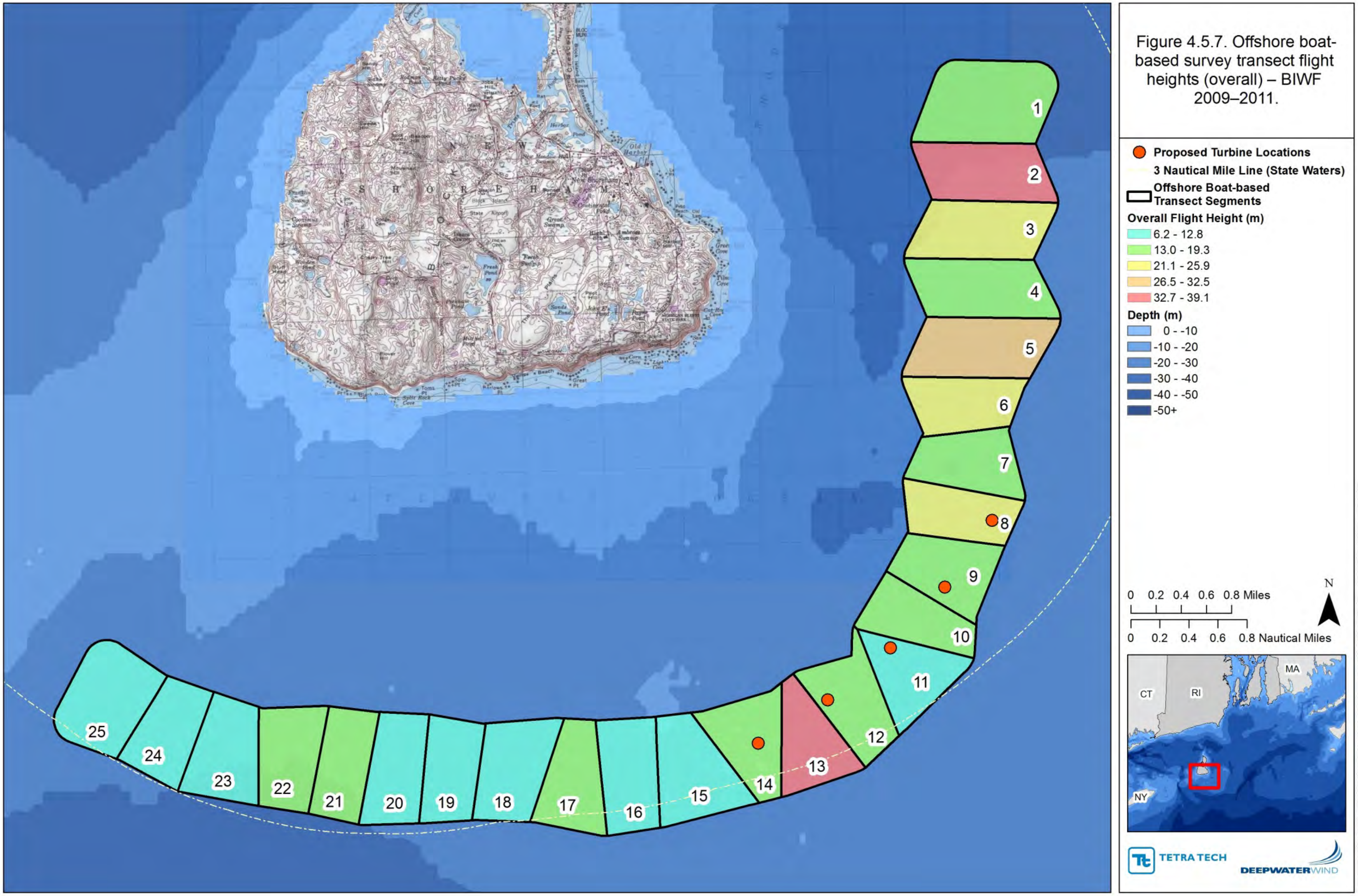


Figure 4.5.7. Offshore boat-based survey transect flight heights (overall) – BIWF 2009–2011.

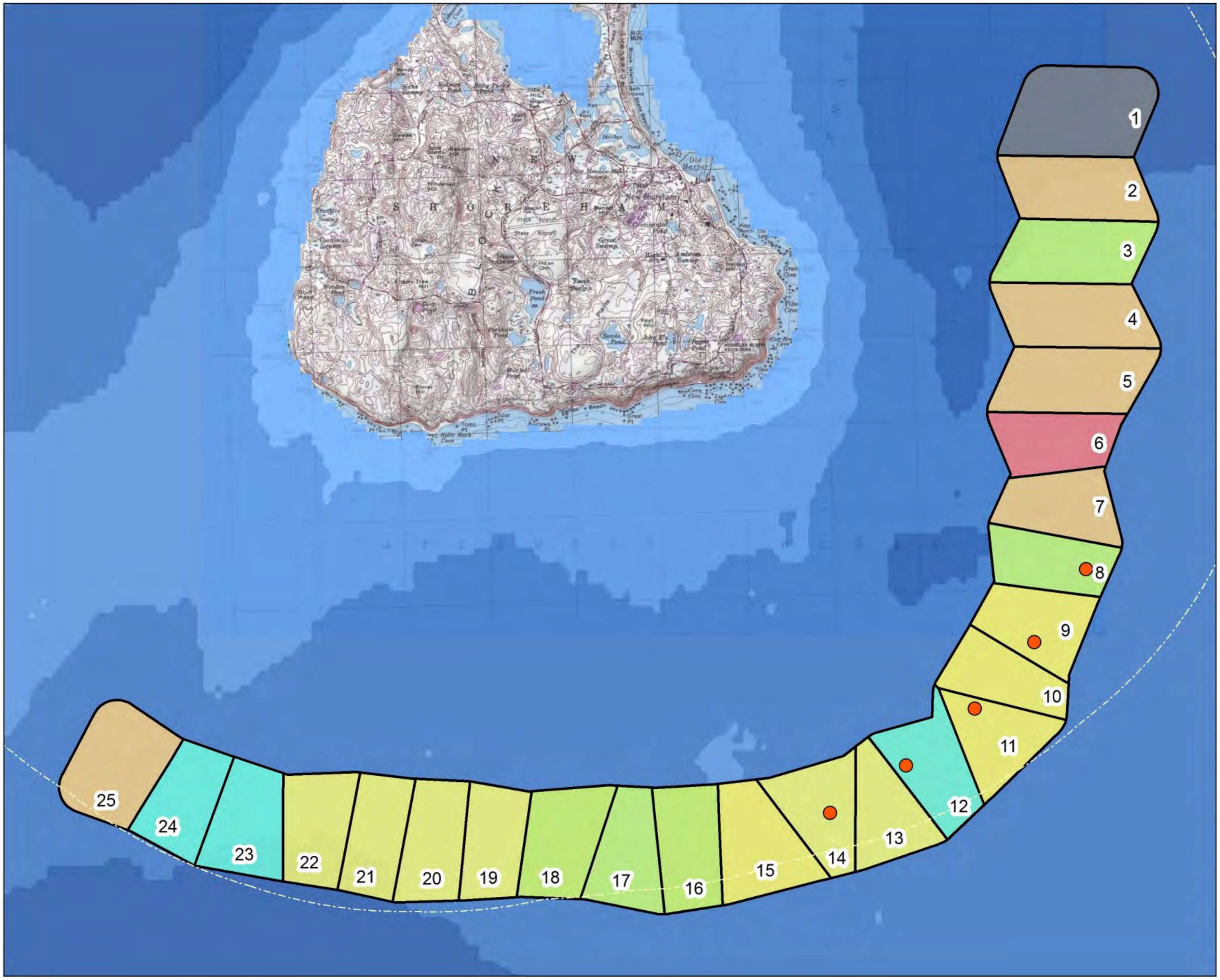


Figure 4.5.8. Offshore boat-based survey transect flight heights (loons) – BIWF 2009–2011.

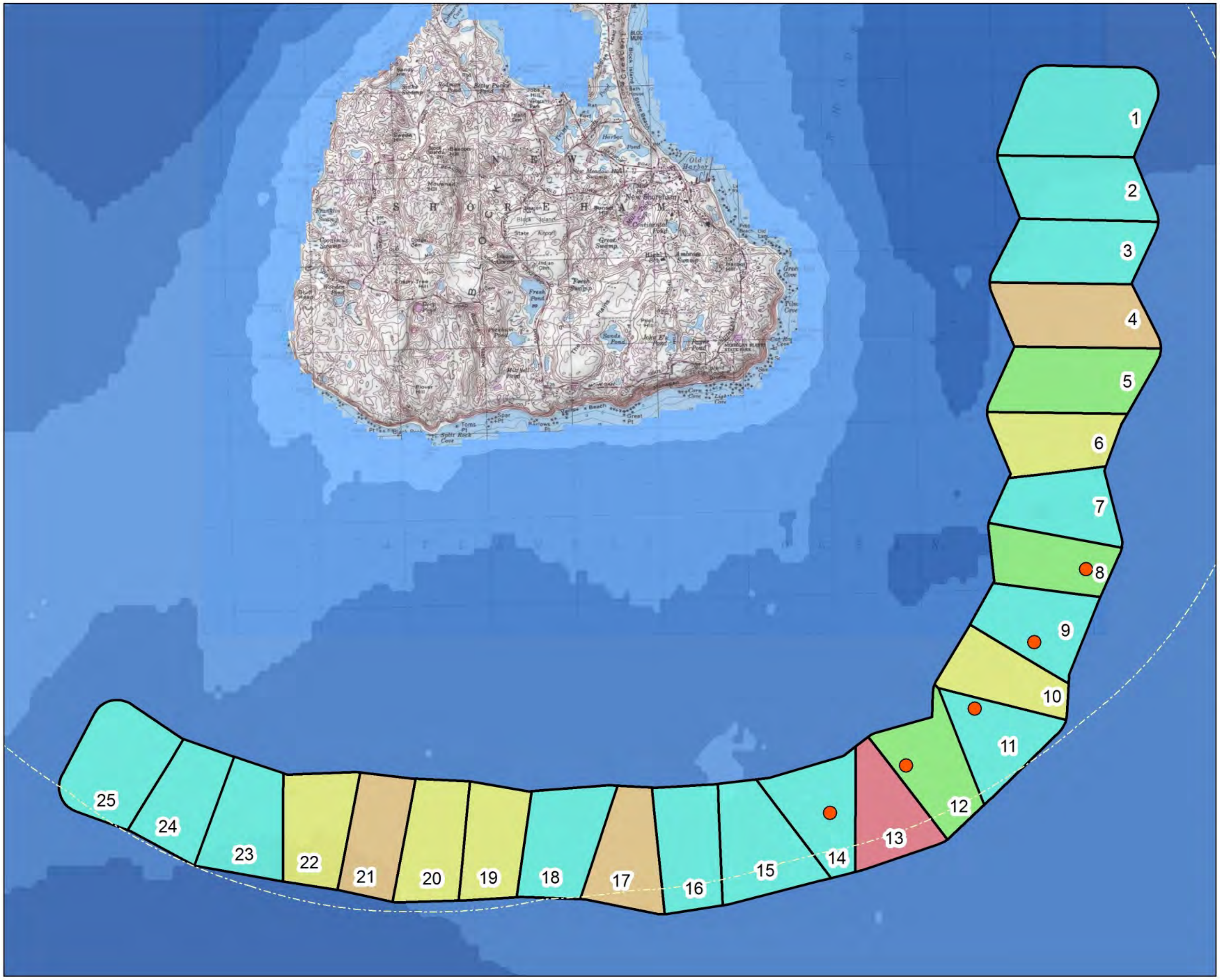


Figure 4.5.9. Offshore boat-based survey transect flight heights (waterfowl) – BIWF 2009–2011.

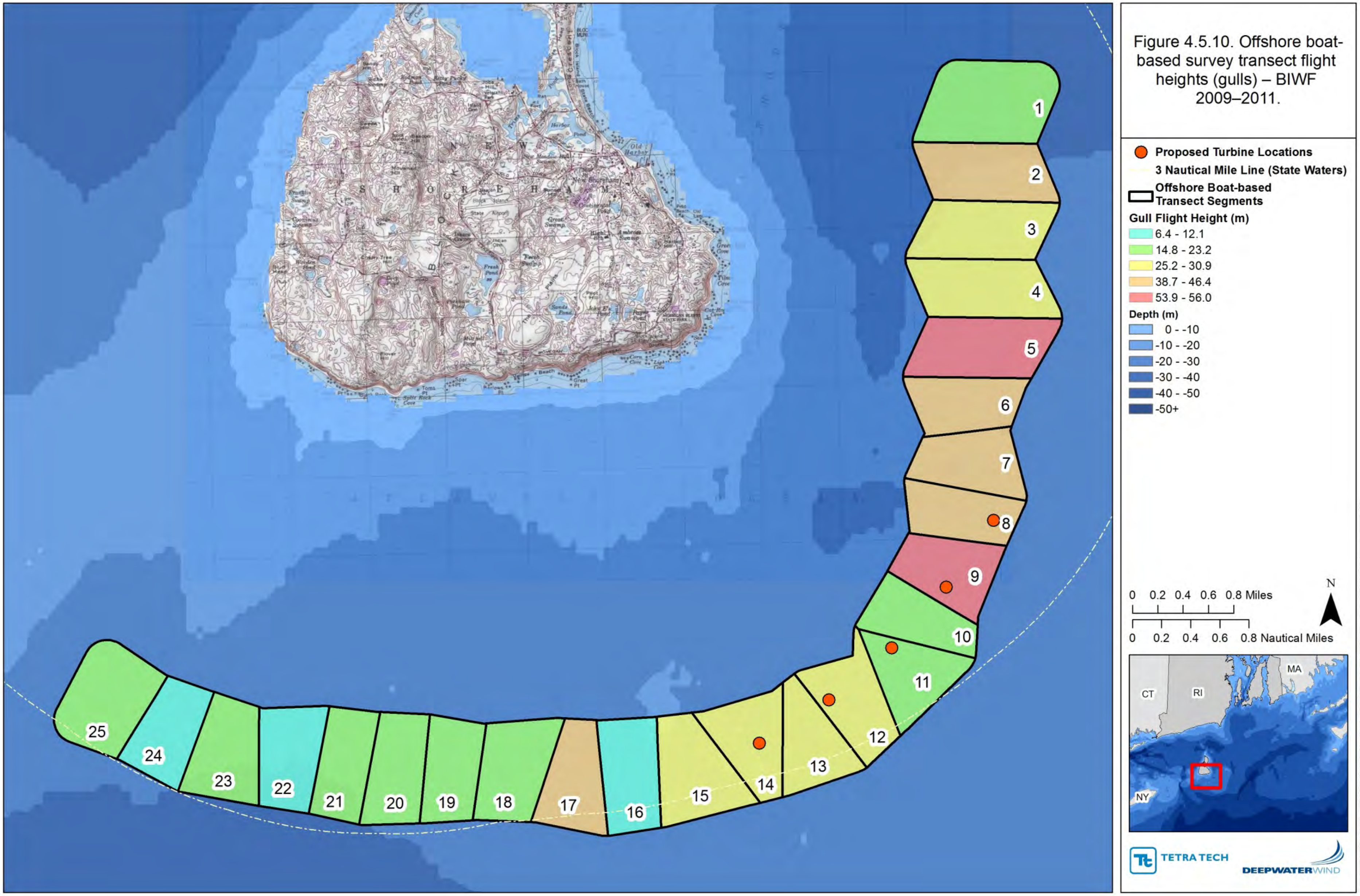


Figure 4.5.10. Offshore boat-based survey transect flight heights (gulls) – BIWF 2009–2011.

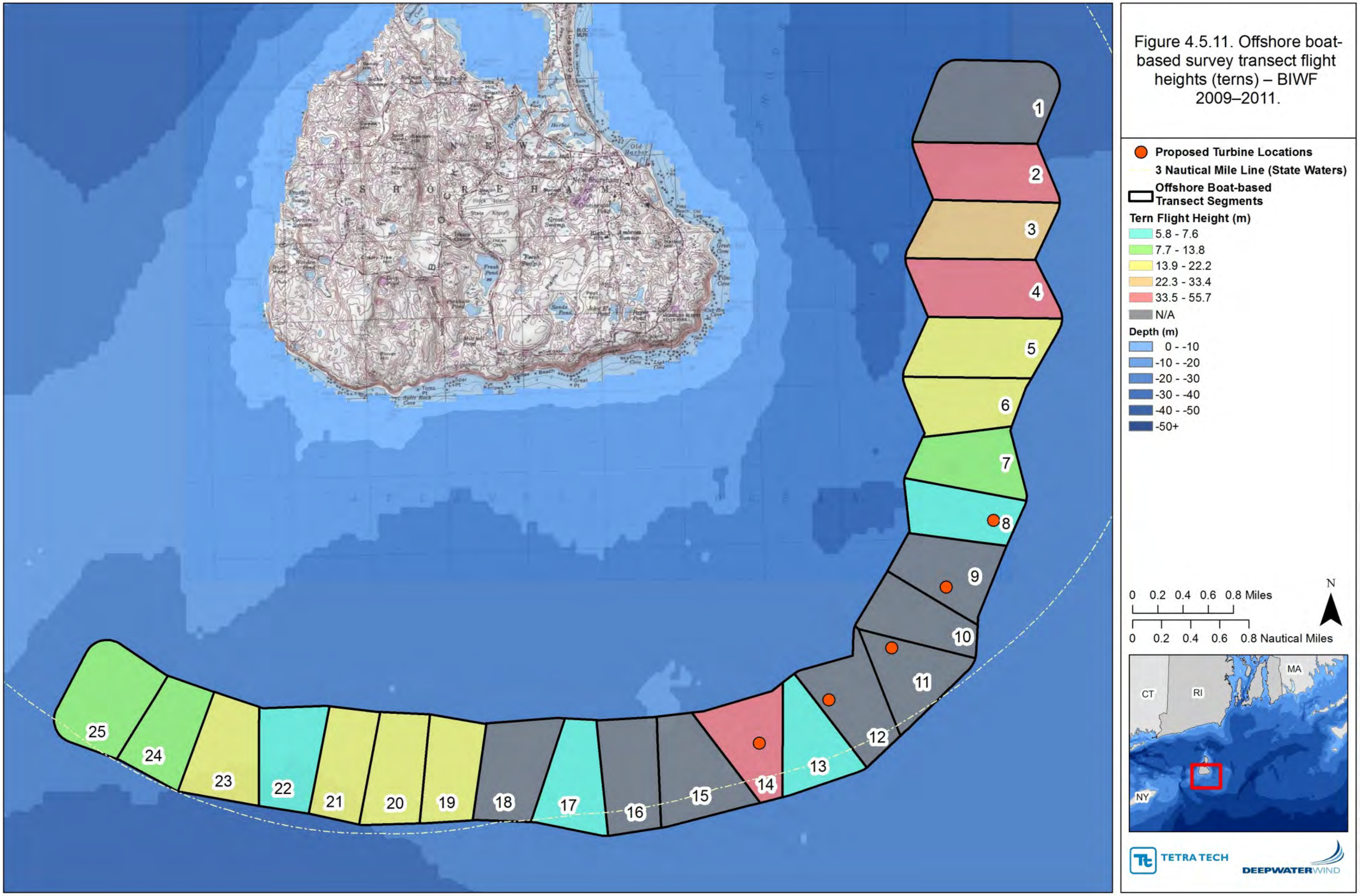


Figure 4.5.11. Offshore boat-based survey transect flight heights (terns) – BIWF 2009–2011.
Proposed Turbine Locations
3 Nautical Mile Line (State Waters)
Offshore Boat-based Transect Segments
Tern Flight Height (m)
5.8 - 7.6
7.7 - 13.8
13.9 - 22.2
22.3 - 33.4
33.5 - 55.7
N/A
Depth (m)
0 - -10
-10 - -20
-20 - -30
-30 - -40
-40 - -50
-50+
0 0.2 0.4 0.6 0.8 Miles
0 0.2 0.4 0.6 0.8 Nautical Miles
N
CT
RI
MA
NY
1
2
3
4
5
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TETRA TECH
DEEPWATERWIND

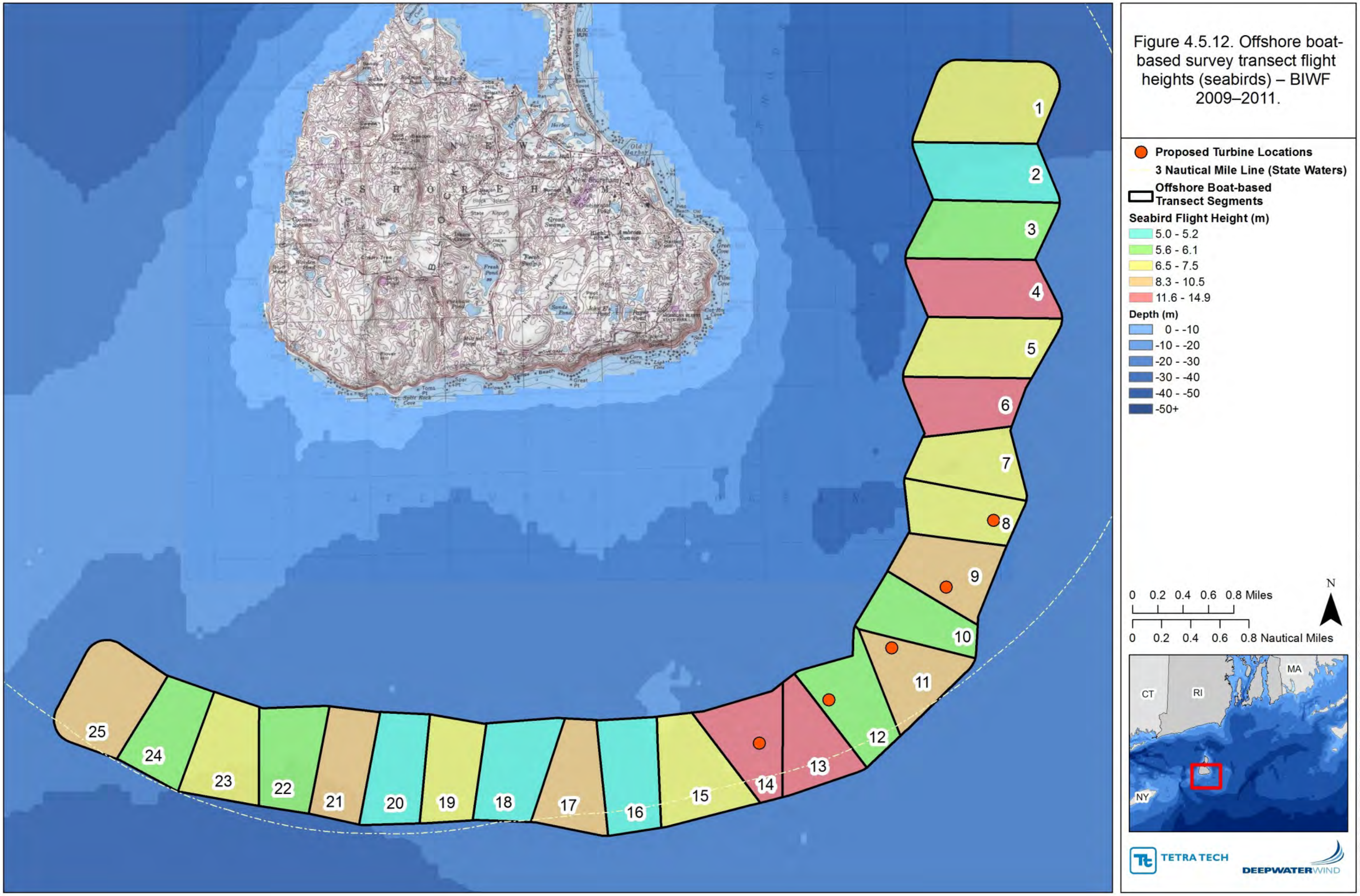

Figure 4.5.12. Offshore boat-based survey transect flight heights (seabirds) – BIWF 2009–2011.

The 2009–2011 offshore boat-based avian surveys provided detailed information on avian species composition, index of abundance, spatial distribution, and seasonal occurrence trends within the Study Area. Surveys documented the arrival and departure of summer residents (e.g., shearwaters, storm-petrels, and double-crested cormorants), fall migrants, the arrival and departure of winter residents (e.g., seaducks, loons, and alcids) and spring migrants. The observed temporal variation in species composition was consistent with established regional species accounts, natural history, and species specific phenology (Sibley 2000, Mowbray 2002, Proctor and Lynch 2005, Leslie 2008).

4.5.5 WEATHER

Weather observations were denoted at the beginning of each survey transect (Table 4.5.11). Fall and spring mean ambient air temperatures were similar (mid-10°s C [50°s F]); temperatures were greatest (as expected) in the summer and lowest in the winter. Mean wind speeds were highest in fall and lowest in winter. Sea state was also the lowest in winter. Because of the greater inherent risks of surveying on a vessel during the winter, surveys were performed on select weather days with very calm seas and lower wind speeds. During the remainder of the year the only weather criteria for conducting a survey was sea states below four.

Table 4.5.11. Summary statistics of weather observations made at the start of each boat-based transect survey – BIWF 2009–2011.

Season	Mean Temperature (Fº)	Average Wind Speed (mph)	Average Douglas Sea Swell State[1]
Fall (September 16–March 15)	56.9	9.2	2.0
Spring (March 16–June 30)	55.4	6.7	2.0
Summer (July 1–September 15)	71.7	6.7	2.0
Winter (December 16–March 15)	37.3	5.0	1.4

[1]The Douglas sea swell state index ranges from 0 (no swell) to 9 (confused, wave length and height indefinable); average sea state during surveys was 1.4 (very low, short and low wave) to 2 (low and long wave).

4.6 OFFSHORE AERIAL HIGH DEFINITION VIDEOGRAPHY

4.6.1 OBSERVATION TOTAL, DIVERSITY, AND ABUNDANCE

Overall Count of Observations

During the 2009 and 2010 survey period the 20 transect (70 segments) grid was sampled nine times. Flights were performed once per month starting in August 2009 and ending in April 2010. A total of 40.5 hours of survey video (4.25 hours per survey) were recorded, during which 3,482 individual birds were counted in the video (Table 4.6.1).

Overall Species Richness and Composition

A total of seven taxa were identified during the aerial HD videography survey including common loon, common eider, northern gannet, great cormorant, great black-backed gull, herring gull, and ring-billed gull. Most birds that were captured on the video could not be classified to species. However, the large majority of these birds were able to be classified to genus or species guild level.

The largest percentage of the 3,482 birds observed in the video were classified as unidentified ducks (n = 1,620, 46.5%) (Table 4.6.1). Seventeen percent (n = 598) of all observations were unidentified *larus* sp.). Unidentified birds made up 13.5% (n = 470) of all birds recorded. Loon captured in the video included unidentified loon (n = 261, 7.5%) and common loon (n = 1, 0.03%). Northern gannets constituted 6.2% (n = 216) of birds, while unidentified alcids made up 4.8% (n = 167). Other gulls, common eider, great cormorant, and unidentified terns made up a relatively minor proportion of the total 3,482 birds observed.

Overall Encounter Rates

The ER for the entire survey and for all species and classifications was 386.9 birds/survey (Table 4.6.1). Unidentified ducks had the highest ER of any group at 180.0 birds/survey. Unidentified larus gulls exhibited the next highest ER of any group (ER = 66.4 birds/survey). Unidentified birds also had a relatively high ER at 52.2 birds/survey; followed by unidentified loon at 29.0 birds/survey, northern gannet at 24.0 birds/survey, and unidentified alcid at 18.56 birds/survey. Cormorants, terns, and identified gulls and waterfowl all had relatively low ER values below 10.0 birds/survey. Northern gannet were the most abundant identifiable species videographed (ER = 24 birds/survey), followed by great black-backed gull (ER = 7.5 birds/survey). The general abundance pattern detected using ER was similar to that of the abundance observed using total bird counts, as described above.

Overall Density

The overall estimated density for all species pooled was 65.57 birds/km^2 (Table 4.6.1). Unidentified ducks had the highest density among the species groups (30.51 birds/km^2), followed by unidentified larus gulls (11.26 birds/km^2). Loons, alcids, and terns had relatively low overall densities. The general abundance pattern found using density was similar to that of the abundance observed using total bird counts and ER, as described above.

Table 4.6.1. Summary of count, species composition, encounter rate, and density observations made during HD aerial survey effort – BIWF 2009–2011.

Species/Guild	Count	% of Total Count	Encounter Rate (birds/survey)	Density (n/km^2)
Common eider	9	0.3%	1.0	0.17
Common loon	1	0.0%	0.1	0.02
Great black-backed gull	68	2.0%	7.6	1.28
Great cormorant	1	0.0%	0.1	0.02
Herring gull	41	1.2%	4.6	0.77
Northern gannet	216	6.2%	24.0	4.07
Ring-billed gull	1	0.0%	0.1	0.02
Unidentified *larus* gull	598	17.2%	66.4	11.26
Unidentified alcid	167	4.8%	18.6	3.15
Unidentified bird	470	13.5%	52.2	8.85
Unidentified duck	1620	46.5%	180.0	30.51
Unidentified loon	261	7.5%	29.0	4.92
Unidentified tern	29	0.8%	3.2	0.55
Total	**3482**	**–**	**386.9**	**65.57**

4.6.2 TEMPORAL DISTRIBUTION

Counts by Time Period

Counts were consistently low from August through December, with totals of less than 200 birds each month (Figure 4.6.1). The fewest birds (*n* = 35) were recorded during the November survey. Counts began to increase in January and reached their highest value during February at 1,531 birds. Counts then remained relatively high during the late winter/early spring period but gradually decreased to just fewer than 600 birds during the April survey.

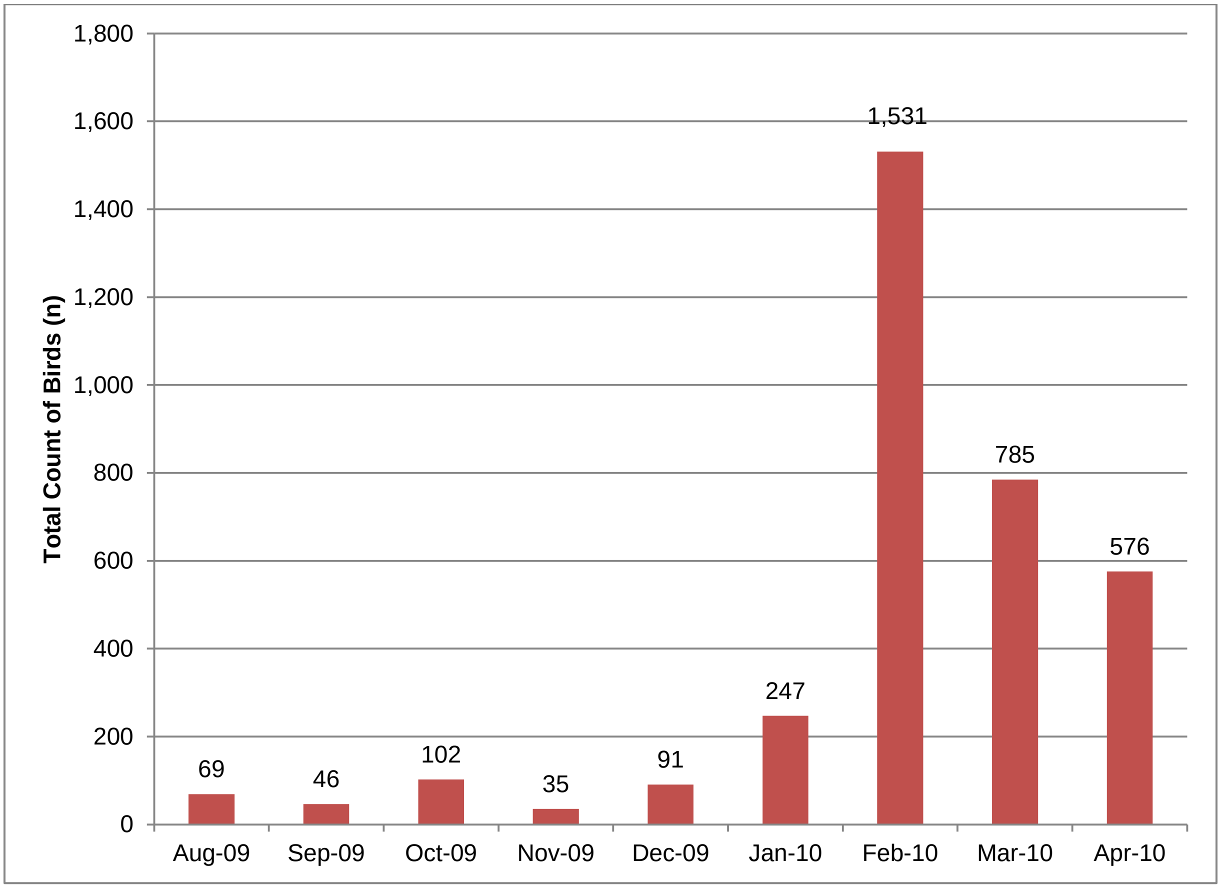

Figure 4.6.1. Total number of birds observed in high definition video per month – BIWF 2009–2011.

Species Richness by Time Period

Gulls were observed in each of the nine survey flight videos, constituting a substantial number of the total count for each survey (Figure 4.6.2). The August survey was notably different from the next eight surveys in that most birds were unclassifiable (unknown birds); additionally most of the birds that were classifiable were determined to be unidentified terns. Terns were only observed in the August video review. Nearly 90% of the birds seen in September were gulls. Northern gannet and a few unknown birds were also recorded in September. Northern gannet were recorded in September, October, November, December, February, March, and April. Peak gannet numbers were observed in the video recorded during April 2010. Unknown birds were observed each month and constituted a different percentage of the total observations each month.

Waterfowl (ducks) were first seen in the October video set, which is consistent with occurrence noted during the boat-based visual surveys. Waterfowl were observed in November, but not in December or January. Peak waterfowl numbers were detected in February when they constituted the largest percentage of all observations (85%). Ducks continued to be present in March, although the percentage was lower (40.5%).

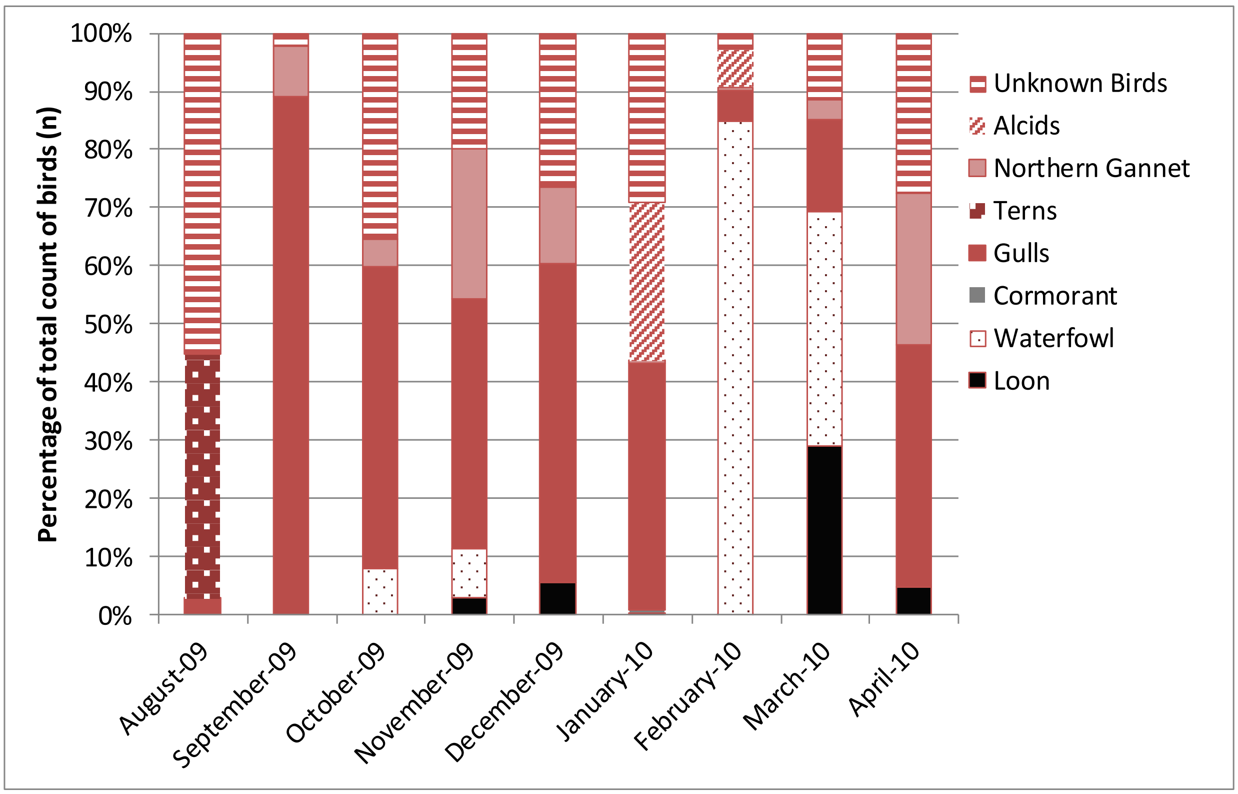

Figure 4.6.2. Percentage of total observations for each species group, per survey period – BIWF 2009–2011.

Density by Time Period

Overall bird density was highest during February, March, and April (Table 4.6.2). February had the highest density at 259.49 birds/km^2. March and April had somewhat lower overall bird density at 133.05 and 97.63 birds/km^2, respectively. Estimated bird density was generally lowest from August through December with densities below 18 birds/km^2 during each month. The lowest overall bird density was recorded in November at 5.93 birds/km^2.

Table 4.6.2. Estimated density per month by species and guild during high definition aerial surveys – BIWF 2009–2011.

Species/Guild	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Overall
Common eider	0.00	0.00	1.02	0.51	0.00	0.00	0.00	0.00	0.00	**0.17**
Common loon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	**0.02**
Great black-backed gull	0.00	0.85	0.68	0.34	1.53	5.08	0.51	1.19	1.36	**1.28**
Great cormorant	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	**0.02**
Herring gull	0.00	0.00	0.00	0.00	4.07	1.86	1.02	0.00	0.00	**0.77**
Northern gannet	0.00	0.68	0.85	1.53	2.03	0.17	1.69	4.41	25.25	**4.07**
Ring-billed gull	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.02**
Unidentified *larus* gull	0.34	5.93	8.31	2.20	2.88	10.85	11.53	19.83	39.49	**11.26**
Unidentified alcid	0.00	0.00	0.00	0.00	0.00	11.36	16.95	0.00	0.00	**3.15**
Unidentified bird	6.44	0.17	6.10	1.19	4.07	12.20	7.29	15.25	26.95	**8.85**
Unidentified duck	0.00	0.00	0.34	0.00	0.00	0.00	220.34	53.90	0.00	**30.51**
Unidentified loon	0.00	0.00	0.00	0.17	0.85	0.17	0.17	38.47	4.41	**4.92**
Unidentified tern	4.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.55**
Overall	**11.69**	**7.80**	**17.29**	**5.93**	**15.42**	**41.86**	**259.49**	**133.05**	**97.63**	**65.57**

4.6.3 Spatial Distribution and Flight Ecology

Counts by Location

From north to south (short transects 1–5 and long transects 6–20), across all east to west segments pooled (A, B, C, and D) the greatest number of birds were counted along transect 11 (n = 1,225) (Table 4.6.3). Within long transects only (6–20) most birds were observed between transects 11 and 15. In general fewer birds were encountered towards the extreme north of the Study Area. From east to west (short transect segments C to D, and long transect segments A, B, C, and D,) for all transects (1–20) pooled, the greatest number of birds were encountered in segment B.

Table 4.6.3. Observation counts by transect and segment during the high definition aerial surveys – BIWF 2009–2011.

Transect-Segment	A	B	C	D	Total
1	n/a	n/a	12	6	**18**
2	n/a	n/a	5	8	**13**
3	n/a	n/a	13		**13**
4	n/a	n/a	6	17	**23**
5	n/a	n/a	5	11	**16**
6	11	3	5	5	**24**
7	1	6	2	***13***	**22**
8		3	16	2	**21**
9	2	2	13	29	**46**
10	358	11		***13***	**382**
11	74	1092	31	28	**1225**
12	3	52	***31***	***6***	**92**
13	36	56	182	26	**300**
14	102	126	***39***	11	**278**
15	53	49	30	16	**148**
16	21	28	***9***	34	**92**
17	83	23	86	50	**242**
18	2	19	16	8	**45**
19	4	13	10	132	**159**
20	38	224	52	9	**323**
Total	**788**	**1,707**	**563**	**424**	**3,482**

Note: Transect-segments where turbines are proposed shown in bold italics.

Encounter Rate by Location

The overall ER for all birds observed was highest at transect-segment 11-B (ER = 121.33 birds/survey) (Table 4.6.4). Three segment-transects had no encounters (D-3, A-8, and C-10). In transect-segments where WTGs are proposed encounter rates ranged from 0.67 birds/survey to 4.33 birds/survey; the combined ER for the six transect segments where WTGs are proposed was 12.33 birds/survey.

Table 4.6.4. Encounter rates per transect segment for all observations pooled during the high definition aerial surveys – BIWF 2009–2011.

Transect-Segment	A	B	C	D	Total
1	n/a	n/a	1.33	0.67	**2.00**
2	n/a	n/a	0.56	0.89	**1.44**
3	n/a	n/a	1.44		**1.44**
4	n/a	n/a	0.67	1.89	**2.56**
5	n/a	n/a	0.56	1.22	**1.78**
6	1.22	0.33	0.56	0.56	**2.67**
7	0.11	0.67	0.22	***1.44***	**2.44**
8		0.33	1.78	0.22	**2.33**
9	0.22	0.22	1.44	3.22	**5.11**
10	39.78	1.22		***1.44***	**42.44**
11	8.22	121.33	3.44	3.11	**136.11**
12	0.33	5.78	***3.44***	***0.67***	**10.22**
13	4.00	6.22	20.22	2.89	**33.33**
14	11.33	14.00	***4.33***	1.22	**30.89**
15	5.89	5.44	3.33	1.78	**16.44**
16	2.33	3.11	***1.00***	3.78	**10.22**
17	9.22	2.56	9.56	5.56	**26.89**
18	0.22	2.11	1.78	0.89	**5.00**
19	0.44	1.44	1.11	14.67	**17.67**
20	4.22	24.89	5.78	1.00	**35.89**
Total	**87.56**	**189.67**	**62.56**	**47.11**	**386.89**

Note: Transect-segments where turbines are proposed shown in bold italics.

Density by Location

Density estimates for each of the 70 transect segments were ranked (Table 4.6.5). The estimated overall density for all species pooled was 65.44 birds/km^2. The highest overall density was estimated in transect segment 11-B (1,402.3 birds/km^2), and the lowest measureable density was at transect segment 7-A (1.28 birds/km^2); three transect segments had no avian density. Avian density was generally higher in the western portions of the Study Area (segments A and B, transects 15–20) (Figure 4.6.3).

Table 4.6.5. Density per transect segment for all observations pooled during the high definition aerial surveys– BIWF 2009–2011.

Transect-Segment	A	B	C	D	Total
1	n/a	n/a	18.49	9.25	**13.87**
2	n/a	n/a	7.71	12.33	**10.02**
3	n/a	n/a	20.04		**10.02**
4	n/a	n/a	9.25	26.20	**17.72**
5	n/a	n/a	7.70	16.94	**12.32**
6	14.13	3.85	6.42	6.42	**7.71**
7	1.28	7.71	2.57	***16.69***	**7.06**
8		3.85	20.55	2.57	**6.74**
9	2.57	2.57	16.69	37.24	**14.77**
10	459.74	14.13		***16.69***	**122.64**
11	95.03	1402.33	39.81	35.96	**393.28**
12	3.85	66.78	***39.81***	***7.71***	**29.54**
13	46.23	71.91	233.72	33.39	**96.31**
14	130.99	161.81	***50.08***	14.13	**89.25**
15	68.06	62.92	38.53	20.55	**47.51**
16	26.97	35.96	***11.56***	43.66	**29.54**
17	106.59	29.54	110.44	64.21	**77.69**
18	2.57	24.40	20.55	10.27	**14.45**
19	5.14	16.69	12.84	169.51	**51.04**
20	48.80	287.65	66.78	11.56	**103.69**
Total	**67.46**	**8.75**	**37.72**	**28.41**	**65.44**

Note: Transect-segments where turbines are proposed shown in bold italics.

Estimated density for those transect segments where turbines are proposed (7-D, 10-D, 12-D, 12-C, 14-C, and 16-C) ranked towards the middle of the distribution of estimated density for all species pooled (Tables 4.6.5 and 4.6.6). Density within transect-segments where the WTGs are proposed ranged from 7.71 birds/km^2 (12-D) to 50.08 birds/km^2 (14-C). Segment 14-C had the highest density for segments where turbines are proposed, but ranked 17th in the overall distribution of all segments. Segment 12-C ranked 22nd, 7-D was 38th, and segments 10-D, 16-C and 12-D ranked below 40th overall.

Table 4.6.6. Summary of observations for transect-segments where turbines are proposed – BIWF 2009–2011.

Transect Segment	Count	Encounter Rate (birds/survey)	Estimated Density (birds/km^2)
7-D	13	1.44	16.69
10-D	13	1.44	16.69
12-C	31	3.44	39.81
12-D	6	0.67	7.71
14-C	39	4.33	50.08
16-C	9	1.00	11.56
Total within Transect Segment where WTGs are proposed	**111**	**12.33**	**23.76**

Density by Location and Species Group

Density for loons was highest in transect-segment 14-B, west of transect-segment 14-C where WTGs are proposed and where loons occurred at a density of 2.57 birds/km^2 (Figure 4.6.4). Loons occurred at 45 of the transect-segments, and loon density was highest in segment B between transects 11 and 14. Waterfowl density was substantially higher than all other species groups, and was concentrated at transect-segment 11-B (1,219 birds/km^2) (Figure 4.6.5). Overall, waterfowl were highly clustered in their spatial distribution, and all 1,629 individuals observed in the videos were within 11 transect-segments. Gull density was more uniform across transect-segments; gulls occurred at 62 of the 70 transect-segments, and were at the highest density in 13-C (214.46 birds/km^2) (Figure 4.6.6). Terns were uncommon and occurred within only four transect-segments, with peak density at 14-A (32 birds/km^2) (Figure 4.6.7). Seabirds were less widely distributed than gulls and were observed within 48 of the 70 transect-segments; seabird density was highest at 17-C (68.06 birds/km^2) (Figure 4.6.8).

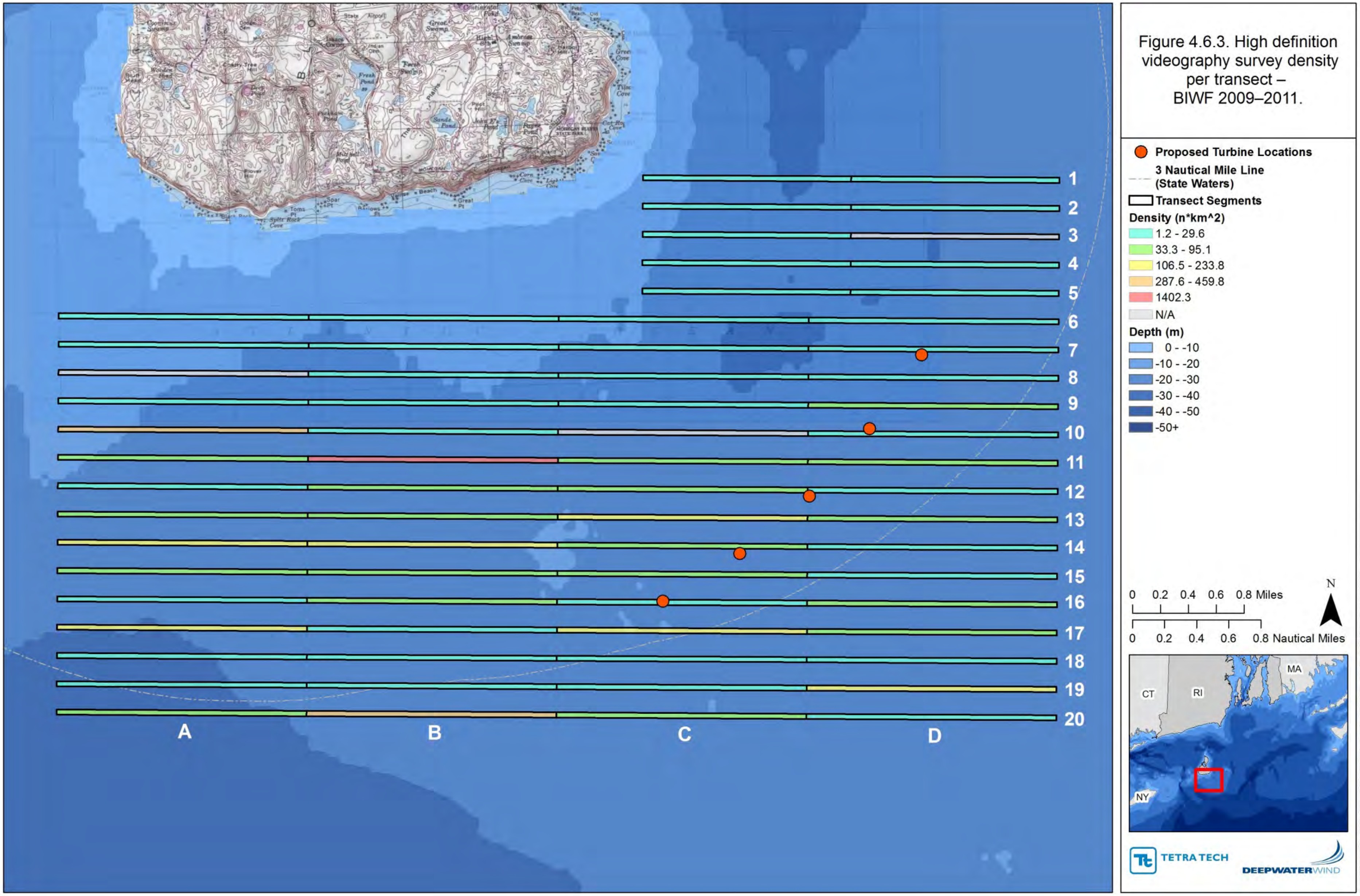

Figure 4.6.3. High definition videography survey density per transect – BIWF 2009–2011.

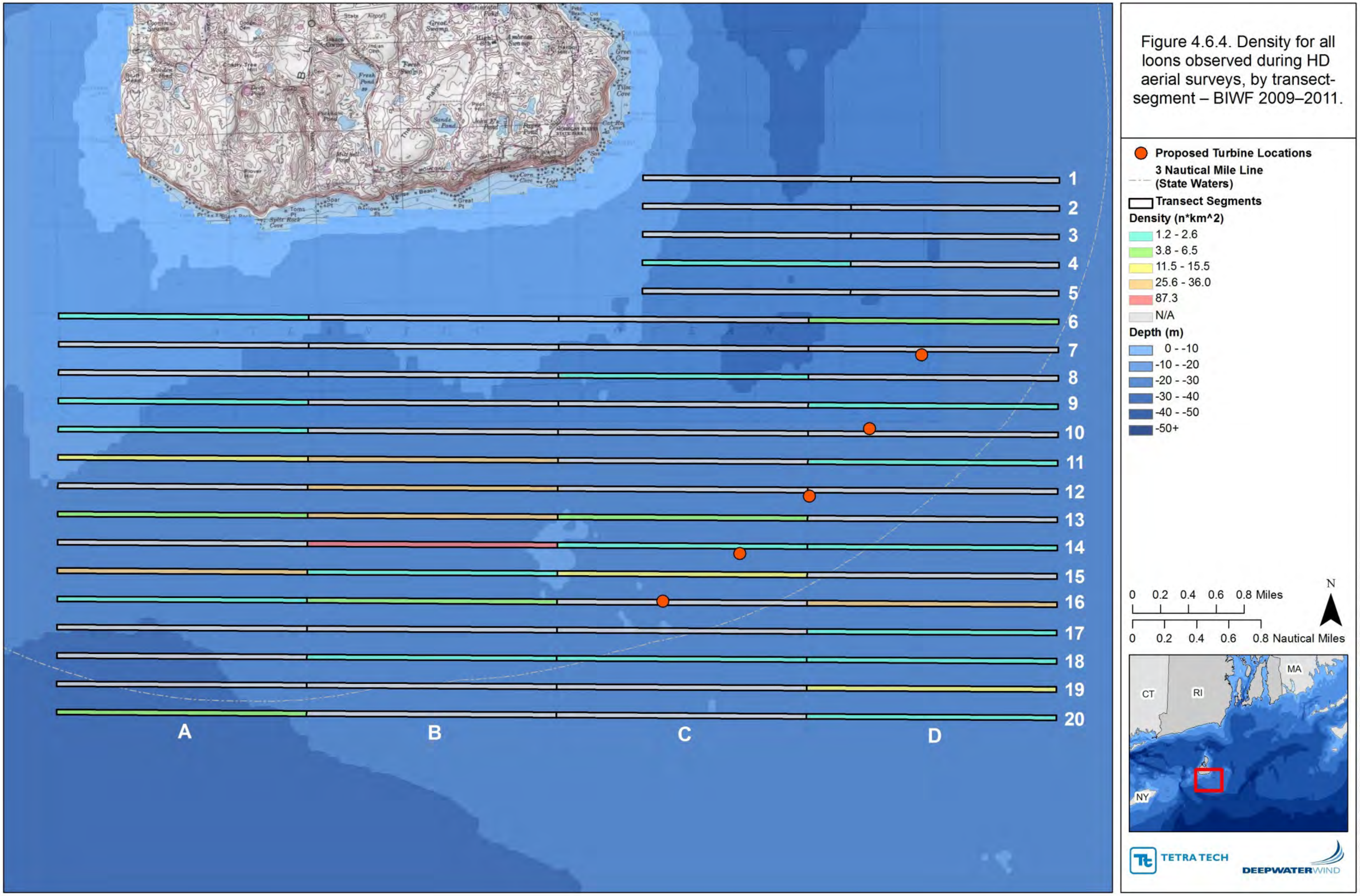

Figure 4.6.4. Density for all loons observed during HD aerial surveys, by transect-segment – BIWF 2009–2011.

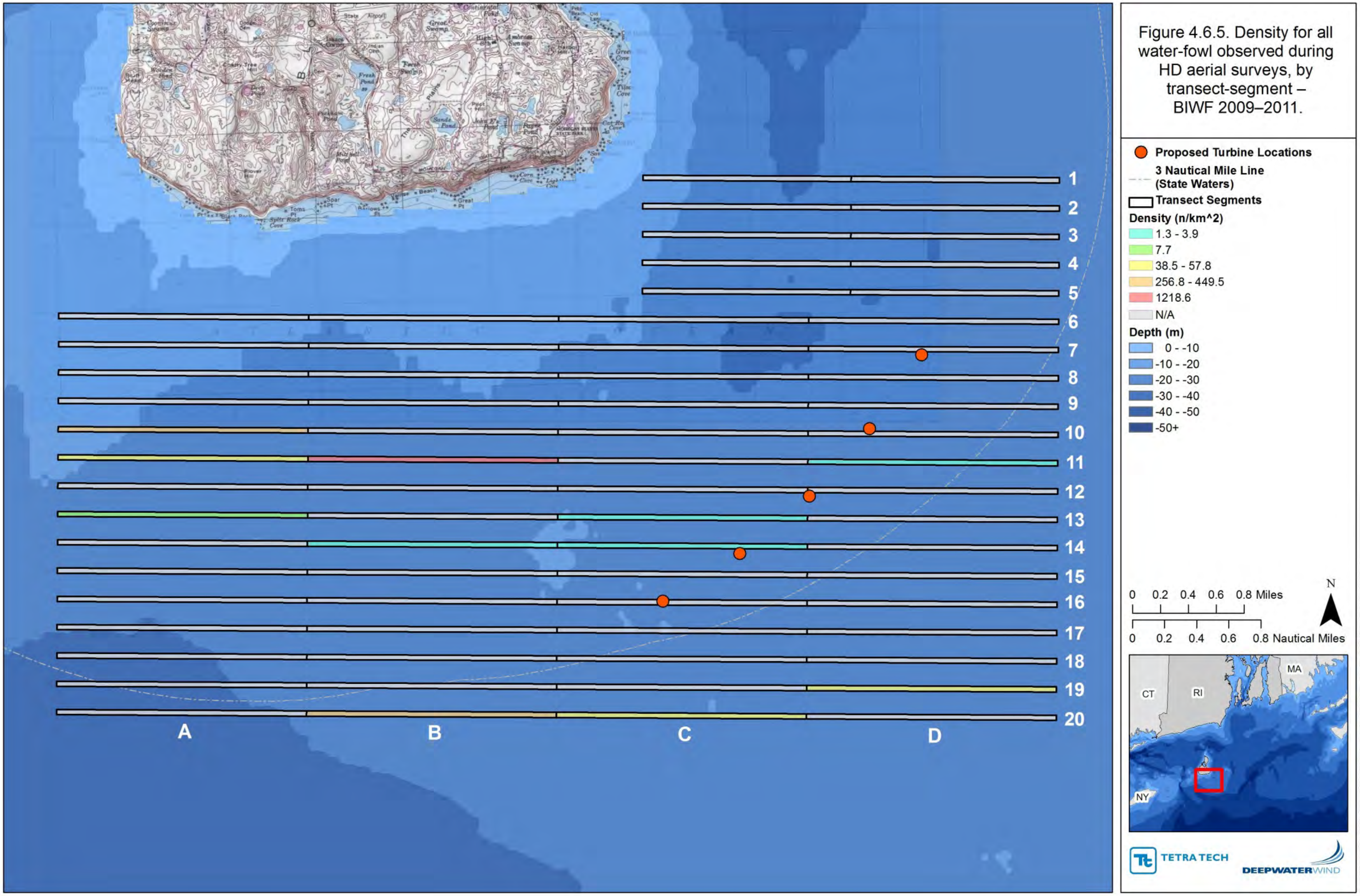

Figure 4.6.5. Density for all water-fowl observed during HD aerial surveys, by transect-segment – BIWF 2009–2011.

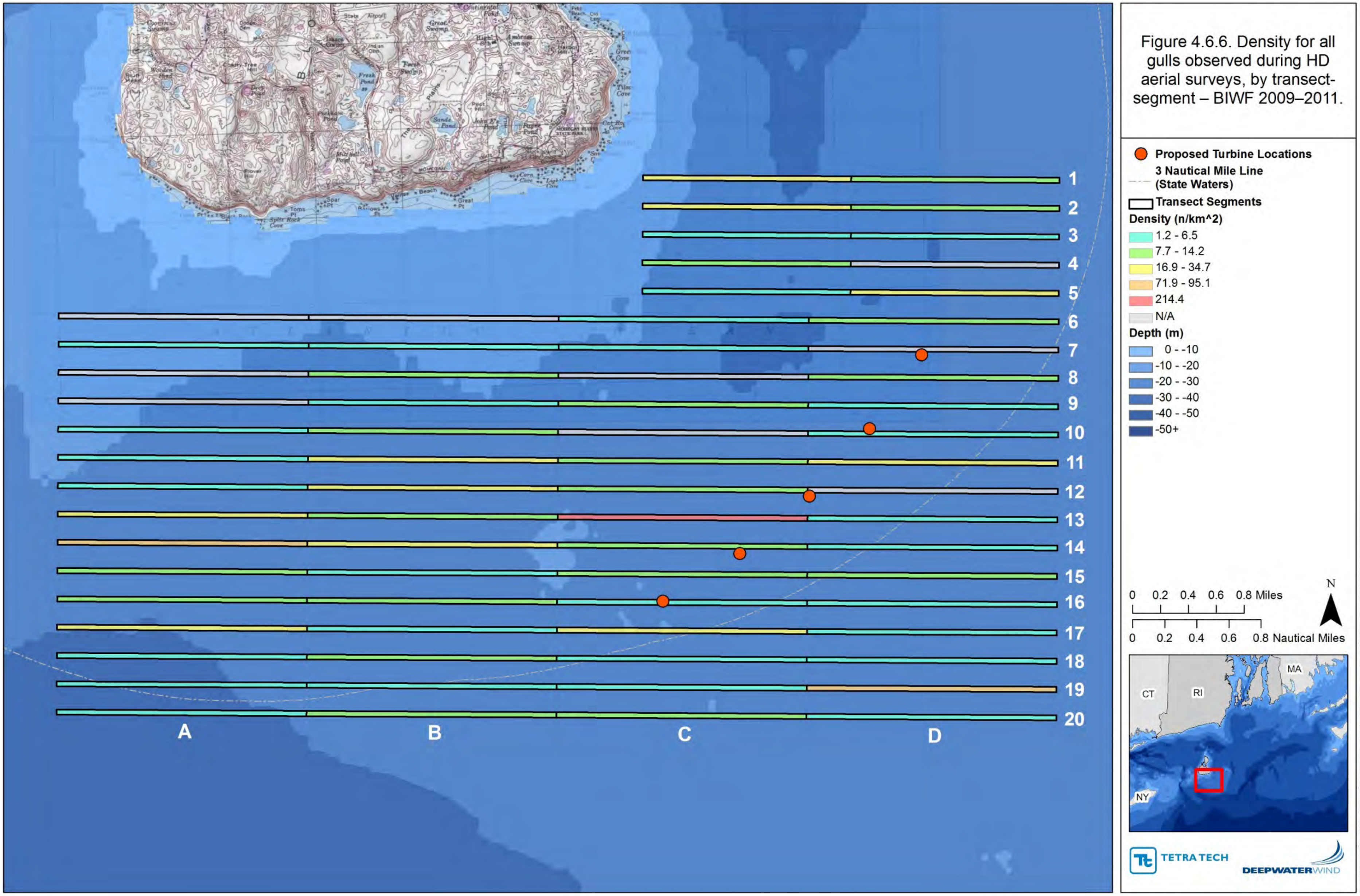

Figure 4.6.6. Density for all gulls observed during HD aerial surveys, by transect-segment – BIWF 2009–2011.

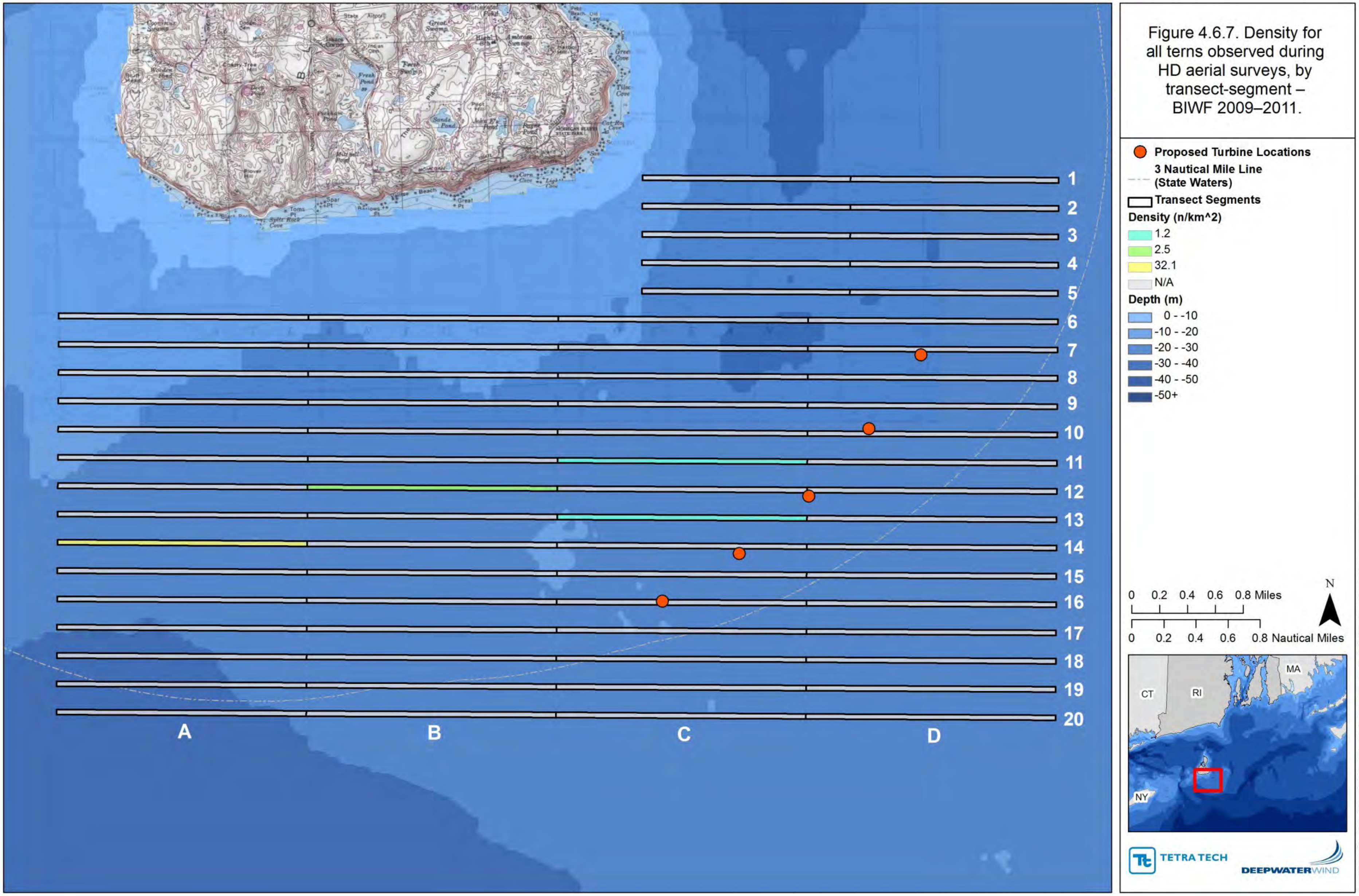
Figure 4.6.7. Density for all terns observed during HD aerial surveys, by transect-segment – BIWF 2009–2011.
Proposed Turbine Locations
3 Nautical Mile Line (State Waters)
Transect Segments
Density (n/km^2)
1.2
2.5
32.1
N/A
Depth (m)
0 - -10
-10 - -20
-20 - -30
-30 - -40
-40 - -50
-50+
0 0.2 0.4 0.6 0.8 Miles
0 0.2 0.4 0.6 0.8 Nautical Miles
N
CT
RI
MA
NY
TETRA TECH
DEEPWATERWIND
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
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17
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19
20
A
B
C
D

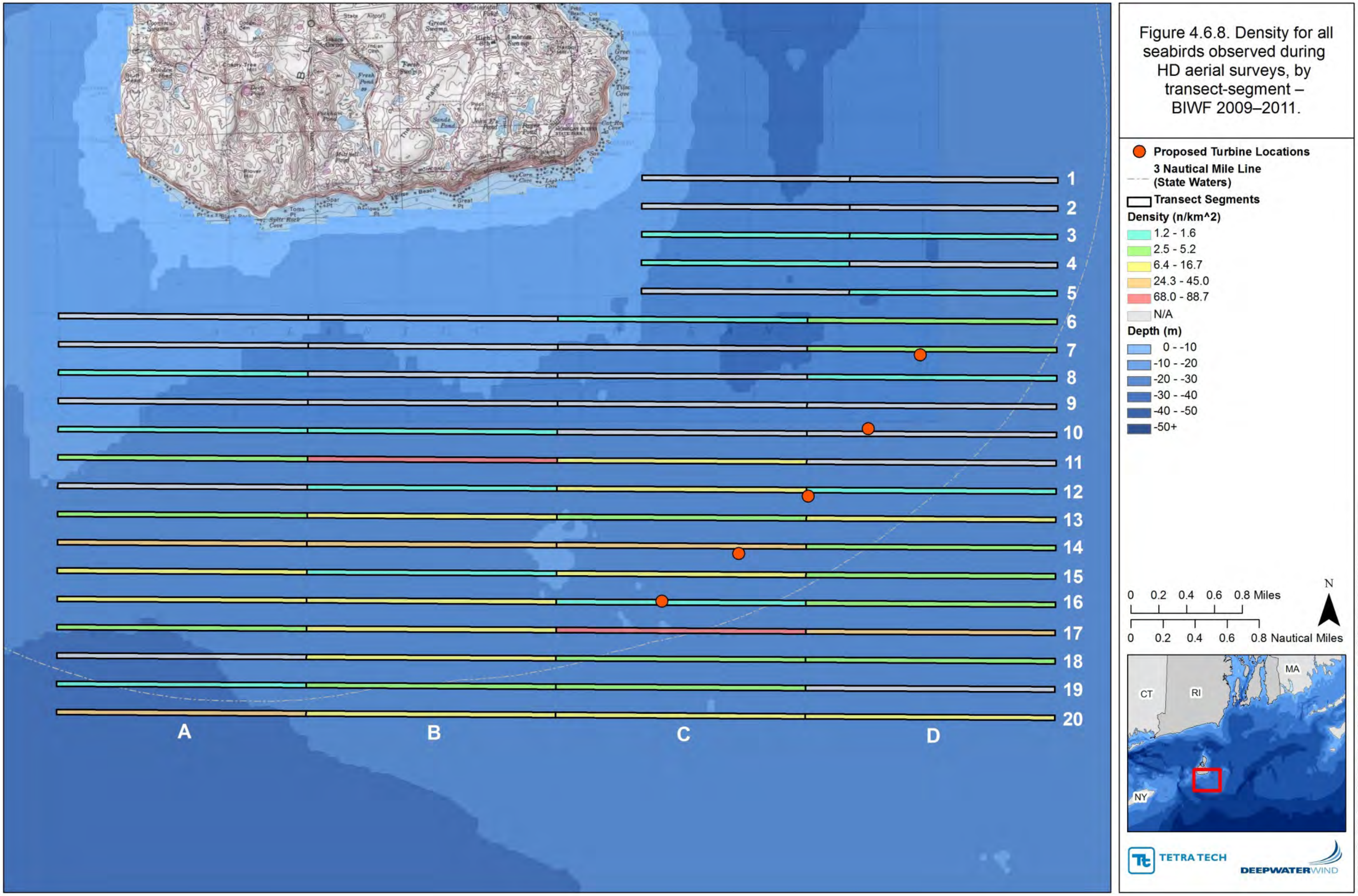

Figure 4.6.8. Density for all seabirds observed during HD aerial surveys, by transect-segment – BIWF 2009–2011.

4.7 MERLIN RADAR

4.7.1 OVERALL MERLIN DATA COLLECTION SUMMARY

Data collected from the VSR were used to quantify target movements (TPR and flight height) through the Study Area. The radar sampled target passage rates and flight heights over the course of several periods and seasons: one partial winter and two full winter seasons (February 27–March 15, 2009, December 16–March 15 in 2010 and 2011), three full springs (March 16–June 30 in 2009, 2010, and 2011), three full summers (July 1–September 15 in 2009, 2010, and 2011), and two full falls (September 16–December 15 in 2009 and 2010). Target movements were assessed from the three different 1-km (0.6 mi) fronts of the VSR Offshore, Nearshore, and Onshore (Figure 3.7.3). Targets were quantified as total number of targets (t)/km/hr. Standardized TPRs for all biological periods and flight heights per day can be found in Appendix B.

All flight heights for the Offshore and Nearshore VSR 1 km fronts (sectors) are presented as the height of targets above mean sea level, and were corrected for the altitude of the radar above the surface of the water on the Southeast Bluff, Block Island (23.4 m [76.8 ft]). All target heights for the Onshore VSR output are given as the height of target above ground level.

Target flight heights are presented as both mean and median heights for biological periods and seasons. Median flight heights may be more useful than mean heights for assessing risk ($\bar{x}$), although mean altitudes are more commonly presented for radar studies of this type. Median ($\tilde{x}$) flight height is the middle flight height within the entire distribution of target flight heights, which separates the upper half of target flight heights (higher flying targets) from the lower half of target flight heights (lower flying targets). The average mean nightly target flight height was also calculated. For seasonal or multi-day summaries the mean flight height is the average of the mean flight heights for each night the radar was operational. For example, the average mean target flight height for three dates with mean flight heights of 50 m (164 ft), 30 m (98 ft), and 20 m (66 ft), respectively would be 33.3 m (109.3 ft).

4.7.2 OFFSHORE VERTICAL SCANNING RADAR: ALL SEASONS AND ALL YEARS COMBINED

Level of Effort

The MERLIN Avian Radar System operated continuously (24 hours a day) during the survey period (February 28, 2009–September 15, 2011). There were 21,724.1 hours available from February 27, 2009 to September 15, 2011, of which 72% (15,688.5 hours) were sampled by the MERLIN offshore VSR (Table 4.7.1). Periods of down time are typical for vertical (X-band) radar because precipitation blocks the smaller wavelength of X-band radar and causes saturation of the radar system. As a result, few if any targets are discernible during rain events, and therefore, periods with rain were excluded from the analysis. This left 15,688.5 hours of useable Offshore VSR data.

Table 4.7.1. Total combined Offshore VSR level of effort.

Offshore VSR	Time in Season (hrs)	Time radar collected data (hrs)	Radar Downtime (hrs)	Radar data with Rain (hrs)	Useable and Analyzed Radar Data (hrs)
Winter	4,581.4	2,132.8	2,448.7	194.2	1,938.6
Spring	7,603.1	7,316.8	286.3	791.9	6,524.9
Summer	5,456.5	4,494.4	962.1	428.6	4,065.8
Fall	4,083.1	3,755.6	327.5	596.4	3,159.3
Total	**21,724.1**	**17,699.6**	**4,024.5**	**2,011.1**	**15,688.5**

Target Passage Rate

During the survey period from 2009 to 2011, the mean TPR from the Offshore VSR was 56.5 t/km/hr for all biological periods. Mean TPR was highest during the daytime at 70.2 t/km/hr (Table 4.7.2).

The highest maximum mean TPR was recorded in winter during dawn periods (610 t/km/hr), and the lowest maximum mean TPR were recorded during the day in summer (226.2 t/km/hr) (Table 4.7.2). The lowest minimum TPR was recorded during the night in the spring (0 t/km/hr), while the highest minimum TPR was during the day in the fall (2.7 t/km/hr).

Average TPRs were generally greatest at dawn or during the day. During all winters combined and all falls combined, average TPR was greatest at dawn. During all summers combined and all spring periods combined, average TPR was highest during the day. During all seasons and all years combined, the average TPR was highest during the day. Average TPR was lowest during dusk in winter and fall, and during the night in summer and spring (Figure 4.7.1). TPR was greatest, by hour, for all seasons and all years pooled, from 5:00 to 10:00, and was lowest just before dawn from 0:00 to 4:00 am (Figure 4.7.2).

Table 4.7.2. Target passage rates for each of four biological periods all seasons and all years combined from the Offshore VSR.

OFFSHORE VSR					
Biological Period		**Dawn**	**Day**	**Dusk**	**Night**
Winter	Average	126.8	104.2	74.1	82.6
	Standard Deviation	131.1	119.5	103.0	106.4
	Median	85.0	59.4	24.0	24.4
	Minimum	0.0	0.2	0.0	0.7
	Maximum	610.0	497.8	386.0	408.9
	Range	610.0	497.6	386.0	408.2
Spring	Average	39.0	45.4	43.1	33.0
	Standard Deviation	67.6	58.9	67.2	51.2
	Median	10.0	21.6	11.5	12.1
	Minimum	0.0	0.1	0.0	0.0
	Maximum	507.6	395.9	357.0	339.4
	Range	507.6	395.8	357.0	339.4
Summer	Average	33.4	44.8	38.4	32.5
	Standard Deviation	57.9	49.4	64.3	54.6
	Median	11.5	22.1	9.0	8.1
	Minimum	0.0	1.7	0.0	0.0
	Maximum	320.0	226.2	301.0	254.3
	Range	320.0	224.5	301.0	254.3
Fall	Average	133.7	132.5	116.0	119.5
	Standard Deviation	126.3	117.0	116.9	112.7
	Median	88.0	99.3	75.0	86.7
	Minimum	0.0	2.7	0.0	1.2
	Maximum	520.0	545.5	494.6	473.0
	Range	520.0	542.9	494.6	471.8
OVERALL	***Average***	***67.0***	***70.2***	***60.9***	***56.5***
	Standard Deviation	***99.7***	***89.0***	***89.2***	***84.0***
	Median	***22.0***	***36.4***	***17.0***	***19.0***
	Minimum	***0.0***	***0.1***	***0.0***	***0.0***
	Maximum	***610.0***	***545.5***	***494.6***	***473.0***
	Range	***610.0***	***545.4***	***494.6***	***473.0***

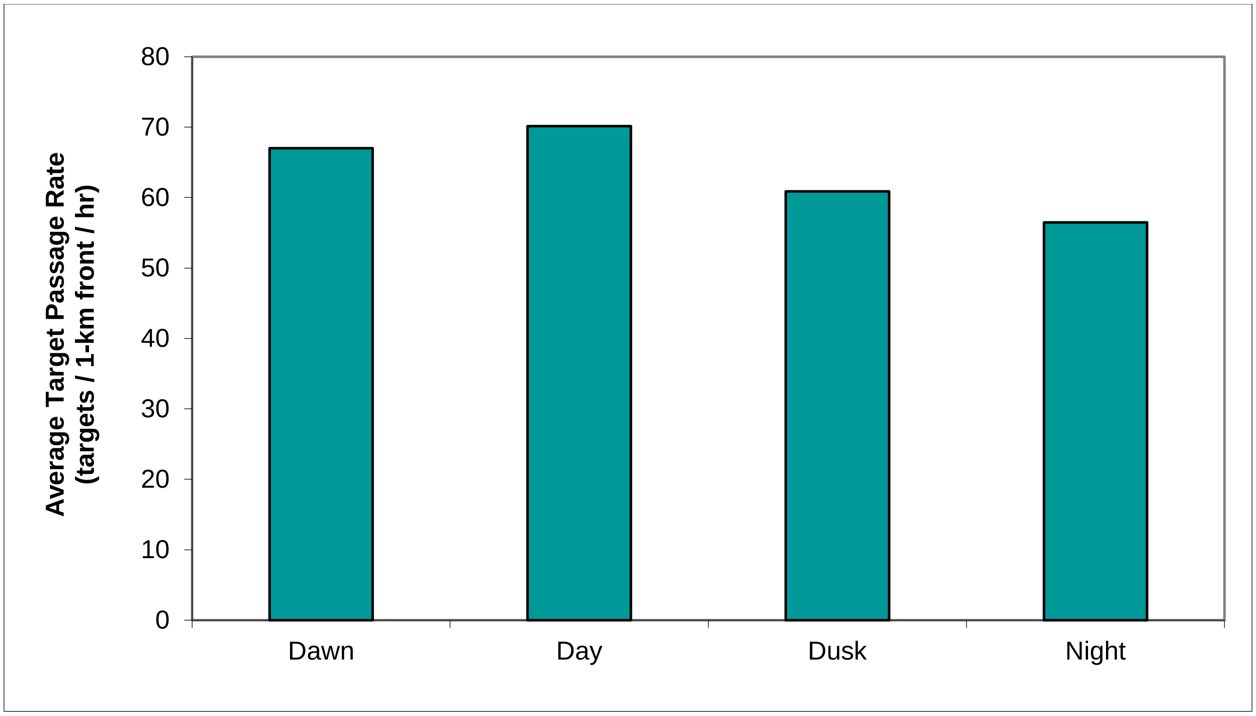

Figure 4.7.1. Average target passage rates by biological period, all seasons and all years combined from the Offshore VSR – BIWF 2009–2011.

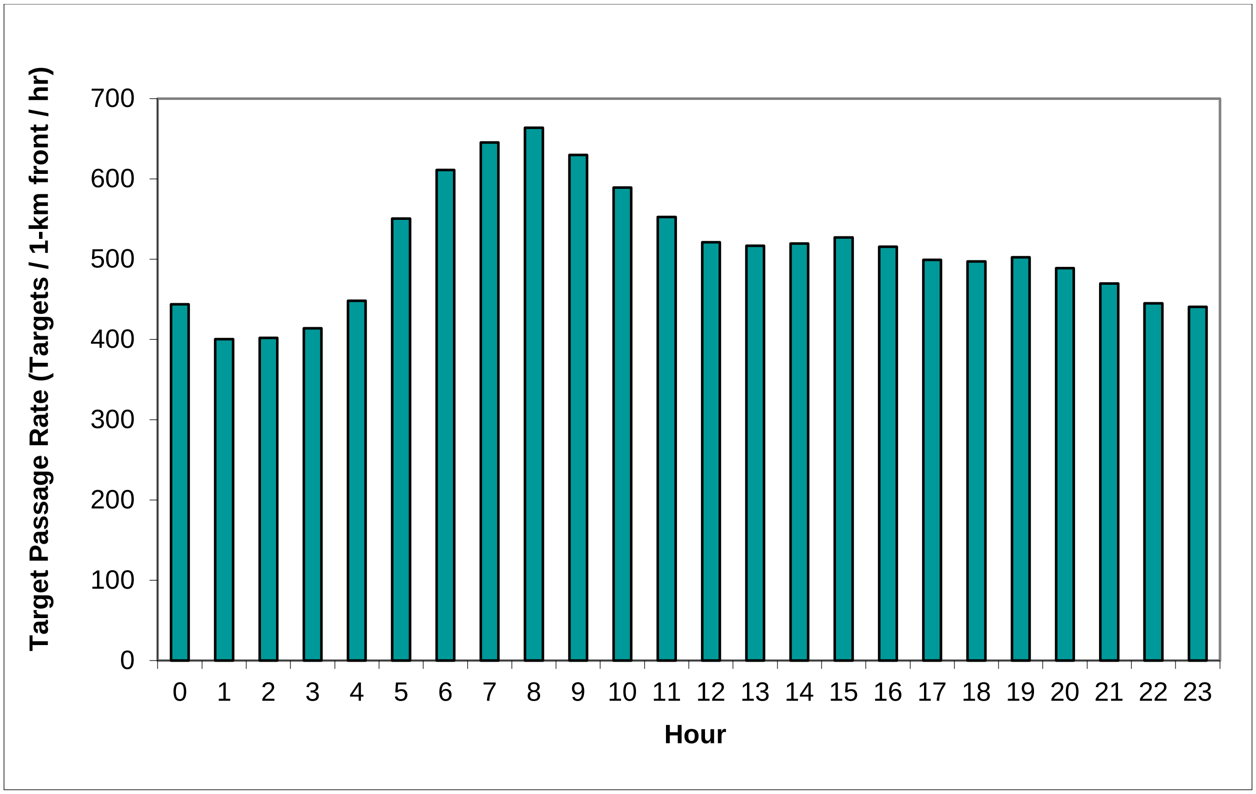

Figure 4.7.2. Average target passage rates by hour, all seasons and all years combined from the Offshore VSR –BIWF 2009–2011.

Flight Height

Overall mean target flight height from the Offshore VSR was lowest during the night (87.2 m [286.1 ft]), and greatest during the day (99.2 m [325.5 ft]) (Figure 4.7.3). Median target flight heights ranged from 48.7 m (159.8 ft) during the night to 53.0 m (173.9 ft) during the day (Table 4.7.3).

Overall, average flight heights were highest during the day in summer (146.9 m [481.9 ft]) and lowest during dusk in the summer (64.1 m [210.3 ft]) (Figure 4.7.6). Median flight heights trended dissimilarly to mean flight heights within and across seasons. The lowest median flight heights (44.4 m [147.7 ft]) were recorded in summer at night, and the highest in fall during the day (78.9 m [258.9 ft]) (Table 4.7.3, Figures 4.7.6 and 4.7.7). Seasonal summaries for mean and median flight heights from the Offshore VSR by biological period are shown in Figures 4.7.4 through 4.7.8.

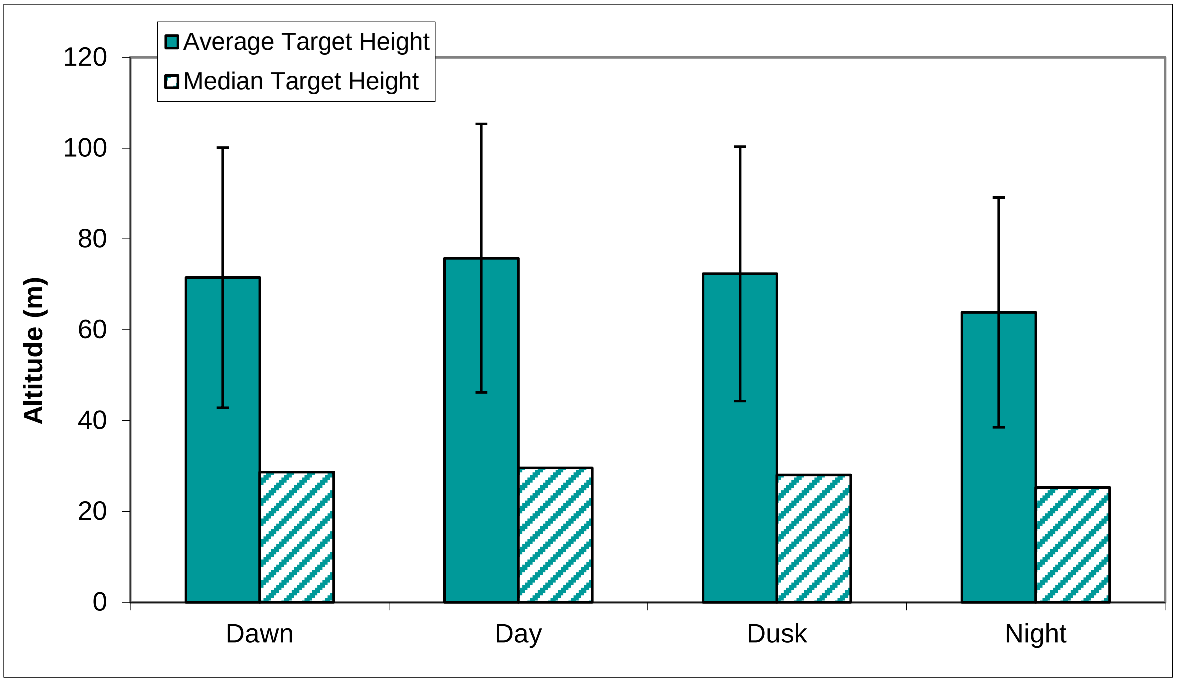

Figure 4.7.3. Average and median flight height by biological period, all seasons and all years combined from the Offshore VSR – BIWF 2009–2011.

Table 4.7.3. Target flight heights for each of four biological periods, all seasons and all years combined from the Offshore VSR – BIWF 2009–2011.

OFFSHORE VSR						
Biological Period		**Dawn**	**Day**	**Dusk**	**Night**	***24-hour***
Winter	Average Flight Height (m)	98.9	102.1	86.7	85.3	***93.9***
	StDev	103.8	123.4	93.1	88.2	***109.0***
	Median Flight Height (m)	76.3	72.4	68.4	67.3	***70.8***
Spring	Average Flight Height (m)	94.9	99.2	95.7	87.2	***94.9***
	StDev	138.9	145.0	150.2	129.8	***140.3***
	Median Flight Height (m)	52.1	53.0	51.4	48.7	***51.4***
Summer	Average Flight Height (m)	112.3	146.9	64.1	65.0	***120.7***
	StDev	168.8	201.3	90.1	94.4	***180.1***
	Median Flight Height (m)	52.4	65.2	44.4	44.4	***54.2***
Fall	Average Flight Height (m)	93.2	97.4	85.7	85.2	***90.3***
	StDev	85.1	99.3	71.1	68.5	***83.6***
	Median Flight Height (m)	78.1	78.9	76.6	76.9	***77.8***
OVERALL	***Average Flight Height (m)***	***94.9***	***99.2***	***95.7***	***87.2***	***94.9***
	StDev	***138.9***	***145.0***	***150.2***	***129.8***	***140.3***
	Median Flight Height (m)	***52.1***	***53.0***	***51.4***	***48.7***	***51.4***

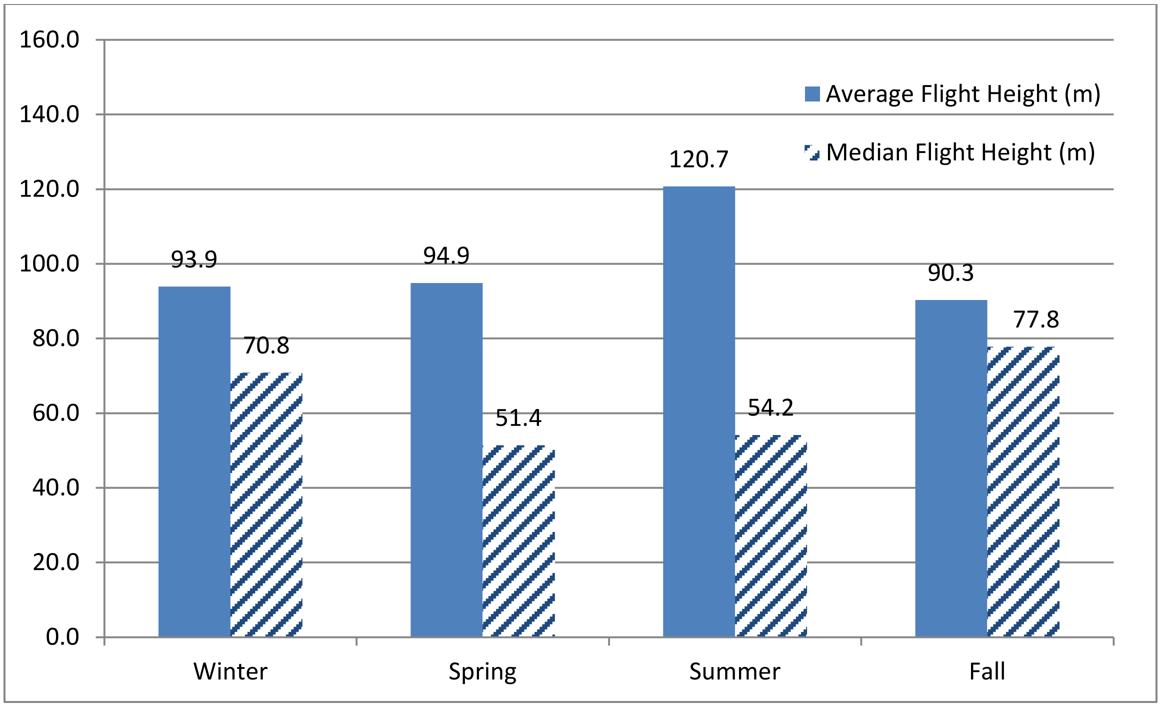

Figure 4.7.4. Twenty-four hour period average and median flight height by seasons for all years combined from the Offshore VSR – BIWF 2009–2011.

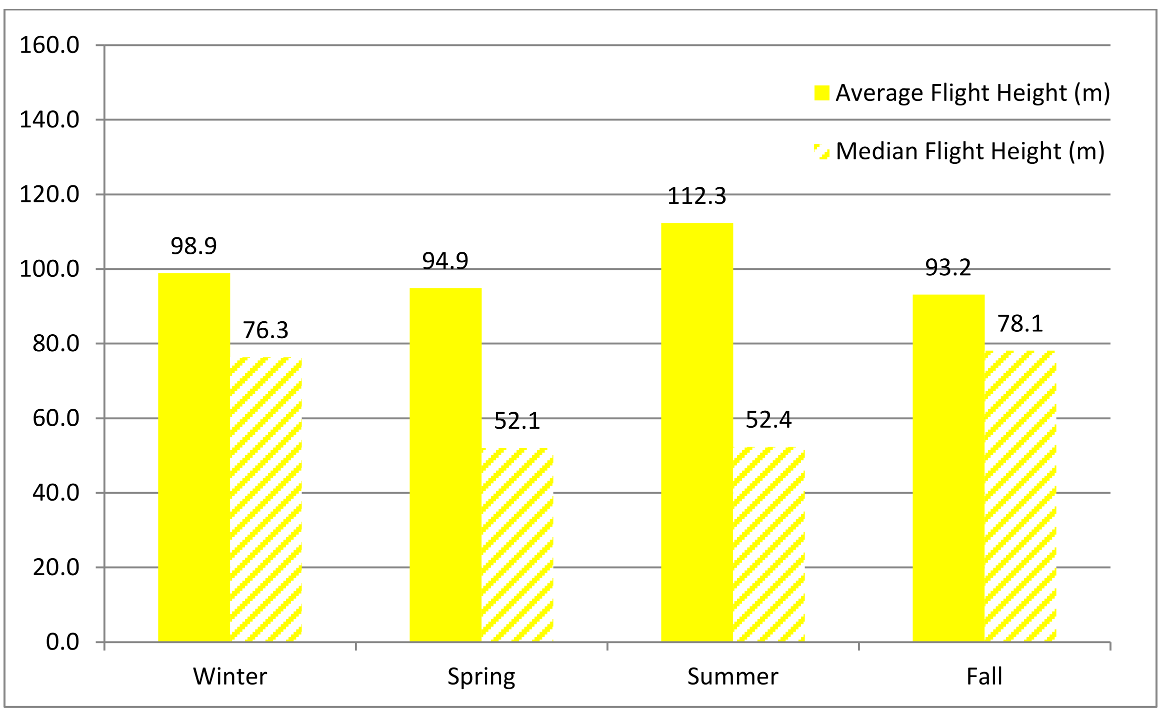

Figure 4.7.5. Dawn period average and median flight height by seasons for all years combined from the Offshore VSR – BIWF 2009–2011.

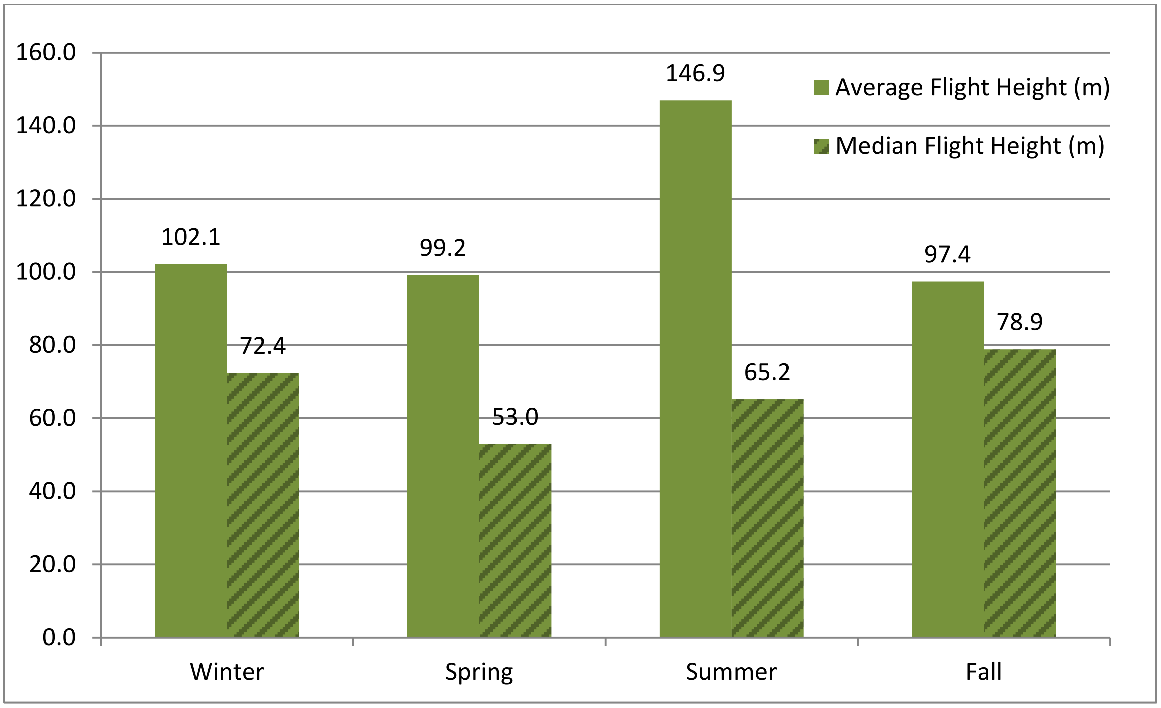

Figure 4.7.6. Daytime period average and median flight height by seasons for all years combined from the Offshore VSR – BIWF 2009–2011.

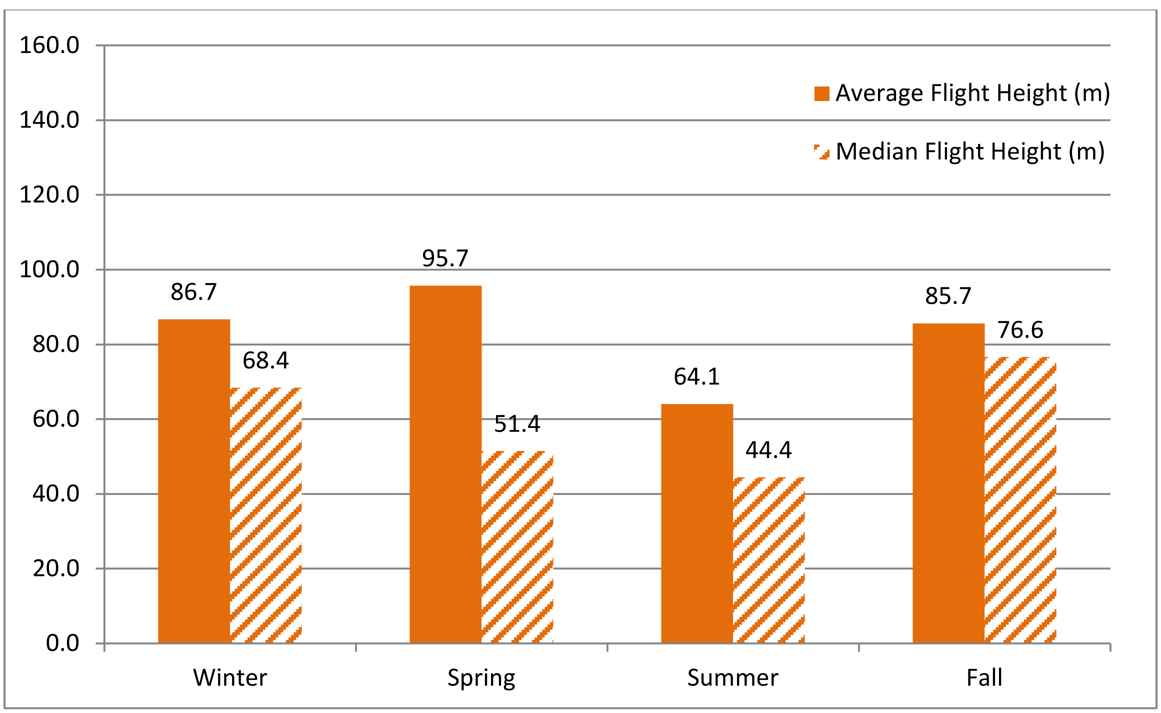

Figure 4.7.7. Dusk period average and median flight height by seasons for all years combined from the Offshore VSR – BIWF 2009–2011.

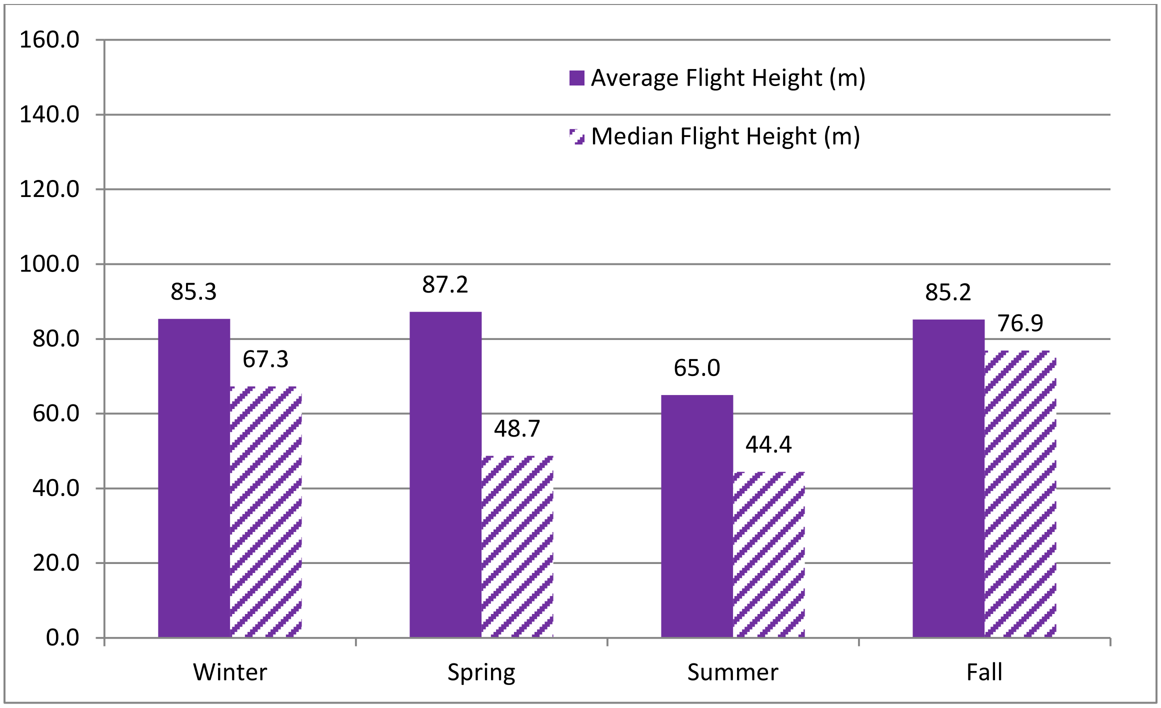

Figure 4.7.8. Nighttime period average and median flight height by seasons for all years combined from the Offshore VSR – BIWF 2009–2011.

4.7.3 Nearshore Vertical Scanning Radar

Level of Effort

A total of 14,486.8 hours of Nearshore VSR data were recorded and analyzed from the BIWF MERLIN system. There were 22,367 hours available during the February 27, 2009–September 15, 2011 survey period, of which 65% were sampled by the MERLIN offshore VSR (Table 4.7.4).

Table 4.7.4. Total combined Nearshore VSR level of effort.

Nearshore VSR	Time in Season (hrs)	Time Radar Collected Data (hrs)	Radar Downtime (hrs)	Radar Data with Rain (hrs)	Useable and Analyzed Radar Data (hrs)
Winter	4,773.2	1,922.3	2,850.9	397.4	1,525.0
Spring	7,771.1	6,878.9	892.1	959.1	5,919.9
Summer	5,403.5	4,312.7	65,444.0	453.2	3,859.5
Fall	4,419.3	3,779.8	639.5	597.4	3,182.4
Total	**22,367.0**	**16,893.8**	**69,826.5**	**2,407.0**	**14,486.8**

Target Passage Rate

During the survey period from 2009 to 2011, the overall mean TPR across all biological periods from the Nearshore VSR was 61.7 t/km/hr. The overall average TPR from the Nearshore VSR was greatest during the nighttime at 91.9 t/km/hr (Table 4.7.5).

The overall maximum average TPR was recorded during the summer at dawn (1,773.0 t/km/hr) (Table 4.7.5). The lowest maximum average TPR was recorded during the night in the winter (87.0 t/km/hr). There were several periods in the winter, spring, summer, and fall when there was no Nearshore TPR (0 t/km/hr). The highest minimum TPR was recorded during the day in the summer (6.8 t/km/hr).

The overall lowest average Nearshore TPRs, all seasons pooled, were recorded during the dusk period. Average TPRs were generally greatest at night (in spring, summer, and fall) and during the day in winter (Table 4.7.5). Average TPRs were lowest during the night in winter, and during dusk in spring, summer, and fall (Table 4.7.5). TPR was greatest, by hour, for all seasons and all years pooled, from 20:00 to 23:00. TPR was lowest just after noon from 13:00 to 17:00 (Figure 4.7.10).

Table 4.7.5. Target passage rates for each of four biological periods all seasons and all years combined from the Nearshore VSR.

NEARSHORE VSR					
Biological Period		**Dawn**	**Day**	**Dusk**	**Night**
Winter	Average	12.9	13.1	10.2	4.6
	Standard Deviation	29.9	27.4	23.9	11.6
	Median	0.0	0.0	0.0	0.0
	Minimum	0.0	0.0	0.0	0.0
	Maximum	220.0	192.5	155.0	87.0
	Range	220.0	192.5	155.0	87.0
Spring	Average	44.6	32.4	21.1	63.2
	Standard Deviation	70.1	35.5	100.6	86.1
	Median	27.0	24.4	5.2	27.9
	Minimum	0.0	0.0	0.0	0.0
	Maximum	490.0	196.1	1,041.0	450.2
	Range	490.0	196.1	1,041.0	450.2
Summer	Average	156.6	141.7	58.2	206.6
	Standard Deviation	219.6	141.4	94.1	241.7
	Median	88.0	100.5	28.0	114.8
	Minimum	0.0	6.8	0.0	3.2
	Maximum	1,773.0	1,006.3	682.0	1,161.0
	Range	1,773.0	999.5	682.0	1,157.7
Fall	Average	90.7	82.4	59.7	199.8
	Standard Deviation	138.1	84.2	62.0	315.6
	Median	59.5	59.5	44.0	67.1
	Minimum	4.0	1.1	0.0	1.7
	Maximum	1,386.0	712.4	394.0	1,986.0
	Range	1,382.0	711.3	394.0	1,984.3
OVERALL	***Average***	***64.5***	***59.3***	***31.2***	***91.9***
	Standard Deviation	***131.3***	***98.5***	***69.0***	***188.9***
	Median	***26.0***	***29.1***	***11.0***	***18.9***
	Minimum	***0.0***	***0.0***	***0.0***	***0.0***
	Maximum	***1,773.0***	***1,006.3***	***1,041.0***	***1,986.0***
	Range	***1,773.0***	***1,006.3***	***1,041.0***	***1,986.0***

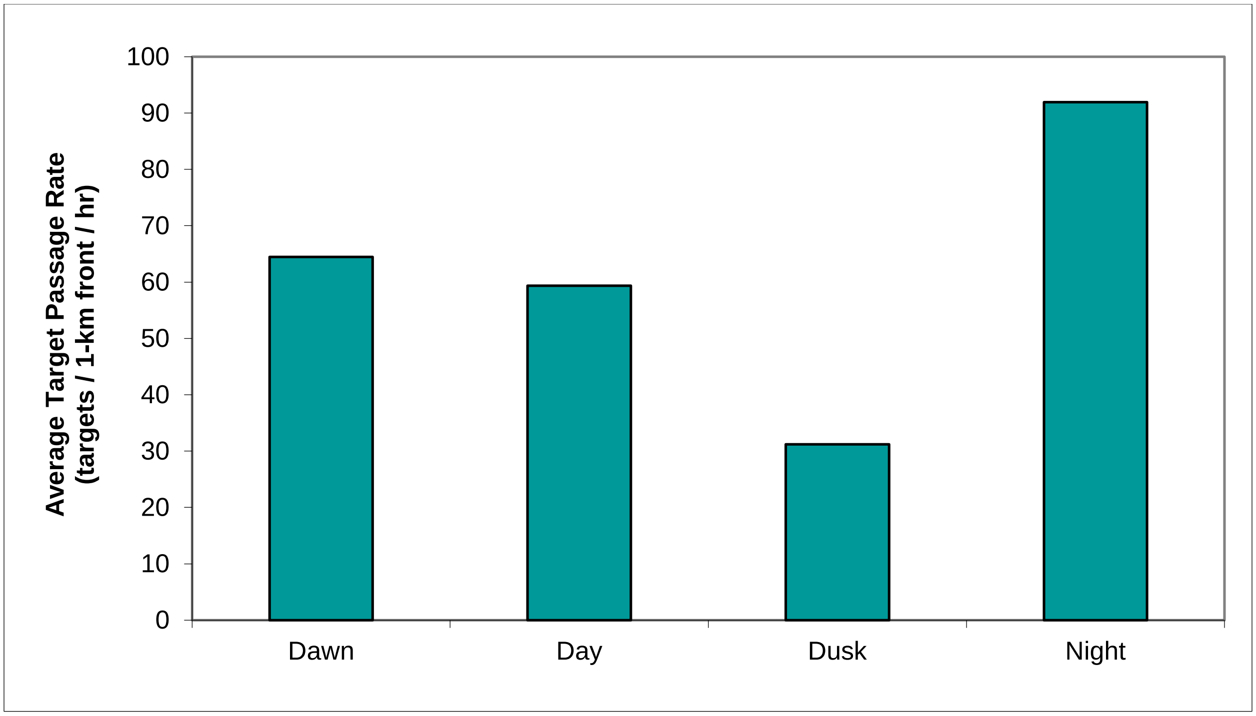

Figure 4.7.9. Average target Passage Rates by biological period, all seasons and all years combined from the Nearshore VSR – BIWF 2009–2011.

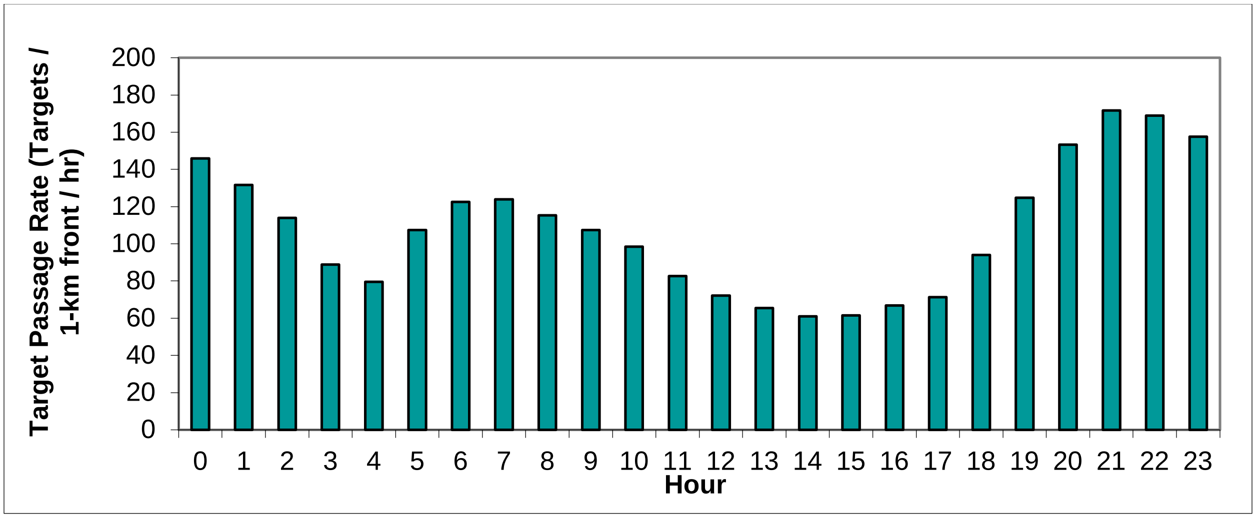

Figure 4.7.10. Average target Passage Rates by hour, all seasons and all years combined from the Nearshore VSR – BIWF 2009–2011.

Flight Height

Overall mean target flight heights from the Nearshore VSR were lowest during dusk (185.2 m [607.6 ft]), and greatest during dawn (251.4 m [824.8 ft]) (Figure 4.7.11). Overall, median target flight heights ranged from 89.8 m (89.8 ft) during dusk to 205.1 m (672.9 ft) during the night (Table 4.7.6).

Average flight heights were highest during dawn in summer (319.7 m [1048.9 ft]), and lowest during dusk in the winter (77.8 m [255.2 ft]) (Figure 4.7.13 and 4.7.15). Median flight heights trended similarly to mean flight heights within and across seasons. The lowest median flight height (45.7 m [149.9 ft]) was recorded in winter during dusk, and the highest in summer during dawn (283.1 m [928.8 ft]) (Table 4.7.6, Figures 4.7.13 and 4.7.15). Seasonal summaries for mean and median flight heights from the Offshore VSR by biological period are shown in Figures 4.7.12 through 4.7.16.

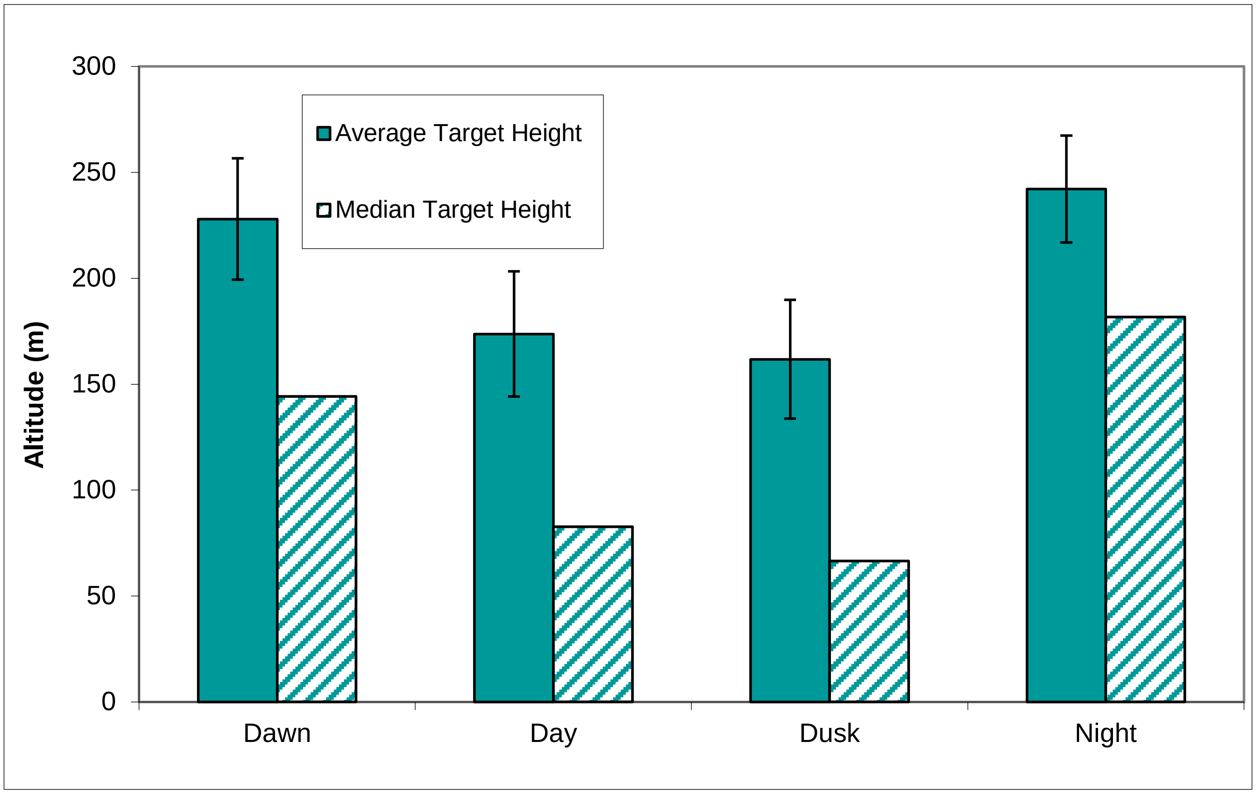

Figure 4.7.11. Average and median flight height by biological period, all seasons and all years combined from the Nearshore VSR – BIWF 2009–2011.

Table 4.7.6. Target flight heights for each of four biological periods, all seasons and all years combined from the Nearshore VSR – BIWF 2009–2011.

NEARSHORE VSR						
Biological Period		**Dawn**	**Day**	**Dusk**	**Night**	***24-hour***
Winter	Average	82.2	104.8	77.8	220.2	***133.0***
	StDev	127.8	156.9	120.4	258.6	***196.3***
	Median	45.7	56.6	45.7	116.7	***62.4***
Spring	Average	240.6	161.0	187.1	252.7	***203.7***
	StDev	258.6	222.8	257.2	229.7	***233.0***
	Median	113.9	71.9	72.5	188.0	***106.9***
Summer	Average	319.7	244.9	243.8	294.9	***272.5***
	StDev	243.7	234.1	230.4	229.7	***233.9***
	Median	283.1	177.6	173.4	256.0	***220.6***
Fall	Average	164.7	168.9	142.5	250.0	***224.9***
	StDev	201.7	195.3	177.5	239.5	***230.7***
	Median	83.4	93.8	71.9	171.5	***145.0***
OVERALL	***Average***	***251.4***	***197.1***	***185.2***	***265.6***	***234.6***
	StDev	***247.9***	***225.5***	***224.7***	***233.9***	***233.5***
	Median	***167.6***	***106.0***	***89.8***	***205.1***	***156.9***

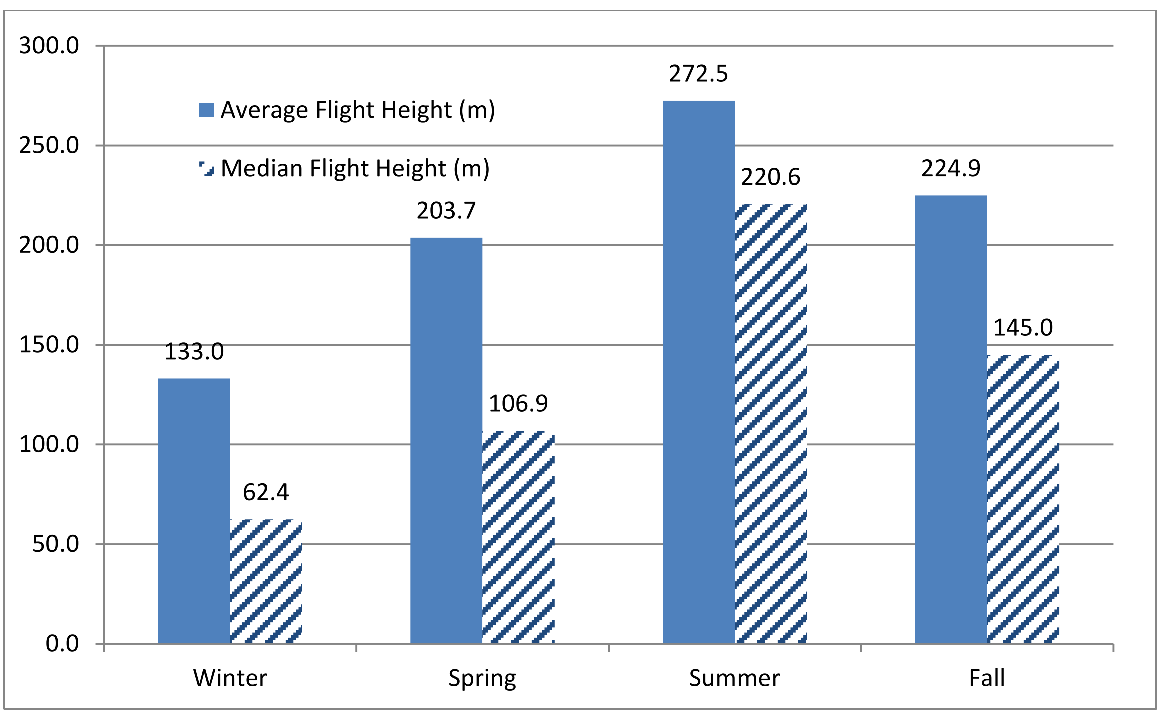

Figure 4.7.12. Twenty-four hour period average and median flight height by seasons for all years combined from the Nearshore VSR – BIWF 2009–2011.

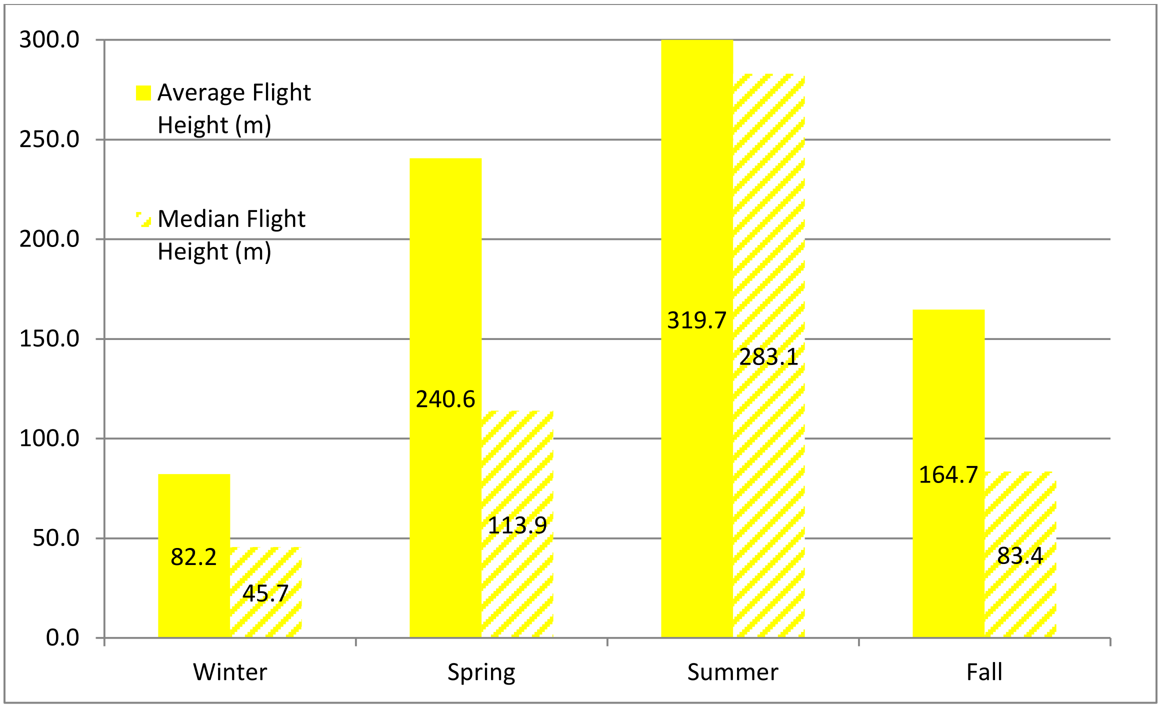

Figure 4.7.13. Dawn period average and median flight height by seasons for all years combined from the Nearshore VSR – BIWF 2009–2011.

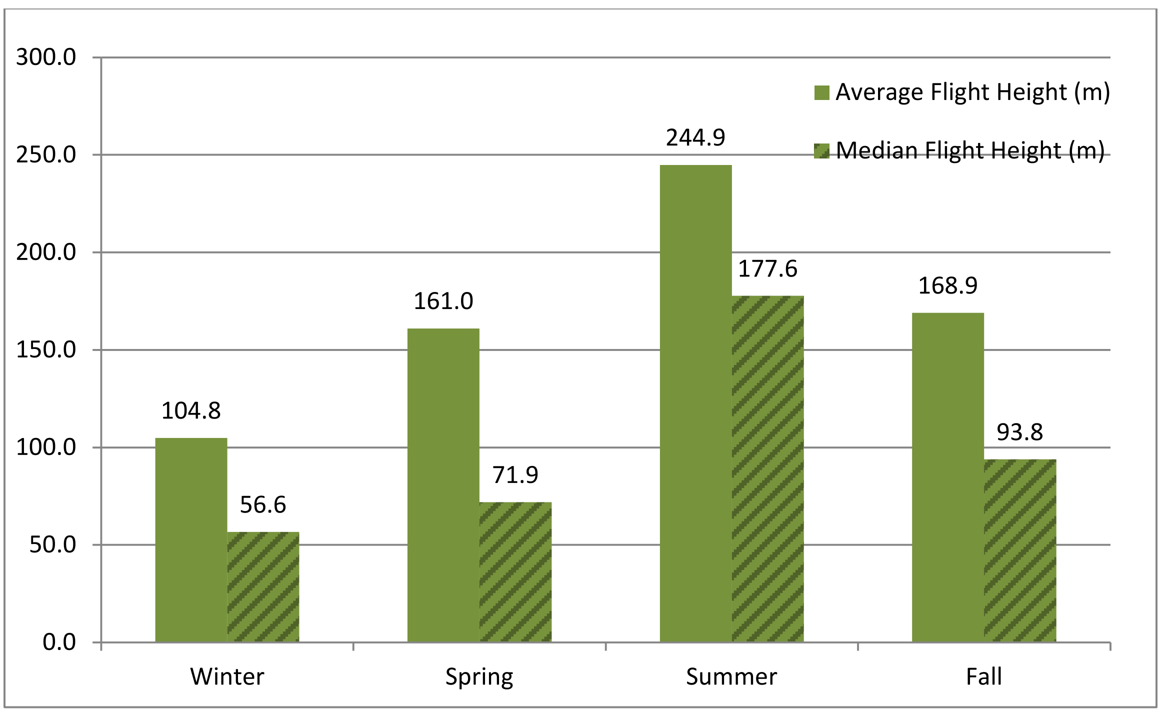

Figure 4.7.14. Daytime period average and median flight height by seasons for all years combined from the Nearshore VSR – BIWF 2009–2011.

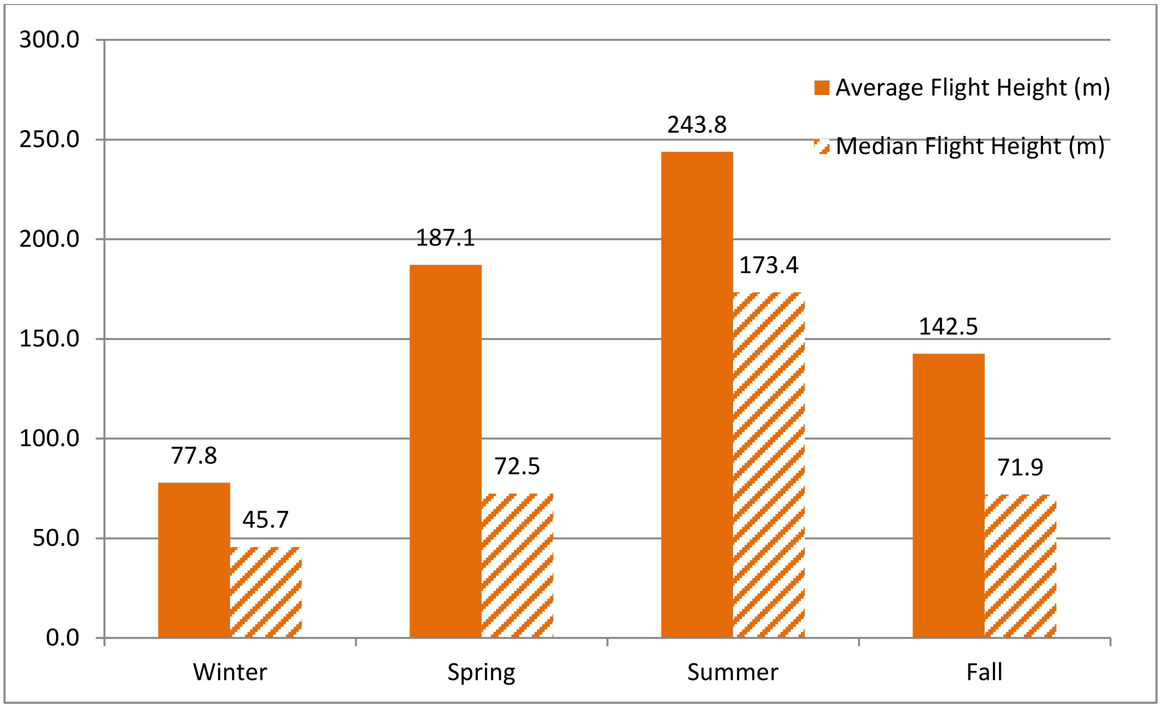

Figure 4.7.15. Dusk period average and median flight height by seasons for all years combined from the Nearshore VSR – BIWF 2009–2011.

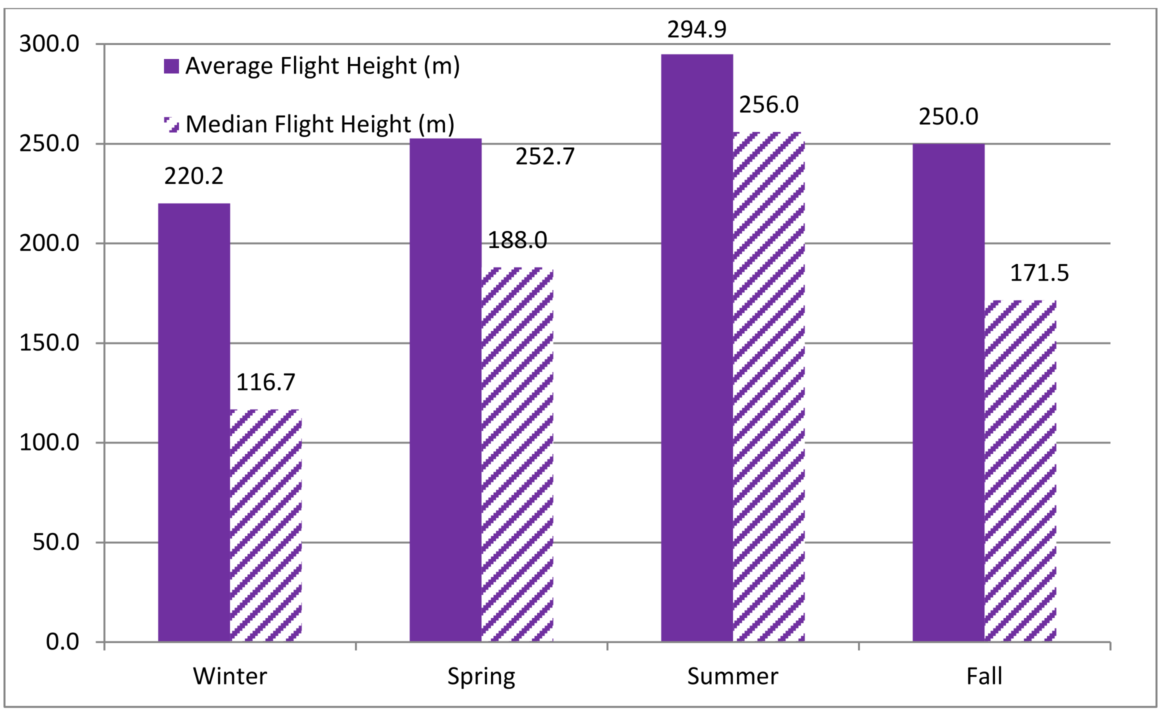

Figure 4.7.16. Nighttime period average and median flight height by seasons for all years combined from the Nearshore VSR – BIWF 2009–2011.

4.7.4 Onshore Vertical Scanning Radar

Level of Effort

A total of 14,486.78 hours of Onshore VSR data were recorded and analyzed from the BIWF MERLIN system. There were 22,367 hours available during the February 27, 2009–September 15, 2011 survey period, of which 65% were sampled by the MERLIN offshore VSR (Table 4.7.7).

Table 4.7.7. Total combined Onshore VSR level of effort.

Onshore VSR	Time in Season (hrs)	Time radar collected data (hrs)	Radar Downtime (hrs)	Radar data with Rain (hrs)	Useable and Analyzed Radar Data (hrs)
Winter	4,773.2	1,922.3	2,850.9	397.4	1,525.0
Spring	7,771.1	6,878.9	892.1	959.1	5,919.9
Summer	5,403.5	4,312.7	65,444.0	453.2	3,859.5
Fall	4,419.3	3,779.8	639.5	597.4	3,182.4
Total	**22,367.0**	**16,893.8**	**69,826.5**	**2,407.0**	**14,486.8**

Target Passage Rate

During the survey period from 2009 to 2011, the overall mean TPR across all biological periods from the Onshore VSR was 149.2 t/km/hr. The overall average TPR from the Onshore VSR was greatest during the nighttime at 204.7 t/km/hr (Table 4.7.8).

Overall maximum TPR was recorded during the night in the fall (2,731.6 t/km/hr) (Table 4.7.8). The lowest maximum TPR was recorded during the night in the winter (78.1 t/km/hr). There were several periods in the winter, spring, and summer when there was no Onshore TPR (0 t/km/hr). The highest minimum TPR was recorded during dawn in the fall (19.0 t/km/hr).

The lowest average TPR recorded by the Onshore VSR varied by season. In the winter the lowest average TPR was recorded during the night (3.7 t/km/hr), in spring and summer the lowest average TPRs were recorded during dusk (30.8 t/km/hr and 137.6 t/km/hr, respectively), and during the fall the lowest average TPR was recorded during the day (114.6 t/km/hr) (Figure 4.7.17). Onshore TPR was greatest, by hour, for all seasons and all years pooled, from 19:00 to 23:00. Combined TPR was lowest from 13:00 to 17:00 (Figure 4.7.18).

Table 4.7.8. Target passage rates for each of four biological periods, all seasons and all years combined from the Onshore VSR – BIWF 2009–2011.

ONSHORE VSR					
Biological Period		**Dawn**	**Day**	**Dusk**	**Night**
Winter	Average	16.8	18.0	9.5	3.7
	Standard Deviation	31.6	31.2	17.3	9.6
	Median	0.0	0.0	0.0	0.0
	Minimum	0.0	0.0	0.0	0.0
	Maximum	182.0	183.4	90.0	78.1
	Range	182.0	183.4	90.0	78.1
Spring	Average	66.5	45.7	30.8	117.0
	Standard Deviation	127.1	38.8	95.2	180.9
	Median	43.0	43.4	17.0	42.4
	Minimum	0.0	0.0	0.0	0.0
	Maximum	1,175.0	230.4	971.0	1,063.0
	Range	1,175.0	230.4	971.0	1,063.0
Summer	Average	329.9	238.5	137.6	302.1
	Standard Deviation	382.4	209.2	176.5	234.6
	Median	193.0	174.8	75.5	250.1
	Minimum	8.0	12.3	0.0	16.1
	Maximum	2,224.0	1,362.4	1,266.0	1,269.0
	Range	2,216.0	1,350.1	1,266.0	1,252.9
Fall	Average	213.5	114.6	118.7	285.4
	Standard Deviation	241.1	121.9	89.2	400.2
	Median	144.0	79.2	96.5	125.4
	Minimum	19.0	10.2	16.0	2.8
	Maximum	1,599.0	946.0	580.0	2,731.6
	Range	1,580.0	935.8	564.0	2,728.8
OVERALL	***Average***	***184.2***	***124.8***	***83.1***	***204.7***
	Standard Deviation	***272.4***	***158.5***	***123.0***	***264.8***
	Median	***84.0***	***69.7***	***43.0***	***113.6***
	Minimum	***0.0***	***2.1***	***0.0***	***0.8***
	Maximum	***2,224.0***	***1,891.6***	***1,266.0***	***2,731.6***
	Range	***2,224.0***	***1,889.5***	***1,266.0***	***2,730.8***

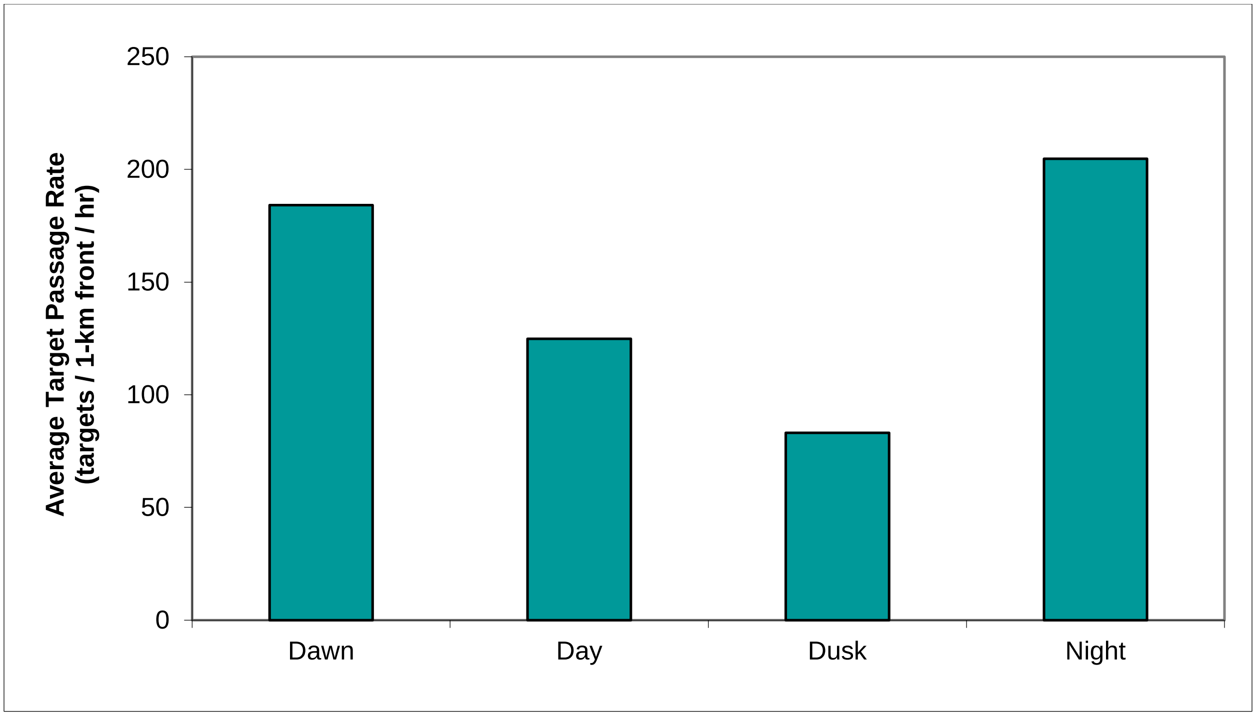

Figure 4.7.17. Average Target passage rates by biological period, all seasons and all years combined from the Onshore VSR – BIWF 2009–2011.

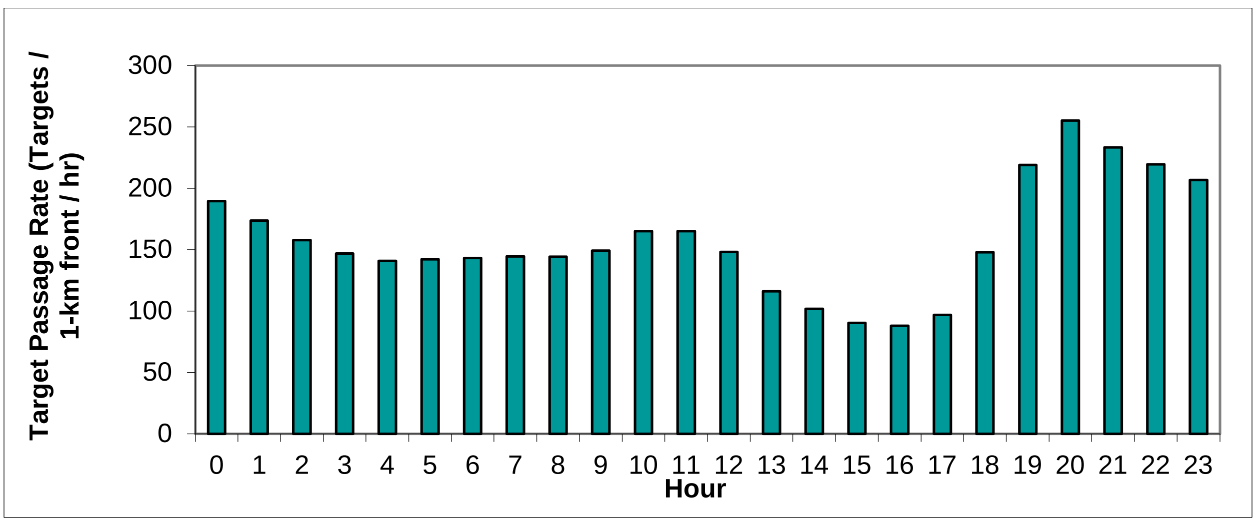

Figure 4.7.18. Average target Passage Rates by hour, all seasons and all years combined from the Onshore VSR – BIWF 2009–2011.

Flight Height

Overall mean target flight heights from the Onshore VSR were lowest during dusk (142.4 m [467.2 ft]) and greatest during dawn (202.3 m [663.7 ft]) (Figure 4.7.19). Overall, median target flight heights ranged from 68.6 m (225.1 ft) during dusk to 152.7 m (500.9 ft) during the night (Table 4.7.9).

Average flight heights were highest during dawn in the summer (241 m [790.7 ft]), and lowest during dawn in the winter (47.2 m [154.9 ft]) (Table 4.7.9 and Figure 4.7.21). Median flight heights did not trend with mean flight heights within and across seasons. The lowest median flight height (33.5 m [109.9 ft]) was in winter during the day, and the highest (199.0 m [652.9 ft) was in the summer during dawn (Table 4.7.9, Figures 4.7.21 and 4.7.22). Seasonal summaries for mean and median flight heights from the Offshore VSR by biological period are shown in Figures 4.7.20 through 4.7.24.

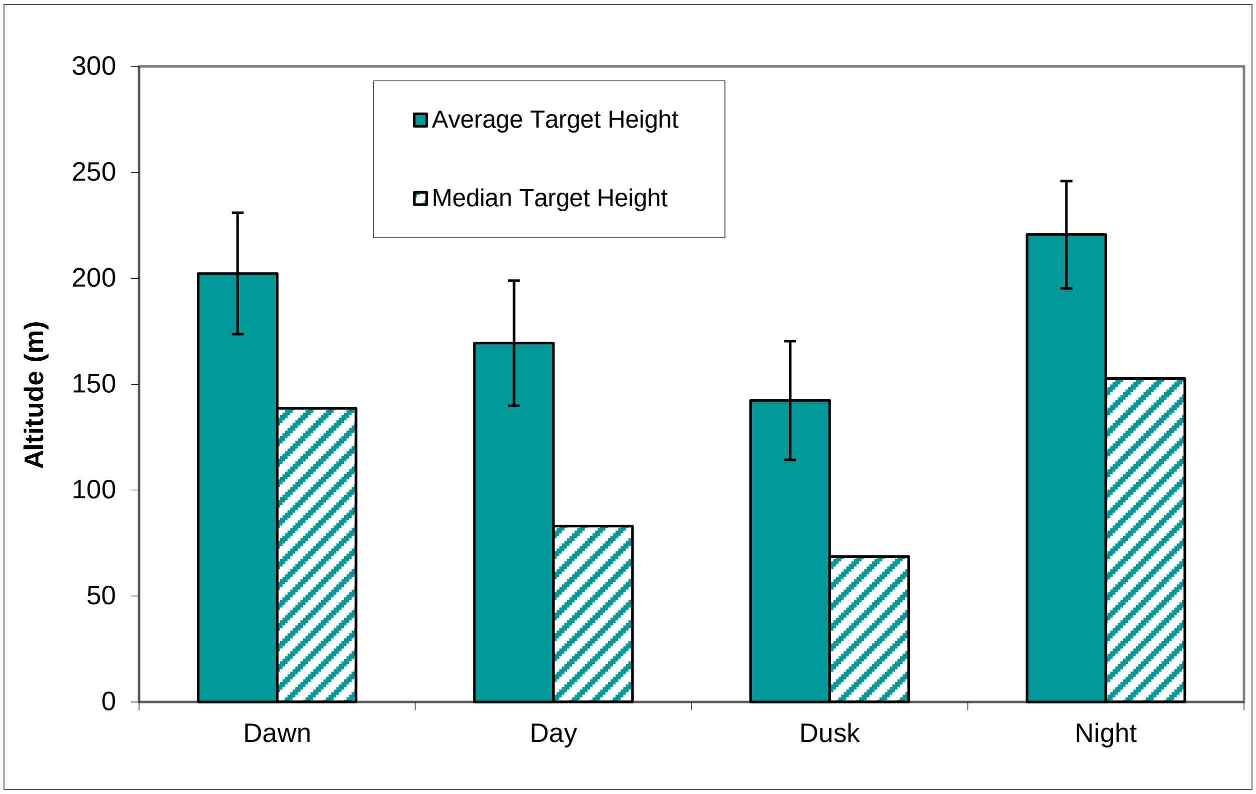

Figure 4.7.19. Average and median flight height by biological period, all seasons and all years combined from the Onshore VSR – BIWF 2009–2011.

Table 4.7.9. Target flight heights for each of four biological periods, all seasons and all years combined from the Onshore VSR – BIWF 2009–2011.

ONSHORE VSR						
Biological Period		**Dawn**	**Day**	**Dusk**	**Night**	***24-hour***
Winter	Average	47.2	78.0	50.5	217.0	***100.7***
	StDev	51.1	136.4	59.3	229.2	***162.6***
	Median	36.9	33.5	36.3	102.4	***38.1***
Spring	Average	210.9	150.8	151.9	210.2	***184.6***
	StDev	208.6	188.4	204.9	191.1	***193.3***
	Median	117.0	54.3	47.9	137.5	***101.2***
Summer	Average	241.0	192.6	172.7	231.0	***211.9***
	StDev	184.2	189.2	164.1	187.2	***188.6***
	Median	199.0	118.0	114.0	173.4	***150.9***
Fall	Average	140.2	145.8	105.4	222.6	***196.7***
	StDev	153.4	157.7	125.0	202.5	***192.3***
	Median	67.4	71.6	49.4	145.1	***121.3***
OVERALL	***Average***	***202.3***	***169.4***	***142.4***	***220.7***	***197.1***
	StDev	***186.5***	***184.1***	***161.7***	***192.8***	***190.1***
	Median	***138.5***	***82.9***	***68.6***	***152.7***	***124.7***

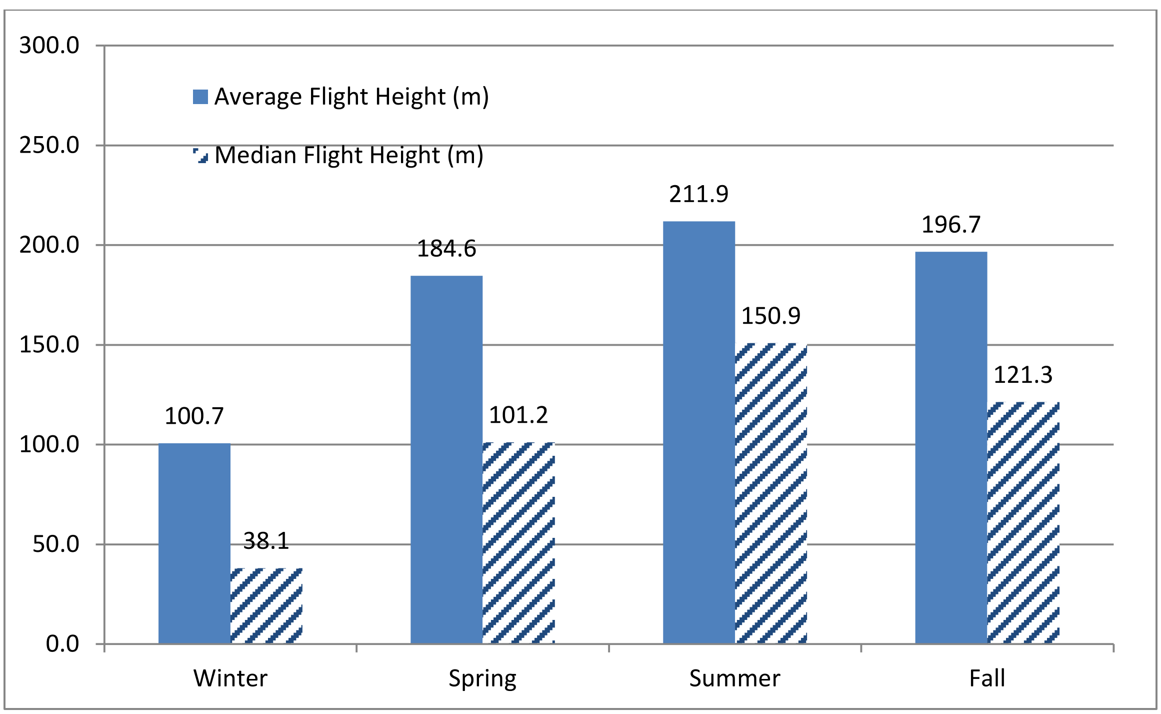

Figure 4.7.20. Twenty-four hour period average and median flight height by seasons for all years combined from the Onshore VSR – BIWF 2009–2011.

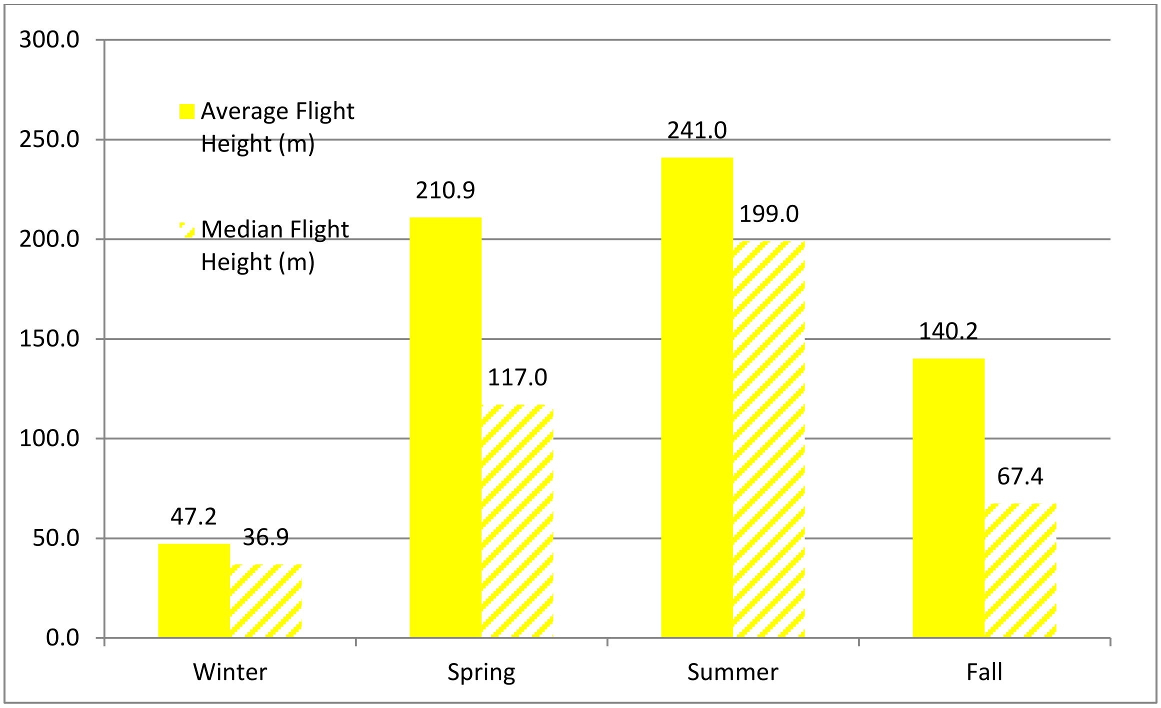

Figure 4.7.21. Dawn period average and median flight height by seasons for all years combined from the Onshore VSR – BIWF 2009–2011.

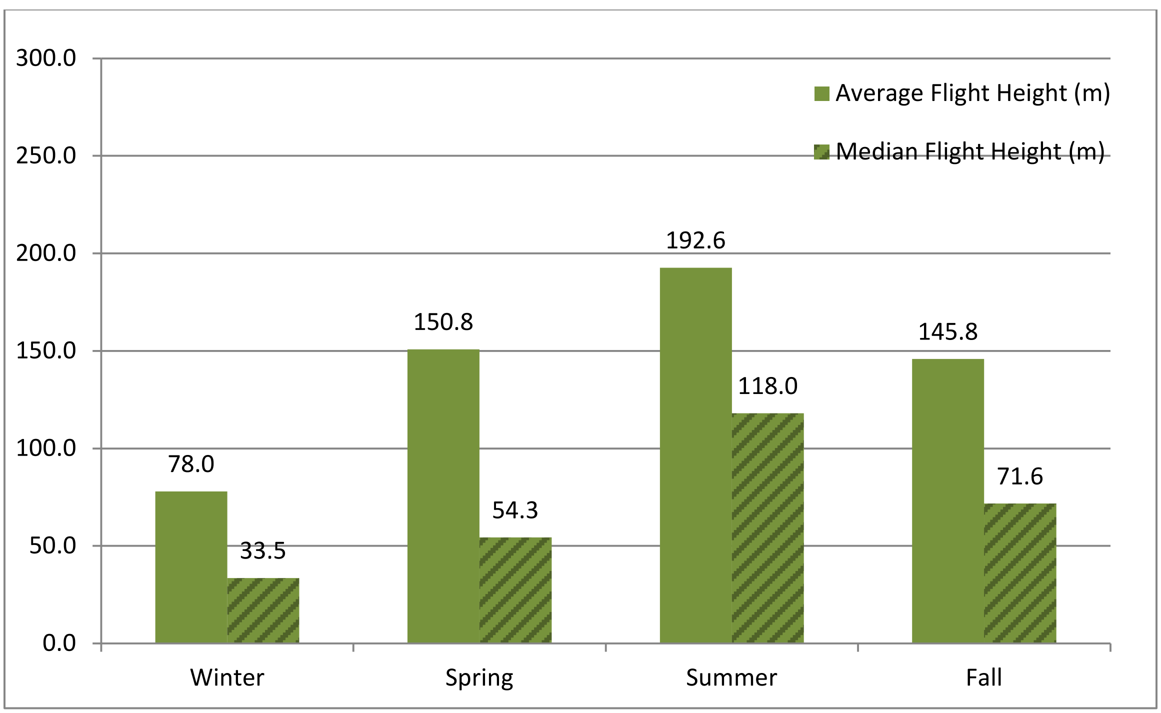

Figure 4.7.22. Daytime period average and median flight height by seasons for all years combined from the Onshore VSR – BIWF 2009–2011.

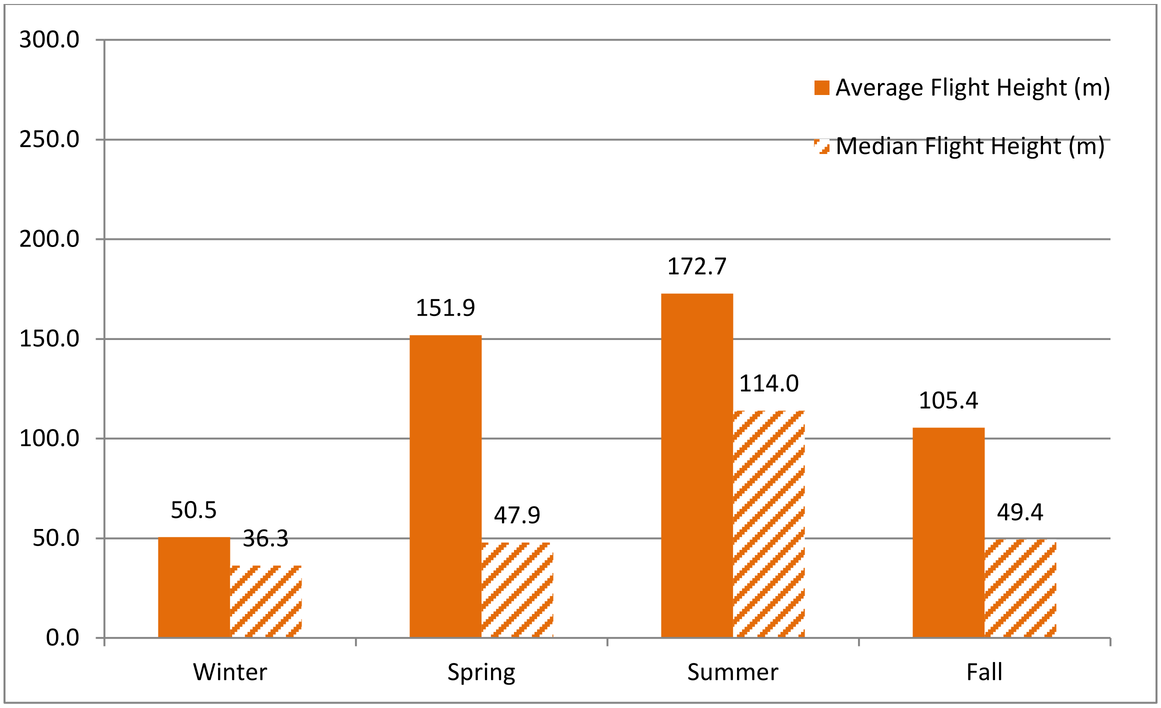

Figure 4.7.23. Dusk period average and median flight height by seasons for all years combined from the Onshore VSR – BIWF 2009–2011.

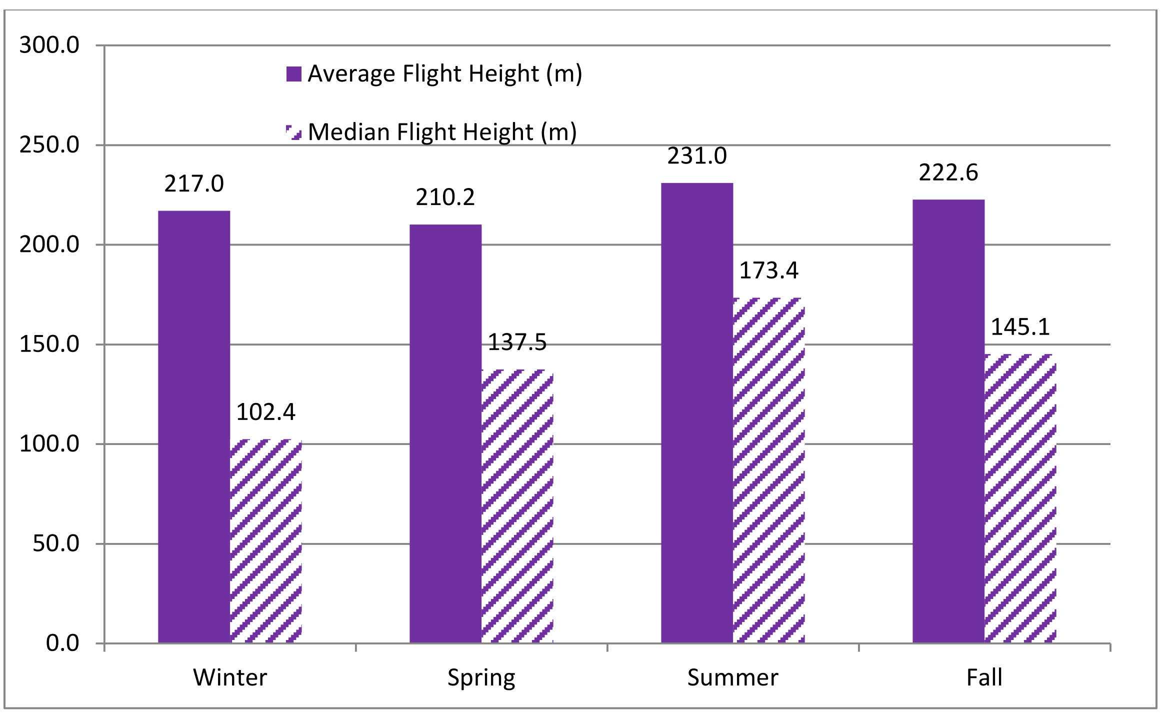

Figure 4.7.24. Nighttime period average and median flight height by seasons for all years combined from the Onshore VSR – BIWF 2009–2011.

4.7.5 Vertical Scanning Radar Comparisons

Biological Period Trends

The Offshore, Nearshore, and Onshore VSR results were compared to assess any trends in TPR and flight height by season and biological period among the three different 1-km fronts (sectors). The greatest average TPR for a biological period was from the Onshore VSR during the night: 204.7 ± 264.8 t/km/hr (Table 4.7.10). The lowest average TPR for a biological period was from the Nearshore VSR output during dusk: 31.2 ± 69.0 t/km/hr (Table 4.7.10). Generally, mean target flight heights were greatest during biological periods with the greatest average TPR rates (Table 4.7.10). This indicates that when there were greater numbers of targets moving through the three VSR sectors, those same targets were also flying, on average, the highest.

Table 4.7.10. Target passage rates (TPRs) and target flight heights for each VSR coverage area for all seasons and all years combined, by biological period – BIWF 2009–2011.

Radar Coverage Area			OFFSHORE VSR	NEARSHORE VSR	ONSHORE VSR
Target Passage Rate (t/km/hr)	Overall Mean TPR	Dawn	67.0 ± 99.7	64.5 ± 131.3	184.2 ± 272.4
		Day	**70.2 ± 89.0**	59.3 ± 98.5	124.8 ± 158.5
		Dusk	60.9 ± 89.2	31.2 ± 69.0	83.1 ± 123.0
		Night	56.5 ± 84.0	**91.9 ± 188.9**	**204.7 ± 264.8**
	Greatest TPR Hour		8:00	21:00	20:00
	Lowest TPR Hour		2:00	15:00	16:00
Flight Height (m)	Overall Mean Flight Height	Dawn	94.9 ± 138.9	241.4 ± 247.9	202.3 ± 186.5
		Day	**99.2 ± 145.0**	197.1 ± 225.5	169.4 ± 184.1
		Dusk	95.7 ± 150.2	185.2 ± 224.7	142.4 ± 68.6
		Night	87.2 ± 129.8	**265.6 ± 233.9**	**220.7 ± 192.8**

Note: Bold text indicates the greatest TPR or highest average flight height within each category.

Seasonal Trends

The greatest seasonal average TPR was recorded during summer by the Onshore VSR (252.0 ± 78.8 t/km/hr), while the lowest average seasonal TPR was recorded by the Onshore VSR during the winter (12.0 ± 9.4 t/km/hr) (Table 4.7.11). Higher average flight heights for Nearshore and Onshore were recorded during periods with the greatest average TPR (Table 4.7.11). The highest average Offshore flight heights were recorded during the summer (120.7 ± 180.1 m [395.9 ± 590.9 ft]) when the average seasonal Offshore TPR was the lowest (37.3 ± 4.8 t/km/hr) (Table 4.7.11).

Studies have demonstrated that nocturnal migrants are potentially at a greater risk of collision than diurnal migrants. To assess trends in nocturnal migration between VSR sectors, a separate comparison of nighttime migration trends for each radar sector was prepared (Appendix B). There were no strong correlations between Offshore nightly TPR and either Nearshore or Onshore nightly TPRs. There was a weak correlation between Nearshore and Onshore nightly TPRs (r = 0.32). It is clear that there was nocturnal migration at each radar sector, but the magnitude of nocturnal migration across radar sectors was highly variable. For example, nocturnal TPR was higher Offshore than Onshore or Nearshore during certain periods, and there was very little Onshore or Nearshore migration in late fall 2010.

Hourly Trends

The hourly distribution of cumulative TPR for the entire survey period at the Nearshore and Onshore VSRs were similar (Table 4.7.11); the peak activity for both Nearshore and Onshore was in the early evening (21:00 and 20:00, respectively). The hours with the lowest cumulative TPR also trended similarly between Nearshore and Onshore. The lowest cumulative TPR Nearshore was at 15:00 and Onshore it was at 16:00. Offshore hourly cumulative TPR was dissimilar to hourly cumulative TPR Nearshore and Onshore. Peak cumulative hourly TPR Offshore was in the morning (8:00), and the lowest TPR was during the afternoon (2:00). These patterns indicate a strong similarity between Onshore and Nearshore temporal activity patterns, and a strong dissimilarity with Offshore temporal activity patterns.

Table 4.7.11. Target passage rates (TPRs) and target flight heights for each VSR coverage area for all seasons and all years combined, by season – BIWF 2009–2011.

Radar Coverage Area			OFFSHORE VSR	NEARSHORE VSR	ONSHORE VSR
Target Passage Rate (t/km/hr)	Overall Mean TPR	Winter	96.9 ± 20.4	10.2 ± 3.4	12.0 ± 9.4
		Spring	40.1 ± 4.7	40.3 ± 15.6	65.0 ± 51.5
		Summer	37.3 ± 4.8	**140.8 ± 53.4**	**252.0 ± 78.8**
		Fall	**125.4 ± 7.7**	108.1 ± 54.1	183.1 ± 121.9
Flight Height (m)	Overall Mean Flight Height	Winter	93.9 ± 109.0	133 ± 196.3	100.7 ± 162.6
		Spring	94.9 ± 140.3	203.7 ± 233.0	184.6 ± 193.3
		Summer	**120.7 ± 180.1**	**272.5 ± 233.9**	**211.9 ± 188.6**
		Fall	90.3 ± 83.6	224.9 ± 230.7	196.7 ± 192.3

Note: Bold text indicates the greatest TPR or highest average flight height within each category.

Peak Activity Trends

TPRs for each VSR radar output (Offshore, Nearshore, and Onshore) were ranked by biological period (dawn, day, dusk, and night). The top five TPR dates were then compared to the mean and median flight heights for the same periods.

Peak activity periods (the top five TPR dates per biological period) at the Offshore VSR were generally during the fall (70%), with some peak periods recorded in winter (25%) and spring (5%). Peak activity periods at the Nearshore VSR were generally during summer (50%), followed by fall (25%) and spring (25%). Peak activity periods at the Onshore VSR were similar to the Nearshore VSR; they occurred during the summer (65%), with fewer during the fall (30%) and spring (5%). Offshore was the only VSR sector with peak TPRs for biological periods in the winter (n = 5).

At the Offshore VSR 95% of flight heights during peak activity periods were within the RSZ of the proposed BIWF turbines (23 m–201 m [75 – 659 ft]). During peak TPRs, Nearshore and Onshore average target flight heights were within the RSZ of the proposed BIWF turbines during 20% and 25% of biological periods, respectively.

In general peak TPRs Offshore were recorded during dawn (Table 4.7.12 and 4.7.13). The overall peak TPR from the Offshore VSR was at dawn on March 7, 2011 (610 t/km/hr); during this period the mean target flight height was 109.7 m (359.9 ft) above mean sea level. The next greatest TPR was recorded on December 1, 2010 during the day, when the TPR was 545.5 t/km/hr and mean flight was 119.3 m (391.4 ft).

Table 4.7.12. Top five target passage rate (TPR) dates and target flight heights (FH) for each VSR coverage area for all seasons and all years combined, during dawn and day – BIWF 2009–2011.

VSR RADAR	DAWN				DAY			
	Top Five TPR Dates	TPR (t/km/hr)	Mean FH (m)	Median FH (m)	Top Five TPR Dates	TPR (t/km/hr)[1]	Mean FH (m)	Median FH (m)
Offshore	03/07/11	610	109.7	109.7	12/01/10	546	119.3	119.7
	10/15/10	520	111.4	113.6	02/10/10	498	370.9	319.1
	10/01/10	515	107.0	108.7	03/07/11	497	111.4	111.8
	04/17/11	508	107.2	108.1	11/17/10	415	116.9	116.7
	03/11/11	420	107.9	105.4	12/14/10	401	110.9	109.7
Nearshore	Top Five TPR Dates	TPR (t/km/hr)	Mean FH (m)	Median FH (m)	Top Five TPR Dates	TPR (t/km/hr)	Mean FH (m)	Median FH (m)
	08/31/10	1773	359.4	326.7	09/10/11	1,006	261.9	240.4
	09/25/09	1386	272.4	302.1	10/09/10	712	170.1	120.6
	08/23/11	978	231.0	206.0	09/14/09	594	225.2	189.2
	07/24/11	906	422.6	443.7	06/24/09	570	75.2	62.7
	08/30/10	871	225.8	196.8	06/20/09	563	90.8	69.1
Onshore	Top Five TPR Dates	TPR (t/km/hr)	Mean FH (m)	Median FH (m)	Top Five TPR Dates	TPR (t/km/hr)	Mean FH (m)	Median FH (m)
	07/31/11	**2,224**	286.7	266.2	09/10/11	1362	258.3	235.0
	08/31/10	1,910	322.2	291.8	09/16/10	946	154.6	119.8
	09/01/10	1,785	279.5	252.4	08/28/09	911	346.5	319.4
	08/23/11	1,702	239.9	215.8	09/14/09	878	242.8	217.3
	08/21/10	1,572	190.7	172.8	08/08/09	738	149.3	83.2

[1] t/km/hr = targets/kilometer/hour

Table 4.7.13. Top five target passage rate (TPR) dates and target flight heights (FH) for each VSR coverage area for all seasons and all years combined, during dusk and night – BIWF 2009–2011.

VSR RADAR	DUSK				NIGHT			
Offshore	Top Five TPR Dates	TPR (t/km/hr)	Mean FH (m)	Median FH (m)	Top Five TPR Dates	TPR (t/km/hr)[1]	Mean FH (m)	Median FH (m)
	09/28/10	495	108.1	108.4	10/01/10	473	108.1	0.0
	11/05/10	414	120.2	114.8	12/14/10	453	111.7	109.7
	12/14/10	401	111.3	110.9	11/30/10	412	114.7	0.0
	10/27/10	391	125.6	118.2	03/06/11	409	103.1	107.2
	11/30/10	388	109.7	111.9	09/30/10	405	106.1	106.3
Nearshore	Top Five TPR Dates	TPR (t/km/hr)	Mean FH (m)	Median FH (m)	Top Five TPR Dates	TPR (t/km/hr)	Mean FH (m)	Median FH (m)
	06/17/09	1041	534.9	572.3	10/06/09	1986	254.8	264.2
	09/15/11	682	144.6	123.5	10/26/10	1315	232.0	224.9
	07/19/11	547	356.5	352.6	10/27/10	1299	53.5	38.0
	06/27/11	492	112.9	81.5	08/20/11	1161	395.4	489.4
	08/27/09	471	400.0	380.9	05/19/09	1018	0.0	0.0
Onshore	Top Five TPR Dates	TPR (t/km/hr)	Mean FH (m)	Median FH (m)	Top Five TPR Dates	TPR (t/km/hr)	Mean FH (m)	Median FH (m)
	09/05/09	1266	150.9	97.2	10/28/10	1552	259.5	185.3
	06/17/09	971	511.5	548.9	10/29/10	1456	160.3	81.7
	08/18/10	792	221.5	193.5	09/25/10	1417	228.5	197.5
	09/15/11	737	128.7	96.6	10/28/09	1315	121.6	58.5
	09/15/09	733	92.0	75.0	10/29/09	1299	347.2	286.2

[1] t/km/hr = targets/kilometer/hour

4.7.6 MERLIN Radar Ground Truthing

Onshore Ground Truthing

Biologists performed a total of 135 point counts for 30 minutes each, resulting in 67.5 hours of onshore avian ground truthing over a ten week period. During this period 6,724 individuals representing 91 species were recorded (Tables 4.7.14 and 4.7.15). Observations from the onshore ground truthing surveys were pooled into five species groups: loons, waterfowl, gulls, seabirds, landbirds, and a seventh group, "other," for species that did not fit into a category.

Table 4.7.14. Species observed during the onshore portion of the MERLIN ground truthing surveys – BIWF 2009–2011.

Common Name	Latin Name
Common loon	*Gavia immer*
Red-throated loon	*Gavia stellata*
Horned grebe	*Podiceps auritus*
Red-necked grebe	*Podiceps grisegena*
Eared grebe	*Podiceps nigricollis*
Northern gannet	*Morus bassanus*
Double-crested cormorant	*Phalacrocorax auritis*
Great cormorant	*Phalacrocorax carbo*
Great blue heron	*Ardea horodias*
Great egret	*Ardrea alba*
Snowy egret	*Egretta thula*
Little blue heron	*Egretta caerulea*
Black-crowned night-heron	*Nycticorax nycticorax*
Yellow-crowned night-heron	*Nyctanassa violacea*
Canada goose	*Branta canadensis*
Brant	*Branta bernicla*
Mallard	*Anas platyrhynchos*
Common eider	*Somateria mollissima*
Long-tailed duck	*Clangula hyemalis*
White-winged scoter	*Melanitta fusca*
Surf scoter	*Melanitta perspicillata*
Black scoter	*Melanitta nigra*
Bufflehead	*Bucephala albeola*
Red-breasted merganser	*Mergus serrator*
Common merganser	*Mergus merganser*
Osprey	*Pandion haliaetus*
Northern goshawk	*Accipiter gentilis*
Sharp-shinned hawk	*Accipiter striatus*
Cooper's hawk	*Accipiter cooperii*
Northern harrier	*Circus cyaneus*
Peregrine falcon	*Falco peregrinus*
Black-bellied plover	*Pluvialis squatarola*
American golden-plover	*Pluvialis dominica*

Common Name	Latin Name
American oystercatcher	*Haematopus palliatus*
Greater yellowlegs	*Tringa melanoleuca*
Spotted sandpiper	*Actitis macularia*
Unknown sandpiper (western, least and/or semi-palmated)	*Calidris spp.*
Common snipe	*Gallinago gallinago*
Willet	*Catoptrophorus semipalmatus*
Whimbrel	*Numenius phaeopus*
Ruddy turnstone	*Arenaria interpres*
Sanderling	*Calidris alba*
Dunlin	*Calidris alpina*
Ring-billed gull	*Larus delawarensis*
Herring gull	*Larus argentatus*
Great black-backed gull	*Larus marinus*
Mourning dove	*Zenaida macroura*
Chimney swift	*Chaetura pelagica*
Belted kingfisher	*Ceryle alcyon*
Downy woodpecker	*Picoides pubescens*
Northern flicker	*Colaptes auratus*
Blue jay	*Cyanocitta cristata*
American crow	*Corvus brachyrhynchos*
Fish crow	*Corvus ossifragus*
Common raven	*Corvus corax*
Barn swallow	*Hirundo rustica*
Northern rough-winged swallow	*Stelgidopteryx serripennis*
Bank swallow	*Riparia riparia*
Tree swallow	*Tachycineta bicolor*
Black-capped chickadee	*Parus atricapillus*
Red-breasted nuthatch	*Sitta canadensis*
Carolina wren	*Thryothorus ludovicianus*
American robin	*Turdus migratorius*
Gray catbird	*Dumetella carolinensis*
Northern mockingbird	*Mimus polyglottos*
European starling	*Sturnus vulgaris*
Yellow warbler	*Dendoica petechia*
Prairie warbler	*Dendroica discolor*
Common yellowthroat	*Geothlypis trichas*
Northern cardinal	*Cardinalis cardinalis*
Eastern towhee	*Pipilo erythrophthalmus*
Field sparrow	*Spizella pusilla*
Savannah sparrow	*Passerculus sandwichensis*
Song sparrow	*Melospiza melodia*
Red-winged blackbird	*Agelaius phoeniceus*
Rusty blackbird	*Euphagus carolinus*

Common Name	Latin Name
Common grackle	*Quiscalus quiscula*
Brown-headed cowbird	*Molothrus ater*
House sparrow	*Passer domesticus*
American goldfinch	*Carduelis tristis*
House finch	*Carpodacus mexicanus*

Table 4.7.15. Total number of individual birds observed during the onshore portion of the MERLIN ground truthing (GT) surveys – BIWF 2009–2011.

Onshore GT Point Location	Loons	Waterfowl	Shorebirds	Gull	Seabirds	Landbirds	Other	Total
1	33	92	19	143	–	132	43	462
2	6	100	1	59	13	126	19	324
3	15	109	157	342	–	89	1	713
4	27	55	–	61	4	67	–	214
5	25	237	–	77	103	69	8	519
6	16	31	–	81	3	310	–	441
7	9	76	–	40	15	306	7	453
8	10	168	–	114	8	116	10	426
9	5	60	3	39	26	279	1	413
10	17	29	–	134	121	122	74	497
11	28	90	–	103	80	47	8	356
12	1	113	–	76	10	148	2	350
13	1	64	1	16	9	162	–	253
14	24	81	10	107	64	78	91	455
15	13	109	1	68	6	633	18	848
Total	**230**	**1,414**	**192**	**1,460**	**462**	**2,684**	**282**	**6,724**

Encounter rate (ER) during the onshore portion of the ground truthing surveys was 49.81 birds/survey (Table 4.7.16). Landbirds were the most abundant, with an ER of 19.88 birds/survey, and shorebirds were the least abundant, with an ER of 1.42 birds/survey.

Table 4.7.16. Encounter rate (ER) by species group and onshore ground truthing (GT) point count location – BIWF 2009–2011.

Onshore GT Point Location	Loons	Waterfowl	Shorebirds	Gull	Seabirds	Landbirds	Other	Overall
1	3.00	8.36	1.73	13.00	0.00	12.00	3.91	**42.00**
2	0.60	10.00	0.10	5.90	1.30	12.60	1.90	**32.40**
3	2.14	15.57	22.43	48.86	0.00	12.71	0.14	**101.86**
4	5.40	11.00	0.00	12.20	0.80	13.40	0.00	**42.80**
5	2.50	23.70	0.00	7.70	10.30	6.90	0.80	**51.90**
6	1.60	3.10	0.00	8.10	0.30	31.00	0.00	**44.10**
7	0.90	7.60	0.00	4.00	1.50	30.60	0.70	**45.30**
8	1.11	18.67	0.00	12.67	0.89	12.89	1.11	**47.33**
9	0.45	5.45	0.27	3.55	2.36	25.36	0.09	**37.55**
10	1.89	3.22	0.00	14.89	13.44	13.56	8.22	**55.22**
11	2.80	9.00	0.00	10.30	8.00	4.70	0.80	**35.60**
12	0.13	14.13	0.00	9.50	1.25	18.50	0.25	**43.75**
13	0.17	10.67	0.17	2.67	1.50	27.00	0.00	**42.17**
14	2.67	9.00	1.11	11.89	7.11	8.67	10.11	**50.56**
15	1.30	10.90	0.10	6.80	0.60	63.30	1.80	**84.80**
Total ER	**1.70**	**10.47**	**1.42**	**10.81**	**3.42**	**19.88**	**2.09**	**49.81**

Offshore

During offshore surveys a total of 148 point counts were conducted for 15 minutes each, resulting in 37 hours of offshore avian observations over a ten week period. A total of 2,883 individuals and 23 species were counted (Table 4.7.17), and observations were pooled into five species groups: loons, waterfowl, gulls, seabirds, and landbirds (Table 4.7.18).

Table 4.7.17. Species observed during the offshore portion of the MERLIN ground truthing surveys – BIWF 2009–2011.

Common Name	Latin Name
Common loon	*Gavia immer*
Red-throated loon	*Gavia stellata*
Sooty shearwater	*Puffinus griseus*
Northern gannet	*Morus bassanus*
Double-crested cormorant	*Phalacrocorax auritis*
Great cormorant	*Phalacrocorax carbo*
Canada goose	*Branta canadensis*
Common eider	*Somateria mollissima*
White-winged scoter	*Melanitta fusca*
Surf scoter	*Melanitta perspicillata*
Black Scoter	*Melanitta nigra*
Black-headed gull	*Larus ridibundus*
Laughing gull	*Laurs atricilla*
Ring-billed gull	*Larus delawarensis*
Herring gull	*Larus argentatus*
Great black-backed gull	*Larus marinus*
Dovekie	*Alle alle*
Chimney swift	*Chaetura pelagica*
Ruby-throated hummingbird	*Archilochus colubris*
Barn swallow	*Riparia riparia*
Common grackle	*Quiscalus quiscula*

Table 4.7.18. Number of individual birds observed during the offshore portion of the MERLIN ground truthing (GT) surveys – BIWF 2009–2011.

Offshore GT Point Count	Loons	Waterfowl	Gulls	Seabirds	Landbirds	Other	Total
1	–	9	30	13	–	7	**59**
2	8	76	37	23	2	–	**146**
3	6	41	34	24	–		**105**
4	10	94	43	40	–	1	**188**
5	20	138	55	37	1	2	**253**
6	13	92	45	85	–	–	**235**
7	7	93	30	48	–	1	**179**
8	11	47	45	34	–	4	**141**
9	8	73	28	40	–	–	**149**
10	16	69	29	44	–	6	**164**
11	16	68	43	58	2	5	**192**
12	38	50	48	99	2	54	**291**
13	26	98	87	21	2	11	**245**
14	37	184	24	63	4	1	**313**
15	26	139	20	33	3	2	**223**
Total	**242**	**1,271**	**598**	**662**	**16**	**94**	**2,883**

The overall ER during the offshore portion of the ground truthing surveys was 19.48 birds/survey (Table 4.7.19). Waterfowl were the most abundant, with an ER of 8.59 birds/survey, and landbirds were the least abundant with an ER of 0.11 birds/survey.

Table 4.7.19. Encounter rate (ER) of species groups observed during the offshore portion of the MERLIN ground truthing (GT) surveys – BIWF 2009–2011.

Offshore GT Point Count	Loons	Waterfowl	Gulls	Seabirds	Landbirds	Other	Total
1	0.00	0.90	3.00	1.30	0.00	0.70	**5.90**
2	0.80	7.60	3.70	2.30	0.20	0.00	**14.60**
3	0.60	4.10	3.40	2.40	0.00	0.00	**10.50**
4	1.00	9.40	4.30	4.00	0.00	0.10	**18.80**
5	2.00	13.80	5.50	3.70	0.10	0.20	**25.30**
6	1.30	9.20	4.50	8.50	0.00	0.00	**23.50**
7	0.78	10.33	3.33	5.33	0.00	0.11	**19.89**
8	1.22	5.22	5.00	3.78	0.00	0.44	**15.67**
9	0.80	7.30	2.80	4.00	0.00	0.00	**14.90**
10	1.60	6.90	2.90	4.40	0.00	0.60	**16.40**
11	1.60	6.80	4.30	5.80	0.20	0.50	**19.20**
12	3.80	5.00	4.80	9.90	0.20	5.40	**29.10**
13	2.60	9.80	8.70	2.10	0.20	1.10	**24.50**
14	3.70	18.40	2.40	6.30	0.40	0.10	**31.30**
15	2.60	13.90	2.00	3.30	0.30	0.20	**22.30**
Total ER	**1.64**	**8.59**	**4.04**	**4.47**	**0.11**	**0.64**	**19.48**

Onshore by Time Period

Species composition and abundance changed throughout the ten week survey period. From late March through the end of April eider, scoters, bufflehead, long-tailed duck, and seabirds were most abundant along the coast at the five bluff and five shore point count sites. After late April the number of individuals observed at each point count site decreased, with waterfowl observations markedly decreasing and observations of summer residents, such as double-crested cormorant, increasing.

Shorebirds were seen infrequently throughout the survey period, with an increase in observations in late April. The most shorebirds were observed at onshore point count site number 3 (Andy's Way), with 82% of all individuals observed. Landbird species were the most abundant group at 7 of the 15 onshore point count sites, and were numerous from late March through mid-April. In late April the total number of individual landbirds observed declined, followed by a secondary increase in May. This pattern was likely a result of migrants arriving on breeding grounds or stopping over on the island in late March and April. After that time, detections may have declined as the number of migrants stopping over dropped; conversely individuals may have been less conspicuous prior to the breeding period starting in early May, with territorial males becoming increasingly vocal throughout May, thereby increasing the number of observations.

Loons, grebes, and cormorant species were most frequently encountered in the early part of the survey period from late March through mid-April; after that time, overall numbers of individuals observed declined markedly. A secondary increase in loon observations was recorded during late April and May.

Canada geese were frequently observed during late April, with the peak observations on April 23, 2009. Wading birds and raptors also exhibited similar patterns of abundance, with the number of observations peaking in late April.

Offshore by Time Period

Waterfowl were the most frequently observed and most abundant species group at offshore point count sites. Most waterfowl observations occurred from late March through late April (peaking in mid-April) when 90% of the 2,113 total waterfowl observations (both onshore and offshore) were recorded; observations in offshore waters declined substantially thereafter. Gull observations were consistent, with moderate numbers of individuals observed throughout the ten week survey period. Observations of diver species peaked in late April, but loons and cormorants remained common throughout the survey period. The only geese seen during the offshore surveys were on April 23, when 77 individuals were observed. Pelagic species, consisting mostly of northern gannets, were observed frequently and consistently during the entire survey. Other pelagic species groups such as alcids were observed sporadically during the early part of the spring survey.

The seaduck population at the offshore point counts peaked in mid-April and declined substantially thereafter. It is likely that this peak was due to spring migrant birds stopping over or staging in the Study Area prior to continuing their migration to more northern breeding grounds (Robertson and Savard 2002, Goudie et al 2000). The survey period characterized a transition in seaduck species composition in the nearshore waters along the southern coast of Block Island. During the winter months through early spring, seaducks winter off the coast; after that time individuals move north to summer breeding grounds (Robertson and Savard 2002, Goudie et al 2000).

Onshore Spatial Distribution and Flight Ecology

The flight height of birds observed during the onshore point count surveys varied between species groups. Overall, most birds were observed sitting, perching, or resting on the water. Individuals observed flying were mostly recorded in the "low" flight height category (1–50 m [3–164 ft] AGL). The fewest number of individuals were seen flying in the "high" flight height category (>150 m [>492 ft]). Gulls and pelagic birds were seen flying at the greatest flights throughout the survey period, and passerines were observed flying at the lowest mean flight heights.

Offshore Spatial Distribution and Flight Ecology

During the offshore ground truthing point counts most species flew at a medium height (50–150 m [164–492 ft]). The fewest number of flying individuals were observed flying in the "high" flight height category (>150 m [>492 ft]). Few individuals were observed sitting on the water; this is in opposition to onshore ground truthing point count observations, during which most individuals were observed sitting or perching at ground level. It is possible that the boat's presence during offshore surveys caused individuals to flush off the water, thereby reducing observations of birds sitting on the water.

Gulls and seaducks were seen flying at the greatest heights during offshore surveys, though seaducks were primarily observed flying in the medium height bin. Passerines were observed flying at the lowest mean flight heights. Pelagic species (consisting mostly of northern gannet) were observed flying low to the water, and diver species (consisting mostly of loons) were observed flying at medium and low heights.

Verification of Radars Detection Abilities

Throughout the ten week survey period in 2009, 2,126 individual birds were tagged during the combined onshore and offshore ground truthing effort. These targets were confirmed by direct visual observation by the field observer, the radar operator, or by both observers. Table 4.7.20 provides the results of the radar ground truthing target confirmation exercise for the onshore portion of the survey, and Table 4.9.21 provides the results of the offshore portion.

The horizontal radar provided the most coverage of the onshore point count sites because of the wide range and orientation of the S-band radar. Analyses determined that 82.3% of targets onshore were tracked within the radar's effective area and were visible to the field observer. During the offshore point count ground truthing surveys there was an attempt to confirm each observed target on the MERLIN Avian Radar System. Because the location of the offshore point count sites allowed radar ground truthing in all three modes of radar operation (horizontal, short-range vertical, and long-range vertical) the results of the confirmations were pooled. The pooled results indicate that the radar system as a whole (X-band and S-band radars) tracked 82.1% of the total number of birds within the coverage area and visible to the field observer. This is an important percentage as it documents the overall effectiveness of the MERLIN system in tracking individual targets above the offshore point count sites. The remaining observed individuals were either not detected by the radar or were not available for radar ground truthing. Targets that were not confirmed by the radar may have been flying in wave clutter, flying behind or adjacent to a vessel, or were simply not detected by either the MERLIN radar software or by the radar operator. Targets that were deemed not applicable for radar confirmation included those known to be flying in a boat shadow or targets that were not observed with enough certainty by either the field biologist or the radar operator.

Table 4.7.20. Onshore point count survey ground truthing summary by species group, for targets tagged on both the horizontal S-band and vertical X-band combined radar – BIWF 2009–2011.

Radar Confirmation	Avian Species Group							Total
	Loons	Waterfowl	Shorebirds	Gull	Seabirds	Landbirds	Other	
No	2	19	0	56	0	49	0	**126**
Yes	74	84	0	186	81	159	2	**586**
N/A[1]	436	1310	198	1218	381	2301	82	**5920**
Total	**512**	**1,413**	**198**	**1,460**	**462**	**2,416**	**84**	**6,632**

[1]Some individuals observed during point count surveys were either not flying above tree line, and therefore not within the radar's zone of reception, or were located in a radar shadow. Radar shadows were observed in many areas of the onshore study site because the radars were optimized to sample for biological targets offshore, in the Study Area.

Table 4.7.21. Offshore point count survey ground truthing summary by species group, for targets tagged on both the horizontal S-band and vertical X-band combined radar – BIWF 2009–2011.

Radar Confirmation	Avian Species Group						Total
	Loons	Waterfowls	Gulls	Seabirds	Landbirds	Other	
No	45	87	72	78	1	52	**335**
Yes	116	862	235	324	1	2	**1,540**
N/A[1]	119	322	291	260	14	2	**1,008**
Total	**280**	**1,271**	**598**	**662**	**16**	**56**	**2,883**

[1]Some individuals observed during point count surveys were either not flying above tree line, and therefore not within the radar's zone of reception, or were located in a radar shadow. Radar shadows were observed in many portions of the onshore Study Area because the radars were optimized to sample for biological targets offshore, in the Study Area. Some targets observed offshore were shadowed by the research vessel or other vessels in the Study Area.

Gulls were the most frequently “tagged” (confirmed) onshore biological targets, followed by passerines and divers. Many birds onshore were not available for radar confirmation because they were either flying below vegetation or were located in an area of radar “shadow.” These shadows occurred exclusively over some of the onshore point count sites because the radar was optimized to sample in the offshore portion of the Study Area. As a result, some portions of the onshore Study Area were not sampled as effectively by the horizontal and vertical radars. The most frequently confirmed offshore biological targets were seabird species, especially northern gannet, followed by passerines and loons.

Flight heights for confirmed avian targets were determined in both vertical scanning radar modes. Flight height was calculated as above mean sea level (AMSL) and corrected for the height of the radar unit [52 m (170 ft)]. Flight height observations of offshore biological targets tagged during the ground truthing provide species specific information about avian behavior. The average flight height of targets tagged in the short-range vertical scanning radar was 97 m (317 ft), and the average flight height of tagged targets in the long-range vertical scanning radar was 85 m (278 ft). These average flight heights are not meant to be representative of the entire radar dataset; tagged ground truthed biological targets may have been flying higher or lower than the overall average of all targets tracked by the MERLIN radar system.

Flight heights from the long- and short-range vertical radars were not substantially different. The short-range vertical radar provided information on targets within 1.4 km (0.75 nm) of the radar unit; the long-range vertical radar provided information on targets 0.5 km (3.0 nm) southeast of the radar. The differences in flight height do not necessarily indicate that targets using the area past 1.4 km (0.75 nm) are flying lower than those flying closer to shore. The data do, however, indicate which species are most readily tracked by the MERLIN radar system's software with the current settings. These species included large pelagics (northern gannet), seaducks, loons, and gulls. Passerine species were tracked well within a strictly defined area limited mainly to the conceptualized radar range. Flight heights are provided for tagged biological targets only and indicate the flight heights of birds seen by either the field observer or radar operator (Figures 4.7.25 and 4.7.26).

Flight heights of radar-confirmed avian targets varied by species. Great black-backed gull had the highest average flight height as recorded by the short-range vertical scanning radar mode. Canada goose had the second highest, followed by swallow species. Cormorants, scoters, and loons had the lowest average flight heights from the short-range vertical radar. The long-range vertical radar-tagged avian targets exhibited a similar pattern of flight height distribution. Gulls and Canada geese flew, on average, higher than most other species.

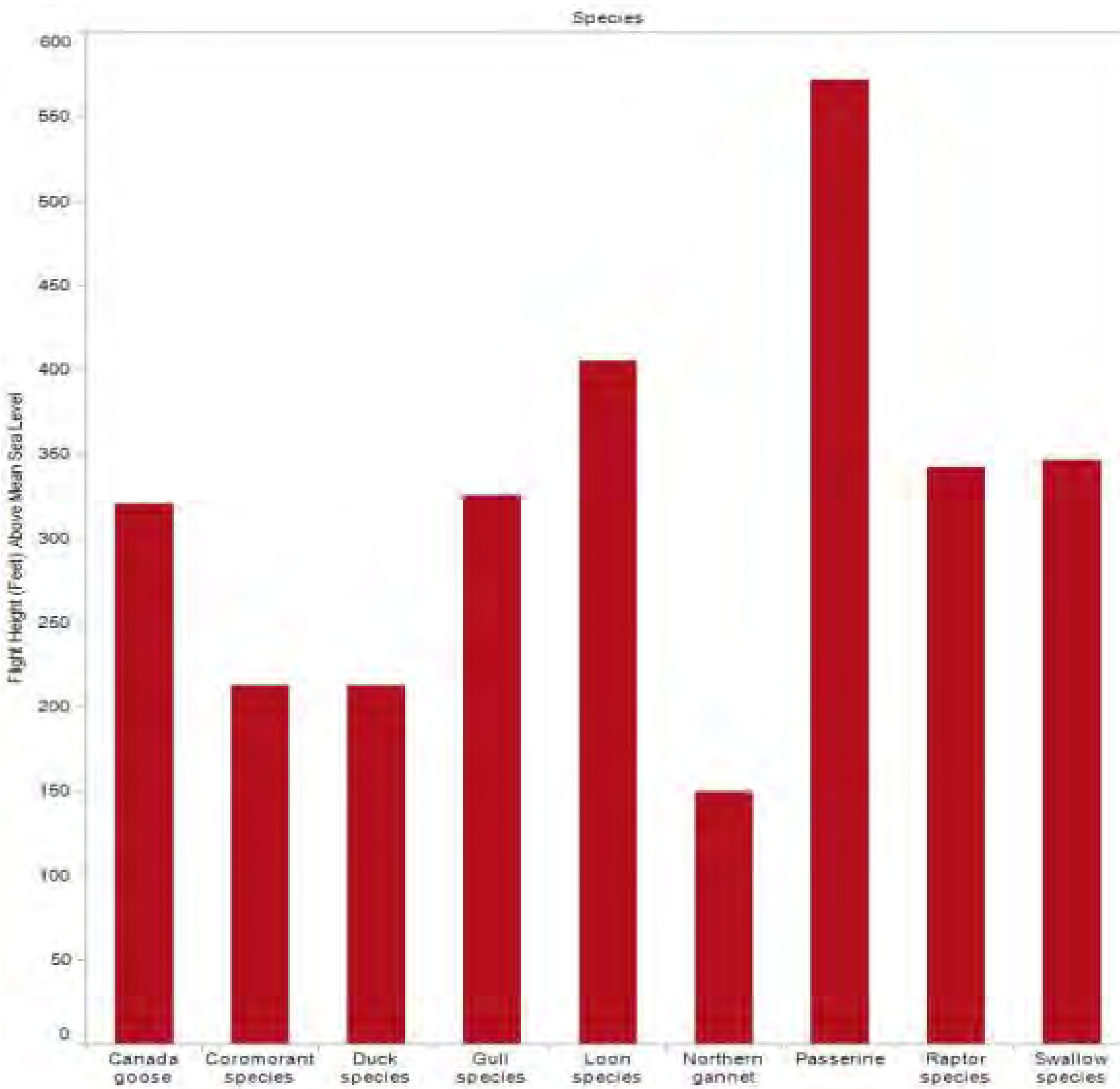

Figure 4.7.25. Average flight height of ground truth tagged targets, Onshore and Nearshore vertical scanning radars combined (VSR) – BIWF 2009–2011.

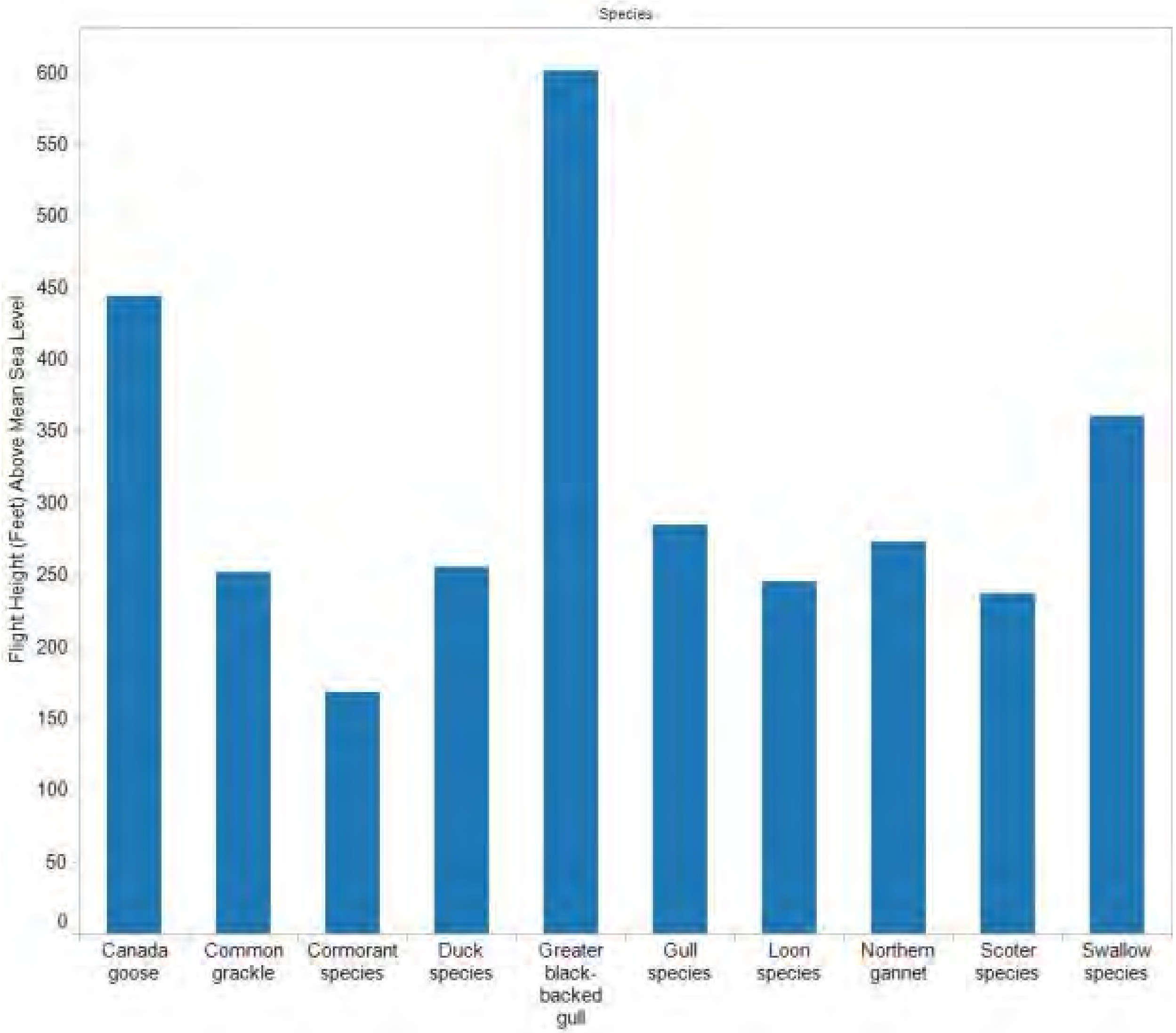

Figure 4.7.26. Average flight height of ground truth tagged targets, Offshore vertical scanning radar (VSR) – BIWF 2009–2011.

Targets that were confirmed on either the vertical short-range or vertical long-range radar were often also tagged on the horizontal scanning radar (HSR). Additionally, some targets were tagged only on the HSR. The most relevant information acquired by the HSR was flight direction. Flight directions were extracted from the MERLIN ground truthing software database and represent a subset of all the targets the MERLIN system was tracking during the survey period; only confirmed avian targets were included in the analysis. It is possible that the larger MERLIN dataset will exhibit a different overall flight direction average of targets moving through the Study Area.

The overall mean flight direction was 67° (east-northeast [ENE]), and the majority of radar-confirmed targets on the horizontal scanning radar were northern gannet (2,239 or 28%) or loon species (2,020 or 25%). Northern gannets had an average flight direction of 69.5° (ENE), and loon species' average flight direction was 60.4° (ENE). These flight paths indicate that the majority of the avian targets ground truthed during the 2009 survey were on a northeasterly flight path through the airspace above and adjacent to the Study Area. This may indicate that the offshore waters located southeast of Block Island, near the proposed preferred Study Area, are generally avoided by avian species moving along the southern and eastern coast of the island. The exposed open ocean and deep water may limit suitable foraging areas, thereby decreasing the number of individuals using those waters (Robertson and Savard 2002, Beauchamp 1992, Goudie and Ankney 1988, Peterson and Ellarson 1977). Furthermore, the migratory or local movements of birds southeast of Block Island seem to avoid a north-to-south or east-to-west flight path, but in general appear to be moving along the south coast of the island and then northeast on a flight path that would eventually lead to Buzzards Bay and Martha's Vineyard, Massachusetts. The majority of avian targets confirmed during the ground truthing effort were avoiding the proposed Study Area and moved on a northeasterly azimuth, which would bring them parallel, and not perpendicular, to the proposed development area. The results of the entire yearlong MERLIN avian radar survey will more accurately indicate the flight direction of biological targets in the Study Area compared with this initial ground truthing effort.

Weather

During the spring onshore point count surveys the mean temperature was 8.9°C (48°F). Wind speeds were generally moderate, with a study period average of 3.8 m/s (8.4 mph), and wind direction varied. Most surveys (79% of point counts) were conducted on days with good to excellent visibility.

During offshore point count surveys the mean temperature was 11°C (52°F). Wind speeds were generally moderate with a survey period average of 3.5 m/s (7.8 mph), and wind direction varied. Most surveys (93% of all point counts) were conducted on days with good to excellent visibility.

4.8 VESPER RADAR

Steeply ascending and descending movements were noted occasionally in the BIWF Study Area, more in the fall than the spring (when insect layer from dispersal is more prevalent), and more frequently at night (bats), though they were also occasionally observed during the day (birds). These ascending and descending movements did not occur every day and neither did the layering of insects. This is in contrast to other locations where the VESPER radar system has been operated (and high bat mortality with wind turbines is known to occur) where layering of insects occurs almost nightly, along with steeply ascending and descending movements.

Also of interest were occasions where the layers or bands of larger migrants (birds most likely, but could include bats) were low in altitude or responded to rain events by descending lower in the atmosphere. These layers and bands set up primarily at higher altitudes (> 150 m [492 ft] and reached as high as 1,000 m [3,281 ft]), but on a small number of occasions they were noted to be lower than 150 m (492 ft). These were not in response to rain but could have been a response to a low cloud base. Although these were rare events during VESPER radar observation, if associated with low visibility, these low altitude flights could represent periods of elevated collision risk for migrant birds.

Larger targets were occasionally observed flying before, during, and after rain showers. No significant alterations in flight height were noted at this site, although this has been seen occurring at other sites where the targets suddenly lowered their flight altitude after the passage of a rain shower. All 316 VESPER images and notes from the fall 2009 and spring 2010 seasons can be found in Appendix C.

4.9 NEXRAD AVIAN ASSESSMENT

All Years, All Months

Over 4 million archived radar records were extracted from the archived data and consolidated to approximately 401,000 hourly records, which met the search criteria for further analysis. A combined analysis was conducted to compare all 14 sites for all years and all months combined. This analysis included all times of day and provides a general broad view of the relative levels of biological activity at each site. In a combined analysis, there is a statistically significant difference in the mean Z (risk) value among the 14 sites (ANOVA, *n* = 121,585, F = 534.77, p<0.0001). A multiple range test (Tukey-Kramer Honestly Significant Difference [HSD] Interval test) indicates that the sites fall into seven statistically significant groups based on the mean level of activity throughout the year. The mean activity at the Block Island site (Site 1) ranks in the lowest activity group (G). Additional descriptive statistics are included in Appendix D.

Table 4.9.1. Multiple range test, comparison of all sites all years all months all times – BIWF 2009–2011.

Site	Homogenous Groups	Mean
10	A	118.73575
9	B	99.27271
12	C	79.49279
11	C	78.76437
13	D	55.19387
14	D	52.81698
5	E	34.71881
7	E	33.10589
6	F	23.80816
8	G	16.10088
4	G	16.07085
1	G	15.96759
3	G	13.53344
2	G	12.50888

Note: Method: 95.0 percent HSD.
Levels not connected by same letter are significantly different.

In an analysis of the offshore sites only, there is still a statistically significant difference in the mean Z value among the seven sites (ANOVA, *n* = 60,806, F = 145.21, p<0.0001). A multiple range test indicates that the sites fall into four statistically significant groups based on the mean level of activity throughout the year. The mean activity at the Block Island site (Site 1) ranks in the second lowest activity group (C).

Table 4.9.2. Multiple range test, comparison of all offshore sites all years all months all times – BIWF 2009–2011.

Site	Homogeneous Groups				Mean
5	A				34.718812
7	A				33.105892
6		B			23.808165
4			C		16.070849
1			C		15.967591
3			C	D	13.533442
2				D	12.508881

Note: Levels not connected by same letter are significantly different

4.9.1 Seasonal Analysis

All Seasons, All Sites

For the purpose of this study, the calculated risk data were divided into spring (March 16–June 30), summer (July 1–September 15), fall (September 16–December 15) and winter (December 16–March 15) seasons. The data were also divided into day and night periods; the hours from 06:00 EST through 18:00 EST were considered day, and the time period starting at 18:00 EST and running through 06:00 EST was considered night. For each of the four seasons there is a statistically significant difference between the 14 sites, although this is strongest during spring and fall.

The monthly mean risk values calculated for all sites combined show significantly greater increases in activity corresponding to the spring and fall nights than other seasons (Figure 4.9.1), so those seasons were analyzed specifically for comparisons of nocturnal migration.

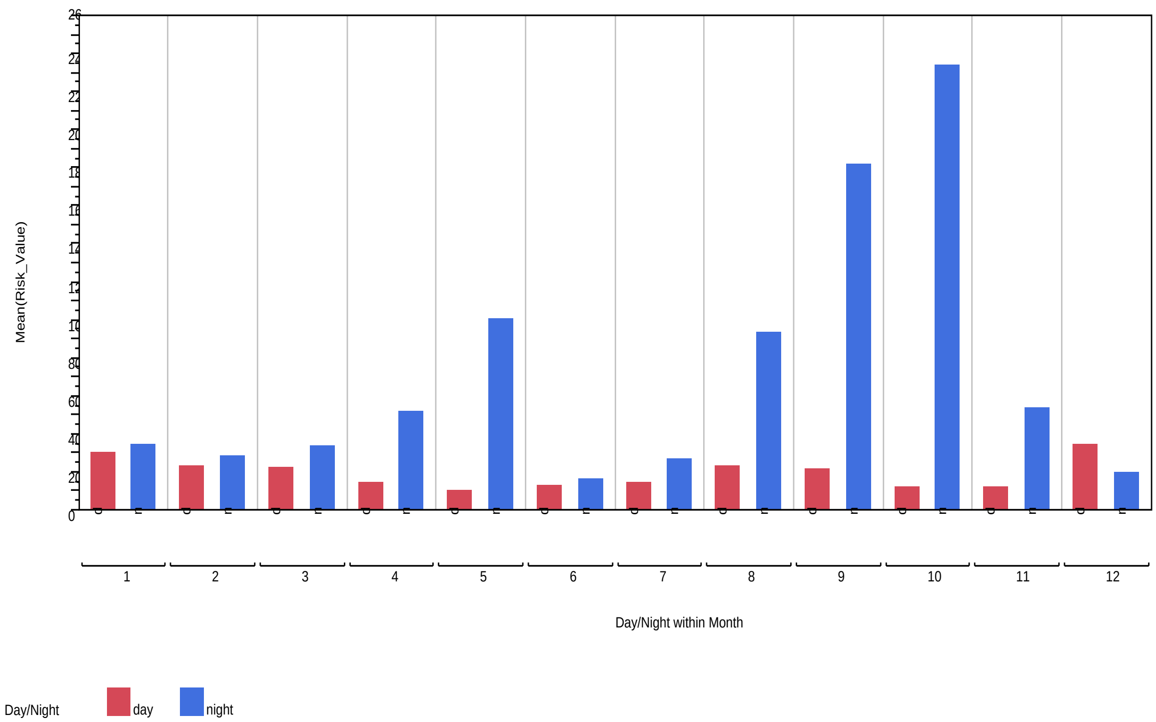

Figure 4.9.1. Monthly mean risk value all sites combined – BIWF 2009–2011.

Fall Migration Analysis

The greatest concern for potential bird impacts by the proposed BIWF project involves the movement of migratory birds during the spring and fall periods. Of particular interest is the movement of night migrants that would pass along the coast during these migrations. Subsequently, the relative abundance of biological activity above the proposed site compared with other locations along the coast and inland with similar radar coverage will provide some insight into the potential risk posed by this site. Fall migration was queried from September 16 through November 31 for each year. Data were also queried from 18:00 hours through 06:00 hours each day during the fall months. There is a statistically significant difference among the mean risk values of the 14 sites during fall nocturnal migration (ANOVA, n = 15,230, F = 240.75, P<0.0001). A multiple range test indicates that the biological activity at the proposed site during nocturnal fall migration ranks 10th out of the 14 sites and falls within the last group, "G." This suggests that while the proposed site may experience a spike during fall nocturnal activity, it is one of the lowest in terms of risk among the 14 sites sampled in this region (Table 4.9.3). Statistical data comparing sites year by year for nocturnal fall migration are included in Appendix D.

Table 4.9.3. Fall migration comparison (all years combined, 2006–2010) – BIWF 2009–2011.

Site	Homogeneous Groups	Mean
10	A	363.87149
9	B	317.48402
11	C	260.28988
12	D	218.21383
14	D E	183.74610
13	E	165.68966
5	F	97.65709
7	F	91.74233
6	G	40.63677
1	G	32.18331
8	G	17.88600
3	G	17.79713
4	G	16.91675
2	G	16.89715

Note: Method: 95.0 percent LSD
Homogeneous groups are identified as having the same letter(s).

Spring Migration Analysis

Spring migration was queried from March 15 through June 30 for each year. Data were also queried from 18:00 hours through 06:00 hours each day during these spring months. There is a statistically significant difference among the mean risk values of the 14 sites during spring nocturnal migration (ANOVA, n = 17562, F = 168.88, P<0.0001). A multiple range test indicates that the biological activity at the proposed site during nocturnal spring migration ranks 12th out of 14 and falls within the sixth and seventh groupings (F, G) out of seven grouping (A–G). This suggests that the proposed site experiences low spring nocturnal activity compared with the other sites in the study and also that activity is lower than in the fall season, indicating that perhaps this area is even less important during spring movements (Table 4.9.4). Statistical data comparing sites year by year for nocturnal spring migration are included in Appendix D.

Table 4.9.4. Spring migration comparison (all years combined, 2006–2010) – BIWF 2009–2011.

Level	Homogeneous Groups	Mean
10	A	167.14206
9	B	143.45741
13	C	91.61959
11	C D	88.21421
14	D	72.30578
12	E	52.73617
5	F	26.60306
7	F G	21.05851
4	F G	19.88325
6	F G	18.62455
8	F G	16.05542
1	F G	7.55214
2	G	6.79471
3	G	6.17336

Note: Method: 95.0 percent LSD.
Homogeneous groups are identified as having the same letter(s).
Levels not connected by same letter are significantly different.

Location Analysis

When the 14 sites were selected for this study, seven offshore sites (sites 1–7) and seven onshore sites (sites 8–14) were chosen. Overall, the seven onshore sites ranked higher in activity than the seven offshore sites in all categories (Table 4.9.5). For all seasons combined, the onshore sites had significantly higher activity (mean = 71.46) when compared with the offshore sites (mean = 21.38) (ANOVA, *n* = 121,598, F = 3694.316, P<0.0001), though this was most pronounced in the fall results.

Table 4.9.5. Seasonal comparison between offshore and onshore sites (all years combined, 2006–2010) – BIWF 2009–2011.

Season	*Offshore Mean Activity*	*Onshore Mean Activity*	*Number*	*F Ratio*	*Prob > F*
Spring	10.773	55.427	35124	1420.537	<.0001*
Summer	21.483	81.241	25441	1306.311	<.0001*
Fall	26.065	119.103	30490	3694.316	<.0001*
Winter	28.817	34.180	30540	22.400	<.0001*

4.9.2 Reflectivity Images from NEXRAD

Graphical depictions of migratory activity are often presented as photographic images that use the NEXRAD base reflectivity values in dBZ (a logarithmic value). The images are often difficult to interpret, as the changes in colors from one reflectivity value to the next represent exponential increases in activity. Figures 4.9.2–4.9.4 provide radar imagery examples of heavy, moderate and light migration activity for the Project Area during nocturnal fall migration. Figures 4.9.5–4.9.7 are examples of activity during nocturnal spring migration.

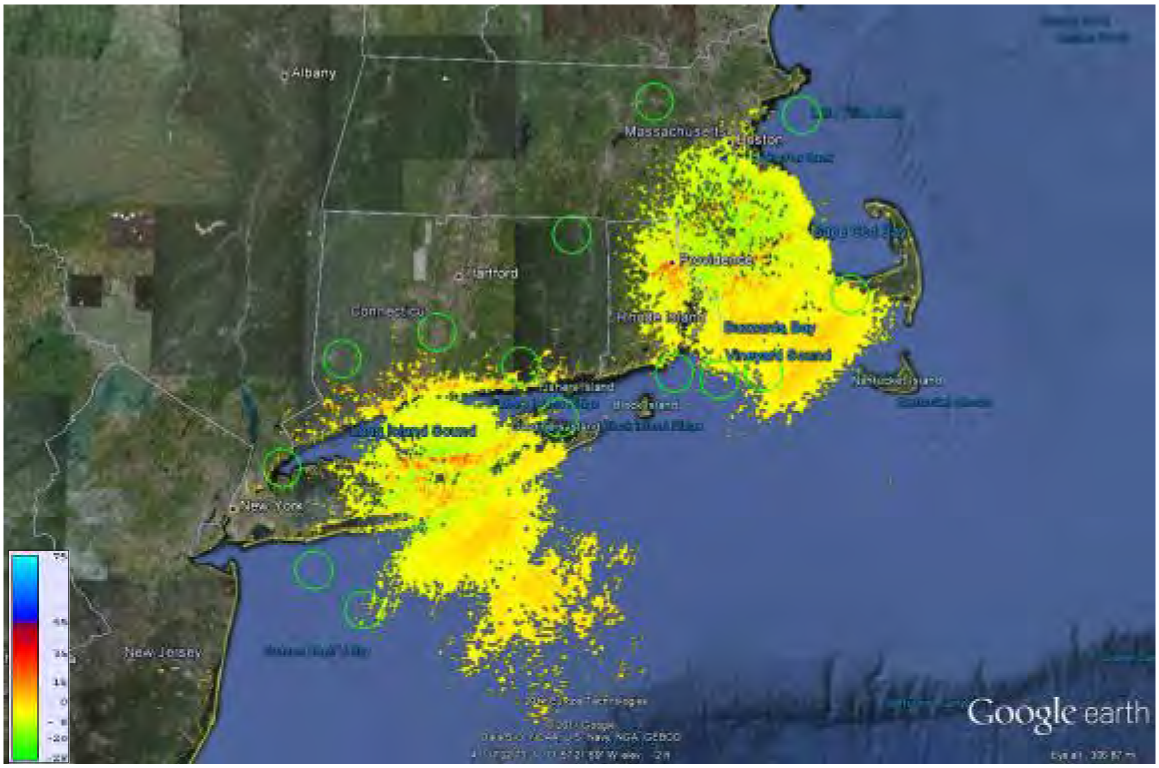

Figure 4.9.2. Heavy intensity fall migration – BIWF 2009–2011.

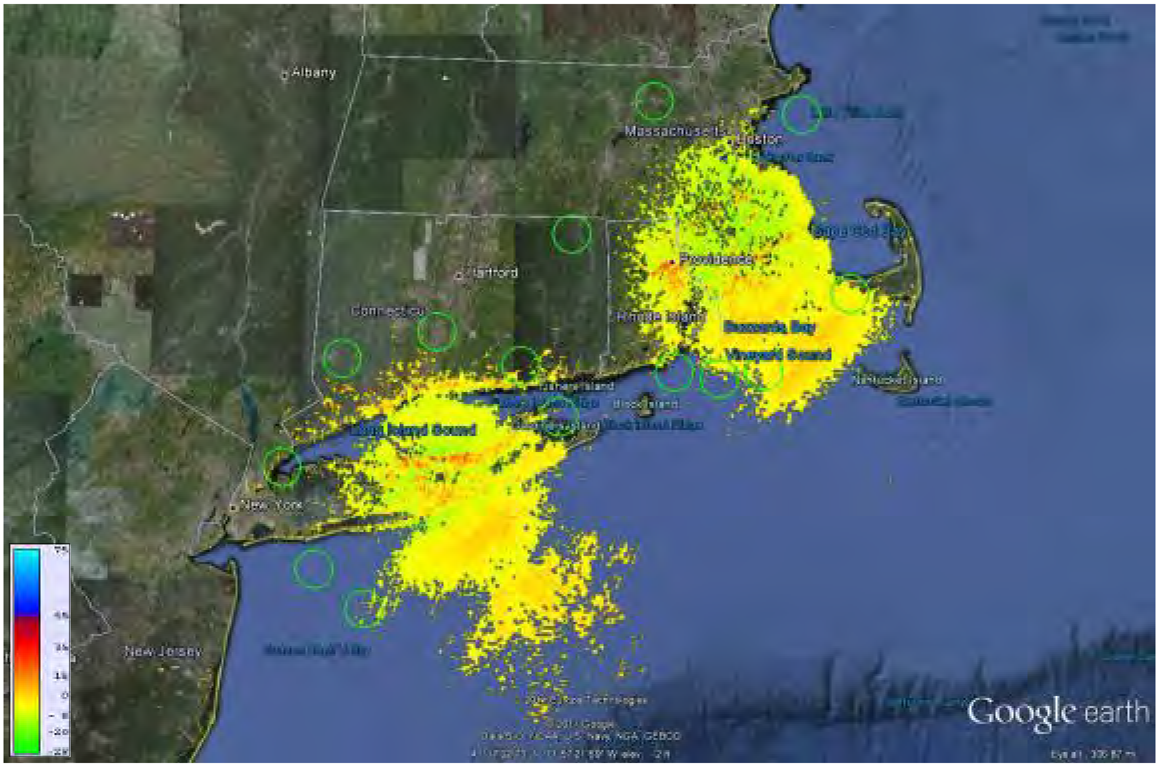

Figure 4.9.3. Moderate intensity fall migration – BIWF 2009–2011.

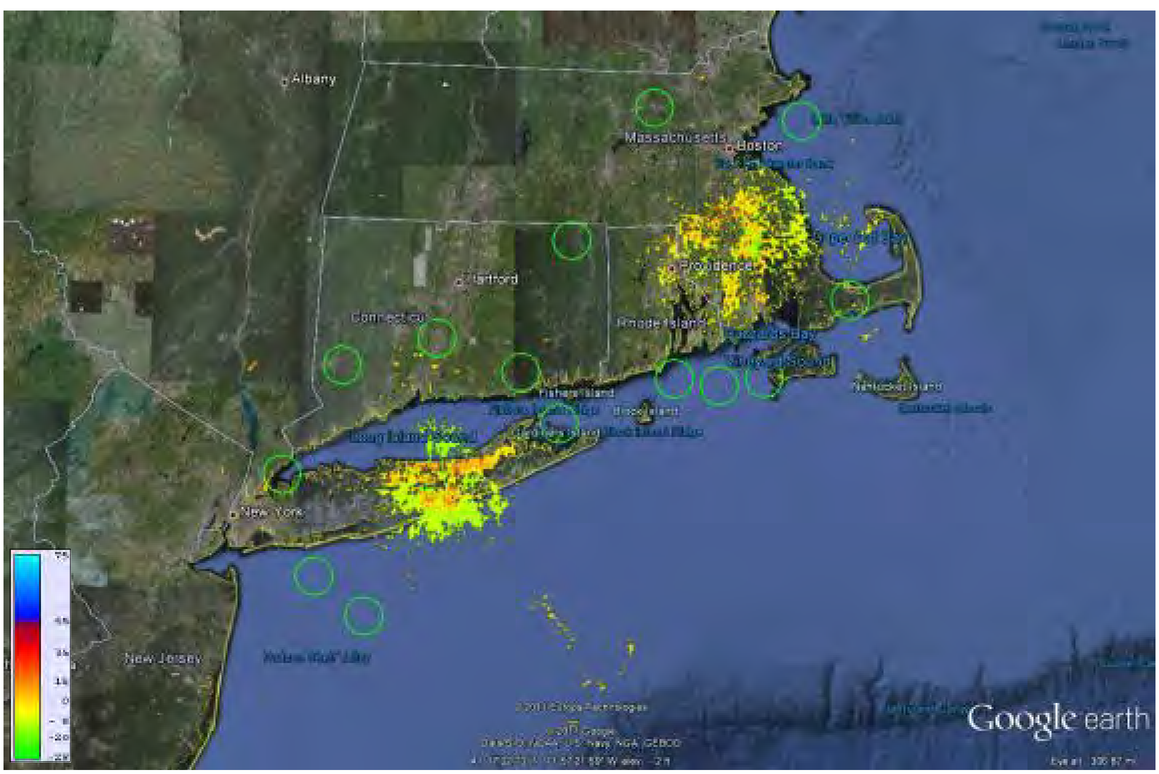

Figure 4.9.4. Low intensity fall migration – BIWF 2009–2011.

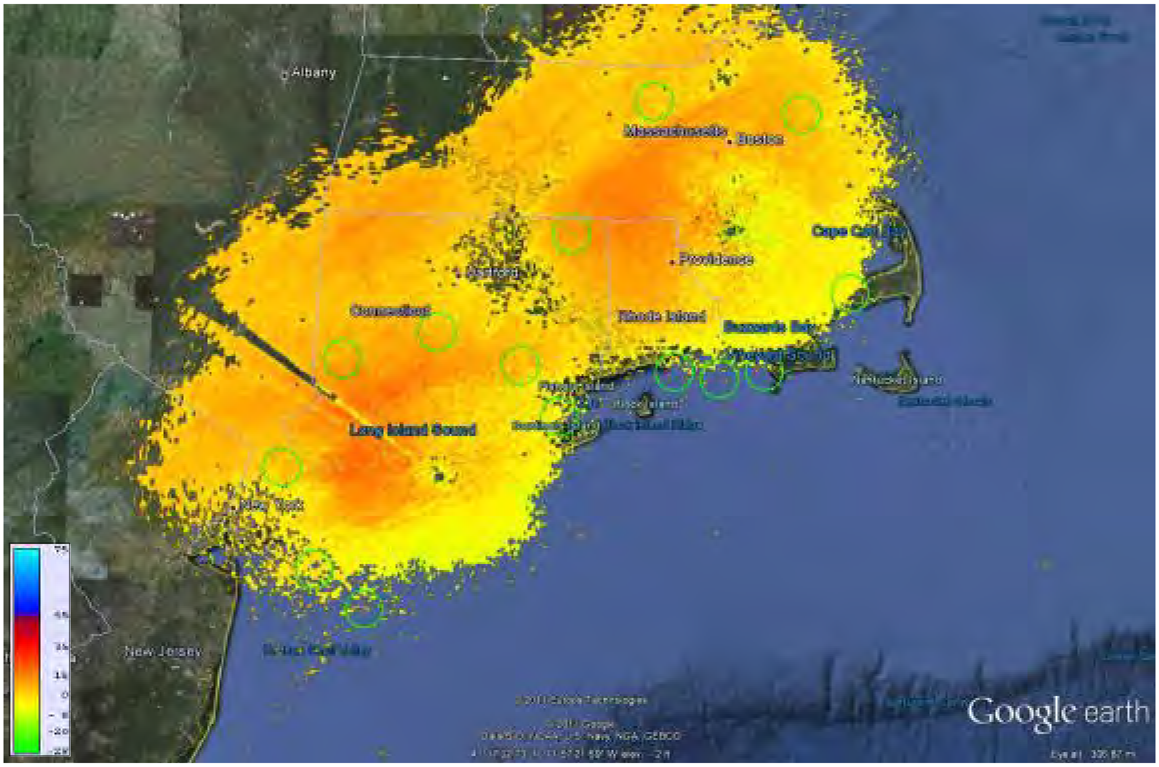

Figure 4.9.5. Heavy intensity spring migration – BIWF 2009–2011.

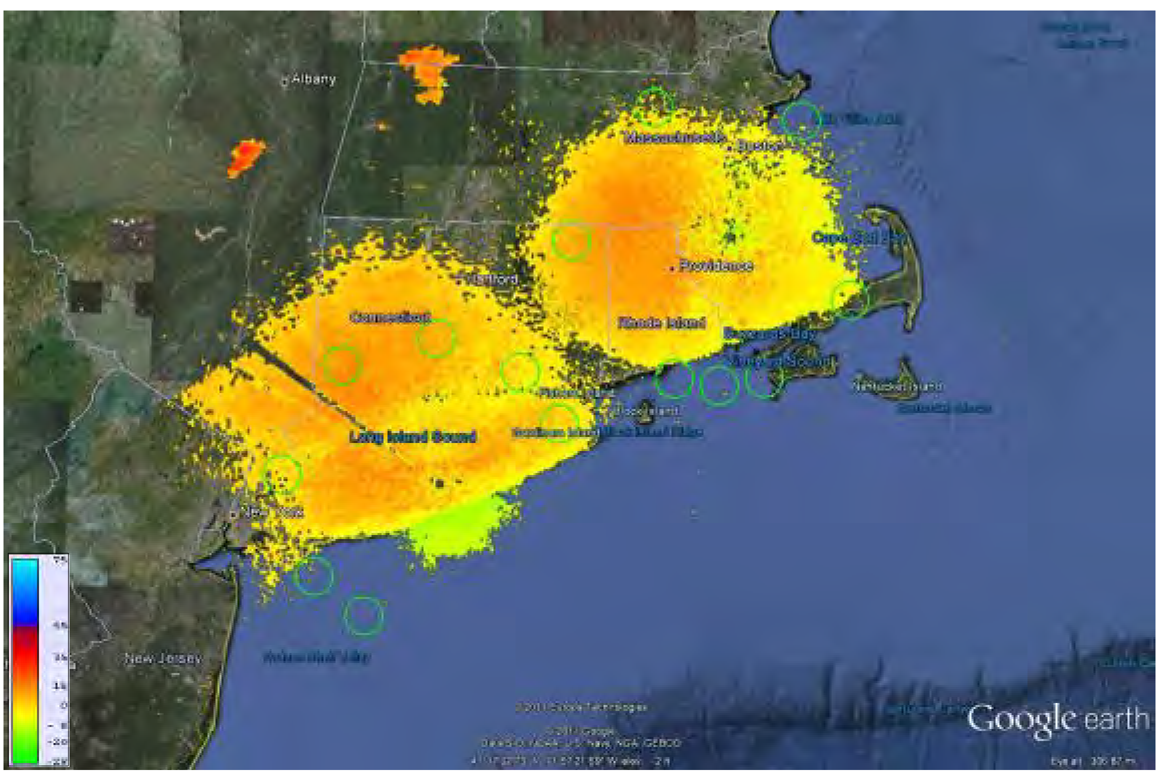

Figure 4.9.6. Moderate intensity spring migration, early morning – BIWF 2009–2011.

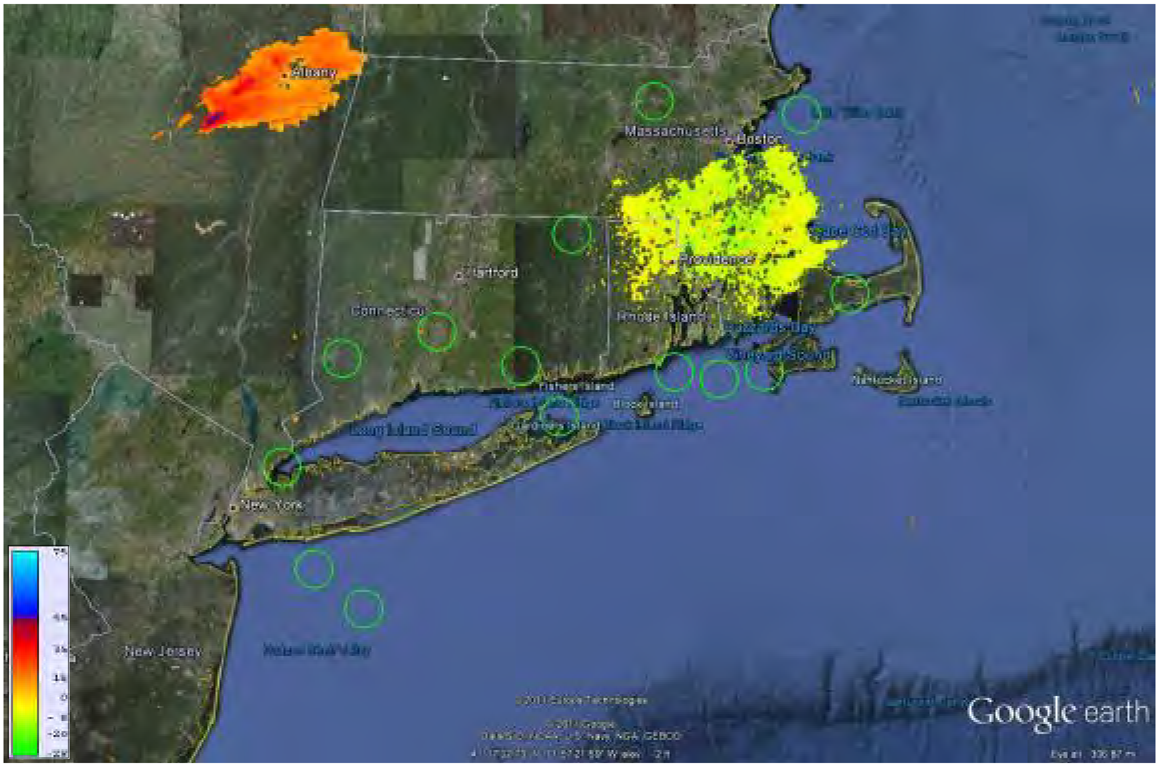

Figure 4.9.7. Low intensity spring migration, early morning – BIWF 2009–2011.

4.9.3 Visibility Data & Analysis

Historical visibility information within the region of the Study Area was accessed through ASOS and AWOS databases to assess the frequency of occurrence of low visibility conditions that could increase risk to birds from the project. Data from all 24 hours of the day were collected from reporting stations at Block Island Airport (KBID) and Westerly State Airport (KWST) in Rhode Island, and Groton-New London Airport (KGON) in Connecticut (Figure 4.9.8). Using a half mile as the threshold for low visibility, this area reported between 1,936 and 2,345 hours (an average of 3.28%) of low visibility conditions (Table 4.9.6). For all three airports, the month with the highest percentage of reported hours with low visibility was June.

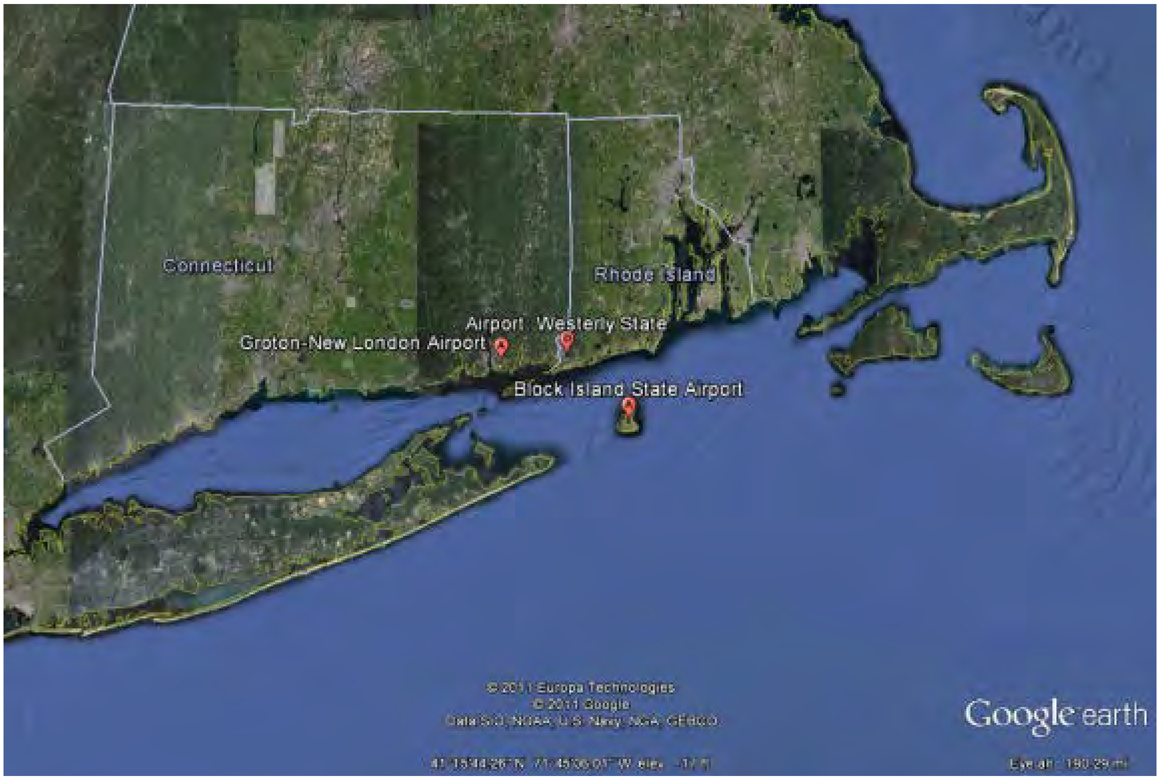

Figure 4.9.8. Airport locations for historical visibility data for the region – BIWF 2009–2011.

Table 4.9.6. Summary of historical visibility data – BIWF 2009–2011.

Weather Station	Date Range	Number of Observation Hours	Number of Hours Poor Visibility	Percentage
Block Island State Airport	1/1/2006–12/31/20010	76,691	1,997	2.60%
Westerly State Airport	1/1/2006–12/31/20010	60,817	2,345	3.86%
Groton-New London Airport	1/1/2006–12/31/20010	57,343	1,936	3.38%

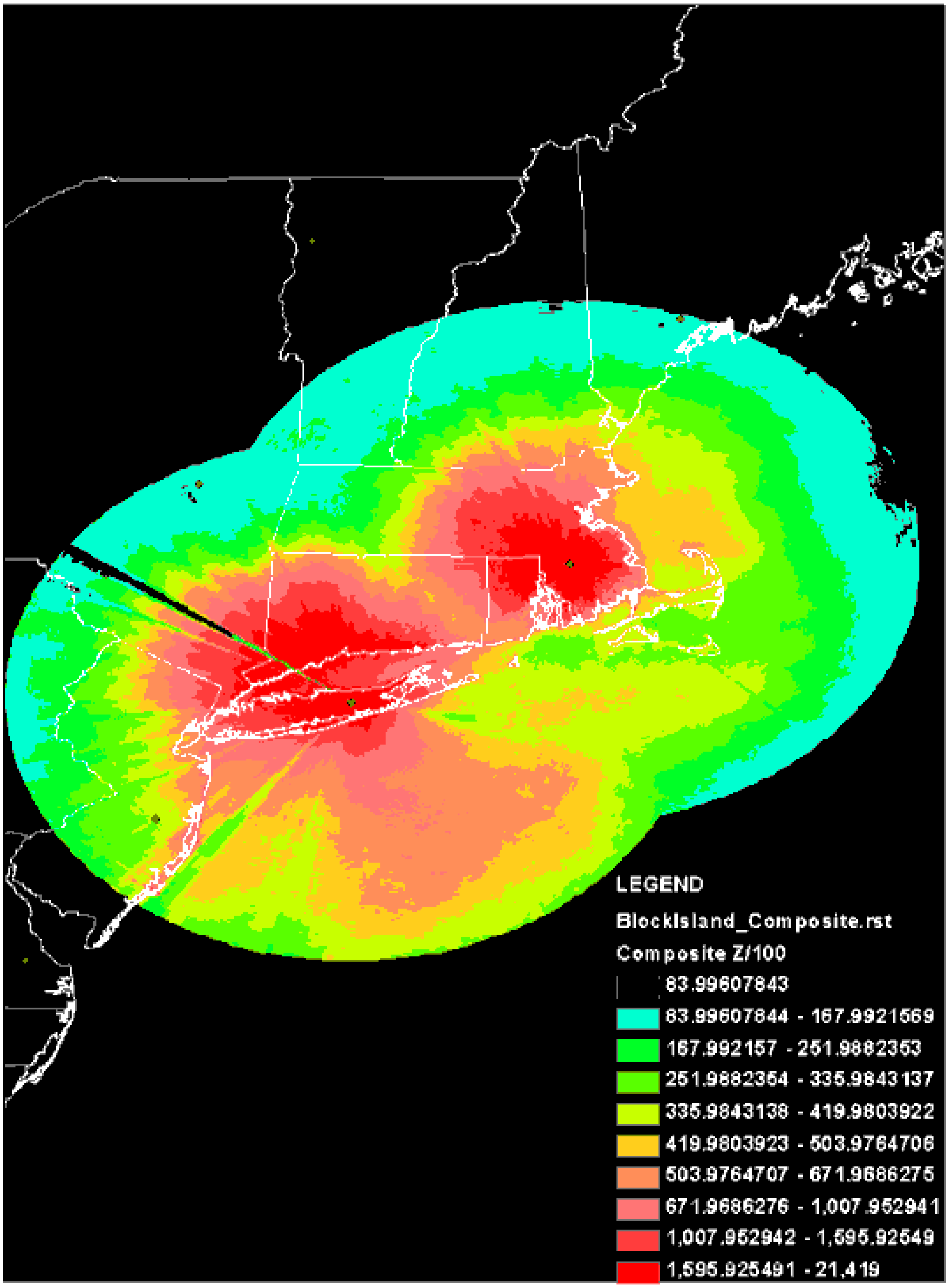

Figure 4.9.9. Composite of all 2010 NEXRAD images with Z values below 200 for the KBOX and KOKX radars – BIWF 2009–2011.

5.0 DISCUSSION

5.1 ONSHORE SEA WATCH AVIAN SURVEYS

5.1.1 SPECIES COMPOSITION AND RICHNESS

Species assemblages were generally found to reflect the habitat types available in the coastal environment of Block Island. As would be expected onshore, landbird species richness was relatively high. However, due to the coastal location of the point count stations, which included shoreline and marine habitats, a relatively large number of shorebird and waterfowl species were also recorded. The shallow water, mudflat, and other wetland habitats surrounding Great Salt Pond yielded several wading bird species, while nearshore waters supported pelagics, such as shearwaters, storm-petrels, and northern gannets. A relatively small number of gull and tern species were recorded; however, this was expected due to the few gull and tern species known to occur in the general area.

5.1.2 OVERALL BIRD ABUNDANCE

While landbirds had the greatest number of individual species, gulls were the most abundant group overall and comprised approximately 38% of all birds observed. This was likely due to the fact that the survey was conducted along the immediate coast where a relatively small number of opportunistic gull species occur in large numbers to take advantage of shoreline and marine habitats. Also, waterfowl had the next highest abundance and comprised approximately 30% of all birds observed. This is also likely due to high use of coastal and marine habitats by waterfowl, particularly during the winter when ice-free conditions provide reliable food resources. While not as abundant as gulls and waterfowl other coastal bird groups including shorebirds, seabirds, and terns collectively made up most of the remaining 30% of all birds observed. Landbirds, making up only 5.1% of all birds observed, were not as abundant as one would expect given the number of landbird species recorded; however, because the point count stations were located along the coast it was not surprising that coastal bird groups greatly outnumbered landbirds.

Calculation of ER for all birds combined and for each species group validated the pattern of relative species abundance observed using bird counts, with gulls and waterfowl having the highest ERs, followed by seabirds, terns, shorebirds, landbirds and finally loons. This is because both methods ultimately rely on the total number of each bird group recorded to determine relative abundance.

Density of birds generally followed a similar abundance pattern as seen using both total bird counts and encounter rate. However, certain sampling stations and bird groups exhibited somewhat higher densities than would have been expected based on total bird counts or encounter rate. This includes the high density of over 300 birds/km2 at Station 3 (Old Harbor Jetty). This is likely due to the high concentration of gulls at low altitude and within the effective area of survey.

5.1.3 OVERALL TEMPORAL AND SPATIAL DISTRIBUTION PATTERNS

Data collected during the summer-fall onshore point count surveys provided information useful to characterize the phenology and spatial distribution patterns of the avian community of Block

Island and the adjacent Study Area. The temporal distribution of species occurrence during the summer-fall surveys was concurrent with expected seasonal trends based on known species accounts (Sibley 2000, Proctor and Lynch 2005, Leslie 2008). Both bird count and encounter rate data show that bird abundance was highest during the winter period, followed by fall, with summer having comparatively few birds. This was primarily due to the abundance of wintering birds, particularly waterfowl that use the ice-free nearshore waters between late fall and early spring. Over 82% of all waterfowl observations were made during the winter/early spring period showing a strong seasonal distribution pattern. Other birds that showed increases or a majority of their observations during the winter/early spring included loons with nearly all loon observations occurring between November and April, with April being the peak of loon activity. While seabird numbers were low in winter, seabirds became one of the most abundant bird groups in April thereby contributed to the overall winter/early spring bird abundance.

Fall saw mostly gulls and waterfowl, but with an increasing number of seabirds and loons, while summer abundance was due primarily to gulls but with terns being the most abundant group during August. In fact, terns only occurred during the month of August. The large tern abundance in August is likely due to late summer tern migration. Shorebirds were present throughout the year showing a less pronounced seasonal pattern; however, higher shorebird numbers in May and August likely correspond with shorebird migration.

As the data indicate the largest number of birds were observed at the southwest promontory of Block Island (Southwest – Station 10) as well as at Great Salt Pond (Andy's Way – Station 1). The abundance at Station 10 appears to be due to the large number of waterfowl observations. In fact, the greatest number of waterfowl observations by far was made at this station. The abundance at Great Salt Pond is likely due to the diversity of available habitats allowing for a wider range of species. Tidal mudflats at Station 1 – Andy's Way provide foraging and resting habitat for a richer and more abundant assemblage of birds. Shorebirds in particular rely on coastal or wetland habitats during migration and breeding (Henningsson and Alerstam 2005).

While stations 2–9 generally had lower abundance, Station 2, similar to Station 1, saw relatively high numbers of shorebirds and terns. Also, Station 3, at Old Harbor Jetty, did not have the shorebirds and terns seen at Stations 1 and 2, nor did it have the high numbers of waterfowl and seabirds seen at the more southern coastal stations, but did have the greatest number of gull observations amongst all stations. This was likely due to the jetty providing ample foraging and scavenging habitat for opportunistic gulls. Stations 4–9 had few shorebirds and terns as seen at stations 1 and 2 but saw increasing numbers of loons, seabirds, and waterfowl. This is likely due to the proximity of these locations to more open, marine nearshore waters, as well as higher numbers of wintering waterfowl.

Flight heights were evaluated both spatially and by species group. Generally, stations located along the southern coast of Block Island had the highest flight heights, with Station 7, Monhegan Bluff having the highest overall average flight height, followed by Station 6 (Payne's Beach), Station 10 (Lewis Dickens Farm) and Station 9 (Black Rock Bluff). Based on a comparison of the relative abundance of species groups by station (Figure 4.1.6) and flight height by species group and point count station (Figure 4.1.11) the high flight heights at these stations appears to be due to the relatively high number of gulls and, in some cases loons, both of which have the highest average flight heights among all bird groups. Gulls are generally abundant at all four of these stations, while loons have their greatest abundance at stations 7 and 9 (Monhegan and Black

Rock Bluff). Also, when comparing figure 4.1.6 and the relative abundance of species groups by season (Figure 4.1.2) it can be seen that gulls are present at these stations in similar numbers throughout the year, with a moderate increase in winter, while loons are found at Stations 7 and 9 in winter and early spring.

Figure 4.1.11 indicates that loon and gull flight heights were at their highest at Station 7 at over 70 m (230 ft) and 53 m (174 ft), respectively. This was likely much of the reason why Station 7 had the highest overall average flight height among all stations. However, with loon being present primarily in winter/early spring it is expected that flight heights would, on average, be lower (although not low) at this station during late spring, summer, and early fall.

The relatively high flight height at Station 6 appears to be primarily due to the abundance of gulls, while the high flight height at Station 10 is primarily due to the presence of a moderate number of high flying loons and gulls. Also, while typically having low flight heights of around 10-15 m, seabirds and terns both had their highest overall average flight heights at Station 10 at 19 m and 22 m, respectively. While loons are mostly present from late fall through early spring seabirds make appearances to varying degrees throughout the year, though mostly occur in late spring and late fall. Terns were found only in August. Also, low flying (10 m [33 ft] or less) waterfowl were most abundant at Station 10 and occurred primarily in winter between January and March. Therefore, while there is a moderate number of high flying loons it appears that during winter (January through March) the average flight height at Station 10 is likely low due to the overwhelming presence of waterfowl. Flight heights at Station 10 are likely high much of the remainder of the year when waterfowl abundance is low and particularly when loon, seabird, and tern abundance is high during April (peak in loon and seabird activity), August (peak in tern activity), and October through December (period of high seabird activity).

The high average flight height at Station 9 appears to be due to the relative abundance of gulls and loons, with loons reaching their greatest abundance at this station. Again, however, due to the abundance of low flying waterfowl in January, February, and March, the average flight height during this period is likely low and high the remainder of the year, particularly in April when most loons are present at this station and Station 7.

Relatively low flight heights at stations 1–5 along the east coast of Block Island appear to mainly be due to the relative abundance of low flying terns, shorebirds, and waterfowl at these locations. In addition, gulls, while having numbers similar to those at the southern coastal stations had atypically low flight heights.

Low flying shorebirds were primarily found at Stations 1 and 2 (Crescent Beach) with relatively few found at Station 3 (Old Harbor Jetty) and other stations. Highest shorebird abundance by far was found at Station 1 at Great Salt Pond at 77%. Shorebirds were found at these stations throughout much of the year with peaks in May and August that likely represent spring and fall migration periods. Surveys sites along the southern coast were characterized by increased wave energy, rocky habitat, and exposure, habitat features which are generally less suitable for shorebird species. Sheltered cove sites, such as 1-Andy's Way and the 3-Old Harbor Jetty offered more suitable shorebird habitat. Tern occurred mostly at Stations 1 and 2 (as well as 10), with relatively few occurring at the remaining stations. As stated previously, terns only occurred at these stations during August. Therefore, because low flying shorebirds were one of the most abundant groups at these stations and occurred throughout the year and gulls flew at atypically low altitudes flight height at these stations is likely low all year.

Interestingly, while Station 3 was overwhelmingly dominated by typically high flying gulls, the overall average flight height was extremely low at only 8 m (26 ft). This appears to be due to the unusually low flight height of gulls at this station at only 7.68 m (25.2 ft). Because gull abundance was found to be rather constant the average flight height at this station was therefore low throughout the year.

Stations 4 (St. Andrews) and 5 (Southeast Light) both saw increasing numbers of low flying seabirds, particularly at Station 5 where seabirds reached peak abundance and were more numerous than any other bird group. This may be due to these points being located in closer proximity to more open marine waters toward the southern end of the island. As stated previously, seabirds mostly occurred in April, July, and late fall (October – December) with peak activity in April. Therefore, low overall flight heights at Station 5 may occur only during these months with higher flight height, led by gulls, occurring at this station during the remainder of the year.

In summary, overall bird abundance was highest in winter and highest at Stations 10 and 1. Gulls were the most abundant group overall and were found throughout the year and across all stations in somewhat similar numbers. Waterfowl, the next most abundant group were found predominately in the winter thereby contributing most of the increased bird abundance at this time of year. Waterfowl were less uniformly distributed spatially than gulls with the greatest abundance occurring at stations 9 and 10. Shorebirds and terns were predominately found at stations 1 and 2, Great Salt Pond (Andy's Way) and Crescent Beach (and Station 10 for terns), with shorebirds being present throughout the year and terns present only in August. Seabirds were primarily found at the southern coastal stations and were present mostly in April, July, and late fall (October through December). Landbirds, like gulls, were found throughout the year and at all stations, although were slightly more abundant during the breeding season.

Stations 6 and 7 (followed by 9 and 10 as mentioned above) had the highest overall flight heights, primarily due to the presence of high flying gulls and loons. Stations 6 and 7, while likely having their highest flight heights in April when loons are at their peak, have high overall flight heights throughout the year due to the constant presence of high flying gulls. Stations 9 and 10, as described above, have high overall flight height during most of the year when gulls and/or high flying loons, terns, and seabirds are present and a low average flight height during winter when waterfowl are overwhelmingly abundant and loons and terns are absent.

Station 1 (and 2) had the majority of low flying shorebird, and, with the exception of Station 10, the majority of typically low flying tern observations. While terns occurred only in August, shorebirds were found throughout the year and this fact, combined with the unusually low overall flight height for gulls at this station likely contributes to the station's low overall flight height throughout the year.

Station 3 had atypically low flying gulls all year. Stations 4 – 8 had increasing, but not significant numbers, of low flying seabirds and loons. Increases in low flying loons and seabirds combined with an abundance of high flying gulls contributed to moderate flight heights for these stations.

Therefore, as can be seen in Table X below, stations 1 and 2 had low flight heights all year and contained most shorebird and tern observations along with moderate or typical numbers of waterfowl and gulls and few loons and seabirds. Station 3 was dominated by low flying gulls all year relatively few observations of other bird groups, while stations 4, 5, and 8 had low to moderate numbers of seabirds, loons, and gulls making for an overall moderate average flight height year round. Stations 6 and 7 were dominated by high flying loons and gulls in winter/early spring (January–April) and high flying gulls the remainder of the year. Stations 9 and 10 had high overall flight heights most of the year due to the presence of high flying loons and gulls, and atypically high flying terns and seabirds. However, Stations 9 and 10 likely had low average flight heights during January–March when low flying waterfowl were overwhelmingly abundant and the high flying terns and seabirds were mostly absent.

From a seasonal perspective, in winter, Stations 1 and 2 had mostly waterfowl, low flying gulls, and some shorebirds along with an overall low average flight height; Station 3 had primarily low flying gulls; Stations 4, 5 and 8 had low flying seabirds and waterfowl along with high flying gulls and an overall moderate average flight height; Stations 6 and 7 had high flying gulls and loons along with low flying waterfowl and an overall average high flight height; and Stations 9 and 10 had mostly low flying waterfowl and high flying gulls but with an overall low average flight height.

In spring/summer Stations 1 and 2 had low flying terns, shorebirds, and waterfowl along with low flying gulls and an overall low average flight height; Stations 3 had mostly low flying gulls and some low flying terns with an overall low average flight height; Stations 4, 5, and 8 had high flying gulls and loons along with low flying waterfowl and seabirds and an overall moderate average flight height; Stations 6 and 7 had high flying gulls and loons along with low flying waterfowl but an overall high average flight height; and Stations 9 and 10 had mostly high flying gulls and loons (spring) and an overall average high flight height.

In fall Stations 1 and 2 had mostly shorebirds, waterfowl, and low flying gulls and a low overall average flight height; Station 3 had mostly low flying gulls; Stations 4, 5, and 8 had mostly high flying gulls, seabirds, and waterfowl along with a moderate overall average flight height; Stations 6 and 7 had mostly high flying gulls; and Stations 9 and 10 had mostly high flying gulls.

Gulls, the most abundant group were found throughout the year with a moderate increase in winter. Gulls were somewhat evenly distributed across all stations with highs occurring at Andy’s Way (Station 1), Old Harbor Jetty (Station 2), and Black Rock Bluff (Station 3) and, while having a high overall average flight height had low average flight heights at Stations 1, 2, and 3 and high flight height at all remaining stations.

Waterfowl, the next most abundant species group overall was primarily found during winter with moderate numbers in the fall and near absence in the summer. The majority of waterfowl were found at the southwest end of the Island at Stations 9 and 10; however, moderate to low numbers were found at all remaining stations and typically had low average flight height at all stations and during all seasons.

Seabirds, terns, shorebirds, and loons followed far behind gulls and waterfowl in overall numbers. Seabirds were found mostly in late spring (April–May), July, and fall. Nearly all seabirds were observed at the more exposed southern end of the island with seabird flight heights generally being low with the exception of Station 10 where the average flight height was unusually high, likely due to high gannet numbers in the fall.

Terns were found almost exclusively in August and primarily at Stations 1, 2, and 10; however, small numbers were found at many of the remaining stations. Tern flight height was typically low except at Station 10.

Shorebirds were found scattered throughout the year, although shorebirds had peaks in August and May that likely corresponded with migration. Shorebirds were primarily found at Stations 1, 2, and 3, and had low flight heights all year.

Loons primarily occurred in winter, early spring, and again in late fall. April saw peak loon numbers. Loons were almost exclusively found at the south and southwest end of the island and loon fight heights were consistently high.

Table 5.1.1. Distribution of most abundant species groups and flight heights by station and season.

Areas	Jan–March	April–August	Sept–December	Average Flight Height
Station 1	Shorebirds, waterfowl, low flying gulls	Terns, shorebirds, waterfowl, Low flying gulls	Shorebirds, waterfowl, low flying gulls	Low – All Year
Station 2	Shorebirds, waterfowl, low flying gulls	Terns, shorebirds, waterfowl, Low flying gulls	Shorebirds, waterfowl, low flying gulls	Low – All Year
Station 3	Low flying gulls	Low flying gulls, terns, shorebirds	Low flying gulls	Low – All Year
Station 4	Seabirds, High flying gulls, waterfowl,	Seabirds, High flying gulls, waterfowl	Seabirds, High flying gulls, waterfowl	Moderate – All Year
Station 5	Seabirds, High flying gulls, waterfowl, loons	Seabirds, High flying gulls, waterfowl, loons	Seabirds, High flying gulls, waterfowl	Moderate – All Year
Station 6	High flying gulls, loons, waterfowl	High flying gulls, loons, waterfowl	Gulls	High – All Year
Station 7	High flying gulls, loons, waterfowl	High flying gulls, loons, waterfowl	Gulls	High – All Year
Station 8	High flying gulls, waterfowl, seabirds, loons	High flying gulls, waterfowl, seabirds, loons	High flying gulls, waterfowl, seabirds	Moderate – All Year
Station 9	Waterfowl, loons, gulls	Loons, gulls	Gulls	High – Late Spring and Summer Low – Winter
Station 10	Waterfowl, loons, gulls	Loons, gulls	Gulls	High – Late Spring and Summer Low – Winter

As one would expect, both gulls had a high frequency of occurrence over the survey period at 100%. Gulls are widely known to be resident throughout the year in coastal Rhode Island. Landbirds likewise had a high frequency of occurrence at 85% indicating that, while relatively few in number, are found throughout much of the year along the shore of Block Island. The frequency of seabirds, shorebirds, and particularly terns at 42%, 30%, and 8%, respectively indicates a relatively strong seasonal occurrence of these species groups. This is also indicated by the seasonal distribution of both total counts and encounter rates for these species groups.. Waterfowl, while having a somewhat high frequency of 85% and being found in nearly all seasons were overwhelmingly abundant during winter. Therefore, while small numbers of waterfowl occurred during the summer breeding season waterfowl showed a strong seasonal distribution pattern. Of note all waterfowl species that were observed during the late spring/summer period, including American black duck and common eider, appeared to be those relatively few that remained during the breeding season.

5.1.4 Migration Patterns

Variability in the spatial distribution of species was especially evident during the late summer-fall migration period (August 15–December 15). During August terns were most abundant at the southern coastal site Lewis-Dicken's Farm (Station 10), and at Andy's Way (Station 1). In late-summer shorebirds were much more plentiful at Andy's Way (Station 1) and Crescent Beach (Station 2). Cormorants exhibited higher encounter rates at Lewis-Dicken's Farm during this period (Station 10). Seabird species were more common along the southern coast in fall. Similarly, more loon observations were recorded along the southern coast during late summer and early fall. Overall, during fall migration abundance patterns shifted slightly towards the south and southwestern point count stations, perhaps evidence for a migration corridor towards the west and southwest via Montauk and Long Island, New York.

5.1.5 Rare, Threatened, and Endangered Species

The federally listed piping plover was observed on two occasions: at Andy's Way (Station 1) and at Great Salt Pond. Piping plovers have a known distribution that includes this area on Block Island and their presence was not unexpected. Observations of the state threatened/endangered peregrine falcon, barn owl, and northern harrier were likewise not unexpected due to the known distribution of these species in the onshore environment of Block Island. Most of the remaining special status birds that were observed included raptors, wading birds, and passerines known to occur on the island. Like the other state listed species these birds are typically restricted to the onshore environment and only cross offshore waters during migration events. A total of 85% of the observations of species of concern were made at 1-Andy's Way.

5.2 ONSHORE RAPTOR MIGRATION SURVEYS

The Block Island raptor survey documented far fewer total raptors as compared to other regional sites over the same time period. In addition, fewer raptor species were observed at Block Island than at the other hawk watch sites. However, Block Island does appear to have a moderate amount of fall peregrine falcon activity along the southern coast. In fact, Block Island recorded more peregrines than three of the four other regional sites despite having many times fewer raptors. This may indicate the relative importance of the southern coast of Block Island to migrating peregrine falcons, although the total peregrine numbers are still similar to many hawk watch sites on the east coast.

Other species observed during the Block Island survey were either common species such as American kestrel, merlin, and Cooper's hawk, or species known to winter or reside on Block Island including northern harrier and bald eagle. However, these species were all recorded in very low numbers with only merlin and Cooper's hawk being noted more than twice. This suggests that Block Island is not particularly important to these and other species of raptors but is primarily a migration route for peregrine falcons.

Like peregrine falcon, northern harrier is listed by the state of Rhode Island; however, only two individuals were observed during the survey and both were seen flying low and hunting over an open field on the Island. These birds also typically occur only over land and rarely venture over water except during migration. Breeding takes place to the north and, therefore, migration likely occurs over open water north of Block Island.

Bald eagles are no longer protected under the federal Endangered Species Act; however, take of bald eagles is regulated under the Bald and Golden Eagle Protection Act. The Block Island raptor survey indicated a very minor occurrence of bald eagle along the southern coast with only one eagle observed. Also, no movements beyond the nearshore coastline were recorded and it is likely that this eagle would not use offshore waters such as those where WTGs are proposed.

It is unclear as to exactly why the spring survey recorded so few raptor observations; however, this could be due to a lack of migration at this distance from the mainland or other coastal areas during the spring. Also, Cooper's hawk were nearly the only species detected during the spring, while fall saw a much greater range of species. Cooper's hawk is a fairly common regional species that can occur year round in the vicinity. While raptor observations made during the fall appear to be more indicative of actual migration, particularly peregrine falcon migration, observations of Cooper's hawk during the spring may reflect more regional or local movements of these birds during one of their more active times of year.

Hawk Watch Site Comparison

Regional hawk watch data appears to indicate that there is a larger concentration of migrant raptors at other coastal locations in New England and the Mid-Atlantic. Concentrations of migrants near certain topographic features such as ridges, coastlines, and water has been frequently demonstrated (Sibley 2001, Dunne et al. 1988). The fall Block Island raptor survey data has demonstrated that a moderate number of peregrine falcons, and few other species, utilize the island during southbound migration. Comparable regional sites consistently record substantially higher numbers of peregrine falcons, as well as other raptor species, than seen at Block Island. This indicates that the magnitude of raptor migration at Block Island is less than that at other similar survey sites along the north-western Atlantic coast. This is likely due to geography and topography. Lighthouse Point and Kiptopeke hawkwatch sites are located on the immediate coast. Birds are known to follow coastlines during migration and the east coast is considered to be a primary route for raptor movement within the Atlantic Flyway. Therefore, Block Island may be located too far from the mainland to see the concentrated raptor migration occurring along the immediate coast. Lighthouse Point regularly records over 10,000 raptors and the Kiptopeke Hawkwatch regularly records over 15,000 raptors each fall. Cadillac Mountain in coastal eastern Maine is the highest point along the entire US eastern seaboard with an elevation of 463 m (1,530 ft) rising steeply from the Atlantic Ocean. The mountainous coastal environment, coastal breezes, and steep granite outcrops provide good conditions for raptor movement at this site.

Peregrine Falcon

The breeding population of peregrine falcons in Rhode Island is listed as Endangered under state law (RIESP 2006). During the 1940s, 1950s and 1960s brought precipitous population declines for the peregrine falcon that were largely attributed to organochloride pesticide use such as DDT. The USFWS estimates that peregrine falcon populations decreased by 88% after the introduction of modern pesticides (USFWS 2009). The species was listed as endangered in 1970 in an effort to protect the species from extinction. Stricter pesticide regulations, a captive-bred reintroduction program, and intensive monitoring efforts were fundamental in the successful recovery of the species. After almost 30 years of being listed as an endangered species, the peregrine falcon was removed from the federal Endangered Species List on August 25, 1999. Peregrine falcons current federal status is “Delisted Taxon-Recovered” (USFWS 2009).

Peregrine falcons were only observed on and near the shore on Block Island with no peregrines observed during any offshore boat-based surveys in the Project Area. However, there remains some potential for the species to occur there given the observed tendency for individuals to fly over open water. Falcon species are known to migrate along coastal areas and some species, primarily peregrine falcon and merlin, are regularly observed flying over offshore waters (Dunne et al. 1988).

The majority of the falcon observations made during the Block Island surveys were of birds traveling above the shoreline on the southern end of the island. Mapped flight paths indicated that many of these birds closely followed the bluffs of the island. Birds were observed traveling southwest around the corner of the primary raptor survey site, Southeast Lighthouse. Observations at other points along the southern coast of the island revealed falcons moving through the area in a west-southwest flight path, foraging and flying close to the bluffs. Peregrine falcons were also observed heading in a southwesterly direction off the southwest corner of the island, flying low directly out over the water, presumably headed toward Montauk, New York. As stated above, no peregrines were observed in the Project Area and the birds observed during the onshore survey were over 4 nm west of the area where WTGs are proposed. Fire Island had similar count totals of peregrine falcons on the same survey days which indicate that many of the birds seen on Block Island are following the Long Island coastline as they migrate south.

Despite attempts to document incoming raptor flight paths during designated raptor surveys no peregrines were observed approaching the Block Island from the mainland. However, during a ferry trip between Point Judith, Rhode Island and Block Island a single juvenile peregrine falcon was observed. This falcon was presumably making the water crossing from mainland Rhode Island to Block Island, as it was observed nearly 6 nm south of the mainland. This individual was flying at approximately 3 m above the water and was moving due south, on course directly to the island (Personal Observation, October 9, 2009). Slack and Slack (1981) found that migrating peregrine falcons used north winds to follow a route from the Rhode Island coast to Block Island and then traveled to Montauk. Their study also suggested that peregrines left the coastline at Point Judith and crossed the sound to Block Island (Slack and Slack 1981). This would put peregrine falcons outside and to the west of the Project Area during their migration from the mainland to Block Island.

Also, during the Block Island surveys no peregrine falcons were observed at a distance further than 1,000 m (3,281 ft) from the island, the majority were recorded 0–500 m (0–1,640 ft). These trends may indicate that peregrine falcons use the bluff lines and coastal habitat of Block Island as a corridor during southbound migration, but are largely absent from areas further offshore and south of the island.

5.3 BAT ACOUSTIC MONITORING

5.3.1 ONSHORE PASSIVE ACOUSTIC MONITORING

Current research shows that tree-roosting migratory bat species have been the predominant species found during post-construction mortality studies at wind farms in North America (Arnett el al. 2008). Overall species diversity and bat activity was low during the passive monitoring surveys onshore at BIWF Study Area during the 2009 summer-fall and spring 2010 migrations periods. During the 920 detector-nights of monitoring three species of long distance tree-roosting bat were positively identified from the acoustic dataset; hoary bat, silver-haired bat, eastern red bat and Myotis species. These species are relatively common in southern New England, have demonstrably secure populations, and were not unexpected (Harvey et al. 2011). Of the 157 call sequences recorded during the onshore passive monitoring surveys 42 calls (26.7%) were from migratory tree bat species. The remaining calls were either not classified to species level or were attributed to Myotis species, most likely little brown bat.

Most bat activity was recorded during August and October in the fall, and in late May during the spring. In northern latitudes it has been established that bat activity generally increases during late-summer when bats prepare for migration and/or hibernation, and when most species mate (Baerwald and Barclay 2009). This is also the period when bats may be at greatest risk of collision (Baerwald and Barclay 2009).

It may not be appropriate to draw definitive conclusions about why bat activity was different across detector locations for two reasons; first, the overall sample size was low (few calls recorded) despite a high level of effort, and second, it is not possible to completely exclude other variables such as wind speed or weather as explanations for the differences in activity rates across Block Island. However, differences in activity rates between locations were noticed in the data set. The met tower detectors (High and Low) recorded calls from silver-haired bat, eastern red bat (at the Low detector only), as well as some unknown low and unknown high frequency calls. In general the met tower detectors had lower activity rates as compared with the Southeast Lighthouse detector, and similar rates of activity to the Southwest Point detector.

There is an inherent difficulty in attempting to interpret the number of recorded call sequences as an indication of abundance; however, detection rates do reflect a relatively lower level of bat activity near the met tower. The limited maximum range of a single Anabat detector (approximately 30 m [100 ft]) makes the characterization of landscape-scale movements, such as migration, difficult to assess. The total number of bat call sequences recorded each night by a given detector may or may not reflect the absolute level of bat activity present at the Study Area, although some studies have suggested that there may be a relationship between the number of call pulses recorded and bat activity levels (Gorresen et al. 2008). The bias in passive acoustic surveys of this type stems from the unknowns associated with recorded call sequences. For example, a single foraging individual may produce a large number of call sequences that are within the range of a given detector set. Conversely, a large number of individual bats may pass the detector set and produce an equally large number of call sequences.

5.3.2 Offshore Passive Monitoring

Little to no information exists on bat activity offshore. Pioneering studies of bats in areas proposed for offshore wind development in Europe (Ahlén et al. 2007, Ahlen et al. 2009) demonstrated occurrence of bats over the open ocean up to 14 km (7.5 nm) from the shore. During active acoustic monitoring off the coast of New Jersey numerous bat call sequences recorded (NJDEP 2010). So, the occurrence of bats of the open ocean, either during migration or foraging bouts, is not unexpected. A small number of call sequences (n = 16) were recorded during the 227 detector-nights of passive offshore acoustic monitoring from a buoy 5.5 km (3 nm) south of Block Island. Of these 16 calls most were unknown high frequency calls (n = 11) that could be attributed to either Myotis species or eastern red bat. Given the known affinity of eastern red bat to coastal areas (Johnson and Gates 2008), it is probable that most of, if not all of the high frequency unknown calls recorded were eastern red bat. Silver-haired bat (n = 3) and hoary bat (n = 2) were also recorded at the offshore buoy detector. Both silver-haired and hoary bat were recorded off the coast of New Jersey (NJDEP 2010).

5.3.3 Active Monitoring

The active acoustic monitoring results were generally consistent with the passive acoustic monitoring surveys. Both techniques demonstrated low overall bat diversity and activity levels in the Study Area. Active acoustic monitoring and passive acoustic monitoring together provide a broader spectrum of information on bat occurrence patters. This is because active monitoring often results in increased call sequence quality and can reveal variation in activity by habitat type (Britzke 2004), while passive monitoring can provide daily activity data at multiple locations over a longer time period. For example, little brown bat was identified during the active acoustic survey though only unknown myotis species call sequences were identified during the passive surveys. Active monitoring did not document any hoary bat call sequences while recordings of this species were comparatively frequent during passive monitoring. Neither active nor passive monitoring documented big brown bats during the monitoring period. Big brown bats are found in nearly all habitats though they are most common in deciduous forests (BCI 2009). Lack of extensive tree habitat and/or the distance of Block Island to the mainland may account for this species not being represented in the survey results.

Only a single silver-haired bat call sequence was documented during the offshore active surveys. Silver-haired bats are long-distance migrants that are known to move over open water. The offshore surveys indicate that Block Island, and to a lesser extent offshore areas, are used during migration by some bat species. Given the distance of Block Island from the mainland shoreline, use of onshore habitats or offshore waters for daily foraging activity is likely low. The bat species documented by active acoustic surveys onshore and offshore of Block Island are not listed as Threatened or Endangered species, either under federal or state law; however, the eastern red bat, silver-haired bat, little brown bat and other myotis species are listed as species of "Greatest Conservation Need" by Rhode Island (RIDEM 2006).

Silver-haired bat was the most commonly recorded (for known call sequences) species during passive monitoring onshore and offshore, and was the only bat detected during the offshore boat-based survey. These results indicate that silver-haired bat migrate through the Block Island area, and may forage or migrate over the open ocean more so than other species recorded. Additionally, during a raptor migration survey at the Southeast Lighthouse on August 27, 2009, a silver-haired bat was observed at approximately 11:30. The bat flew from below the south bluff and roosted under a window ledge on Southeast Lighthouse. It remained there for the duration of the raptor observation, using the lighthouse as a day roost. This species has a distinctive pelage and was positively identified using a spotting scope while it roosted. It is probable that this species was using Block Island as stopover habitat on its southbound migration.

The acoustic survey results indicate a low level of activity during migration; however, extrapolating bat abundance from these data should be done with caution considering the limitation of acoustic sampling. Although an estimate of population abundance using acoustic data is not possible these surveys do provide estimates of relative activity level of bats in both the onshore and offshore portions of the BIWF Study Area (Hayes 1997). Acoustic monitoring is a valuable method, although inherent biases, such as difficulties interpreting the number of recorded call sequences and the limited maximum range of a single detector, are important considerations. Also, the survey results are a sample of bat activity in the airspace surrounding the detectors and are not necessarily indicative of bat activity throughout the entire Study Area. Activity patterns of bats vary temporally depending on environmental factors such as insect abundance, air temperature, and precipitation. Because of the large temporal variation in bat activity, the greater the number of survey nights surveyed the higher probability of an accurate assessment of activity trends. Small datasets can underestimate or overestimate activity levels because the survey nights may represent very high or low activity patterns depending on weather and food resource abundance (Hayes 1997). The onshore and offshore passive sampling efforts provide a comparatively large sample size and robust dataset that is likely indicative of the bat assemblage in the BIWF Study Area. This assumption is supported by the passive acoustic survey results which detected more diversity and generally more activity than the more limited active sampling efforts. Correlations between bat activity patterns and weather conditions are fully explored in the Risk Assessment section of this report (Section 6.7).

Species composition and activity level are likely a subset or “snapshot” of actual occurrences. The passive acoustic surveys occurred over the course of two seasons, and are likely more representative of the bat community present on Block Island than the active sampling results. The data from the 2009 summer/fall and 2010 spring monitoring periods are an indication of general activity levels and typical species occurrence (i.e., the probability of detecting common species is greater when sampling during fewer survey nights). Results from the active acoustic bat monitoring, in combination with the passive acoustic monitoring, indicate an overall low level of bat activity onshore, and very low activity levels offshore of Block Island.

5.4 AVIAN ACOUSTIC MONITORING

The fall 2009 and spring 2010 avian acoustic monitoring effort yielded a limited number of flight calls attributed to three different species groups. More flight calls were recorded at Lewis-Dickens’ Farm than at either Southeast Light or at New Harbor, combined.

Species groups recorded on Block Island during the fall and spring monitoring efforts consist of common migrants which typically occur in Rhode Island (Breeding Bird Atlas Explorer 2012). Representatives of each species group (wood-warblers, thrushes, and sparrows) are widespread on Block Island during migration and summer residency periods (Audubon Society of Rhode Island 2003).

Recorded calls were compared to calls of all species likely to occur in the Block Island area during migration which included all species known to occur east of the Mississippi. Due to some inter-specific overlap between flight call parameters a species group level classification provided the most conservative cladistic approach to analysis. Although recorded calls could be attributed to only three species groups, additional call recognizers were used. For example, the 'blackbird' call recognizer included reference calls of all species known to occur east of the Mississippi River in the genera; *Icterus, Dolichonyx, Sturnella, Agelaius, Molothrus,* and *Quiscalus*. However, the only species in this group known to migrate at night are bobolink (*Dolichonyx oryzivorus*), orchard oriole (*Icterus spurius*), and Baltimore oriole (*Icterus galbula*). The 'finches and allies' call recognizer contained reference calls of all eastern species in the genera; *Piranga, Cardinalis, Spiza, Pheusticus, Passerina, Coccotharaustes, Carduelis, Carpodacus, Pinicola,* and *Loxia.* The 'mimic-thrush' call recognizer included reference calls from the genera; *Mimus, Dumetella,* and *Toxostoma.* The 'swallows and martins' call recognizer contained reference calls from the genera; *Hirundo, Petrochelidon, Stelgidopteryx, Riparia, Tachycineta,* and *Progne.* The 'wood-warbler' call recognizer contained reference calls for all of the North American *Parulidae* species occurring east of the Mississippi River, including all species in the genera: *Dendroica*, *Vermivora*, *Parula*, *Mniotilta*, *Setophaga, Protonotaria, Helmitheros, Geothlypis, Oporornis, Seiurus, Limnothlypis, Wilsonia,* and *Icteria*.

The avian acoustic data from Block Island provide a glimpse of species composition of the nocturnal passerine migrants flying over the island during spring and fall migration. Call rates were unexpectedly high in the spring at Lewis-Dickens' Farm, although we cannot assume that activity was lower in the fall because of the quality of the recordings during that time. The avian acoustic data do seem to indicate that nocturnal passerine migrant activity is higher over the southwestern portion of Block Island (near Lewis-Dicken's Farm) than at the southeastern terminus of the island. Despite inconsistency in the quality of recordings, those seasons when good quality recordings were made elucidate a clear southwestern trend in activity rates.

5.5 OFFSHORE BOAT-BASED AVIAN SURVEYS

Species assemblages were generally found to reflect the offshore marine habitat available in the Study Area. As would be expected during the offshore survey bird groups with the greatest number of species included seabirds, followed by waterfowl and gulls. Seabirds, including shearwaters, petrels, and alcids are known to occupy offshore waters for most of their life history. Likewise many waterfowl, primarily seaducks, use shallow offshore waters for foraging, particularly during the winter when they take advantage of ice-free conditions and abundant fish and benthic resources. Gull richness was likewise expected, again given the marine environment. Other bird groups found, but with fewer species, included loons, terns, and shorebirds. Terns and shorebirds will at times use offshore areas for foraging as well as during migration events. Somewhat unexpectedly, a few landbirds were also seen during the offshore survey.

5.5.1 Overall Bird Abundance

Not surprisingly, waterfowl and seabirds were the most abundant bird groups overall accounting for nearly half (~48%) of all bird observations. Gulls were next in abundance and accounted for an additional 15% of all birds recorded. While only two loon species were recorded during the survey loons accounted for nearly 10% of all birds observed. This is likely because loons can often be found in relatively large numbers wintering in the ice-free waters of southern New England. The remaining bird groups including terns, shorebirds, and landbirds were found in comparatively low numbers; not unexpected given that these species typically spend a greater proportion of their life history along the immediate shoreline than do seabirds and ducks.

Observed avian abundance differed markedly between segments where turbines are proposed (segments 8-14) and segments where turbines are not proposed (segments 1–7 and 15–25) with over 80% of all bird observations being recorded in the segments where turbines are not proposed. This was true for all species groups as well where the large majority (between 75 and 85%) of waterfowl, seabirds, gulls, loons, and terns were recorded where turbines are not proposed. Also, in segments where turbines are not proposed species groups were most abundant in segments 15–25, located at the southwest end of the Study Area.

Calculation of ER for all birds combined and for each species group validated the pattern of relative species abundance observed using bird counts, with waterfowl, seabirds, and gulls having the highest ERs, followed by loons, shorebirds, terns and finally landbirds. This is because both methods ultimately rely on the total number of each bird group recorded to determine relative abundance.

Density of birds generally followed a similar abundance pattern as seen using both total bird counts and encounter rate. This included expected high densities of waterfowl, seabirds, and gulls and relatively low densities of other offshore bird groups.

5.5.2 Overall Temporal and Spatial Distribution Patterns

Data collected during the transect surveys provided information useful to characterize the phenology and spatial distribution patterns of the avian community in the offshore Study Area where turbines are currently proposed, as well as nearby areas where turbines are not proposed. The temporal distribution of species occurrence during the offshore survey was concurrent with expected seasonal trends based on known species accounts (Sibley 2000, Proctor and Lynch 2005, Leslie 2008). Both bird count and encounter rate data show that bird abundance was highest during the late winter/early spring period (March–April) followed by the late fall/early winter (October–February) period. This pattern was primarily due to the abundance of wintering waterfowl, loons, and certain seabirds including alcids and gannets, with most of these species being detected at this time.

While summer had much lower bird abundance overall, summer was the period when shearwaters/petrels were most abundant and the relatively few shorebirds and terns occurred. Shearwaters/petrels appear to use these waters as summer residents taking advantage of their preferred offshore foraging habitat.

Therefore, winter abundance was due to the presence and large proportion of waterfowl, loon, and certain seabird (gannets and alcids) species, while summer saw shearwaters/petrels and gulls being dominate.

As indicated by the results, the majority of birds flew less than 10 m (33 ft) above the water (72.8%). A relative minority flew between 10 and 25 m (33 and 82 ft) (20%) and between 26 and 125 m (6.9%), while very few, 0.3%, flew between 126 and 200 m (85 and 410 ft) (Table 4.5.9). Only gull species were observed flying between 126 and 200 m (410 and 656 ft). Birds were also frequently seen sitting on the water (*n* = 1,099, 15.8%).

Of the waterfowl, the large majority of all species flew below 10 m. While the majority of all seabirds flew below 10 m (33 ft), northern gannets flew slightly higher with about 20% flying between 10 and 25m (33 and 82 ft). For gulls, the species with the fewest numbers, including Bonaparte's and laughing gull, had low flight heights with nearly all flying below 10 m (33 ft). However, the most abundant gulls, including ring-billed, herring, and black-backed gull saw the majority flying between 10 and 125 m (33 and 82 ft).

Loons, as a whole, flew above 10 m (33 ft); however, there was variation among the two species observed with the majority of common loon flying between 10–25m (33–82 ft), while the majority of red-throated loon flew below 10m. Cormorants flew primarily within the 10–25 m (33–82 ft) flight height band, as did common and least terns. However, forester's tern flew below 10 m (33 ft). Some species flew lower than others, for example Wilson's storm petrel flew <10 m (<33 ft) above the water during nearly 100% of observations, as did 18 other species (Table 4.5.9).

Flight heights were also evaluated spatially, temporally, and by species group. The highest average flight height at approximately 20 m (66 ft) was found where wind turbines are not proposed at segments 1–7. This is also where the fewest overall birds were observed. However, the next highest average flight height of around 17m was found in segments 8–14, where wind turbines are currently proposed and where the overall number of birds recorded was only slightly more than at segments 1–7. Flight heights for segments 15–25, where the large majority of birds were observed, had by far the lowest flight height at around 7 m. Therefore, even where flight heights were greatest the average flight height for all segments was found to be below the lower rotor swept zone at 23 m (76 ft). In addition, segments 1–7, where the average flight height was highest among the three segment groups, are located where no WTGs are proposed.

For segments 1–7 it appears that the relatively high overall flight height is due to the abundance of high flying gulls throughout the year and generally fewer low flying waterfowl and seabirds than at segments 8–14 and 15–25. Gulls were the most abundant group recorded within these segments and had the highest average flight height recorded during the entire study at over 36 m. While loons also had a high flight height in segments 1–7, the number of loons observed was very low, with only terns being recorded in lower numbers. Like gulls, waterfowl and seabirds were relatively abundant in segments 1–7; however, as stated above, these species groups were found in lower numbers than in segments 8–14 and 15–25 and were primarily found during winter/early spring. Because gulls were more abundant than any other species group throughout much of the year it appears that segments 1–7 generally had a high flight height during each season (although flight height may have been somewhat reduced in winter/early spring when gull numbers are lower and waterfowl and seabird numbers were higher).

Segment 2 was the only segment within segments 1–7 with an average flight height above the lower rotor swept zone at 23 m (76 ft). Both gulls and terns had high flight heights with the average tern height at around 55 m (180 ft). However, due to low relative tern abundance it is likely that the overall high flight height at segment 2 is contributed mostly by high flying gulls. Also, because gulls were found consistently in all seasons it is likely that the average flight height at segment 2 is within the rotor swept zone during much of the year.

For segments 8–14 the relatively high flight height is due primarily to higher flying gulls during late spring, summer, and fall. However, low flying waterfowl were the most abundant group overall and were more numerous in segments 8–14 than in segments 1–7. This combined with a greater number of low flying seabirds (alcids and gannets) than were found in segments 1–7 likely contributed to a lower flight during the winter/early spring. Also, a greater abundance of low flying seabirds (shearwaters) may have also reduced the overall average flight height in summer. Fall likely sees the highest flight height in segments 8–14 due to the abundance of high flying gulls and lower numbers of low flying waterfowl and seabirds.

Interestingly, the actual average flight height for waterfowl in segments 8–14 was relatively high (18m); however, this was due to an atypically high flight height for waterfowl (63 m [207 ft]) in one segment, segment 13. The remaining segments actually had very low flight heights of around 5 to 6m. Therefore, overall, flight heights for waterfowl in segments 8–14, with the exception of segment 13, were low.

In addition, segment 13 was the only segment within segments 8–14 with an average flight height within the rotor swept zone. Based on both abundance and flight height data the relatively high average flight height was contributed mostly by the unusually high flying waterfowl. However, because waterfowl mostly occurred during between late fall and early spring the high flight height within the rotor swept zone at segment 13 likely occurred only during this period.

Waterfowl and seabirds were the most abundant groups, followed by gulls in segments 15–25. Waterfowl and seabirds were both found to have low flight heights of around 6 m; however, both species groups were primarily recorded in winter/early spring. The next most abundant species group was gulls, which had an atypically low flight height of around 14 m (46 ft). Terns had a moderate flight height of around 13 m (43 ft); however, terns were found in comparatively low numbers. Therefore, low flight heights occur in winter due to the abundance of low flying waterfowl and seabirds and low flight heights occur during the remainder of the year due primarily to low flying gulls.

Therefore, as can be seen in Table 5.5.1 below, segments 1–7 were dominated by low flying waterfowl and high flying gulls along with some low flying seabirds (gannets and alcids) in winter; therefore, overall flight height in winter at segments 1–7 was low to moderate. Moderate to high flying loons also occurred, but in comparatively low numbers. During summer segments 1–7 were dominated by high flying gulls with some low flying seabirds (shearwaters) making for an overall moderate flight height. Moderate to high flying terns also occurred in summer but in few numbers. In fall segments 1–7 recorded mostly high flying gulls with some, but comparatively few low flying waterfowl and seabirds (gannets) making for an overall moderate to high flight height.

Segments 8–14 were dominated by low flying waterfowl and low flying seabirds with some high flying gulls in winter; therefore, overall flight height in winter at segments 8–14 was low. Moderate flying loons also occurred, but in comparatively low numbers. During summer segments 8–14 were dominated by high flying gulls along with low flying seabirds (shearwaters) making for an overall low to moderate flight height. A few high flying terns occurred, but in very low numbers. In fall segments 8–14 recorded mostly high flying gulls with some low flying waterfowl and seabirds (gannets) making for an overall moderate flight height.

Segments 15–25 were dominated by low flying waterfowl and low flying seabirds with relatively few high flying gulls in winter; therefore, overall flight height in winter at segments 15–25 was low. Moderate to high flying loons also occurred, but in comparatively low numbers. During summer segments 15–25 were dominated by low flying seabirds (shearwaters) and some high flying gulls making for an overall low flight height. Again, terns occurred in summer, but in low numbers. In fall segments 15–25 recorded mostly low flying waterfowl and low flying seabirds with some high flying gulls making for an overall low flight height.

Table 5.5.1. Distribution of the most abundant species groups and flight heights by segment and season.

Area	Jan–April	May–August	Sept–December	Average Flight Height by Season	Overall Average Flight Height
Segments 1–7	Low Flying **Waterfowl** and High Flying **Gulls** with Some Low Flying Seabirds (Alcids and Gannets)	High Flying **Gulls** and Some Low Flying Seabirds (Shearwaters)	High Flying **Gulls** with Relatively Few Low Flying Waterfowl and Seabirds (Gannets)	Jan–April – Low to Moderate May–Aug – Moderate Sep–Dec – Moderate to High	20 m – Moderate (between 10 and 20 m)
Segments 8–14*	Low Flying **Waterfowl** and Low Flying **Seabirds** (Alcids and Gannets) with Some High Flying Gulls	High Flying **Gulls** and Low Flying **Seabirds** (Shearwaters)	High Flying **Gulls** with Some Low Flying Waterfowl and Seabirds (Gannets)	Jan–Apr – Low May–Aug – Low to Moderate Sep–Dec – Moderate	17.9 m – Moderate (between 10 and 20 m)
Segments 15 – 25	Low Flying **Waterfowl** and Low Flying **Seabirds** with Few High Flying Gulls	Low Flying **Seabirds** (Shearwaters) and Some High Flying **Gulls**	Low Flying **Waterfowl** and **Seabirds** (Gannets) with Some High Flying **Gulls**	Jan–Apr – Low May–Aug – Low Sep–Dec – Low	9 m – Low (between 0 and 10 m)

* Note that the actual average flight height for waterfowl for segments 8–14 was moderate at ~18m; however, this was because waterfowl had an atypically high flight height at over 60 m at segment 13. The typical flight height for waterfowl at the remaining segments within segments 8–14 was less than 10m.

5.5.3 RARE, THREATENED, AND ENDANGERED SPECIES

As stated in the results, no observations of federally listed piping plover or roseate tern were made during the survey. While these species are known to occur in Rhode Island Sound, with piping plover foraging and breeding on suitable shorelines and roseate tern known to forage and stage in the eastern mainland, it is not well understood to what degree these species migrate across the open waters of the sound. Based on the results of this survey it appears that if the Study Area is occasionally used in this capacity it is likely at a very low level due to a lack of observations over a one year period of intensive survey. It should be noted that some shorebirds that were observed could not be classified to species and that there remains the possibility that a few of these individuals may be piping plover. However, even so, the number of shorebirds in total was extremely low.

Birds of concern, which included a number of the pelagic species, were observed during the study. However, the large majority of these birds were found outside of areas proposed for wind turbines and all of these birds were flying below the rotor swept zone.

5.6 OFFSHORE AERIAL HIGH DEFINITION VIDEOGRAPHY

While the offshore aerial videography survey yielded limited information on species composition, it did provide useful data on bird abundance and spatial and temporal distribution over a large geographic area in a relatively short period of time. Aerial videography also provided an accurate picture of all birds occurring on study area waters during each sample period thereby providing a more complete census of bird numbers, location, and timing than can usually be achieved using human observers.

Based on the result of the videography survey terns, along with unidentified birds, dominated during the late summer period in August; however, overall bird numbers, including terns and unidentified birds were very low (Table 5.6.1). Terns were almost entirely found in transects 1 – 7, although not in transect segment 7C where WTGs are proposed, while unidentified birds occurred somewhat evenly distributed throughout all segments including segments where WTGs are proposed.

Low bird numbers continued through the fall to early winter period (September–January) although the composition shifted and northern gannets, waterfowl, and loon began arriving for the winter and increased in number. Gulls were also consistently present and at times made up the majority of all birds recorded, particularly in September when gulls comprised nearly 90% of all birds. Northern gannets were found throughout most transects and segments and had no distinct spatial distribution pattern, while waterfowl were clustered more in transects 10 and 11, particularly segment 11B, and transects 19 and 20. Loons were mostly found in transect segments 11–20, while gulls were somewhat evenly distributed throughout. Northern gannets were found in somewhat low numbers in all segments where WTGs are proposed except segment 10D. Waterfowl and loons were only found in one segment, where WTGs are proposed, segment 14C. Waterfowl and loons were found in comparatively low numbers in this segment. Gulls were found in most of the segments where WTGs are proposed; however, they were found in somewhat low numbers.

Alcids occurred in relatively large numbers only in January. Alcids were found in low numbers in two of the segments where WTGs are proposed, segments 12C and 14C.

During late winter/early spring (February–March) waterfowl were by far the most abundant group and, as stated above were mostly in transects 10, 11, 19, and 20. Loons were the next most abundant group in February with loons being found mostly in transect segments 11–20, with most being found in segments 14B and 11B, and were relatively few in transects 1–7. With the exception of segment 14C no loons or waterfowl were found in transect segments where WTGs are proposed.

During April northern gannets, gulls, and unidentified birds shared abundance. As state above, northern gannets, gulls, and birds were evenly distributed across the transect segments.

Calculation of ER for all birds combined and for each species group validated the pattern of relative species abundance observed using bird counts. This is because both methods ultimately rely on the total number of each bird group recorded to determine relative abundance.

Density of birds generally followed a similar abundance pattern as seen using both total bird counts and encounter rate. This included expected high densities of waterfowl, loons and gulls and relatively low densities of other offshore bird groups.

Table 5.6.1. Distribution of the most abundant species groups by transect segment and season.

Area	August	Sept–January	Feb– March	April
Segments 1–7	Terns and Unidentified Birds	Gulls, Unidentified Birds, Northern Gannets	Gulls and Unidentified Birds	Gulls, Northern Gannets, Unidentified Birds
Segments 8–20	Unidentified Birds	Gulls, Unidentified Birds, Northern Gannets, Waterfowl, and Loons	Waterfowl, Loons	Gulls, Northern Gannets, Unidentified Birds
Segments where WTGs are Proposed	Relatively Few Unidentified Birds	Northern Gannet – All but Segment 10D Waterfowl and Loons – Only Segment 14C Gulls – Most Segments Unidentified birds – Most Segments	Waterfowl and Loons – Only Segment 14C	Gulls, Northern Gannets, Unidentified Birds

5.7 MERLIN RADAR

5.7.1 Vertical Scanning Radar

The BIWF MERLIN radar collected near-continuous data from February 28, 2009 to September 15, 2011. The radar sampled TPRs and flight heights over the course of one partial winter and two full winter seasons (February 27–March 15, 2009; December 16–March 15 in 2010 and

2011), three full springs (March 16–June 30 in 2009, 2010, and 2011), three full summers (July 1–September 15 in 2009, 2010, and 2011), and two full falls (September 16–December 15 in 2009 and 2010). Average TPRs during the survey period varied across the four biological periods (dawn, day, dusk, and night) and between seasons (winter, spring, summer, and fall), but were generally the greatest during the dawn in summer.

Overall the highest passage rates were recorded onshore during nights in the fall and summer, nearshore during night in the fall, and offshore during dawn in late winter. Peak TPR during the February 28, 2009–September 15, 2011 survey period was recorded onshore at dawn on July 31, 2011 (2,224 t/km/hr). During this period average flight height (286.7 m [940.6 ft]) was well above the RSZ of the proposed BIWF turbines. The highest passage rate recorded in the Nearshore VSR sector was at night on October, 6, 2009, when the mean flight height was 254.8 m (836.0 ft). The greatest passage rate in the Offshore VSR sector was recorded on March 7, 2011 (610 t/km/hr) during dawn; average target flight height was 109.7 m (360.0 ft).

Although the MERLIN system is not capable of determining the taxonomy of target, the type and nature of activity (i.e., general species composition and type of movement) occurring within each of the three radar sectors (Offshore, Nearshore, and Onshore) can be deduced by comparing the temporal distribution of peak TPRs and known avian phenology.

The peak onshore TPR in late summer at dawn (July 31, 2011) could be attributed to early morning foraging activity and local transit of summer resident species on Block Island. The species richness and abundance of landbirds on Block Island peaks in the summer, especially late in summer when young-of-the-year become volant. It could be concluded that the high TPRs recorded onshore during late summer may be a result of increased early morning local bird activity. The next greatest TPRs were recorded onshore and nearshore at night during fall. These high passage rates were most likely the result of nocturnal passerine migration over southeast Block Island and just off the southern shore. During the same period, offshore (at night in fall) TPRs were much lower. Peak nighttime fall TPR offshore was 473 t/km/hr (October 1, 2010). Peak nighttime TPR onshore was 1,552 t/km/hr (October 28, 2010), and 986 t/km/hr nearshore. So on the peak nights of migration offshore, nearshore, and onshore, respectively, offshore TPR was 76% lower than nearshore and 70% lower than TPR onshore.

The results of the BIWF project diurnal avian migration studies indicate that diurnal fall migrants (primarily raptors) move down Block Island from the north, and then leave the island to the southwest heading in the general direction of Long Island, New York. This is also likely the case with nocturnal migrants. Much lower nocturnal TPRs offshore during the fall when TPRs onshore and nearshore were at their peak is a strong indication that the vast majority of nocturnal migrants remain over Block Island or very near to the coast of Block Island. Based on a review of the BIWF MERLIN radar results, BIWF avian acoustics, and the RI Ocean SAMP radar survey, it can be concluded that nocturnal migration is generally greatest during the fall and that nocturnal migrants can be found across the southern coast and nearshore areas of Block Island. Results of the avian acoustic surveys for the BIWF indicate that there was nocturnal passerine migration activity over the southwest corner of the island. From the BIWF MERLIN radar study it is evident that less nocturnal migration occurs offshore than onshore or nearshore.

The increase in nocturnal migration TPR during the fall was not unexpected. It is well known that young-of-the-year migrants (or naïve migrants) increase the overall abundance of individual passerines undertaking migration, especially along the coast. The results of Mizrahi et al. (2010) radar study on Block Island observed a similar increase in passage rates in fall. Mizrahi et al. (2010) also demonstrated a clear increase in average flight heights during the night as compared to day.

Offshore, during the winter and fall periods, average TPR was greatest during the dawn period, whereas during the spring and summer average TPR was greatest during the day. The lowest average TPRs were recorded during dusk in fall and winter, and at night in spring and summer. This seems to indicate that throughout the year average target activity is greatest during the dawn and daylight hours, and is lowest during the dusk and nighttime hours, although nighttime activity during fall was often very high.

Offshore, average and median flight heights were highest during biological periods of high activity (dawn and day) ($\bar{x}$ = 94.9 m [311.4 ft] and 99.2 m [325.5 ft] and $\tilde{x}$ = 52.1 m [170.9 ft] and 51.4 m [168.6 ft], dawn and day, respectively). Offshore during the winter at dawn, when TPR was highest (126.8 t/km/hr), the average target flight height was 98.9 m [324.5 ft]. There are two possible explanations for increased TPR at dawn during the winter: targets may be gulls leaving Block Island to forage at sea for the day, and/or the targets may be seaducks moving from inshore waters further offshore to forage.

Given the timing of peak offshore TPR during dawn in the winter it is possible that this activity is a result of gull and seaduck activity. Data from the boat-based avian surveys confirm this (Table 4.5.4) as do observations made during the MERLIN ground truthing surveys. During the boat-based survey period gull (specifically herring gull and great black-backed gull) encounter rates were highest in the winter. Herring gull ERs peaked in February (32 birds/survey) and great black-backed gull encounters peaked in December (28 birds/survey). Seaduck encounter rates and density were also highest during the winter and early spring. The results of the MERLIN ground truthing surveys indicated that the MERLIN system tracked primarily gulls and waterfowl during the early morning and daytime when visual surveys were performed. Additionally, flight heights of gulls observed during the offshore boat surveys were generally high (above 25 m [82 ft]), and flight heights of gulls tagged on the MERLIN system during ground truthing were often very high (above 150 m [492 ft]) (Section 4.7.6). So although one cannot rule out that seaducks were partly responsible for the increase in passage rates during the winter offshore, it seems that gulls likely comprised a large percentage of targets during this time. Furthermore, the average flight heights recorded during peak periods of activity offshore is likely largely attributable to gulls due to their higher flight heights, although the targets were most likely a mix of seaducks and gulls.

During peak passage rate periods offshore the average target flight height was within, though at the upper portions of, the RSZ of the proposed BIWF turbines. During peak TPR nearshore and onshore the average flight height of targets was generally above the RSZ of the proposed BIWF turbines. Another difference between the Offshore VSR and the Nearshore/Onshore VSR was the seasonal patterns of peak activity. Most peak activity periods offshore were recorded during the fall (70%) and winter (25%), whereas at the Nearshore and Onshore VSR peak activity periods were during the summer (55% and 80%, respectively) and during the spring and fall. At the Nearshore and Onshore VSRs no peak activity periods were recorded during the winter. Additionally, during most peak activity periods offshore average target flight heights were within the RSZ (95% of peak periods), whereas only 20% (nearshore) and 25% (onshore) of the biological period average flight heights were within the RSZ. This indicates that targets generally flew lower offshore and that most activity was during the fall and winter. Nearshore, most targets flew higher (above the RSZ), and peak activity was concentrated in the summer and to a lesser extent in the shoulder seasons (spring [20% of peak periods] and fall [25% of peak periods]). Onshore peak activity was concentrated in the summer (80% of peak periods); there was much less peak activity in spring and fall (10% of peak periods, spring and fall).

Although the MERLIN radar system is not capable of making species level identification, it is possible to infer general patterns in species occurrence based on the peak activity periods in the VSR dataset as well as the results of the boat-based and onshore visual surveys. For example, it was concluded during the boat-based surveys that seaduck abundance was highest, in general, during the fall migration period and winter. Therefore, it is possible to infer that the majority of targets moving through the airspace sampled by the Offshore VSR were likely seaducks. The Offshore VSR coverage area is also the most likely to support migrating and foraging seaducks since it is a greater distance from shore and seaducks were observed during the boat-based surveys (performed within the general airspace of the Offshore VSR). Countless fewer fall peak activity periods were recorded in the fall by the Nearshore VSR than the Offshore, and even fewer peak periods were recorded in fall at the Onshore VSR.

5.7.2 Ground Truthing Discussion

Ground truthing successfully demonstrated the accuracy of the detection capability of the MERLIN radar system, with over 84% confirmation of observer and MERLIN initiated detections. These results indicate that the radar was operating efficiently at recording individual birds moving over select portions of Block Island and all of the proposed offshore Study Area.

During the ground truthing effort the radar observer made observations regarding the general performance of the radar system. General observations made during that time indicate that the vertical radar was least effected by wave clutter, while the horizontal radar was severely affected by wave cluttering during high wind periods, especially when winds were out of the southwest. The radar tracked targets very well under most conditions, and the operation of the HSR during high wind events allowed the radar observer to record incidents of low target confirmation success during ground truthing. Most of the negative confirmation between field observations and the radar operator were the result of obstruction by wave clutter in the HSR or a result of targets being shadowed by the research vessel or other vessels.

The radar was exceptionally good at tracking large pelagic species such as northern gannet; these avian targets were tracked outside of the conceptualized radar sampling area shown in Figure 3.7.2. This supports findings that avian radar may be more effective over water than land (McFarlane and Lester 2005). Smaller targets were tracked in the airspace shown in Figure 3.7.2, but not much beyond that. There was at least one incident during the radar ground truthing survey where a small passerine species was observed from the research vessel at approximately 5.2 km (2.8 nm) from the coast, and was tracked on horizontal and vertical radar to the island. During observations it was noticed that, on occasion, a target moving through the airspace behind a vessel was lost from the radar display screen, but was often picked up again on the opposite side of the boat. Other radar shadows occurred on the island where topography and/or vegetation blocked portions or the entire radar beam and therefore caused the airspace behind the radar shadow to be under-sampled. This was likely due to the radar's optimization for sampling the airspace offshore and not onshore. There were no radar shadows observed in the offshore Study Area.

It appeared that the radar was tracking larger targets better than smaller targets at the far edge of the radar's range. This was most apparent in the HSR operations; VSR appeared to have the same sensitivity throughout its range. The horizontal radar did not track boats during normal operations, while the vertical scanning radar did track boats; these boats were tagged during ground truthing so that subsequent boat tracking information can be excluded from the final dataset.

The point count surveys also provided relevant data on species composition, relative abundance, and seasonal migratory patterns. Of the greatest significance was the information gleaned about temporal variations in seasonal abundances of species groups, such as seaducks, and the composition of the coastal avian community during the spring migration period. Flight height and flight direction data from the ground truthing effort provide a thorough assessment of species specific flight characteristics during spring migration.

A marked decrease was observed in both abundance and species diversity of seaducks and pelagics as the survey period progressed from late winter through late spring. The seaduck species observed during the survey period represent a fairly typical assemblage for a New England coastal area (Robertson and Savard 2002, Elphrick et al. 2001, Goudie et al 2000). The species observed included scoter species, long-tailed duck, common eider, and merganser species. None of these species are federally or state listed; however, seaducks are a species group of concern due to observed indirect displacement impacts from offshore wind development in Europe (Desholm et al. 2006a).

The higher concentration of ducks observed along the southwest coastal area was to be expected due to the lower water depth (Robertson and Savard 2002, Ford and Gieg 1995, Beauchamp 1992, Goudie and Ankney 1988, Peterson and Ellarson 1977). Lower depths allow for better foraging opportunities for nearly all species observed during the survey period.

The trend observed in the abundance of diver species indicates that the majority of individuals were wintering in the Study Area and summering elsewhere. The increase in diver observations recorded during May was likely the result of loons observed in flight as they moved toward breeding areas to the north, coupled with the influx of double-crested cormorants (a summer resident) moving into the coastal waters of Block Island (Goudie et al. 2000, Ford and Gieg 1995). The wintering community of seaducks, loons, grebes and great cormorants was gradually replaced by double-crested cormorants and other summer residents. An influx of spring migrants was similarly observed in the species composition of the onshore passerine community, which gradually diversified as the survey period progressed and more spring migrants arrived.

The results of the horizontal radar ground truthing effort indicate that gulls were the most frequently "tagged" (confirmed) biological targets, followed by passerines and divers. It is likely that this observed trend in the ground truthing success for different species groups is due to the behavior, conspicuousness, or abundance of the species. For example, gulls were likely the most frequently confirmed biological targets because they are large, had high average flight heights, and were abundant. These traits increase the likelihood of confirming a target tracked on the

MERLIN display, compared with, for example, a ground dwelling species such as ring-necked pheasant. For other species groups such as passerines, the high success rate in confirming their detection on the horizontal radar was likely a result of the large number of individuals observed in the Study Area. Diver species were also frequently confirmed on both the vertical and horizontal radar displays. The majority of these individuals were common loon, one of the largest birds in the region and one of the most conspicuous in flight. The large size would provide for a higher radar reflective area, and therefore increases the likelihood of confirming them as targets on the radar; they were also abundant.

The flight direction of avian targets moving through the offshore Study Area was well documented by the large sample size of ground truth tagged targets. The vast majority of individuals flew towards the northeast or east-northeast during the spring study (Appendix B). This is to be expected due to the overall pattern of migration trending northeast in the spring. However, the micro-topography of the island's coast, as well as the micro-climactic factors of the offshore Study Area, indicate that avian target movements southeast of the island trend away from the proposed preferred development area. Targets generally moved parallel to the proposed turbine string and did not move perpendicular under most circumstances; the most indicative evidence to support this comes from the large number of northern gannet and loon species tracked by the MERLIN radar and confirmed by the radar observer. Over the course of the survey period 2,239 northern gannet were ground truthed tagged on the HSR; the average flight direction of these targets was 69.5°. Additionally, 2,020 loon species were confirmed with an average flight direction of 60.4°. Both northern gannet and loons (most targets were common loon) are known migrant species, leaving coastal waters in early and mid-spring to migrate north to breeding grounds. Therefore, it is apparent that because the majority of targets tagged on the horizontal radar were gannets and loons, and the average flight direction was perpendicular to the preferred project location, there is probably little spring migration activity, at least by large bodied water birds directly through the Study Area, perpendicular to the proposed turbine array. Gull species movements also trended northeast, and the majority of gulls are considered non-migratory, which may indicate that general avian movements, during migration and otherwise, tend to be towards the northeast/southwest axis, parallel to the proposed turbine string configuration.

The spring 2009 point count surveys and radar ground truthing effort provide a detailed characterization of the spring migration period and the functionality of the MERLIN Avian Radar System. The surveys identified a transition in species composition from winter residents to spring migrants and summer residents. Overall the average flight height was 85 m (278 ft) for ground truthed targets in the long-range vertical radar, which provided information out to 5.6 km (3 nm) and is therefore likely the most representative of the preferred development location. Overall flight direction averaged northeast, which brings the heading of most birds moving through the Study Area on a course parallel to the proposed turbine string. These data provide valuable information on spring migration and demonstrated the effectiveness of the avian radar system. Taken as a whole, this information and the results of the planned 2009/2010 surveys will allow a comprehensive assessment of, characterization of, and risk assessment for the avian community in the Study Area.

5.8 VESPER RADAR

Results of the VESPER surveys indicated that there was very little use of the airspace above Block Island by bats. At the radar site steeply ascending and descending movements were noted occasionally, mostly in the fall than the spring. The VESPER radar provides supplemental information to the bat acoustic surveys. Both monitoring techniques revealed that bat activity is generally minimal on Block Island in coastal waters.

Deepwater Wind was also able to evaluate the effectiveness of the VESPER radar technology during the BIWF avian surveys. It is clear that there is potential for the VESPER radar to be an excellent tool for assessing nocturnal avian and bat migration offshore. The systems should be considered for use during assessments of larger offshore wind farms in the future. Because of the smaller size of the VESPER, as compared to the MERLIN unit, as well as the relatively "finer-grained" data it produces the radar shows promise to become a standardized survey technique. However, advances in signal processing and analysis need to catch up with the current state of the data gathering abilities of the system.

5.9 NEXRAD AVIAN ASSESSMENT

Archived NEXRAD data were analyzed to determine if biological activity was significantly greater at the Block Island site than at the comparison sites along the coast. The Block Island site data indicated that the site was not the location of the greatest levels of activity when compared to the other sample sites for all years, all months, and at all times of day; in fact, the Block Island site generally ranked near the bottom. It also ranked low during spring migration, and achieved a lower middle ranking during the fall. There are no published data that suggest that migratory birds fly into wind turbines that are clearly visible. Subsequently, nighttime—when low visibility conditions occur at the same time as migration—would be the period of time when mortality risk is greatest. To further understand this risk probability, visibility data were collected from the weather reporting station closest to the proposed BIWF site. These data show a low percentage of low visibility conditions.

As wind projects move offshore, the northeast U.S. Atlantic coast is an area of concern for the potential impacts of wind farms on migratory bird movements. While NEXRAD data do not indicate that the proposed site is a migration "hot spot," a significant movement of biological targets is still possible in the region, particularly to the west and south of the Study Area. The NEXRAD data support a movement pattern of birds inland of the proposed location, more consistent with a trajectory for bird movements inland over Massachusetts and Connecticut and towards Long Island. Bird activity levels are higher at all of the inland locations compared with any of the seven offshore sites included in this study. During fall migration, the only offshore sites that showed an uptick in biological activity were sites 7 and 5. Further support of this pattern is illustrated by a compilation of all the reflectivity data from the KBOX and KOKX stations for the entire 2010 year (Figure 4.9.9). To eliminate the effects of weather, only images that were in clear air mode were used, and any Z values above 200 were omitted. Again, this depicts bird activity focused over land in Massachusetts, Connecticut, and Rhode Island, with lower activity levels over water in the Study Area compared with off the coast of Long Island.

6.0 RISK ASSESSMENT

The intention of Section 6 is to evaluate the potential risks to birds and bats from the BIWF. Sections 6.1 through 6.5 define the potential risks to birds and bats from the construction and operation of the proposed BIWF. These sections also describe the possible magnitude of the risks. Measures to avoid or minimize risk to birds and bats are discussed in Section 6.6.

The framework for the risk assessment was adapted from Garthe and Hüppop (2004), Fox et al. (2006), Petersen et al. (2006), and MacLean et al. (2009). The evaluation methods were developed in coordination with USFWS, including comments made on the Draft Avian and Bat Risk Assessment Methodologies (Deepwater Wind and Tetra Tech 2009).

Risk was evaluated qualitatively, but the evaluations were informed by site specific empirical data. Empirical data were culled from the BIWF Offshore Study Area (data from the boat-based and aerial videography surveys), BIWF Study Area (data from the Block Island Onshore Study Area and the Offshore Study Area), and from the Block Island MERLIN avian radar system.

Five risk categories were evaluated and included both construction and operational impacts. These were also further divided into direct and indirect effects, and include:

1. Construction
    a. Direct Effects
        i. **Direct habitat loss and change**
    b. Indirect Effects
        i. **Disturbance during construction**
2. Operational
    a. Direct Effects
        i. **Collision during operation**
    b. Indirect Effects
        i. **Displacement of foraging birds during operation**
        ii. **Barrier effect on birds transiting or migrating through the area during operation**

Concerns have been raised that some bird species may be displaced from areas near the turbine locations during construction (temporary effects) and operation (longer term) (Drewitt and Langston 2006). A lack of validated research on potential displacement effects in general (Stewart et al. 2007), and specifically for seabirds and other species using the marine environment, makes predicting the level of impact difficult, but there are some existing studies of wind farms in northern Europe that provide useful data. Post-construction surveys at offshore wind farms in the North Sea have demonstrated that birds, and to a lesser extent bats, may avoid areas where offshore turbines are installed (Guillemette and Larsen 2002, Christensen and Hounisen 2004, Fox et al. 2006, Ahlén et al. 2007).

During construction of the wind farm birds may be disturbed by increased vessel traffic and construction equipment. During operation of the wind farm avoidance behavior can impact birds in two ways: the turbines may displace birds from foraging in the area resulting in indirect habitat loss and/or the wind farm may act as a barrier to movement (Fox et al. 2006). Other impacts include the potential direct impacts to altered seafloor and airspace habitat as well as direct impact to individual birds through collision with turbine blades or towers.

6.1 CONSTRUCTION IMPACTS

6.1.1 DISTURBANCE DURING CONSTRUCTION

Introduction

Disturbance during construction is the disruption of normal behavior patterns of birds in the Project Area during construction and decommissioning, and is differentiated from avoidance during operation by the shorter duration of impact. Episodic and short duration construction and decommissioning activities such as increased vessel traffic and loud noise may disturb birds feeding, staging, transiting, or migrating through the BIWF Project Area.

Evaluation

During construction and decommissioning of the BIWF, noise and vessel activities will likely displace some birds. Additionally birds are likely to avoid the operational wind farm because of the WTGs and associated foundation structures. The installation of the turbine jacket foundations and associated pile driving is anticipated to occur between May and June 2014. Installation of the WTGs themselves will not begin until after the jacket foundations are in place. Turbines will be installed as early as June and installation will be completed by the end of July 2014. Installation of the WTGs may disturb summer residents foraging or transiting through the area where turbines are being installed. The risk of impacts from disturbance to birds in the BIWF is expected to be minimal.

During the BIWF avian surveys overall relative abundance and densities offshore were low during the late-spring and summer period. During the BIWF boat-based surveys there were a total of only 62 encounters with birds in June and July in the area where WTGs are proposed. Forty-eight percent of these birds were shearwaters, 31% were gulls, and 11% were northern gannets, while the remaining encounters were terns and storm-petrels. Overall these 62 encounters represent less than 0.9% of all bird encounters. Cumulatively there were 170 encounters within 1 km (0.6 mi) of the proposed WTG area, 199 within 2 km (1.2 mi), and 276 within 4 km (2.5 mi). In the worst case birds would be disturbed at a distance of 4 km (2.5 mi) from the BIWF WTG installation area (a distance greater than what has been observed in Europe for most species [BOWind 2008]) during the June and July construction period. Because the abundance of species occurring within the WTG area during the construction period is low, there is not a sizeable enough population of birds present for the risk of disturbance impacts to be significant.

Installation of the subsea export cable may disturb benthic communities and therefore may impact species that forage on benthic invertebrates (i.e., seaducks). Although avian surveys were not performed over the entire area where the subsea export and transmission cables will be installed, the water depth (approximately 25 m [82 ft]) in these areas is generally greater than what is considered accessible by avian species that forage on benthic organisms in Rhode Island Sound (Winiarski, Trocki et al. 2011). For the portion of the subsea export cable that was surveyed during the BIWF avian assessment, no seaducks (e.g., common eider and scoters) were observed from May through July when the cable installation is expected to occur. In sum, installation of the cable will not impact foraging seaducks because the water depth along most of the cable route is too deep, and seaducks are generally absent from the BIWF Project Area during the proposed May to July construction period.

There is potential for cable installation activity to disturb birds nesting along coastal Block Island and Rhode Island. Any breeding birds on either Block Island or on mainland Rhode Island in coastal and upland areas adjacent to the waters where subsea transmission cables are being laid will not be affected. There will be no impact on these populations because the cable-laying vessel will be more than 4 km (2.2 nm) from shore during most of the installation period, and because the vessel will move progressively and predictably in a manner similar to other recreational and commercial vessel traffic in the area. The cable landfall sites on Block Island and on the mainland were evaluated for RTE species. No state or federally listed species are known to nest at the proposed cable landfall sites (Enser 2006).

Conclusions

The potential for disturbance during construction to impact migrating, resting, or feeding birds and bats is low. Furthermore, any disturbance impacts are unlikely to have an effect on population fitness because the abundance of birds and bats in the area during the proposed construction period is low, and construction activity will be short in duration, limited in spatial area, and is not expected to appreciably increase vessel traffic above current levels.

6.2 OPERATIONAL IMPACTS

6.2.1 DIRECT COLLISION

Introduction

Birds and bats are known to collide with moving turbine blades and stationary components and may also be physically harmed by air turbulence around turbines, both at land-based and offshore facilities (Langston and Drewitt 2008). Turbine lighting, weather conditions, and visibility are the most significant factors effecting collision risk. However, birds and bats have been identified as groups at risk of collision with offshore turbines primarily because they have been frequently found as victims of collisions with land-based wind turbines (Erickson et al. 2005; Drewitt and Langston 2006; Arnett et al. 2007).

The actual impact on populations from the increased mortality rates as a result of collisions has not been adequately addressed in the literature. Nonetheless, resilience to increases in mortality varies among avian populations and species due to differences in reproductive strategies, population size, as well as adult and juvenile survival rates (Fox et al. 2006). For example, migrant passerines (e.g., songbirds) are found more often in post-construction mortality monitoring at land-based wind facilities compared with other groups of birds (Arnett et al. 2007). In North America at newer generation land-based wind energy facilities outside of California approximately 80 percent of documented mortalities have been songbirds, of which 50 percent are often nocturnal migrants (Erickson et al. 2001, Drewitt and Langston 2006, Johnson et al. 2007, Strickland and Morrison 2008).

It is important to note that flight behavior, in general, and avoidance of turbines during flight, specifically, are important variables to incorporate when estimating collision risk (Chamberlain et al. 2006; Garvin et al. 2011). Post-construction monitoring at the Nysted and Horns Rev offshore wind farms in Denmark demonstrated that most birds (more than 90%) that were on a flight trajectory towards the wind farm avoided passing near or between turbines. General estimates of fatality rates for common eider were modeled from the results of avian radar surveys and thermal imaging systems at Nysted wind farm (Petersen et al. 2006). Petersen et al. (2006) were able to conclude, with 95% confidence that out of 235,000 eiders passing by the facility, between 0.018 and 0.020% would collide with all turbines during fall migration.

There is little information available on estimated fatality rates at operating offshore wind farms in Europe. It is not possible to conduct traditional ground searches for birds or bats killed by the turbines offshore. Although technology has been employed to help assess fatality rates, including thermal imaging systems (Desholm 2003), there are currently little data available on operating offshore wind farms to use for predictive purposes. Therefore, post-construction monitoring will be important for risk validation, especially for the first offshore wind farms build in North America.

Collision Risk Evaluation

Collision risk was primarily evaluated by reviewing what data currently exist for bird collisions at existing offshore wind farms as well as the specific abundance and distribution patterns of birds within the BIWF Study Area. Although little data are available for making specific predictions on collision numbers, data from European offshore wind farms provide some estimation of potential impacts to particular species and species groups. As previously stated, only a very small percentage of bird groups evaluated were found to directly collide with turbine blades; the large majority of birds avoided the turbines.

During the offshore boat-based and radar studies it was found that overall numbers of birds were very low in comparison with regional populations and surveys conducted in the nearshore and onshore environment. Also, of the birds recorded within the Study Area only a small percentage were found within the area where WTGs are proposed, and overall flight heights were generally low and below the typical RSZ. Therefore, it is anticipated that even a worst case scenario (where all birds within 4 km [2.5 mi] of the WTGs could potentially collide with turbines or other structures) would have a relatively minor effect on overall regional populations because the overwhelming majority of these birds would successfully navigate around or altogether avoid the turbines. The more likely scenario (where all birds within 1–2 km (0.6–1.2 mi) of the WTGs would be susceptible to direct collision) further reduces the number of birds at risk, especially when factoring in the overall low flight height of birds found within the Study Area. The most likely scenario, therefore, is that few birds would actually be susceptible to collision and only a very small percentage of these would result in fatalities.

Despite the evidence that the greatest number of avian fatalities at wind farms are songbirds, raptor mortality has historically received the most attention due to (1) the relatively greater impact of mortality to long-lived species with low reproductive rates, and (2) sensitive species concerns (e.g., bald and golden eagles). Raptor mortality at newer land-based wind projects has been low relative to older-generation wind farms, although there is substantial regional variation in raptor mortality rates (ranging from 0 to 0.87 raptors/MW/study period [summarized in Bay et al. 2011]. Although limited, previous research suggests that raptor occurrence (use) at proposed wind energy facilities may be a factor in calculating risk of mortality (e.g., Erickson 2007). However, no raptors were observed within the Project Area where turbines are proposed during any of the site-specific avian surveys; raptors were primarily found only on Block Island or in nearshore areas. Furthermore, comparisons with raptor observation data at four Northeast hawk watch sites suggest that the BIWF Study Area does not serve as a significant raptor migration corridor (Section 4.2). Therefore, the potential collision risk to raptors in the offshore Study Area appears to be very low.

Finally, even if one assumes a positive relationship between avian (or bat) occurrence in a project area and mortality, it is important to keep in mind that not all individuals passing through the RSZ will encounter turbines. Additionally, most risk models assume no avoidance, which is known to be far from the truth. Thus, whether individuals simply do not encounter turbines or actively avoid them in flight, the percentage of those individuals passing within the RSZ actually colliding with turbines is likely to be very low.

Based on the above assessment as well as known collision risk information from European offshore wind farms, the turbine collision risk for birds and bats at the BIWF will be low to very low. This risk can be further reduced through measures taken during the design and construction phases of the Project including avoidance and minimization measures such as siting the turbines away from areas known to concentrate birds (e.g., coastal shallow areas, mudflats).

Evaluation Visibility

Visibility is thought to be a major factor influencing collision at wind farms. Nocturnally migrating passerines in particular are known to be at a higher risk of collision during periods of low visibility. The impact of poor visibility on species that may be at risk in the marine environment is not as well known (Petersen et al. 2006). Post-construction monitoring data from Horns Rev and Nysted did not include enough observations during poor visibility to determine the effect of visibility on collision risk.

Visibility data from the Block Island State Airport in Block Island, Rhode Island (Northeast Regional Climate Center 2011) were available from July 14, 2009 through September 15, 2011, or 85% of the BIWF avian study period (the BIWF avian studies ran from February 27, 2009 through September 15, 2011). The visibility sensor at the Block Island State Airport is located on the airport property at an elevation of 34 m (110 ft) above mean sea level. Visibility data were recorded hourly; of the 19,056 hours recorded between July 14, 2009 and September 15, 2011 a total of 16,187 hours of visibility data were available (Table 6.2.1). Relative visibility was assessed in miles. Visibility ranged from 0.19 mi to 10 mi. Visibility distances were then combined into five categories; Very Poor (0.19–0.25 mi), Poor (0.5–1.25 mi), Fair (1.5–2.5 mi), Good (3–6 mi), and Excellent (7–10 mi).

Table 6.2.1. Visibility totals from July 14, 2009 to September 15, 2011 at the Block Island State Airport by visibility category, season, and time period.

Time Period	Very Poor	Poor	Fair	Good	Excellent	Total Hours
Winter Days	21	54	69	144	1,689	**1,977**
Winter Nights	8	57	57	161	2,054	**2,337**
Spring Days	36	46	16	108	962	**1,168**
Spring Nights	41	49	40	158	1,102	**1,390**
Summer Days	21	51	54	117	2,040	**2,283**
Summer Nights	**59**	95	73	301	2,180	**2,708**
Fall Days	43	33	44	134	1,734	**1,988**
Fall Nights	38	33	30	193	2,042	**2,336**
Total Hours	**267**	**418**	**383**	**1,316**	**13,803**	**16,187**

During most hours of the day and night visibility at the Block Island State Airport was Excellent (*n* = 13,803 hrs, 85.3%). Visibility was Good 8.1% (*n* = 1,316 hrs) of the time, and during only 2.6% and 1.6% of the time was visibility Poor or Very Poor, respectively. A majority of the Very Poor (22.1%) and Poor (22.7%) visibility periods were recorded during the night in the summer. The fewest Very Poor (3.0%) and Poor (7.9%) visibility periods were recorded during winter nights, and fall days and nights (fall days and nights were tied for the least number of Poor visibility hours), respectively (Figures 6.2.1 and 6.2.2).

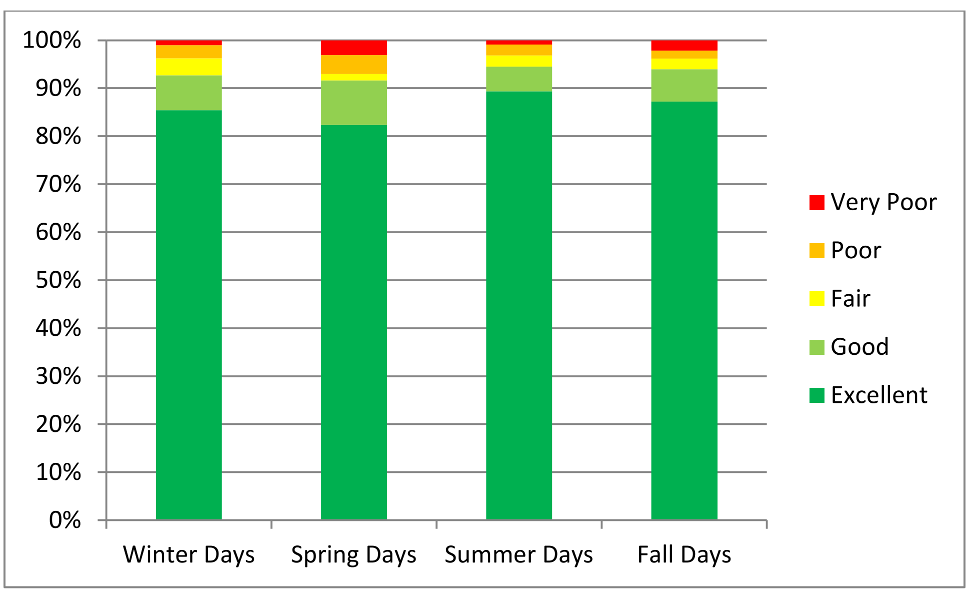

Figure 6.2.1. Percentage of hours of Very Poor, Poor, Fair, Good, and Excellent visibility during the daytime at the Block Island State Airport.

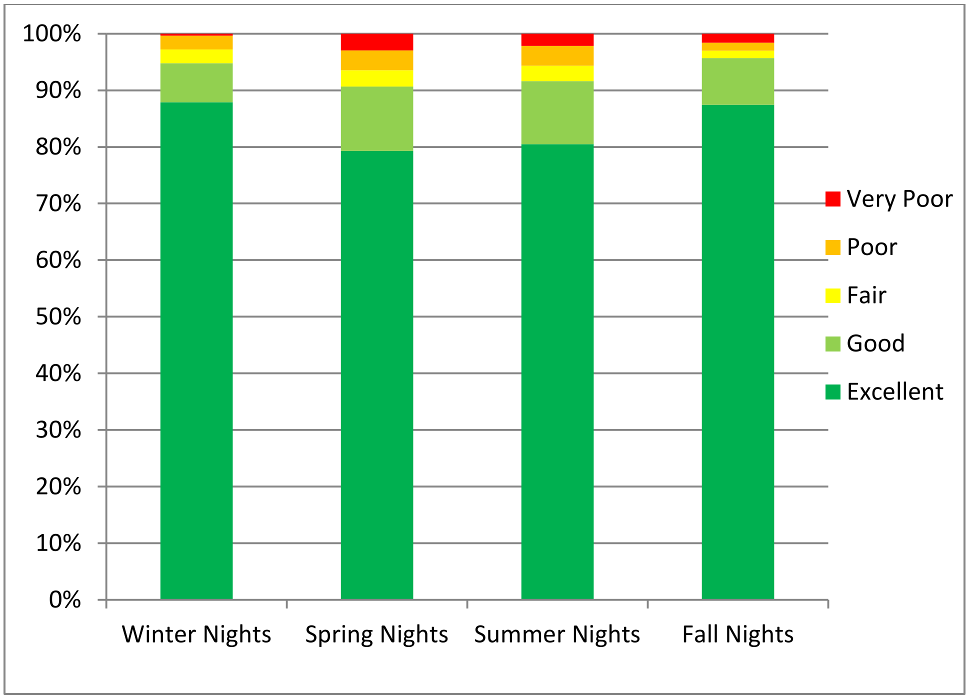

Figure 6.2.2. Percentage of hours of Very Poor, Poor, Fair, Good, and Excellent visibility during the night at the Block Island State Airport.

Average passage rates from the BIWF MERLIN Offshore VSR sector were compared to the Block Island State Airport visibility data (Figures 6.2.3 and 6.2.4). During the MERLIN avian radar studies the highest average passage rates offshore were recorded during dawn in fall, during the day in fall, and during dawn in the winter. Average offshore passage rates during all other survey periods were substantially lower. Also, during both day and night in all seasons, seasonal average passage rates were lower during longer periods of Poor and Very Poor visibility. This was especially evident during the night in summer.

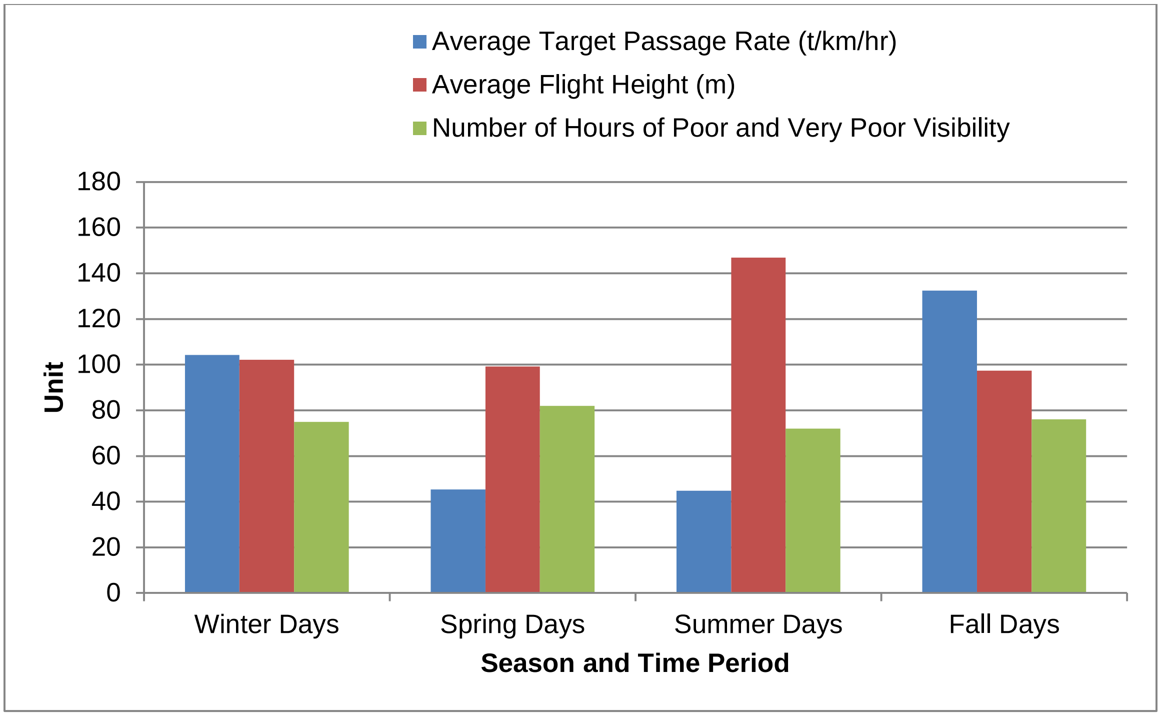

Figure 6.2.3. Passage rates from the Offshore VSR during the day, by season, compared with average flight heights and the number of poor and very poor visibility hours – BIWF 2009–2011.

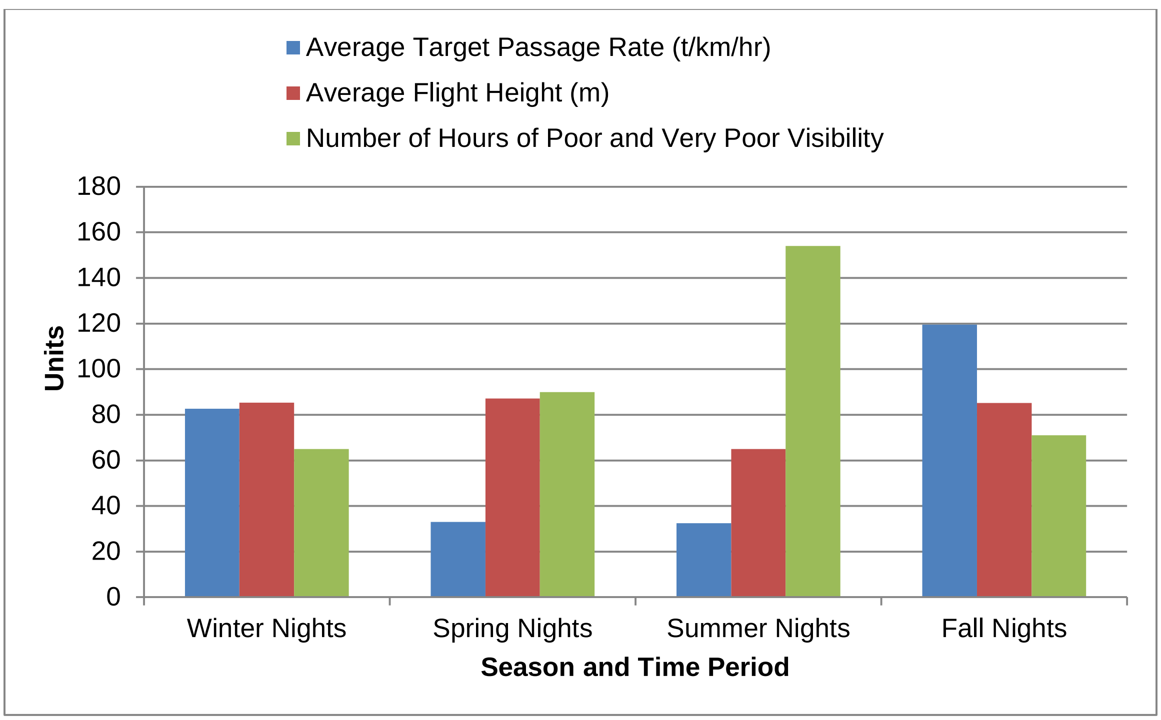

Figure 6.2.4. Passage rates from the Offshore VSR during the night, by season, compared with average flight heights and the number of poor and very poor visibility hours – BIWF 2009–2011.

Conclusions

No federally listed avian or bat species were observed during the BIWF survey period. Raptors were not found in the BIWF Project Area, and collision risk to these species is therefore considered very low. Other bird groups including seabirds, waterfowl, loons, and cormorants were found in the general Study Area (mostly southwest of the proposed WTGs); however, relative abundance of all these bird groups was low within 1 km (0.6 mi) of the Project Area. In addition, flight heights were low overall, further reducing the risk to birds even found in close proximity to the proposed wind farm. Therefore, it is expected that the proposed project would have a minor direct collision risk to bird populations in comparison with siting the project in other offshore environments.

6.2.2 DISPLACEMENT OF FORAGING AND RESTING BIRDS DURING OPERATION

Introduction

Displacement is defined as a shift in the distribution of foraging birds during operation of the wind farm and results in an effective reduction in foraging habitat that may affect fitness at the individual or population level. The impacts of displacement are especially significant if regionally important foraging sites become unavailable to individuals or whole populations of birds. (See Section 6.2.3 for an evaluation of the displacement of transiting or migrating birds, and Section 6.1.1 for an evaluation of the displacement of birds during construction.)

Post-construction monitoring studies from the North Sea found that the most abundant species in the Nysted wind farm area prior to construction exhibited the greatest avoidance of the wind farm after construction (Petersen et al. 2006). Species that both did and did not display a preference for the wind farm area prior to construction also avoided the area post-construction (Petersen et al. 2006). Some species (herring gull) seemed to have a slight attraction to the wind farm area after construction, but no species showed a significant increase in use of the area after turbines were constructed (Petersen et al. 2006). Petersen et al. (2006) concluded that although many species avoided foraging in the wind farm areas after construction, the proportion of the available foraging habitat effectively lost to the population due to the development was relatively small. Only at a large scale, perhaps for multiple offshore wind projects concentrated in a small spatial area, may biologically significant effects be expected (BOWind 2005; Petersen, Christensen et al. 2006; Petersen and Fox 2007; BOWind 2008). Species considered most likely to exhibit turbine avoidance behavior based on post-construction monitoring in Europe include scoters, loons, long-tailed ducks, and cormorants (Perrow et al. 2006). Research on seaducks at an operational offshore wind facility in Europe documented varying magnitudes of displacement (Guillemette and Larsen 2002, Guillemette and Larsen 2007) and revealed that displacement effects were significant only in areas that had been previously used for foraging (Guillemette and Larsen 2007). In addition Guillemette and Laresen (2007) were able to demonstrate that habitat loss within the turbine area was not always complete and that individuals were still able to forage in the inter-turbine areas. There was effectively no displacement in areas where birds practiced no or little foraging prior to construction.

The results of the BIWF avian surveys and the RI Ocean SAMP provide information on the relative importance of the BIWF Study Area and surrounding region to foraging and migrating birds in Rhode Island Sound. By examining the relative abundance and occurrence patterns of birds within the BIWF Study Area and in the context of regional trends it was possible to assess the level of risk of displacement from the BIWF to specific species groups as well as to birds as a whole. Seaducks, gannets, terns, and other species (particularly scoters, loons, long-tailed ducks, and cormorants [Perrow et al. 2006]) that currently forage in the BIWF Study Area are more susceptible to displacement because they forage at higher densities in the BIWF Project Area (Guillemette and Larsen 2007). This displacement would constitute an effective loss of a portion of available foraging habitat and may result in reduced food consumption or elevated energy expenditure (Fox et al. 2006).

Evaluation

Winiarski et al. (2011) estimated the size of the RI Ocean SAMP study area to be 4,000 km^2 (1,544 mi^2). However, only certain portions of the SAMP study area contain suitable foraging habitat depending on the species guild. For example, an area approximately ≤ 25 m^2 (≤ 82 ft^2) in size has water depths suitable for foraging seaducks, while other species that forage on demersal fish may be less restricted in their selection of foraging sites. Assuming that all of the BIWF Project Area as well as the 1, 2, and 4-km (0.6, 1.2, and 2.5-mi) buffers around the Project Area contain suitable foraging habitat for at least some species groups, the BIWF Project Area still only constitutes a small percentage of the total available foraging habitat in Rhode Island Sound. For example, the 4-km (2.5-mi) buffer around the BIWF encompasses 83.5 km^2 (32.2 mi^2) and is assumed to be the worst case scenario scale of effective foraging habitat lost as a result of displacement. At worst the BIWF has the potential to cause an effective loss of approximately 2.1% of available foraging habitat within the region (i.e., the RI Ocean SAMP study area). This 2.1% effective loss assumes that all areas in Rhode Island Sound are equally suitable for foraging birds (likely not the case) and that birds will exhibit complete avoidance of the BIWF at 4 km (2.5 mi) (also likely not the case, as demonstrated by Petersen et al. [2006]).

Individual species exhibited different foraging preferences within the BIWF Study Area (Table 6.2.2). Samples of bird activity within each of the three avoidance threshold buffers were derived from the boat-based surveys. Loons exhibited foraging preferences for the 1-km (0.6 mi) buffer, as did shearwaters, storm-petrels, and terns. Cormorants were not observed foraging within 1, 2, or 4 km (0.6, 1.2, or 2.5 mi) of the BIWF Project Area. Seaducks were also not observed foraging within 1 and 2 km (0.6 and 1.2 mi), but 93% of all foraging seaducks encountered during the boat-based surveys were observed within 4 km (2.5 mi) of the BIWF Project Area. Northern gannets did not show a strong preference for areas within 1 or 2 km (0.6 or 1.2 mi) of the Project Area, although 38% of all foraging gannets encountered were within 4 km (2.5 mi) of the BIWF.

Assuming that the boat-based surveys provided a representative sample of avian foraging patterns in the Study Area, the percentages listed in Table 6.2.2 provide a rough estimate of the portion of the avian population in the BIWF Study Area expected to be susceptible to displacement, with displacement being incurred by all birds found within 1 km (0.6 mi) of the Project Area. For example, 92% of all foraging shearwaters encountered during the boat-based surveys were within 1 km (0.6 mi) of the BIWF Project Area. It can be inferred that the BIWF may effectively exclude a large majority (92%) of the shearwaters foraging in the BIWF Study Area. This evaluation is also applicable for the other species and species groups in Table 6.2.2. For most species, including those found to be particularly susceptible to displacement in European studies (e.g., loons, cormorants, and certain waterfowl) only a small portion of the population occurring within the BIWF Project Area would incur effective loss of foraging habitat.

Table 6.2.2. Percentage of total count of each species or species group observed foraging or resting on the water within the BIWF Offshore Study Area at a 1-km, 2-km, and 4-km buffer.

Species / Species Group	1 km	2 km	4 km	Total Birds Encountered (*n*)
Loons	30%	43%	62%	338
Cormorants	0%	0%	0%	5
Shearwaters	92%	92%	95%	120
Storm-petrel	60%	63%	77%	65
Northern gannet	20%	20%	38%	250
Alcids	17%	31%	66%	149
Waterfowl	0%	0%	93%	333
Gulls	16%	22%	33%	748
Terns	35%	45%	85%	20
OVERALL*	**27%**	**28%**	**56%**	**2,034**
Bats**	0%	0%	100%	16*

Note: Percentages also represent the estimated portion of the population using the BIWF Study Area that would incur effective loss of foraging habitat within each buffer area after construction of the BIWF.

* Includes birds that were not identifiable; species and species groups include only positively identified birds.

** Values are for total number of bat call sequences recorded, not individual bats.

Seaducks often exhibit high fidelity to foraging areas and would therefore likely be more susceptible than other species groups to displacement (Robertson, Cooke et al. 2000). However, seaducks (the most abundant species group in Rhode Island Sound) were not observed foraging within 2 km (1.2 mi) of the BIWF Project Area.

Habitat conditions may be the underlying reason why relatively few birds such as seaducks were found to occur within the immediate Project Area. For example, the mean water depth of the BIWF Study Area is 26.1 m (85.7 ft), while the mean water depth where the WTGs are proposed is approximately 25.2 m (82.7 ft), with a minimum depth of 23 m (75.5 ft). Paton, Winiarski et al. (2010) found evidence of seaducks in the RI Ocean SAMP study area foraging at depths up to 25 m (82 ft), thus it is probable that the waters within the 1 and 2-km (0.6 and 1.2-mi) buffers are somewhat suiteable for seaducks to forage. While the possibility of individual seaducks foraging in the Project Area cannot be ruled out, waters south of the Project Area are more shallow and likely provide better foraging habitat. Consequently, the BIWF is likely to have proportionately less of a displacement effect on foraging waterfowl at the currently proposed project location than at a site situated in more shallow waters such as to the southwest where a greater number of seaducks were observed.

Conclusions

Disturbance may impact birds at a distance of 1–2 km (0.6–1.2 mi) (the distances at which avoidance behavior manifests) for most species (gulls and seaducks), and perhaps up to 4 km (2.5 mi) for some species (loons) (Kahlert, Desholm et al. 2000; Petersen, Christensen et al. 2006). If birds avoid foraging near the BIWF at a distance of 1 km (0.6 mi) the effective loss of foraging habit would be 11 km^2 (4 mi^2); at 2 km (1.2 mi) there would be an effective loss of 28 km^2 (11 mi^2)of foraging habitat; and at 4 km (2.5 mi) 83.5 km^2 (32 mi^2) of foraging habitat would effectively be lost (Figure 6.1.1).

At a regional scale, the worst case scenario assumes a total loss of all effective foraging habitat within the entire 4 km (2.5 mi) buffer, or about 2.1% of available habitat in Rhode Island Sound; however, it is likely that the actual loss of habitat is considerably less. This is based on the fact that only a minor percentage of all birds recorded in the BIWF Study Area were found within 1 km (0.6 mi) of the BIWF Project location. Also, calculations of the scale of foraging habitat effectively lost due to displacement assumes complete avoidance and also assumes that all portions of the habitat within each buffer are equally suitable for foraging. In reality birds are unlikely to exhibit 100% avoidance, and the habitat within each buffer area is not homogenous.

Because the size of the habitat effectively lost due to the BIWF is a small proportion of the total available foraging habitat for all species in the region, and the use of the BIWF area by foraging birds is relatively low, it is concluded that there will not be a significant displacement effect on the avian population of Rhode Island Sound as a result of the Project.

6.2.3 Barrier Effect

Introduction

Avoidance is a long-term change in a migrating or transiting population's behavior in response to an offshore wind farm. Avoidance behaviors may cause individuals to alter migration or daily transit flight routes (e.g., the wind project may act as an effective barrier to movement) in an effort to evade the wind farm. Increases in flight distance may cause a reduction in fitness for those birds that occurred in the Project Area prior to construction of the wind farm, due to increased demands on energetics (Fox et al. 2006). (Fitness refers to the ability to survive and reproduce and is a function of, among other factors, adult survival rates and demographic stochasticity [Saether et al. 2004].) Avian and bat species will likely exhibit some avoidance behavior, requiring some redirecting of their flight paths (Petersen and Fox 2007).

At Nysted and Horns Rev wind farms Petersen et al. (2006) concluded that avoidance behavior, initiated at a distance of between 1.5 and 2 km (0.9 and 1.2 mi) from the turbine, caused a change in flight paths for between 71% and 86% of the birds that were on a trajectory to enter the wind farms. Birds flying closer to the wind farm made more dramatic modifications to flight paths to avoid the turbines (Petersen et al. 2006). Furthermore, there was a reduction of between 63% and 83% in use of the wind farm airspace after turbines were installed. By examining the avian radar flight trajectory of individuals and flocks Petersen et al. (2006) were able to determine that birds made "gradual and systematic modifications to their flight routes in response to the visual stimulus of the wind farm."

The Danish studies also concluded that avoidance responses differed by time of day and by species (Petersen et al. 2006, Fox et al. 2006). Birds made modifications to flight trajectories closer to the turbines during the night than during the day (Petersen et al. 2006), and additional data from Nysted indicate that many of the birds at night may have modified flight paths vertically (i.e., increased flight altitude) to avoid the wind farm (Petersen et al. 2006). As for differences among species, loons and gannets never flew between the turbines at Nysted, but other species (greater black-backed gull and herring gull) did fly between the turbines with no sign of avoidance. The degree to which the BIWF presents a barrier to movement is likely to be more significant for some species (loons and northern gannets) than to others (gulls). The effects that increases in migration or daily transit flight distances may have on avian fitness is difficult to determine. The most abundant species in the BIWF Study area (loons, gannets, terns, seaducks, shearwaters, alcids, and gulls) are all capable of making long distance flights.

Barrier effect was evaluated as a potential impact on birds in flight (during migration or daily transits between foraging and roosting areas) within the BIWF Study Area. An avoidance response caused by the sight of novel structures (turbines) in the marine environment could create a barrier to movement for some species. This barrier to movement would cause individuals to increase flight distances to circumvent the wind project. Lengthening flight paths would force individuals to increase energy consumption and could result in a reduction in fitness if the increase in energy was significant enough (Fox et al. 2006).

The installation of the BIWF WTGs is likely to elicit some level of visually triggered avoidance response by individual birds using the airspace within and around the BIWF Project Area. This is especially true for those species that do not commonly encounter human-made structures in the environment, such as pelagic seabirds and alcids. The avoidance threshold (i.e., at what distance birds begin to avoid the turbines) may be as much as 4 km (2.5 mi) in any one direction, though Petersen et al. (2006) found it to be within 1.5–2.0 km (0.9–1.2 mi). Avoidance threshold can be used to determine the magnitude of potential risk posed by barrier effects from the BIWF (Garthe and Hüppop 2004, Peteresen et al. 2004, Drewitt and Langston 2006).

The magnitude of the risk is directly related to the number of individuals that flew through the area prior to construction as well as the ability of species to accommodate increases in flight distance during migration or daily transit flights. Therefore, one must consider the avoidance threshold, number of birds known to occur in the area, and energetic capacity of each species in order to assess the magnitude of the potential risk. The former two variables are easily quantified, as maximum avoidance thresholds for many common species have been determined in European studies (Maclean 2009) and the number of birds moving through the Study Area was determined during BIWF avian studies. However, the energetic capacity of affected birds to accommodate an increase in flight distance to avoid the wind farm is not quantifiable. Thus, one must simply assume that species able to undertake long-distance migrations would also be able to accommodate a slight increase in energy demands to circumvent the BIWF (a maximum area of 83.5 km^2 [32.2 mi^2] if avoidance responses are initiated at a 4 km [2.5 mi] distance).

The effects of displacement on foraging birds and birds making daily transits (non-migratory movements) between foraging and roosting areas is likely to be greater than the effects on migratory birds. This is because transiting birds may need to circumvent the BIWF more frequently than migrating birds that would only need to avoid the area during migration, although it should be noted that foraging and migration are not mutually exclusive behaviors. Species that were observed undertaking what were assumed to be daily transit movements through the Study Area included seaducks, northern gannets, and alcids, as well as gulls and terns. Movements were assumed to be transits if birds were observed in flight outside of known migration periods. This assumption may not hold true for all observations but is likely fairly accurate for most encounters.

Evaluation

Data from the BIWF Study Area surveys were used to determine the number of birds that are known to occur within the Project Area and the three avoidance threshold buffers. Avoidance sensitivity derived from the results of post-construction monitoring performed at operating offshore wind farms in Europe were used to determine the avoidance threshold buffers (Table 6.2.3).

Table 6.2.3. General levels of avoidance behavior responses to large commercial-scale offshore wind energy facilities in Denmark (Fox et al. 2006).

Species	Avoidance of Operational Wind Farm *	Wind Facility
Loons (*Gavia* spp.)	High	Horns Rev
Long-tailed duck (*Clangula hyemalis*)	High	Nysted
Common scoter (*Melanitta nigra)*	Moderate	Horns Rev
Terns (*Sterna spp.*)	Moderate	Horns Rev
Alcids (*Uria aalge and Alca torda*)	Moderate	Horns Rev

High = complete avoidance; Moderate = occurred in vicinity of turbine array but generally not within inter-turbine areas; Low = occurred within inter-turbine areas

*Adapted from Fox et al. 2006

Table 6.2.4. Density of all birds observed during the 2009–2011 boat-based surveys in the BIWF Study Area by transect segment, including segments within the area where WTGs are proposed and adjacent segments.

Average Density (n/km^2)*	Loons	Waterfowl	Gulls	Terns	Seabirds	Overall (All Species Observed)
North of WTG Area (Survey Segments 1–7)	0.12	0.48	0.88	0.08	0.42	1.75
WTG Area (Survey Segments 8–14)	0.23	0.35	0.49	0.12	0.45	1.45
West of WTG Area (Survey Segments 15–25)	0.32	0.97	0.67	0.06	0.99	2.72

* Normalized for level of effort and area surveyed.

Note: Red shading indicates area of greatest relative density, yellow indicates second highest relative density, and green indicates lowest relative density.

Avian and bat species migration routes extend hundreds and sometimes thousands of miles from breeding areas to wintering grounds. Avoidance thresholds for migrants moving through the BIWF area is expected to range from minimal avoidance of the immediate WTG area for some species, to no more than 4 km (2.5 mi) from the WTG area for others (Fox et al. 2006). Migratory birds are thought to be able to accommodate changes in energy budgets and alterations of their migration routes. Most species that occur in the BIWF area, including seaducks, gannets, and loons, would be able to increase their migration route by tens of kilometers without incurring substantive physiological effects or reduced fitness. In a worst case scenario (assuming avoidance to 4 km [2.5 mi]) the maximum increase in migration distance around the BIWF area would be at most 4 km (2.5 mi) and would be within acceptable limits.

The three avoidance buffers used for barrier effect risk evaluation were 1, 2, and 4 km (0.6, 1.2, and 2.5 mi). Each buffer assumes that all birds flying through the airspace either 1 km (0.6 mi), 2 km (1.2 mi), or 4 km (2.5 mi) from the BIWF turbines will exhibit 100% avoidance of the area. The total area of the turbines at the proposed BIWF will displace 0.093 km^2 (0.36 mi^2) of sea surface and the air column above it to a maximum of 177 m (581 ft) above sea level (this area was calculated by summing the area of each of the five turbine's RSZs). Birds will have a barrier to movement, at a minimum, within 0.093 km^2 (0.36 mi^2) of sea surface and the air space above to 177 m (581 ft). This is the size of the barrier effect if birds exhibited an avoidance response at the turbines (essentially no avoidance threshold). Thus at a minimum birds will be required to avoid a total of 0.093 km^2 (0.36 mi^2) of the sea scape during migration and daily transit. However, birds are expected to exhibit avoidance behavior of the BIWF at a much greater distance (Chamberlain, Rehfisch et al. 2006, Fox, Desholm et al. 2006; Masden, Haydon et al. 2009). If birds start to change their trajectory to avoid the BIWF at 1 km (0.6 mi) from the turbine array then there will be an effective barrier to movement over 11.1 km^2 (4.3 mi^2) of sea surface. If avoidance is at 2 km (1.2 mi) then the effective barrier to movement covers 29.1 km^2 (11.2 mi^2), and at 4 km (2.5 mi) covers 83.5 km^2 (32.2 mi^2). These avoidance thresholds are the worst case scenarios, which assume that 100% of all birds that move through the BIWF Study Area completely change their trajectory to avoid the turbine array at 1 km (0.6 mi), 2 km (1.2 mi), or 4 km (2.5 mi). But avoidance is not expected to be 100% for all individuals (BOWind 2008).

The BIWF boat-based surveys provided the most refined spatial data available for evaluation of risk from barrier effects. During the boat-based surveys there were 4,785 detections of birds in flight during the daytime. This resulted in an overall encounter rate of 149.5 birds observed in flight/survey. Of these 4,785 encounters of birds in flight, 21.5% (*n* = 1,030, or an average of 32.2 birds in flight/survey) were within the immediate BIWF Project Area where the WTGs are proposed (corresponding to survey transect segments 8–14). The average encounter rate for birds in flight across the entire BIWF offshore Study Area was 149.5 birds in flight/survey. Within 1 km (0.6 mi) of the BIWF Project Area there were 1,335 detections of birds in flight with an average of 41.7 birds in flight/survey. Within the 2 km (1.2 mi) buffer there were 1,903 detections (ER = 59.5 birds in flight/survey), and within the 4 km (2.5 mi) buffer there were 3,274 detections (ER = 102.3 birds in flight/survey). Assuming the BIWF boat-based surveys are representative of the actual population of birds flying through the BIWF offshore Study Area, at worst (i.e., if all birds of all species exhibit 100% avoidance of the BIWF) the BIWF might be expected to create a barrier to movement for 28% of all birds in the Study Area at 1 km (0.6 mi), 40% of birds at 2 km (1.2 mi), and 68% of all birds in the Study Area at 4 km (2.5 mi).

A large percentage (more than 35%) of all loons, shearwaters, storm-petrels, northern gannets, alcids, gulls, terns, and passerines observed in flight during the boat-based surveys were within 1 km (0.6 mi) of the BIWF Project Area (Table 6.2.5). The percentage of observations of birds in flight increased, for most species groups, within the 2 km (1.2 mi) and 4 km (2.5 mi) buffers.

Table 6.2.5. Percentage of total count of each species or species group observed in flight within the BIWF Offshore Study Area at a 1-km, 2-km, and 4-km buffer.

Species / Species Group	1 km	2 km	4 km	Total Birds Encountered (*n*)
Loons	49%	57%	77%	240
Cormorants	8%	9%	10%	88
Shearwaters	39%	52%	74%	98
Storm-petrel	24%	42%	64%	50
Northern gannet	34%	42%	71%	611
Alcids	30%	39%	64%	309
Waterfowl	20%	37%	68%	2,312
Shorebirds	0%	0%	69%	13
Gulls	35%	41%	72%	953
Terns	32%	32%	42%	81
Passerines	100%	100%	100%	2
OVERALL	**28%**	**40%**	**68%**	**4,785**
Bats*	0%	0%	100%	16*

* Values are for total number of bat call sequences recorded, not individual bats

The results of the MERLIN radar surveys are also useful for evaluating risk of barrier effects, especially to nocturnal migrants, which were not quantified in other BIWF surveys. During the 2009–2011 surveys average target passage rates offshore were generally less than 25% of passage rates onshore and nearshore. Peak passage rates at night during migration were especially low compared to peak passage rates at night closer to Block Island (Section 4.7.5). Because migration offshore is much lower than migration onshore and nearshore it is concluded that the proposed location of the BIWF nearly 5.5 km (3 nm) from the coast of Block Island effectively reduces the risk of creating a barrier effect to the movements of the vast majority of migrants in the BIWF Study Area.

Conclusions

In the worst case, 100% of the individuals flying through the proposed turbine area would be prevented from flying through the area after construction and would be required to fly an increased distance around the turbines (perhaps as much as 4 km [2.5 mi]). However, the overall importance of the BIWF area to birds in Rhode Island Sound, as well as the relative number of birds in the Project Area when compared to nearshore and onshore areas, appears to be low. Therefore, the impact of even the worst case scenario would not have a significant effect on regional bird populations and would be considerably less than if the WTGs were constructed in other locations, particularly in nearshore habitat.

As the avoidance threshold increases in distance from the BIWF the magnitude of birds that could be at risk also rises. It is estimated that, at worst, approximately 42 birds per day could be at risk from barrier effects at an avoidance threshold of 1 km (0.6 mi) assuming that all of the birds encountered were on a trajectory towards the BIWF and all will exhibit complete avoidance of the wind farm after construction. This estimation is based on the fact that during boat-based surveys 42 birds/survey were observed within the 1 km (0.6 mi) threshold. At an avoidance threshold of 2 km (1.2 mi) the magnitude of potential risk increases to 59 birds/day, and at 4 km (2.5 mi) it is predicted to be at most 102 birds/day. In reality it is highly unlikely that 100% of the birds observed during the boat-based surveys were on a trajectory towards the BIWF turbine array area. Studies on avoidance thresholds and rates for birds in flight at existing offshore wind farms indicate that avoidance is not 100% and that the turbines do not present a complete barrier to movement for many species (Fox, Christensen et al. 2006; Desholm no date). Post-construction monitoring data, including the passage rates and trajectories of birds approaching the BIWF turbines, will be required to determine the magnitude of the barrier effect.

Risk to Bats

Recent research has found tree and tree-crevasse roosting migratory bats to be the predominant species recovered during post-construction mortality studies at operational wind farms in North America (Arnett et al. 2008). Results from these mortality studies show the three bat species most commonly encountered during ground searches were long-distance (Lasiurine) migratory bats: hoary bat, silver-haired bat, and eastern red bat (Kunz et. al 2007, Arnett et al. 2008). The migratory species (hoary bat, silver-haired bat, eastern red bat), as well as evening bat, were positively identified from recordings made during the BIWF surveys, primarily on Block Island. Overall, there was very little bat activity offshore.

Patterns of activity in the Project Area do not suggest the presence of a large bat migration corridor in the vicinity of BIWF Project Area. If a substantial migration corridor did exist over the Project Area, the data should show a high ratio of minutes of bat activity to detector nights, and greater numbers of bat "events." The sporadic and diffused occurrence of bats in the recordings indicates that few individuals use the BIWF Project Area.

6.3 AVOIDANCE AND MINIMIZATION MEASURES

During construction of onshore facilities on Block Island and the mainland, temporary displacement of foraging water birds may occur, but no long-term or significant impacts to nesting shorebirds are anticipated. Construction of the onshore facilities and cable landfall sites will occur outside of the spring nesting period and the use of Hoirzontal Directional Drilling (HDD) will minimize potential impacts to shoreline habitats. Additionally, the limited size of the onshore facilities and the small footprint of the equipment necessary for the installation of the upland portions of the export cable and transmission line will be relatively small in relation to the adjacent available nesting and foraging habitat.

Although loud noises during construction could theoretically cause bats to avoid the area, bats are not common in the BIWF area so construction activity is not expected to impact bats. However, lighting on construction vessels operating at night has some potential to attract bats if insects congregate near the work lights. Deepwater Wind has agreed to monitor bat activity in the BIWF Project Area during construction.

Impacts to birds using the Project Area for foraging or staging versus those moving through the area during migration should be considered differently. Disturbance and displacement impacts on migrant birds and bats moving through the BIWF turbine array area are expected to be minimal (i.e., not significant on a population level to any species known to occur in the Project Area).

Disturbance to the seafloor and benthic macroinvertebrates may also have an indirect impact on foraging behavior of some piscivorours birds. Although unlikely, changes to the benthic community as a result of installation of the turbine foundations, could change the distribution and abundance of fish.

Although there is always some potential for avian and bat mortality due to collisions with turbines during operation, Deepwater Wind expects that impacts to avian and bat species associated with avoidance behavior of the operational wind facility will be minimal based on the study results and the relatively small size of the Project compared to other operating land-based wind energy projects in the United States. Pre-construction surveys have demonstrated that the proportion of birds foraging and/or migrating through the Project Area compared to surrounding areas was low. The primary collision risk posed to birds from the BIWF are the wind turbines, though there is also a risk of collision associated with construction and maintenance vessels and onshore transmission lines. The use of key avoidance and minimization measures such as burying all onshore transmission lines is expected to significantly reduce risk of non-turbine collision.

Finally, Deepwater Wind has reduced the number of wind turbines and chosen WTG sites and alignments that are considered to have the least potential for impacts to avian and bat species. In an attempt to avoid displacement of and direct impacts on avifauna the WTGs have been sited within state waters as far as possible from shore and the proposed orientation of the turbine array, southwest to northeast, is parallel to the avian migration routes documented during the site-specific survey efforts. Further, the relative size of the turbine site in relation to Rhode Island Sound is minimal and therefore will likely not pose a barrier to migration. The scale of the Project Area is predicted to impact less than one tenth of one percent of the available air space and water surface available in this region of Rhode Island Sound. There will be substantial air space and water surface available adjacent to the proposed Project Area for foraging and migrating birds and bats.

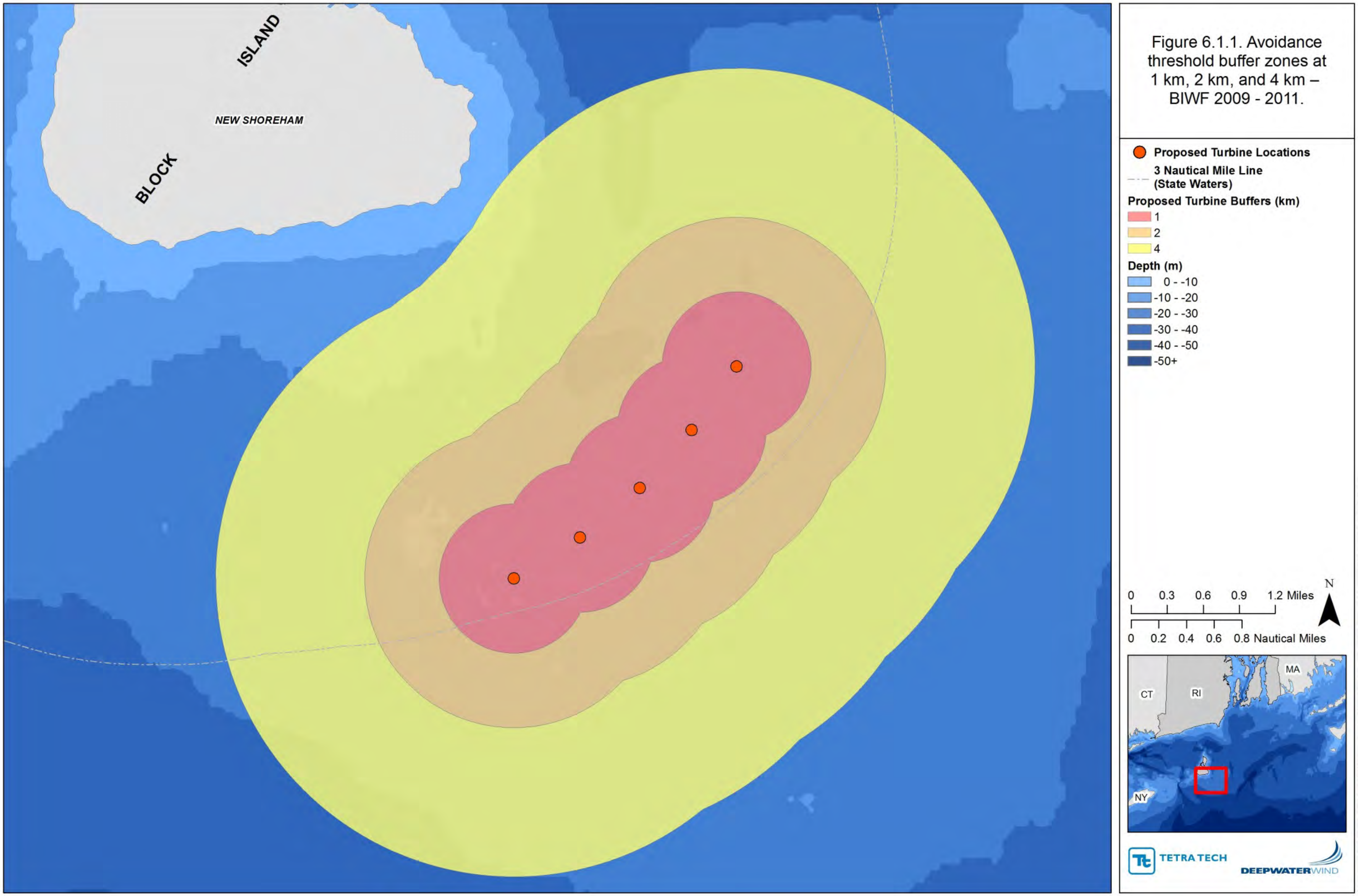

Figure 6.1.1. Avoidance threshold buffer zones at 1 km, 2 km, and 4 km – BIWF 2009 - 2011.

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8.0 APPENDICES

APPENDIX A: PHOTOGRAPHIC RECORD

Photo No.: 1
Date: 6/13/2009
Photographer: L. Gilpatrick
Direction: South
Location: Andy's Way – Onshore Survey Point 1

Photo No.: 2
Date: 6/13/2009
Photographer: L. Gilpatrick
Direction: North
Location: Andy's Way – Onshore Survey Point 1
The majority of shorebirds observed during surveys were documented feeding at this point during low tides. Common terns were also observed roosting and feeding at this point during the summer.

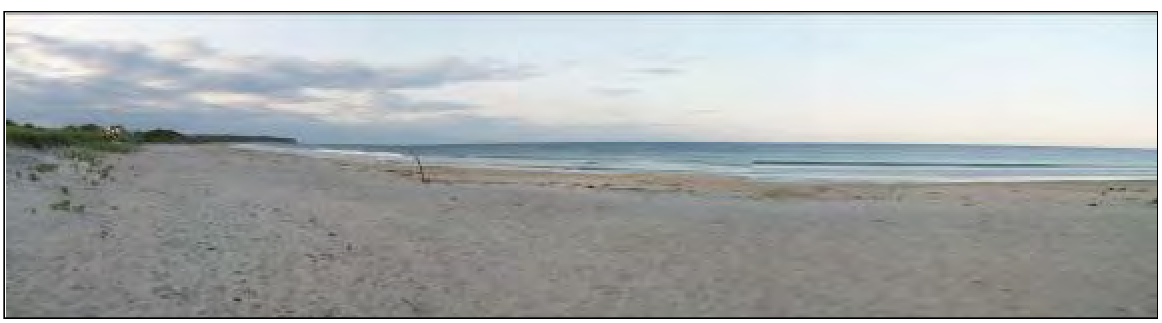


Photo No.: 3
Date: 6/13/2009
Photographer: L. Gilpatrick
Direction: North
Location: Crescent Beach – Onshore Survey Point 2 and Roving Raptor Survey Point

Photo No.: 4
Date: 6/13/2009
Photographer: L. Gilpatrick
Direction: Southeast
Location: Crescent Beach – Onshore Survey Point 2 and Roving Raptor Survey Point
Terns were observed foraging in the shallow waters at this point during the July surveys.

Photo No.: 5
Date: 6/14/2009
Photographer: L. Gilpatrick
Direction: Northeast
Location: Old Harbor Jetty – Onshore Survey Point 3
Shorebirds, seaducks, gulls, and wading birds were observed using this area.

Photo No.: 6
Date: 6/14/2009
Photographer: L. Gilpatrick
Direction: Northeast
Location: St. Ann's Church – Onshore Survey Point 4 and Roving Raptor Survey Point
Shorebirds and seaducks were frequently observed at this point. Observation of harbor seals in cove on November 18, 2009.

Photo No.: 7
Date: 6/14/2009
Photographer: L. Gilpatrick
Direction: Southeast
Location: Southeast Light – Onshore Survey Point 5 and Main Raptor Survey Location
Peregrine falcons were observed turning the corner and heading west-southwest following the bluff closely.

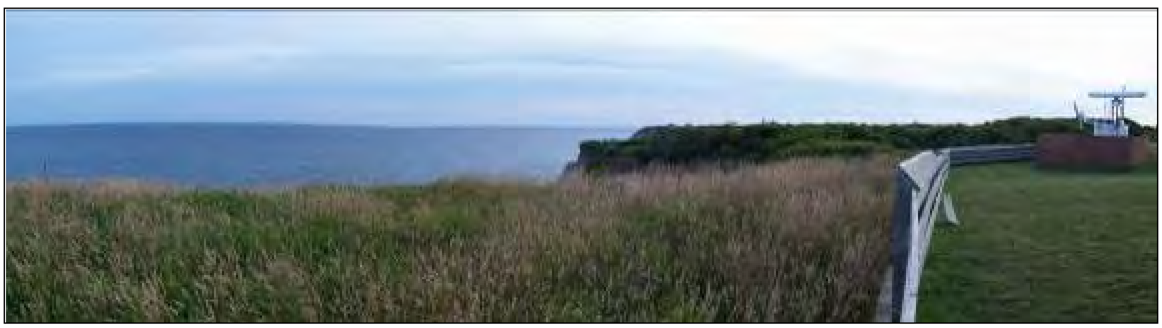


Photo No.: 8
Date: 6/14/2009
Photographer: L. Gilpatrick
Direction: Southwest
Location: Southeast Light – Onshore Survey Point 5 and Main Raptor Survey Location
Peregrine falcons most frequently observed following bluff line shown above.

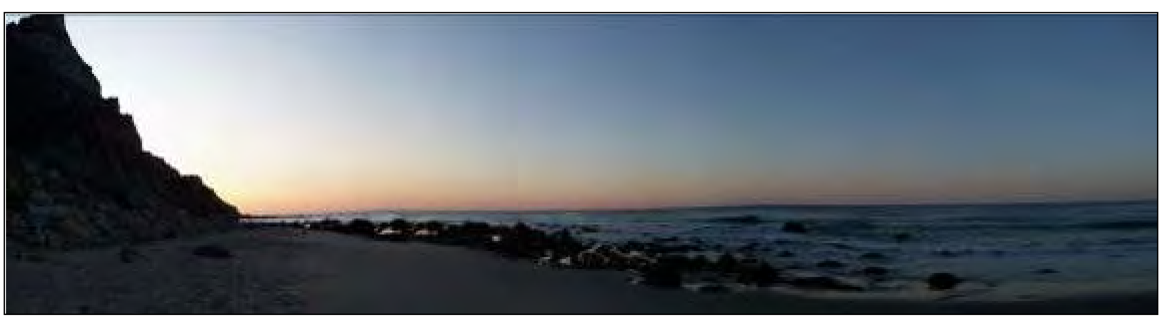


Photo No.: 9
Date: 6/14/2009
Photographer: L. Gilpatrick
Direction: Southeast
Location: Stairs – Onshore Survey Point 6 and Roving Raptor Survey Point

Photo No.: 10
Date: 6/14/2009
Photographer: L. Gilpatrick
Direction: Southwest
Location: Stairs – Onshore Survey Point 6 and Roving Raptor Survey Point
Seaducks were frequently seen rafting nearshore. Peregrine falcons also observed following bluff line heading in a westerly direction at this point.

Photo No.: 11
Date: 6/14/2009
Photographer: L. Gilpatrick
Direction: Southeast
Location: Mohegan Bluffs – Onshore Survey Point 7

Photo No.: 12
Date: 6/14/2009
Photographer: L. Gilpatrick
Direction: Southwest
Location: Mohegan Bluffs – Onshore Survey Point 7

Photo No.: 13
Date: 6/21/2009
Photographer: L. Gilpatrick
Direction: South
Location: Painted Rock – Onshore Survey Point 8

Photo No.: 14
Date: 6/14/2009
Photographer: L. Gilpatrick
Direction: Southwest
Location: Black Rock – Onshore Survey Point 9 and Roving Raptor Survey Point
Gulls were frequently seen roosting on beach. Peregrine falcons also observed following bluff line heading west-southwest at this point.

Photo No.: 15
Date: 6/14/2009
Photographer: L. Gilpatrick
Direction: Southwest
Location: Black Rock – Onshore Survey Point 9 and Roving Raptor Survey Point
Gannets and gulls were commonly observed foraging to the southwest.

Photo No.: 16
Date: 6/14/2009
Photographer: L. Gilpatrick
Direction: Southeast
Location: Lewis Farm – Onshore Survey Point 10 and Roving Raptor Survey Point
Cormorants were frequently observed roosting on bluff in left of frame.

Photo No.: 17
Date: 6/14/2009
Photographer: L. Gilpatrick
Direction: Southwest
Location: Lewis Farm – Onshore Survey Point 10 and Roving Raptor Survey Point
Seaducks and loons commonly observed using nearshore waters at this point.

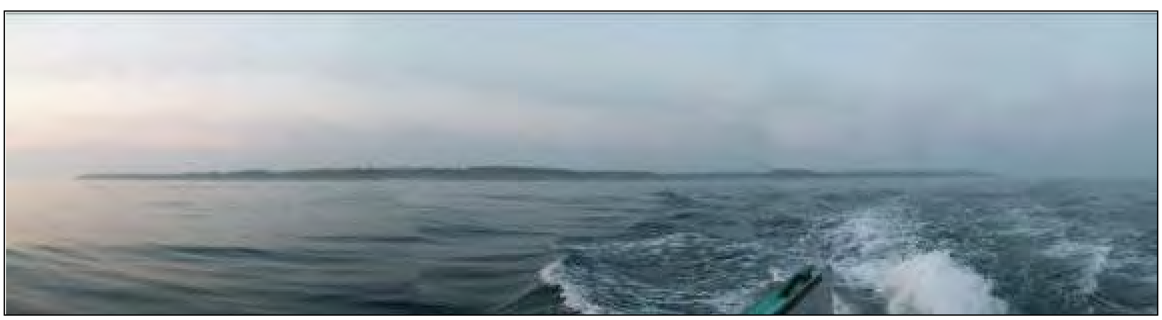


Photo No.: 18
Date: 6/21/2009
Photographer: L. Gilpatrick
Direction: Northwest
Location: Offshore Boat-Based Surveys.
View of Block Island from offshore boat transect.

Photo No.: 19
Date: 9/30/2009
Photographer: L. Gilpatrick
Direction: East
Location: North Bluff Roving Raptor Point

View east from Roving Raptor Point on North Bluffs. An attempt was made to observe peregrine falcons flying in over the water from this point.

Photo No.: 20
Date: 9/16/2009
Photographer: L. Gilpatrick
Direction: Southeast
Location: Met Tower

Southeast view from Roving Raptor Point at Met Tower.

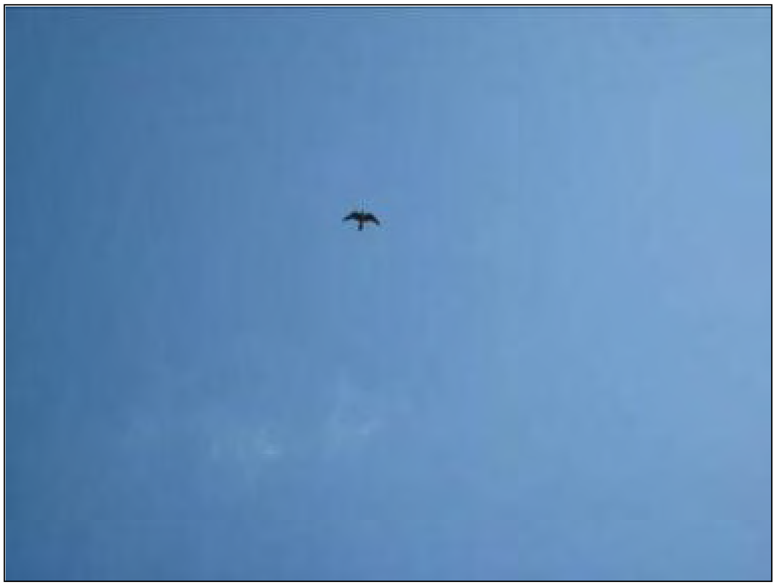


Photo No.:	21
Date:	9/29/2009
Photographer:	L. Gilpatrick
Direction:	N/A
Location:	Main Raptor Observation Point – Southeast Light.

Peregrine falcon flying above bluff line.

Photo No.:	22
Date:	8/19/2009
Photographer:	L. Gilpatrick
Direction:	North
Location:	Block Island Helicopter Survey

View of Block Island looking North from helicopter during August survey.

Photo No.: 23
Date: 8/19/2009
Photographer: L. Gilpatrick
Direction: N/A
Location: Block Island Helicopter Survey

View of HD camera mounted in helicopter during August survey.

Photo No.: 24
Date: 8/19/2009
Photographer: L. Gilpatrick
Direction: N/A
Location: Block Island Helicopter Survey

View of water from helicopter during August HD video survey.

Photo No.: 25
Date: 5/20/2009
Photographer: L. Gilpatrick
Direction: South
Location: Active Acoustic Bat Survey: Road Transect

View of representative freshwater pond, tree, and open meadow habitat along active acoustic bat survey area.

Photo No.: 26
Date: 5/3/2009
Photographer: L. Gilpatrick
Direction: North
Location: Active Acoustic Bat Survey: Point 3 (Southwest Point)

View from active acoustic bat survey point P3 showing representative beach habitat at Southwest Point.

Photo No.: 27
Date: 4/15/2009
Photographer: L. Gilpatrick
Direction: South
Location: Active Acoustic Bat Survey: Point 5 (Great Salt Pond)

View south from active acoustic bat survey point P5 on the east side of Great Salt Pond (end of Andy's Way).

Photo No.: 28
Date: 4/15/2009
Photographer: L. Gilpatrick
Direction: North
Location: Active Acoustic Bat Survey: Point 5 (Great Salt Pond)

View south from active acoustic bat survey point P5 on the east side of Great Salt Pond (end of Andy's Way).

Photo No.: 29
Date: 5/07/2009
Photographer: L. Gilpatrick
Direction: Southwest
Location: Active Acoustic Bat Survey: Road Transect (Rodman's Hollow)

View of blooming shadbush shrubland habitat in the Rodman's Hollow area. This is representative of habitat along portions of the active acoustic bat survey road transects.

Photo No.: 30
Date: 5/21/2009
Photographer: L. Gilpatrick
Direction: West
Location: Active Acoustic Bat Survey

View of representative bluff habitat.

Photo No.: 31
Date: 9/23/2009
Photographer: L. Gilpatrick
Direction: N/A
Location: Active Acoustic Bat Survey

View of representative vegetation along bluffs within the vicinity of the survey area.

Photo No.: 32
Date: 5/02/2009
Photographer: L. Gilpatrick
Direction: South
Location: Active Acoustic Bat Survey: Walking Transect 1

View of habitat along Mansion Beach.

Photo No.:	33
Date:	3/25/2009
Photographer:	L. Gilpatrick
Direction:	East
Location:	Active Acoustic Bat Survey: Points 8 and 9

View of representative habitat. Note the freshwater pond in the foreground and ocean in background.

Photo No.:	34
Date:	3/25/2009
Photographer:	L. Gilpatrick
Direction:	N/A
Location:	Low met tower bat detector base station

Photo No.: 34
Date: 09/2009
Photographer: A. Svedlow
Direction: West
Location: Met tower Detector High

Detector at >50 meters in met tower near entrance to New Harbor.

Photo No.: 35
Date: 09/2009
Photographer: A. Svedlow
Direction: Wes
Location: Met tower Detector Low

High and low met tower bat detector base station, powering systems and data connection. Low detector in foreground.

Photo No.: 36
Date: 09/2009
Photographer: A. Svedlow
Direction: East
Location: Lewis-Dicken's Farm

Stake detector located at Lewis-Dicken's farm.

Photo No.: 38
Date: 09/2009
Photographer: A. Svedlow
Direction: South
Location: Southeast Lighthouse Radar

AR-125 bat detector mounted on top of MERLIN Avian Radar System at Southeast Lighthouse.

Photo No.: 39
Date: 10/2009
Photographer: A. Svedlow
Direction: N/A
Location: Buoy

SD-1 bat acoustic microphone mounting setup on weather buoy, prior to deployment.

Photo No.: 40
Date: 10/2009
Photographer: A. Svedlow
Direction: South Southeast
Location: Lighthouse Radar

Buoy deployed with bat acoustic system 3 nm south of Block Island. Buoy was located on offshore avian survey transect 2.

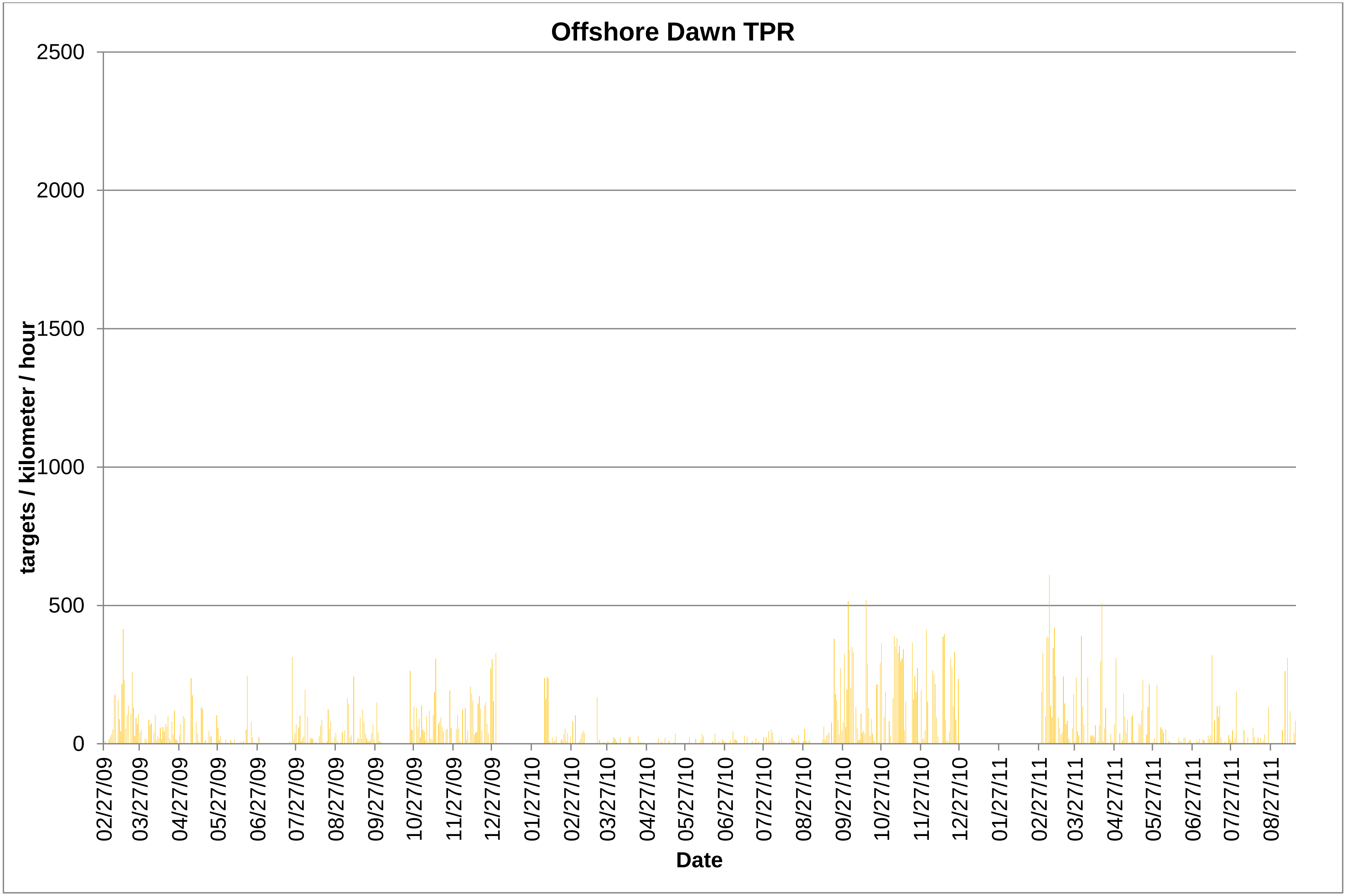
Photo No.: 41
Date: 9/2009
Photographer: P. Cronin
Direction: N/A
Location: HD aerial survey

Atlantic white-sided dolphins recorded on HD video.

Photo No.: 42
Date: 10/2009
Photographer: P. Cronin
Direction: N/A
Location: HD aerial survey

Northern gannet recorded on HD video.

APPENDIX B: SUPPLEMENTAL MERLIN RADAR DATA


Offshore Dawn TPR
targets / kilometer / hour
2500
2000
1500
1000
500
0
02/27/09
03/27/09
04/27/09
05/27/09
06/27/09
07/27/09
08/27/09
09/27/09
10/27/09
11/27/09
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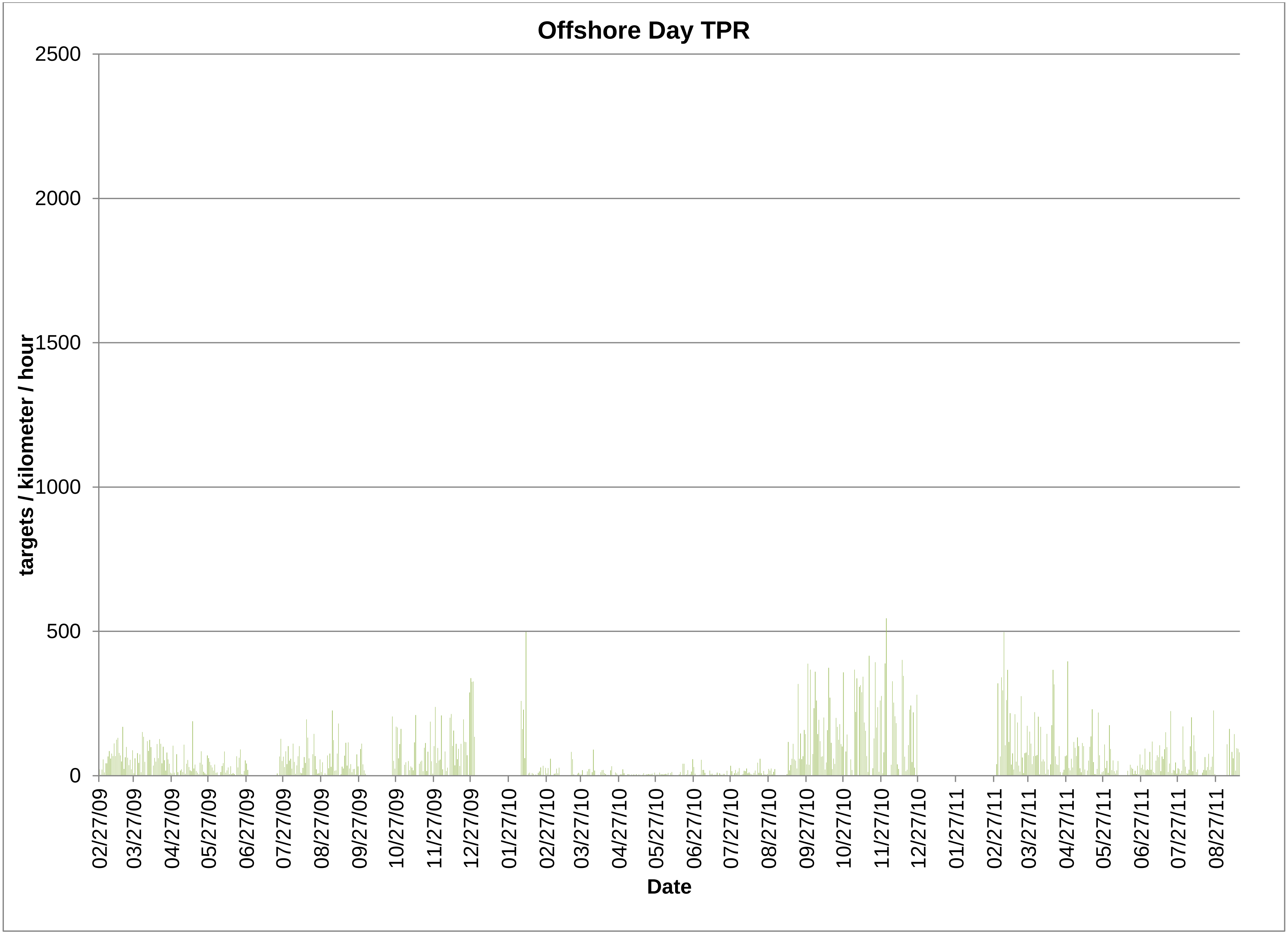
07/27/11
08/27/11
Date



Offshore Day TPR
2500
2000
1500
1000
500
0
targets / kilometer / hour
02/27/09
03/27/09
04/27/09
05/27/09
06/27/09
07/27/09
08/27/09
09/27/09
10/27/09
11/27/09
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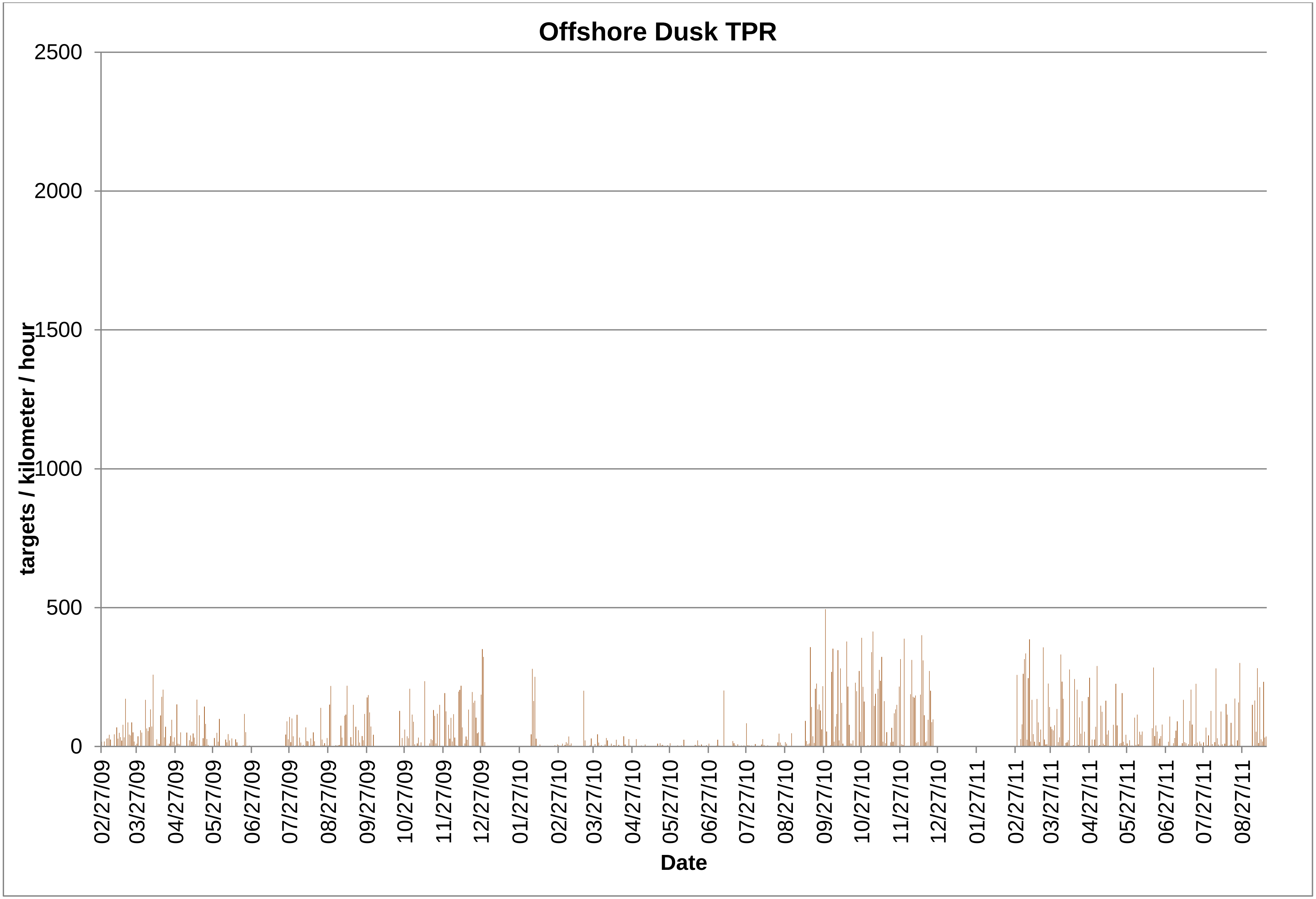
Date


Offshore Dusk TPR
targets / kilometer / hour
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2000
1500
1000
500
0
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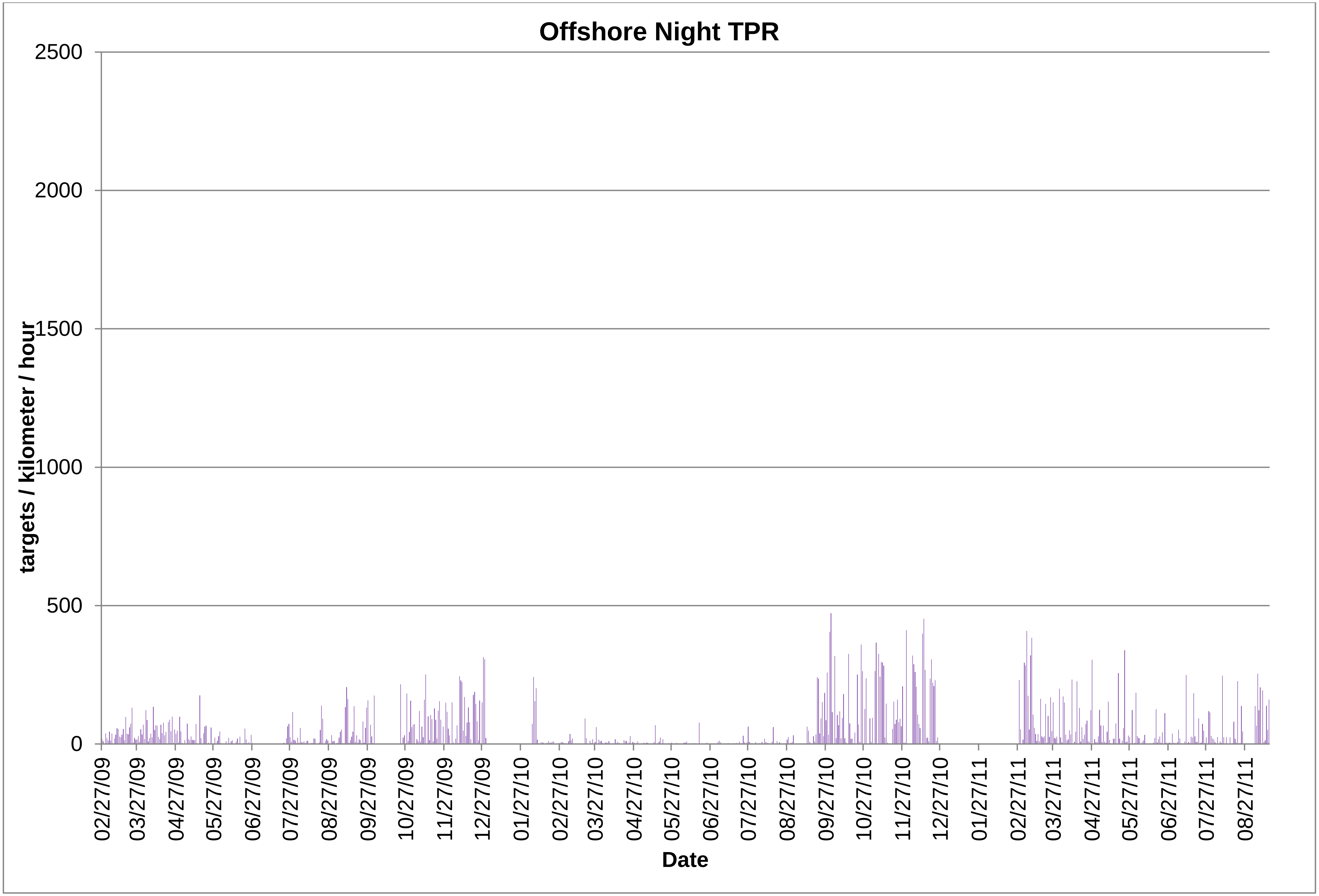
08/27/11
Date


Offshore Night TPR
targets / kilometer / hour
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2000
1500
1000
500
0
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08/27/11
Date

Date	Flight Height Above Mean Sea Level								Target Passage Rates			
	Dawn_Avg_AGL_m	Dawn_Median_AGL_m	Day_Avg_AGL_m	Day_Median_AGL_m	Dusk_Avg_AGL_m	Dusk_Median_AGL_m	Night_Avg_AGL_m	Night_Median_AGL_m	Dawn TPR	Day TPR	Dusk TPR	Night TPR
02/27/09	112.9	75.8	77.0	51.3	44.1	35.6	53.3	42.0	8	22	17	19
02/28/09	54.7	45.8	84.7	63.2	36.2	36.2	58.4	36.2	10	4	2	11
03/01/09	0.0	0.0	41.5	35.1	36.7	35.9	0.0	0.0		22	18	
03/02/09	0.0	0.0	45.5	37.4	0.0	0.0	44.8	36.4		57		39
03/03/09	43.4	38.9	75.8	41.2	138.5	98.5	95.1	73.1	16	11	28	21
03/04/09	203.2	138.3	108.8	79.2	89.4	80.7	124.5	78.6	26	43	30	13
03/05/09	113.2	116.7	109.2	73.1	127.6	84.1	91.8	67.9	35	43	42	45
03/06/09	85.7	59.7	66.9	46.0	47.0	42.0	100.2	44.4	53	67	25	13
03/07/09	144.3	84.1	106.5	73.1	0.0	0.0	55.4	40.8	176	85	0	38
03/08/09	102.8	68.8	92.6	67.9	0.0	0.0	0.0	0.0	180	59		
03/09/09	0.0	0.0	47.9	39.2	41.9	39.4	87.7	46.7		77	44	19
03/10/09	108.9	81.5	96.6	73.1	76.0	76.0	67.1	41.4	160	68	2	34
03/11/09	57.3	46.0	47.9	39.9	56.7	40.8	42.0	37.9	89	112	69	57
03/12/09	59.4	50.5	84.4	67.9	81.4	84.1	94.2	60.9	46	68	28	54
03/13/09	97.9	69.4	99.7	73.1	145.9	105.7	129.8	78.9	215	125	49	26
03/14/09	129.6	78.6	114.1	78.6	130.6	65.8	136.5	92.3	414	131	34	24
03/15/09	90.5	65.2	111.2	75.8	118.2	81.3	125.9	97.5	229	79	21	34
03/16/09	137.8	89.8	100.1	65.2	62.3	42.1	68.1	48.7	55	70	78	54
03/17/09	121.1	92.3	103.3	76.1	102.2	75.8	133.9	92.0	105	50	33	15
03/18/09	89.6	65.2	107.4	75.8	83.5	56.9	70.2	45.7	138	169	172	98
03/19/09	0.0	0.0	163.6	116.7	48.9	48.9	68.4	48.7	0	24	2	37
03/20/09	83.0	63.6	70.0	48.7	62.4	47.2	122.1	81.3	107	64	87	36
03/21/09	143.8	108.1	123.6	92.3	145.8	108.4	99.1	70.2	260	100	43	60
03/22/09	107.4	79.8	109.0	78.6	71.3	48.7	79.1	48.7	131	62	40	73
03/23/09	67.5	46.9	86.0	54.2	76.3	46.6	69.2	46.6	29	36	87	131

03/24/09	54.2	41.2	70.2	48.7	44.7	42.3	60.5	45.7	94	55	51	6
03/25/09	108.5	96.6	97.1	76.1	184.4	104.2	114.2	84.4	72	22	18	22
03/26/09	123.4	71.3	114.3	86.8	290.6	257.6	96.1	75.8	108	89	5	16
03/27/09	140.2	115.3	152.5	118.2	230.2	130.1	98.9	65.2	40	9	10	17
03/28/09	156.5	133.0	102.6	70.6	61.4	48.7	66.1	48.7	52	60	37	28
03/29/09	0.0	0.0	0.0	0.0	0.0	0.0	91.9	48.7				9
03/30/09	42.6	42.6	48.5	39.2	47.0	42.3	56.7	43.2	2	78	59	53
03/31/09	129.3	81.3	127.7	86.8	81.4	65.2	115.3	80.7	20	44	50	34
04/01/09	179.0	119.4	87.9	51.4	0.0	0.0	67.3	46.9	15	74		70
04/02/09	0.0	0.0	129.8	78.9	0.0	0.0	88.5	65.2		12	0	18
04/03/09	80.8	54.2	75.7	43.8	53.4	43.2	46.3	40.8	87	151	168	122
04/04/09	43.7	41.7	53.4	42.3	49.4	43.2	49.0	40.8	67	135	65	87
04/05/09	49.4	39.1	70.4	48.7	73.8	55.4	97.8	86.8	74	48	56	10
04/06/09	268.0	303.8	0.0	0.0	183.9	47.2	45.4	38.6	3		69	21
04/07/09	40.0	38.0	55.3	42.9	54.2	40.8	60.2	42.6	40	120	134	38
04/08/09	64.5	43.2	69.1	46.4	73.7	53.4	91.7	62.4	103	87	72	24
04/09/09	142.4	93.4	126.0	92.3	120.7	97.5	109.8	91.8	16	124	259	135
04/10/09	116.8	65.2	131.5	89.5	0.0	0.0	108.7	81.3	29	99		51
04/11/09	98.4	86.8	0.0	0.0	0.0	0.0	55.3	43.2	20			68
04/12/09	47.6	37.6	47.1	40.8	111.1	118.3	61.2	44.7	58	35	26	67
04/13/09	83.8	51.9	71.2	46.6	82.8	55.7	130.4	91.2	18	62	10	26
04/14/09	154.1	97.5	169.1	103.0	169.2	175.5	67.5	43.2	61	49	9	18
04/15/09	56.5	41.7	47.9	41.4	59.9	44.4	58.8	42.1	45	110	112	70
04/16/09	47.2	40.8	68.9	45.0	87.2	63.9	89.0	56.6	72	61	179	39
04/17/09	117.1	90.5	99.3	65.2	102.9	69.1	124.9	86.8	62	127	205	77
04/18/09	150.3	95.2	115.0	81.9	164.6	123.1	117.8	77.2	102	111	33	32
04/19/09	104.8	76.7	82.0	48.7	56.3	43.2	84.9	51.9	20	43	71	44
04/20/09	47.9	39.1	56.8	41.7	0.0	0.0	0.0	0.0	12	101		

04/21/09	46.1	35.3	55.0	42.0	0.0	0.0	79.4	43.4	81	54		79
04/22/09	81.4	64.9	96.9	53.9	38.7	38.8	91.4	48.1	32	18	10	88
04/23/09	52.4	42.0	64.2	43.2	81.5	60.4	111.0	69.4	120	80	38	46
04/24/09	133.7	113.0	126.6	86.8	109.1	78.6	123.8	86.8	16	57	96	98
04/25/09	117.9	97.5	134.9	88.0	66.5	48.7	74.0	48.5	13	42	17	4
04/26/09	0.0	0.0	133.0	75.8	127.8	62.4	162.4	65.2	0	11	33	53
04/27/09	70.1	40.3	140.8	77.7	59.0	56.8	79.2	48.7	32	8	4	37
04/28/09	49.8	41.5	89.3	61.2	85.4	59.7	91.2	55.4	72	104	152	48
04/29/09	0.0	0.0	81.5	48.7	70.3	49.2	133.9	106.0		11	10	7
04/30/09	90.1	58.8	0.0	0.0	141.1	62.9	54.7	42.6	101		8	99
05/01/09	52.8	41.4	55.5	40.9	43.3	42.3	57.1	42.3	93	75	51	45
05/02/09	0.0	0.0	339.2	262.4	36.2	36.2	91.5	65.3		12	1	4
05/03/09	44.9	43.5	0.0	0.0	0.0	0.0	0.0	0.0	5			
05/04/09	0.0	0.0	393.4	335.8	0.0	0.0	240.5	56.9		18		14
05/05/09	0.0	0.0	120.8	43.2	0.0	0.0	0.0	0.0		22	0	0
05/06/09	426.4	385.2	78.1	47.2	43.3	40.5	114.4	44.7	238	13	50	74
05/07/09	54.4	43.8	58.6	42.3	0.0	0.0	61.9	44.7	175	108		18
05/08/09	203.4	203.4	147.3	83.1	66.5	46.9	57.7	45.5	2	7	23	14
05/09/09	0.0	0.0	252.9	130.1	61.5	45.2	53.0	43.2		42	40	27
05/10/09	43.3	38.9	52.3	42.3	72.8	45.0	72.9	54.2	79	55	17	15
05/11/09	62.1	46.0	109.6	72.5	102.2	79.2	152.4	103.0	37	30	47	15
05/12/09	193.7	130.1	164.1	98.4	113.6	67.3	113.5	79.2	9	19	32	13
05/13/09	0.0	0.0	101.2	71.6	55.5	43.2	78.8	56.9	0	16	9	72
05/14/09	68.6	51.9	61.1	44.7	51.5	40.8	0.0	0.0	132	189	169	
05/15/09	55.6	42.9	59.3	40.8	0.0	0.0	111.1	50.4	125	25	0	1
05/16/09	0.0	0.0	103.4	48.7	69.6	48.7	182.6	54.2	0	39	113	176
05/17/09	35.3	35.4	170.7	50.7	0.0	0.0	57.9	43.5	12	17		22
05/18/09	0.0	0.0	78.3	43.5	219.8	219.8	303.6	232.2		11	2	1

05/19/09	0.0	0.0	171.6	99.4	76.0	65.2	100.4	75.2	0	5	30	39
05/20/09	102.3	65.2	108.4	81.3	101.7	81.3	109.6	76.4	47	45	144	63
05/21/09	88.7	75.2	100.1	70.3	84.2	65.2	73.1	49.8	27	85	81	66
05/22/09	54.1	39.9	63.6	45.0	50.2	42.3	138.3	59.7	27	39	27	2
05/23/09	0.0	0.0	105.8	65.0	95.0	62.3	135.5	87.7	0	14	6	5
05/24/09	35.0	35.0	105.8	48.7	0.0	0.0	123.0	77.8	2	9		2
05/25/09	0.0	0.0	260.3	138.8	189.5	189.5	56.5	43.2	0	4	2	60
05/26/09	58.3	42.6	59.6	43.2	0.0	0.0	0.0	0.0	103	70		
05/27/09	54.6	40.9	66.5	44.4	0.0	0.0	77.8	66.4	58	61	0	2
05/28/09	144.6	106.9	60.6	43.5	64.3	48.7	60.0	46.0	14	48	31	23
05/29/09	74.9	44.7	407.8	379.7	366.3	352.3	99.9	99.9	27	36	3	0
05/30/09	379.3	238.6	114.1	65.2	75.8	53.3	87.5	57.7	5	29	49	12
05/31/09	100.4	100.4	89.4	47.8	52.6	38.0	50.1	41.1	2	18	17	28
06/01/09	0.0	0.0	67.4	47.2	94.2	65.2	63.2	45.8	0	39	99	46
06/02/09	113.5	51.0	145.6	81.3	30.1	30.1	112.6	94.7	16	10	1	4
06/03/09	388.1	298.5	115.2	65.2	0.0	0.0	0.0	0.0	4	12		
06/04/09	0.0	0.0	86.8	86.8	160.6	160.6	110.9	120.9		0	1	0
06/05/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
06/06/09	46.8	43.2	72.7	46.4	52.4	45.3	55.5	40.8	13	13	25	10
06/07/09	228.5	122.0	215.6	125.2	68.2	62.4	109.2	97.5	4	34	15	1
06/08/09	0.0	0.0	186.8	108.1	121.1	75.8	120.2	81.3		44	45	22
06/09/09	93.6	86.6	65.9	41.7	58.4	46.1	179.4	79.2	16	84	22	1
06/10/09	0.0	0.0	170.3	119.0	0.0	0.0	74.7	44.4	0	11	0	10
06/11/09	0.0	0.0	86.0	45.7	45.0	40.8	251.4	54.2		18	29	14
06/12/09	0.0	0.0	93.6	45.3	0.0	0.0	311.2	192.9		29	0	1
06/13/09	0.0	0.0	137.2	66.8	0.0	0.0	0.0	0.0	0	6		
06/14/09	99.8	78.7	202.9	55.4	86.5	57.5	65.4	45.2	8	33	26	9
06/15/09	543.7	543.7	94.2	50.8	62.3	56.9	61.3	45.0	1	6	15	20

06/16/09	208.5	168.2	214.7	124.6	29.2	29.2	72.9	69.3	9	9	1	4
06/17/09	192.9	192.9	249.9	173.7	48.7	48.7	60.6	45.7	2	6	2	27
06/18/09	65.8	42.3	0.0	0.0	0.0	0.0	0.0	0.0	51			
06/19/09	54.4	42.3	81.5	45.0	0.0	0.0	119.4	119.4	247	67	0	0
06/20/09	56.9	56.9	163.3	99.6	34.6	36.2	114.1	38.0	2	29	5	3
06/21/09	0.0	0.0	50.1	40.9	43.4	42.0	45.1	40.8		63	117	56
06/22/09	46.3	41.8	50.4	42.3	42.3	40.9	47.8	40.8	80	91	52	16
06/23/09	47.6	46.3	63.9	46.0	31.0	31.0	86.3	88.3	22	6	1	3
06/24/09	0.0	0.0	148.9	78.3	48.7	48.7	223.8	141.1	0	5	1	7
06/25/09	553.8	515.3	190.0	119.4	64.0	65.2	143.7	69.4	3	17	3	2
06/26/09	494.9	443.7	326.9	235.1	0.0	0.0	52.8	42.3	3	53		33
06/27/09	65.2	65.2	206.4	130.1	188.3	188.3	250.6	119.1	1	43	2	4
06/28/09	308.0	306.3	232.0	168.2	0.0	0.0	153.9	35.9	24	20	0	1
07/22/09	57.7	35.3	111.2	43.2	0.0	0.0	91.4	46.0	9	8	0	5
07/23/09	401.8	401.8	0.0	0.0	0.0	0.0	0.0	48.7	2			
07/24/09	50.0	44.7	54.5	43.2	82.5	54.8	64.3	41.7	313	67	43	20
07/25/09	182.5	107.7	275.7	195.3	97.7	62.4	72.9	46.6	16	128	91	64
07/26/09	85.6	47.2	84.2	47.5	41.7	38.8	49.9	101.1	39	51	26	73
07/27/09	69.5	40.8	61.3	45.7	51.6	43.2	69.9	43.2	71	66	106	25
07/28/09	58.1	57.2	324.8	272.4	102.2	48.4	115.6	48.7	4	30	16	10
07/29/09	121.5	65.2	244.4	145.8	58.5	43.2	51.9	45.0	59	85	101	115
07/30/09	68.1	48.7	64.6	46.1	63.9	48.4	73.9	53.9	102	40	37	15
07/31/09	179.5	170.6	76.1	44.7	0.0	0.0	52.7	44.9	8	102		13
08/01/09	287.2	239.2	361.7	320.0	508.4	511.7	102.8	82.8	20	53	3	4
08/02/09	153.0	54.2	206.1	97.5	59.5	47.8	59.5	43.2	25	59	114	23
08/03/09	306.1	211.5	239.0	152.9	135.7	49.0	153.1	58.1	195	25	3	5
08/04/09	103.0	108.4	227.3	151.3	90.1	83.1	70.8	62.4	4	112	32	58
08/05/09	105.3	49.0	99.0	47.2	62.1	52.8	141.9	161.2	98	48	14	7

08/06/09	173.3	168.2	162.2	96.9	32.5	32.5	87.1	52.4	3	8	1	5
08/07/09	157.6	122.5	148.3	78.6	175.2	127.0	256.8	44.4	22	36	6	9
08/08/09	229.9	160.9	226.0	143.8	0.0	0.0	90.2	111.9	19	67	0	4
08/09/09	117.8	69.1	80.7	49.3	62.9	48.7	59.6	129.5	18	103	69	10
08/10/09	0.0	0.0	165.9	81.3	71.5	51.1	114.1	0.0	0	11	20	12
08/11/09	183.5	58.6	152.5	129.5	103.2	78.6	127.0	70.3	4	9	18	1
08/12/09	184.2	141.2	156.4	97.9	0.0	0.0	0.0	97.5	4	28		
08/13/09	0.0	0.0	92.6	54.9	74.7	65.2	90.9	96.2		64	29	4
08/14/09	191.3	143.6	179.0	114.1	347.4	254.9	123.0	120.8	28	45	6	4
08/15/09	237.3	140.9	235.8	173.7	123.1	103.0	111.4	0.0	66	195	51	21
08/16/09	128.6	81.3	155.0	97.3	160.7	140.4	138.1	0.0	86	132	19	18
08/17/09	165.1	129.6	145.0	82.8	0.0	0.0	0.0	118.3	6	60		
08/18/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.1				
08/19/09	0.0	0.0	0.0	0.0	0.0	0.0	131.9	43.2			0	6
08/20/09	319.6	200.8	241.9	157.2	184.3	184.3	59.4	39.6	7	74	1	51
08/21/09	51.7	43.2	59.4	44.0	51.4	39.6	66.5	50.5	125	145	139	138
08/22/09	41.8	37.1	49.1	39.6	41.2	42.0	43.8	48.1	53	68	25	92
08/23/09	45.4	39.9	43.4	36.5	43.6	40.0	69.3	48.7	82	22	4	1
08/24/09	319.6	303.5	191.5	79.9	48.8	39.9	108.5	48.7	6	7	12	11
08/25/09	111.2	54.2	154.7	81.0	109.5	130.1	68.2	88.9	3	9	3	18
08/26/09	109.8	48.7	75.8	48.7	85.3	43.2	78.1	0.0	22	57	31	12
08/27/09	79.1	47.0	183.8	75.8	61.5	57.2	139.8	43.8	40	13	4	2
08/28/09	438.0	419.5	124.4	53.7	52.6	42.6	0.0	60.9	10	47	151	
08/29/09	0.0	0.0	0.0	0.0	45.3	42.5	50.5	65.2			218	32
08/30/09	0.0	0.0	51.0	38.0	65.5	65.5	90.3	0.0		9	1	9
08/31/09	64.2	47.3	179.9	102.5	0.0	0.0	89.5	79.6	4	4	0	11
09/01/09	87.2	51.7	125.7	70.3	0.0	0.0	0.0	91.7	42	70		
09/02/09	0.0	0.0	133.2	81.3	318.6	314.5	160.9	88.0		26	5	3

09/03/09	139.7	92.4	193.5	103.0	41.0	35.0	139.1	48.7	48	77	3	5
09/04/09	41.1	41.1	166.4	104.6	47.1	43.2	118.5	46.0	2	31	5	23
09/05/09	103.7	75.8	151.5	81.3	262.8	230.2	77.8	97.5	166	226	6	45
09/06/09	50.4	40.5	60.7	45.3	57.9	43.2	61.9	0.0	143	123	75	52
09/07/09	126.9	51.4	202.2	98.7	48.8	38.9	235.7	40.8	24	17	32	3
09/08/09	204.0	89.5	279.3	174.0	0.0	0.0	0.0	41.7	31	19	0	
09/09/09	0.0	0.0	57.3	43.2	46.6	41.4	47.9	40.8		77	111	134
09/10/09	52.0	42.6	48.5	41.4	45.6	42.6	47.0	65.2	243	181	115	206
09/11/09	0.0	0.0	0.0	0.0	42.1	39.6	45.6	65.8			219	163
09/12/09	33.1	30.1	86.8	48.7	0.0	0.0	103.6	65.2	6	6	0	5
09/13/09	76.1	56.9	148.5	85.6	50.7	50.7	108.9	46.4	21	32	2	14
09/14/09	142.0	78.3	181.6	102.8	84.5	51.4	110.0	0.0	18	25	34	27
09/15/09	162.9	103.0	141.8	80.9	206.2	89.5	72.1	43.2	95	70	7	45
09/16/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.1				
09/16/09	1471.4	53.2	128.7	25.3	160.4	24.2	52.2	43.8	18	114	150	137
09/17/09	114.4	25.1	29.6	24.1	32.0	24.1	67.1	84.7	124	35	2	9
09/18/09	360.4	30.1	47.7	24.1	55.0	24.2	55.5	43.2	78	115	71	32
09/19/09	62.4	23.6	26.0	24.4	27.2	24.1	160.2	67.9	38	25	1	4
09/20/09	197.4	26.6	36.2	23.6	39.6	24.2	57.2	77.3	21	40	59	16
09/21/09	174.4	25.7	33.8	24.7	37.4	24.1	109.7	43.2	11	12	14	14
09/22/09	69.4	23.9	26.4	24.1	27.6	24.1	111.2	43.2	8	23	2	4
09/23/09	867.4	39.0	86.9	25.6	104.7	24.2	57.8	42.3	16	24	38	81
09/24/09	74.4	24.6	26.9	0.0	28.1	24.1	60.8	42.3	39	4	23	5
09/25/09	668.4	37.4	67.6	23.9	82.1	24.2	50.5	40.8	69	74	117	59
09/26/09	1255.4	52.4	124.7	24.4	154.7	24.2	49.4	0.0	14	32	1	131
09/27/09	1646.4	62.1	142.3	23.6	181.2	24.2	45.6	43.2			177	158
09/28/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.3	149	93	185	
09/29/09	797.4	39.4	75.3	24.8	92.7	24.1	57.8	65.0	42	111	123	69

09/30/09	333.4	29.7	43.9	24.4	51.1	24.1	63.4	43.2	10	39	72	28
10/01/09	45.4	23.9	25.7	23.5	26.3	24.2	79.4	0.0	5	19	2	3
10/02/09	1083.4	59.8	158.9	26.2	198.1	24.2	54.0	0.0	4	8	42	175
10/03/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/04/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/05/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/06/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/07/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/08/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/09/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/10/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/11/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/12/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/13/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/14/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/15/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/16/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/17/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/18/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/19/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/20/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/21/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.9				
10/22/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10/23/09	2276.4	66.3	195.7	23.8	239.0	24.2	47.8	47.8			128	216
10/24/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.7	264	206		
10/25/09	305.4	27.6	40.5	25.0	46.3	24.1	74.5	0.0	51	52	31	23
10/26/09	407.4	30.2	46.8	24.3	54.5	24.2	61.2	43.2	49	24	1	31
10/27/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	59.7	135	170	61	

10/28/09	1938.4	56.5	172.4	24.5	206.7	24.2	50.0	46.0		167		183
10/29/09	172.4	24.8	32.8	24.6	35.4	24.2	107.6	43.2	130	60	37	12
10/30/09	577.4	32.1	56.5	25.9	67.7	24.1	70.7	44.4	61	110	30	44
10/31/09	1355.4	51.8	150.7	24.1	179.8	24.2	50.3	42.9	92	162	208	156
11/01/09	700.4	37.5	68.2	25.6	84.4	24.1	60.6	42.0	24		2	61
11/02/09	902.4	39.6	74.4	25.7	92.9	24.1	61.5	279.4	138		115	69
11/03/09	880.4	40.5	76.5	25.0	95.2	24.1	55.1	46.9	51	38	89	72
11/04/09	39.4	0.0	24.4	24.4	25.3	23.9	373.5	47.5	44	46	8	2
11/05/09	155.4	26.2	37.8	23.8	41.0	24.2	63.0	43.2	14	3	0	18
11/06/09	139.4	25.6	30.0	24.1	32.8	24.1	78.8	81.3	101	51	11	9
11/07/09	1558.4	48.7	115.8	25.3	143.0	24.2	53.8	49.8	7	20	32	120
11/08/09	138.4	24.3	31.2	23.6	32.3	24.3	96.2	44.7	119	32	3	9
11/09/09	829.4	33.2	72.5	26.9	85.8	24.2	76.7	42.0	19	28	15	62
11/10/09	338.4	27.9	42.1	24.5	47.7	24.2	65.5	43.2	15	19	0	24
11/11/09	2065.4	58.3	146.8	25.0	183.3	24.2	50.3	0.0	104	115		160
11/12/09	3293.4	74.1	223.7	23.9	274.9	24.2	48.0	40.8	186	210	235	252
11/13/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.2	308			
11/14/09	1126.4	51.0	94.7	24.4	123.4	24.1	48.3	43.8				100
11/15/09	205.4	26.6	33.7	23.8	37.3	24.1	63.9	44.7	71	42	1	14
11/16/09	1398.4	49.1	98.9	26.7	127.8	24.1	62.6	50.8	80	49	11	104
11/17/09	1207.4	43.2	90.0	26.8	113.2	24.1	63.9	43.2	96	52	27	90
11/18/09	151.4	25.5	30.4	24.0	33.1	24.1	83.9	48.7	61	16	23	10
11/19/09	1386.4	51.7	119.9	27.5	152.2	24.1	56.3	43.8	45	97	131	129
11/20/09	1107.4	39.9	91.9	25.9	110.8	24.2	68.7	42.3		114	110	87
11/21/09	270.4	27.6	37.0	25.4	43.2	24.1	101.4	40.8	52	17	11	20
11/22/09	1531.4	51.4	112.7	26.6	143.9	24.1	55.1	43.2	54	83	118	120
11/23/09	1253.4	61.2	139.9	24.2	178.4	24.2	47.5	48.7				155
11/24/09	1125.4	42.7	88.6	26.3	110.9	24.1	59.3	40.5	192	188	150	87

11/25/09	36.4	23.9	23.9	23.6	24.6	23.9	97.9	0.0	57	50	2	1
11/26/09	580.4	38.7	70.0	24.1	86.0	24.1	47.1	43.2	0	8	1	63
11/27/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.9		103		
11/28/09	1928.4	53.8	139.5	26.1	172.6	24.2	54.3	43.2		238	192	149
11/29/09	1512.4	49.4	111.7	25.5	139.9	24.2	53.1	46.3	52	45	127	116
11/30/09	534.4	35.9	64.7	25.5	79.2	24.1	63.7	0.0	104	96		56
12/01/09	424.4	29.5	47.6	24.3	54.6	24.2	68.4	41.7	55	52	78	31
12/02/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	97.5	10	56	28	
12/03/09	1975.4	58.4	138.3	24.0	173.9	24.2	47.2	0.0		209	103	151
12/04/09	81.4	23.7	27.8	24.3	28.9	24.2	119.9	65.2	124	22	18	5
12/05/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.0			117	
12/06/09	280.4	25.7	38.9	25.3	43.1	24.2	92.8	97.9	130	84	32	20
12/07/09	902.4	35.1	74.1	28.5	90.8	24.2	83.5	42.9	17	16	4	67
12/08/09	59.4	23.7	26.7	23.9	27.5	24.2	117.9	43.8	50	28	1	4
12/09/09	3122.4	73.1	217.8	24.0	268.1	24.2	48.0	43.2			198	245
12/10/09	3056.4	61.5	214.2	24.6	253.5	24.2	49.2	50.8	207	201	204	230
12/11/09	2991.4	63.7	205.6	25.2	247.7	24.2	49.1	44.4	182	214	219	224
12/12/09	667.4	31.9	61.0	26.0	72.0	24.2	78.0	48.7	157	104	69	49
12/13/09	1438.4	56.5	156.2	27.2	193.2	24.2	60.1	44.7	33	156		170
12/14/09	378.4	28.9	45.4	25.3	52.8	24.1	77.1	42.3	40	36	11	29
12/15/09	980.4	37.7	83.7	26.3	100.9	24.2	63.7	45.0	42	111	36	77
12/16/09	54.3	43.2	66.5	44.4	42.5	40.3	52.4	81.3	146	57	24	132
12/17/09	50.5	43.8	56.5	43.2	49.0	44.4	62.6	0.0	173	93	133	79
12/18/09	145.9	106.6	168.9	116.1	355.9	355.9	113.2	43.2	127	34	2	17
12/19/09	104.1	83.8	61.9	46.0	0.0	0.0	0.0	43.8	48	110		
12/20/09	0.0	0.0	0.0	0.0	53.6	43.4	48.6	45.0			196	177
12/21/09	47.5	39.6	46.7	42.3	51.5	43.2	52.1	40.8	138	195	158	189
12/22/09	47.1	41.4	50.1	41.7	48.9	42.3	59.6	42.9	149	118	165	145

12/23/09	44.0	39.6	53.5	42.5	47.1	42.3	46.7	42.3	73	116	104	82
12/24/09	52.4	42.6	51.6	43.2	47.4	44.9	50.4	0.0	38	71	48	13
12/25/09	0.0	0.0	44.8	44.1	47.7	43.5	47.7	42.8	0	3	51	157
12/26/09	50.0	46.0	50.4	45.7	0.0	0.0	0.0	47.3	272	288		
12/27/09	48.4	43.2	50.8	46.3	48.4	43.5	48.2	49.6	306	338	187	150
12/28/09	57.7	48.7	61.0	48.1	63.5	49.3	52.7	173.7	155	325	351	314
12/29/09	0.0	0.0	55.3	51.1	56.8	53.6	55.4	0.0		327	323	306
12/30/09	66.9	51.3	96.2	65.2	132.4	107.1	231.9	0.0	328	135	16	22
12/31/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/01/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/02/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/03/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/04/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/05/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/06/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/07/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/08/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/09/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/10/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/11/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/12/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/13/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/14/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/15/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/16/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/17/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/18/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/19/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				

01/20/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/21/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/22/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/23/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/24/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/25/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/26/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/27/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/28/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/29/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/30/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/31/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/01/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/02/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/03/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.1				
02/04/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.0				
02/05/10	0.0	0.0	0.0	0.0	61.5	48.7	53.0	44.7			44	73
02/06/10	48.4	43.2	52.2	46.6	52.9	47.9	52.0	46.9	238	259	280	242
02/07/10	46.9	42.9	51.8	43.2	47.7	43.2	54.1	103.0	163	161	164	155
02/08/10	52.7	45.7	56.7	46.0	59.4	45.7	61.6	0.0	241	229	251	202
02/09/10	76.6	48.7	76.0	52.1	70.8	65.2	197.0	89.4	236	61	28	16
02/10/10	657.3	592.6	370.9	319.1	0.0	0.0	0.0	124.6	10	498		
02/11/10	0.0	0.0	154.9	163.3	0.0	0.0	92.5	103.0		1	0	3
02/12/10	90.7	77.5	137.7	97.5	154.7	105.7	151.2	77.0	22	8	7	5
02/13/10	148.8	97.5	117.6	96.2	199.7	199.7	122.4	238.4	7	11	2	6
02/14/10	130.6	133.7	65.7	51.7	59.7	59.7	104.3	46.6	13	2	1	4
02/15/10	147.0	101.7	114.6	93.2	150.3	150.3	247.8	87.0	27	9	2	1
02/16/10	0.0	0.0	139.5	115.4	0.0	0.0	75.1	86.0		7	0	3

02/17/10	0.0	0.0	61.5	48.7	0.0	0.0	110.6	86.8	0	1	0	5
02/18/10	96.7	97.5	145.3	92.3	0.0	0.0	120.8	146.2	3	5	0	10
02/19/10	158.8	144.1	96.9	59.7	71.9	71.9	102.2	146.5	16	2	2	4
02/20/10	114.6	57.5	139.4	97.5	0.0	0.0	192.6	128.4	12	10	0	5
02/21/10	102.7	79.9	118.2	92.3	48.7	48.7	173.4	0.0	34	15	1	8
02/22/10	165.5	116.7	143.9	92.3	173.7	173.7	151.6	45.7	56	29	1	10
02/23/10	102.9	66.4	0.0	0.0	0.0	0.0	0.0	0.0	11			
02/24/10	65.5	53.0	87.9	48.7	86.7	48.7	61.3	45.3	40	34	5	1
02/25/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	133.0				
02/26/10	138.7	52.1	65.3	43.8	645.8	824.7	119.0	67.6	27	28	7	3
02/27/10	48.7	48.7	176.1	106.8	201.5	219.2	166.3	140.4	1	8	4	4
02/28/10	139.8	103.0	102.5	70.3	124.6	124.6	103.3	206.0	81	27	1	7
03/01/10	0.0	0.0	63.2	51.1	232.5	143.8	187.9	43.2		3	3	6
03/02/10	133.9	89.5	109.2	70.3	210.0	168.2	265.5	288.6	103	59	10	3
03/03/10	0.0	0.0	0.0	0.0	51.4	51.4	50.2	99.9			2	3
03/04/10	79.3	44.7	172.7	61.0	465.5	471.8	307.4	107.5	4	1	6	2
03/05/10	133.2	55.3	121.9	92.3	309.3	146.2	137.2	141.1	8	7	16	2
03/06/10	162.6	108.1	158.5	124.6	151.6	141.1	161.2	121.4	18	8	11	11
03/07/10	148.0	89.5	148.4	98.7	140.0	123.5	174.4	130.1	38	24	36	36
03/08/10	130.7	119.4	144.3	117.3	179.0	177.8	150.8	86.3	47	9	4	14
03/09/10	111.7	97.5	126.4	98.7	160.3	157.2	151.4	113.9	40	28	11	21
03/19/10	135.5	103.0	125.1	97.5	115.7	94.1	115.6	173.7	169	83	201	92
03/20/10	0.0	0.0	161.0	122.5	179.1	136.9	149.3	0.0		58	22	21
03/21/10	123.5	108.4	182.5	131.3	0.0	0.0	230.6	45.3	14	5	0	1
03/22/10	0.0	0.0	177.2	195.6	0.0	0.0	0.0	125.2		1	0	
03/23/10	0.0	0.0	0.0	0.0	0.0	0.0	66.0	48.7				12
03/24/10	62.6	46.9	87.9	63.9	61.3	63.6	158.5	60.0	7	7	5	4
03/25/10	130.4	135.9	130.3	89.5	93.6	58.8	69.5	98.7	5	10	29	17

03/26/10	0.0	0.0	118.7	51.3	38.0	38.0	86.4	66.7	0	4	1	3
03/27/10	138.8	77.2	107.0	84.1	146.5	146.5	120.2	0.0	10	3	1	7
03/28/10	129.9	113.9	115.3	80.7	70.3	48.7	101.8	44.7	7	19	9	61
03/29/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	134.3				
03/30/10	0.0	0.0	0.0	0.0	55.0	43.2	74.7	121.9			44	16
03/31/10	49.6	48.7	172.6	124.6	226.1	205.8	170.1	123.1	5	3	14	10
04/01/10	88.1	81.3	159.1	122.3	141.1	141.1	153.5	120.0	23	15	1	11
04/02/10	112.5	77.3	118.2	86.5	250.4	216.0	223.2	132.5	18	23	5	4
04/03/10	91.2	62.4	111.2	75.8	193.2	193.2	212.1	128.1	7	24	1	2
04/04/10	0.0	0.0	83.2	76.6	0.0	0.0	156.3	126.7	0	1	0	6
04/05/10	363.3	363.3	124.6	84.1	79.5	81.3	182.7	178.4	1	13	7	6
04/06/10	205.9	130.1	128.6	97.5	153.0	92.3	165.6	65.2	23	91	31	4
04/07/10	363.9	304.1	165.6	146.5	179.7	143.6	194.9	74.9	3	18	22	10
04/08/10	0.0	0.0	89.4	89.4	189.8	189.8	73.1	62.9	0	0	2	2
04/09/10	34.2	34.2	0.0	0.0	0.0	0.0	83.4	122.8	2			2
04/10/10	97.6	97.6	72.5	67.6	86.8	83.0	96.9	105.1	2	3	10	2
04/11/10	157.1	157.1	144.8	65.8	188.6	188.6	160.9	121.9	2	3	1	3
04/12/10	104.5	97.5	135.2	92.3	194.7	146.5	131.0	104.8	3	12	5	18
04/13/10	118.4	103.0	128.4	104.3	109.2	65.2	154.5	102.3	24	19	4	4
04/14/10	155.2	105.7	149.7	102.0	175.2	129.5	135.2	0.0	25	20	24	8
04/15/10	192.1	200.8	149.4	103.0	0.0	0.0	103.8	118.7	5	9	0	4
04/16/10	48.4	48.4	74.3	52.1	38.1	39.7	0.0	98.1	1	6	6	
04/17/10	41.1	41.1	160.7	108.4	0.0	0.0	239.6	141.1	1	0		1
04/18/10	0.0	0.0	233.4	125.8	0.0	0.0	90.0	108.3	0	3	0	2
04/19/10	0.0	0.0	238.7	200.9	0.0	0.0	206.8	108.4	0	1	0	15
04/20/10	141.9	144.1	178.8	140.7	124.3	108.4	146.4	90.2	28	19	37	10
04/21/10	187.8	98.7	188.7	124.6	118.2	108.4	151.5	130.1	4	33	7	11
04/22/10	192.7	169.9	184.8	113.9	0.0	0.0	120.1	125.5	6	2		2

04/23/10	0.0	0.0	107.6	87.7	0.0	0.0	162.4	0.0	0	2	0	7
04/24/10	84.7	82.7	164.4	110.0	166.4	124.6	155.5	94.9	4	12	27	29
04/25/10	211.5	211.5	149.4	91.4	43.5	34.4	0.0	55.3	1	8	3	
04/26/10	0.0	0.0	348.5	274.4	0.0	0.0	152.7	83.1		3		8
04/27/10	0.0	0.0	44.7	44.7	0.0	0.0	71.2	121.5	0	0	0	5
04/28/10	143.5	143.5	81.6	79.9	88.2	88.2	94.7	120.0	2	5	2	1
04/29/10	116.7	116.7	138.0	97.5	30.4	30.4	158.9	83.4	2	5	1	4
04/30/10	113.4	113.9	159.5	122.5	162.1	119.4	152.3	65.2	5	23	27	10
05/01/10	0.0	0.0	195.7	115.6	32.5	32.5	154.6	88.3	0	9	1	2
05/02/10	0.0	0.0	274.2	151.7	0.0	0.0	109.5	103.1	0	1	0	1
05/03/10	0.0	0.0	66.6	49.6	0.0	0.0	84.9	156.3	0	1	0	1
05/04/10	0.0	0.0	218.9	116.7	124.5	134.7	143.9	65.0	0	5	3	4
05/05/10	170.9	170.9	138.5	113.8	191.0	191.0	160.5	71.9	1	5	1	5
05/06/10	164.4	119.4	111.5	92.3	0.0	0.0	138.3	41.5	21	2	0	2
05/07/10	0.0	0.0	352.3	198.2	133.3	97.5	105.2	46.0	0	5	7	5
05/08/10	80.6	48.7	69.0	44.9	44.7	44.7	45.8	124.6	9	3	1	5
05/09/10	51.3	48.7	88.0	67.6	0.0	0.0	51.5	146.2	4	4	0	1
05/10/10	0.0	0.0	94.5	97.2	113.9	113.9	190.8	103.0	0	2	1	1
05/11/10	142.7	84.1	274.5	225.0	628.1	628.1	150.4	119.4	22	5	1	1
05/12/10	0.0	0.0	0.0	0.0	0.0	0.0	110.8	515.7			0	0
05/13/10	168.6	131.6	121.1	110.0	151.7	151.7	158.2	75.8	3	4	1	7
05/14/10	316.8	276.7	151.1	104.2	0.0	0.0	518.6	102.8	9	4	0	68
05/15/10	0.0	0.0	122.4	137.7	0.0	0.0	80.7	162.7	0	1	0	2
05/16/10	0.0	0.0	237.8	152.5	89.5	89.5	167.7	45.0	0	4	1	4
05/17/10	240.9	240.9	185.1	97.5	135.7	86.2	158.5	85.3	2	9	10	8
05/18/10	353.1	439.1	0.0	0.0	0.0	0.0	82.7	120.3	6			23
05/19/10	47.7	42.3	73.0	47.2	76.6	75.8	78.3	84.1	37	5	12	1
05/20/10	200.8	200.8	276.2	136.2	131.1	84.1	147.7	0.0	1	4	4	17

05/21/10	471.2	471.2	152.2	102.8	219.2	212.7	108.7	131.6	1	6	6	3
05/22/10	0.0	0.0	301.8	195.3	56.3	56.3	0.0	73.8	0	4	1	0
05/23/10	0.0	0.0	440.1	446.9	0.0	0.0	156.9	171.1	0	5	0	1
05/24/10	38.9	38.9	73.3	57.5	0.0	0.0	84.7	78.6	1	7	0	1
05/25/10	0.0	0.0	187.5	87.7	86.0	44.1	187.1	106.6	0	3	4	4
05/26/10	235.0	249.6	93.7	61.8	0.0	0.0	77.6	88.9	3	11	0	2
05/27/10	122.2	95.3	158.6	105.7	152.7	118.2	144.9	35.3	3	4	12	5
05/28/10	386.9	386.9	248.3	132.2	0.0	0.0	84.1	54.2	2	4	0	2
05/29/10	156.6	172.1	165.1	107.2	0.0	0.0	35.3	102.0	4	3		0
05/30/10	161.4	35.9	329.1	276.7	366.9	366.9	74.1	647.3	24	11	1	1
05/31/10	0.0	0.0	161.1	103.0	230.1	230.1	160.6	95.6	0	5	2	4
06/01/10	139.2	139.2	112.3	64.2	0.0	0.0	509.6	85.0	2	5		1
06/02/10	130.1	130.1	239.4	157.2	71.0	70.9	124.6	127.8	1	4	4	1
06/03/10	0.0	0.0	121.7	97.2	0.0	0.0	174.1	120.2	0	5	0	1
06/04/10	47.8	41.8	171.2	98.4	162.7	162.7	149.2	60.9	18	7	1	1
06/05/10	551.9	551.9	152.3	69.1	35.5	32.4	123.4	79.5	1	5	4	1
06/06/10	0.0	0.0	88.3	49.9	0.0	0.0	77.1	79.5	0	10		5
06/07/10	0.0	0.0	285.0	222.4	108.5	97.9	108.9	0.0	0	1	24	5
06/08/10	138.1	129.5	246.3	151.7	0.0	0.0	102.6	88.0	16	9	0	9
06/09/10	87.8	62.4	167.6	98.2	0.0	0.0	0.0	126.4	35	13		
06/10/10	52.8	46.6	82.2	60.3	0.0	0.0	132.1	0.0	27	3	0	1
06/11/10	0.0	0.0	145.0	89.4	0.0	0.0	196.1	0.0	0	1	0	1
06/12/10	0.0	0.0	167.3	124.6	0.0	0.0	0.0	87.7	0	1		
06/13/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
06/14/10	0.0	0.0	0.0	0.0	0.0	0.0	85.9	103.0			0	3
06/15/10	517.2	509.9	318.6	189.2	0.0	0.0	0.0	75.8	3	4		
06/16/10	0.0	0.0	156.0	123.1	110.6	83.9	184.5	86.8		13	6	3
06/17/10	70.9	60.4	320.6	135.6	109.4	109.7	155.6	159.2	8	1	3	1

06/18/10	275.6	275.6	148.1	100.5	132.6	96.2	127.5	146.1	2	42	22	78
06/19/10	200.5	124.6	208.8	135.6	252.9	234.0	163.1	140.0	37	42	5	2
06/20/10	165.6	165.6	148.7	112.2	0.0	0.0	146.1	0.0	2	3	0	0
06/21/10	35.4	34.4	150.6	92.3	122.1	154.8	206.6	124.6	3	5	7	2
06/22/10	304.0	308.4	287.8	204.9	0.0	0.0	0.0	114.5	9	19		
06/23/10	884.5	884.5	255.4	182.4	75.8	75.8	125.7	114.5	1	3	1	1
06/24/10	311.6	168.2	129.8	84.4	0.0	0.0	143.3	0.0	3	5	0	5
06/25/10	183.3	131.3	149.5	94.3	169.6	132.8	159.3	65.2	15	14	4	1
06/26/10	256.7	239.2	225.3	157.2	0.0	0.0	0.0	56.9	8	57	0	
06/27/10	215.9	211.8	226.6	168.2	112.5	97.5	67.7	0.0	5	30	10	2
06/28/10	61.8	64.7	75.3	52.5	0.0	0.0	65.1	160.1	4	8		0
06/29/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0			
06/30/10	0.0	0.0	0.0	0.0	0.0	0.0	172.2	81.9			0	1
07/01/10	254.2	219.5	176.5	131.6	0.0	0.0	82.6	91.8	14	3	0	1
07/02/10	91.1	91.1	250.0	195.3	0.0	0.0	0.0	96.6	1	4	0	
07/03/10	198.2	145.9	175.6	119.4	101.0	61.5	108.9	119.7	45	56	3	8
07/04/10	170.8	104.8	142.2	108.4	132.8	104.3	113.1	0.0	16	20	24	12
07/05/10	210.8	149.0	153.9	108.4	145.6	169.4	149.8	0.0	14	20	3	6
07/06/10	124.8	81.9	191.5	103.0	0.0	0.0	0.0	0.0	12	10		
07/07/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	244.1				
07/08/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	143.5				
07/09/10	0.0	0.0	0.0	0.0	521.9	525.7	266.5	67.7			202	1
07/10/10	135.8	113.3	142.4	104.3	334.3	334.3	150.8	172.4	3	18	1	1
07/11/10	37.7	37.7	218.2	140.3	233.1	233.1	144.1	0.0	2	7	1	3
07/12/10	282.7	230.5	119.0	92.3	0.0	0.0	238.2	238.1	30	7	0	2
07/13/10	338.2	298.0	296.2	192.6	32.5	32.5	0.0	81.3	3	3	1	
07/14/10	87.8	81.6	164.3	132.8	0.0	0.0	238.1	92.3	25	4	0	0
07/15/10	263.4	263.4	142.9	119.0	0.0	0.0	187.8	111.3	2	4	0	2

07/16/10	0.0	0.0	196.3	141.1	118.0	119.4	119.8	132.5	0	11	20	3
07/17/10	157.2	157.2	0.0	0.0	118.0	101.6	116.2	74.0	1		12	1
07/18/10	97.8	92.3	150.1	81.3	162.3	183.1	168.0	91.1	9	9	4	4
07/19/10	48.7	48.7	180.7	135.3	0.0	0.0	138.7	0.0	1	4	0	1
07/20/10	289.0	192.6	213.3	120.6	96.9	89.8	115.9	78.6	4	3	8	9
07/21/10	255.2	130.2	206.2	122.3	0.0	0.0	0.0	434.1	20	6		
07/22/10	0.0	0.0	152.2	126.3	0.0	0.0	104.0	363.6		7	0	2
07/23/10	181.2	118.8	0.0	0.0	88.2	45.7	448.0	103.4	10		3	30
07/24/10	427.3	427.3	358.9	317.2	0.0	0.0	387.3	130.4	2	17	0	7
07/25/10	0.0	0.0	249.1	254.9	203.9	61.2	96.3	90.9	0	2	3	1
07/26/10	0.0	0.0	178.4	123.4	98.5	98.5	180.6	67.4	0	3	2	6
07/27/10	125.9	113.9	138.4	92.3	133.7	97.5	121.6	107.2	24	35	84	63
07/28/10	0.0	0.0	146.7	97.5	99.8	65.2	98.8	189.2		16	5	7
07/29/10	114.2	97.5	218.9	151.7	140.3	165.3	153.7	144.6	22	2	4	3
07/30/10	149.7	99.0	184.3	139.7	0.0	0.0	235.1	112.6	4	9	0	3
07/31/10	111.0	86.8	226.0	135.7	293.0	304.7	180.0	144.3	45	20	3	1
08/01/10	137.0	77.0	152.8	123.4	0.0	0.0	216.8	70.5	11	9	0	2
08/02/10	226.8	162.7	201.7	146.5	0.0	0.0	166.2	86.5	51	14	0	6
08/03/10	227.3	138.3	194.1	124.6	95.1	63.3	98.9	90.9	40	26	9	2
08/04/10	114.4	126.7	81.8	92.9	43.2	43.2	174.0	70.3	10	2	1	0
08/05/10	0.0	0.0	302.3	224.6	0.0	0.0	132.9	92.3	0	3	0	3
08/06/10	0.0	0.0	251.1	173.7	0.0	0.0	181.4	67.0	0	6	0	1
08/07/10	0.0	0.0	175.4	119.7	113.9	113.9	115.6	100.8	0	17	1	7
08/08/10	224.0	173.7	166.4	113.9	170.5	189.8	169.2	113.9	11	16	7	3
08/09/10	244.4	61.5	269.6	200.8	157.0	131.9	137.7	70.5	3	25	27	19
08/10/10	463.1	509.9	309.0	218.0	110.6	104.0	148.0	52.2	17	9	6	8
08/11/10	268.8	293.8	143.0	65.2	122.2	122.2	85.6	46.7	4	12	1	4
08/12/10	184.3	113.8	152.1	108.4	52.8	52.8	64.9	396.2	4	7	2	3

08/13/10	343.2	246.2	120.8	93.8	80.8	80.2	74.6	99.0	4	5	4	3
08/14/10	0.0	0.0	234.0	146.7	0.0	0.0	335.1	523.6	0	3	0	0
08/15/10	0.0	0.0	203.8	92.3	104.3	104.3	148.3	275.3	0	10	2	8
08/16/10	71.1	46.9	402.6	361.9	0.0	0.0	505.3	65.2	6	18	0	61
08/17/10	0.0	0.0	225.2	152.6	65.2	65.2	308.6	111.5	0	4	2	1
08/18/10	180.2	89.4	156.7	108.4	65.2	65.2	75.1	48.7	20	45	2	2
08/19/10	193.0	147.9	191.3	120.2	145.9	145.9	154.3	54.2	14	10	1	10
08/20/10	98.5	65.2	160.4	97.5	224.9	224.9	62.8	0.0	11	59	1	2
08/21/10	397.5	330.9	159.2	99.3	80.6	43.2	75.9	0.0	4	9	15	7
08/22/10	114.7	119.3	0.0	0.0	68.6	48.7	0.0	0.0	6		46	
08/23/10	69.0	43.2	62.4	43.4	49.3	48.7	0.0	165.4	33	16	14	
08/24/10	53.0	36.7	54.0	43.2	48.1	48.7	0.0	113.0	8	5	5	
08/25/10	0.0	0.0	124.7	86.3	206.0	206.0	176.2	113.9		4	1	1
08/26/10	166.4	173.7	222.8	158.6	486.4	486.4	160.7	86.2	3	6	1	3
08/27/10	204.6	168.2	143.0	82.7	89.2	86.8	142.7	102.6	9	24	16	16
08/28/10	143.2	110.1	194.0	141.7	79.6	67.7	122.4	90.8	54	18	10	25
08/29/10	149.8	70.9	187.8	108.4	48.7	48.7	139.1	112.6	12	25	1	2
08/30/10	127.6	127.5	171.0	125.8	118.8	118.8	121.4	136.5	4	5	1	5
08/31/10	137.9	117.9	136.3	85.6	390.7	390.7	211.5	0.0	8	14	1	8
09/01/10	236.7	238.6	158.5	86.8	252.0	212.1	195.8	0.0	15	23	48	31
09/02/10	108.7	60.3	128.5	112.7	0.0	0.0	0.0	0.0				
09/03/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
09/04/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
09/05/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
09/06/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
09/07/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
09/08/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
09/09/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	97.5				

09/10/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	95.9				
09/11/10	0.0	0.0	0.0	0.0	96.5	94.1	102.0	108.4	16	6		
09/12/10	124.5	107.8	119.2	105.4	96.9	99.0	99.6	130.7	62	117	92	63
09/13/10	139.1	97.5	192.8	160.6	113.3	122.0	124.6	115.9	16	19	20	49
09/14/10	182.0	157.2	180.4	146.5	193.9	175.6	171.0	0.0	31	37	8	8
09/15/10	111.2	111.2	118.0	105.7	107.1	99.0	133.3	97.5	33	59	11	3
09/16/10	196.9	154.6	112.1	104.5	104.7	103.0	0.0	90.8	42	110	358	
09/17/10	0.0	0.0	103.7	104.0	104.7	102.2	104.2	102.0		57	142	29
09/18/10	154.9	127.0	122.6	103.0	119.0	120.3	99.8	100.5	77	53	37	9
09/19/10	106.6	130.1	133.4	102.3	99.0	85.3	104.2	108.1	3	25	13	34
09/20/10	104.0	103.0	108.2	105.7	110.0	104.9	104.2	99.3	380	318	208	241
09/21/10	121.7	108.3	126.7	105.7	110.6	108.4	114.0	106.9	180	59	227	236
09/22/10	116.2	108.4	106.7	103.0	106.6	100.5	105.1	102.0	160	147	134	39
09/23/10	189.9	141.1	177.6	143.8	135.8	121.5	117.0	116.7	88	58	152	93
09/24/10	122.9	114.8	146.1	113.9	77.9	56.3	103.4	101.1	33	67	130	151
09/25/10	105.4	106.5	109.7	104.8	103.2	98.8	140.5	103.0	272	158	62	28
09/26/10	171.2	112.7	144.3	110.9	104.0	105.1	104.4	105.7	48	144	217	185
09/27/10	109.4	106.3	123.1	104.2	0.0	0.0	104.3	103.0	77	39	0	86
09/28/10	112.8	104.5	108.8	107.5	108.1	108.4	106.3	105.7	325	388	495	258
09/29/10	105.2	107.2	132.1	103.0	134.5	119.6	109.6	107.5	61	38	54	34
09/30/10	108.0	104.5	106.8	105.1	0.0	0.0	106.1	106.3	196	368		405
10/01/10	107.0	108.7	0.0	0.0	0.0	0.0	108.1	0.0	515			473
10/02/10	104.6	102.6	108.4	102.0	189.0	124.6	111.2	106.2	339	75	5	115
10/03/10	111.3	105.7	107.6	105.4	106.5	103.3	0.0	93.5	204	234	269	
10/04/10	110.0	110.9	108.6	108.7	109.4	108.4	107.7	105.1	350	360	352	318
10/05/10	111.7	105.7	108.6	103.0	116.4	111.2	98.3	103.9	332	260	17	21
10/06/10	0.0	0.0	120.5	103.0	117.0	101.0	106.8	110.6		144	72	105
10/07/10	112.6	108.1	105.0	103.0	112.8	110.0	109.5	100.2	133	194	117	68

10/08/10	105.3	100.2	114.0	106.3	116.7	111.5	120.5	110.3	57	120	347	118
10/09/10	146.8	120.9	241.8	173.7	116.2	118.7	111.8	133.1	13	66	22	20
10/10/10	177.8	162.7	121.9	109.0	116.1	107.2	122.6	121.9	14	68	281	94
10/11/10	205.3	157.2	197.5	156.1	156.0	134.3	170.1	178.8	109	202	157	180
10/12/10	137.7	124.4	172.9	141.5	153.7	158.4	148.0	0.0	40	22	10	21
10/13/10	161.2	124.7	201.4	160.0	0.0	0.0	234.2	110.9	48	46	0	5
10/14/10	246.4	189.8	133.4	108.7	0.0	0.0	0.0	101.4	39	158		
10/15/10	111.4	113.6	109.2	108.7	107.6	110.6	111.7	105.7	520	374	378	326
10/16/10	114.1	111.2	110.5	109.7	107.6	107.4	102.8	108.7	289	271	216	74
10/17/10	106.4	103.0	114.8	105.4	104.8	103.0	112.6	194.7	130	114	78	19
10/18/10	112.0	95.9	163.9	119.4	139.7	119.4	137.7	110.9	29	23	11	19
10/19/10	163.8	141.1	197.9	157.7	361.5	394.3	190.8	0.0	90	59	10	3
10/20/10	184.2	174.9	217.9	163.0	126.6	114.5	123.2	112.7	37	41	22	41
10/21/10	172.3	134.0	132.6	114.8	0.0	0.0	0.0	113.9	11	201		
10/22/10	0.0	0.0	113.4	108.1	112.2	108.4	119.7	112.1		170	230	251
10/23/10	127.3	119.1	114.2	111.2	118.9	110.9	125.3	111.2	214	125	199	71
10/24/10	196.6	150.5	184.1	151.4	0.0	0.0	131.2	108.7	215	178		8
10/25/10	142.2	126.4	116.2	108.7	118.5	108.7	112.5	0.0	5	110	272	360
10/26/10	112.2	110.7	111.1	110.0	116.9	116.1	110.5	113.9	292	102	53	263
10/27/10	109.1	109.7	123.4	113.9	125.6	118.2	0.0	110.9	363	358	391	
10/28/10	0.0	0.0	0.0	0.0	121.2	111.2	123.5	0.0			215	127
10/29/10	146.9	127.5	118.2	109.7	105.1	103.0	113.8	0.0	98	84	162	238
10/30/10	113.2	105.7	111.9	108.6	0.0	0.0	0.0	113.9	189	143		
10/31/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	113.9				
11/01/10	0.0	0.0	0.0	0.0	128.6	127.9	128.2	108.7			5	92
11/02/10	132.7	109.0	192.8	147.8	0.0	0.0	174.0	0.0	82	57	0	8
11/03/10	159.7	115.0	198.5	149.9	144.1	158.1	122.2	108.4	28	20	4	94
11/04/10	0.0	0.0	0.0	0.0	108.0	107.4	0.0	109.4			340	

11/05/10	114.9	110.9	115.4	112.1	120.2	114.8	111.1	0.0	164	368	414	263
11/06/10	112.1	108.7	114.3	109.4	111.2	108.3	111.3	115.8	389	221	146	366
11/07/10	113.8	110.3	124.2	113.0	109.2	104.2	0.0	113.9	352	337	190	
11/08/10	126.7	119.4	0.0	0.0	0.0	0.0	120.0	118.2	382			326
11/09/10	114.6	115.1	116.3	115.1	107.7	105.7	115.4	113.9	329	308	208	243
11/10/10	116.3	116.4	116.2	116.1	116.2	116.7	118.2	110.6	353	314	276	297
11/11/10	118.2	118.2	115.1	115.8	111.4	111.2	116.0	124.3	300	289	237	295
11/12/10	115.4	115.8	113.7	113.0	114.4	113.9	114.9	110.1	309	343	323	283
11/13/10	103.8	101.3	119.4	113.0	185.8	203.2	135.5	154.2	342	184	17	24
11/14/10	135.2	117.3	164.9	130.1	117.6	104.8	119.8	0.0	50	155	163	146
11/15/10	149.8	124.6	135.5	112.2	111.5	89.2	147.3	0.0	152	68	12	5
11/16/10	184.3	184.3	195.8	141.1	133.8	117.1	0.0	0.0	2	13	52	
11/17/10	0.0	0.0	116.9	116.7	0.0	0.0	0.0	118.8		415		
11/18/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	110.3				
11/19/10	0.0	0.0	0.0	0.0	222.7	157.2	142.3	118.5			15	55
11/20/10	122.1	116.5	120.7	120.9	115.7	107.2	121.3	110.0	366	26	67	153
11/21/10	118.3	110.3	122.9	108.7	142.7	119.4	142.1	113.6	161	129	17	72
11/22/10	143.0	119.4	141.5	119.4	123.5	110.3	123.7	108.7	244	393	120	88
11/23/10	129.6	112.2	129.7	113.9	112.2	108.3	120.1	116.8	186	168	134	161
11/24/10	121.4	116.7	114.7	113.9	111.5	108.6	110.7	107.1	275	237	150	79
11/25/10	106.2	108.4	113.8	108.7	0.0	0.0	118.4	113.9	9	14	0	91
11/26/10	0.0	0.0	116.0	110.3	107.8	105.2	109.9	103.9		260	216	64
11/27/10	112.5	110.6	111.4	111.8	113.6	113.9	119.0	108.4	192	276	315	209
11/28/10	91.9	94.9	206.4	178.8	174.6	159.2	138.0	112.4	18	9	8	5
11/29/10	97.4	81.3	196.8	138.9	511.5	423.0	153.5	0.0	19	81	5	6
11/30/10	132.5	118.8	116.2	111.5	109.7	111.9	114.7	0.0	49	389	388	412
12/01/10	116.1	117.0	119.3	119.7	0.0	0.0	0.0	0.0	413	546		
12/02/10	102.9	103.3	0.0	0.0	0.0	0.0	0.0	0.0	153			

12/03/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	115.4				
12/04/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.2				
12/05/ 10	0.0	0.0	109.6	105.5	113.3	106.6	119.0	111.2		38	188	320
12/06/ 10	112.0	112.1	114.1	113.9	114.9	116.7	110.6	110.0	266	327	312	288
12/07/ 10	107.8	109.0	111.6	109.7	106.6	105.1	112.6	112.1	250	254	179	260
12/08/ 10	111.2	111.2	112.5	107.5	116.3	107.4	114.6	113.9	217	206	176	207
12/09/ 10	109.5	105.7	117.1	109.7	120.1	105.1	128.9	109.7	97	183	184	107
12/10/ 10	164.7	120.0	179.9	130.1	192.0	146.5	129.8	0.0	27	39	13	73
12/11/ 10	0.0	0.0	182.8	135.6	132.5	129.8	116.3	110.6	0	24	16	58
12/12/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	113.0				
12/13/ 10	0.0	0.0	0.0	0.0	108.9	108.4	111.5	112.4			187	399
12/14/ 10	112.1	109.4	110.9	109.7	111.3	110.9	111.7	109.7	387	401	401	453
12/15/ 10	116.2	119.4	111.3	113.6	110.8	113.6	114.8	119.4	396	346	310	268
12/16/ 10	108.7	106.0	130.8	110.0	121.0	107.5	121.9	151.7	85	66	113	22
12/17/ 10	151.1	133.0	129.4	112.1	111.8	114.8	132.0	110.9	12	16	15	22
12/18/ 10	177.5	170.9	161.1	130.1	154.5	131.0	177.9	113.9	7	21	19	10
12/19/ 10	122.4	113.9	124.8	111.2	119.7	110.4	112.9	111.5	45	106	96	236
12/20/ 10	118.8	116.8	111.1	109.7	109.5	110.6	114.3	111.2	308	229	272	306
12/21/ 10	112.4	113.9	114.2	113.3	111.1	108.4	114.5	111.2	278	244	201	222
12/22/ 10	105.9	105.1	107.0	103.0	107.3	106.8	113.2	105.7	135	47	88	209
12/23/ 10	114.0	115.9	114.7	113.9	101.2	98.4	114.0	121.5	332	220	98	230
12/24/ 10	117.6	110.6	121.6	103.9	127.9	127.9	110.3	0.0	87	28	2	11
12/25/ 10	0.0	0.0	106.9	106.9	0.0	0.0	179.3	0.0	0	0	0	24
12/26/ 10	122.2	107.5	123.6	113.9	0.0	0.0	0.0	0.0	235	281		
12/27/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/28/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/29/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/30/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				

12/31/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/01/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/02/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/03/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/04/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/05/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/06/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/07/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/08/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/09/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/10/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/11/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/12/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/13/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/14/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/15/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/16/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/17/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/18/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/19/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/20/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/21/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/22/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/23/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/24/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/25/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/26/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/27/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				

01/28/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/29/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/30/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
01/31/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/01/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/02/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/03/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/04/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/05/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/06/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/07/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/08/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/09/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/10/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/11/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/12/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/13/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/14/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/15/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/16/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/17/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/18/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/19/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/20/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/21/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/22/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/23/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/24/ 11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				

02/25/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
02/26/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	103.0				
02/27/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	101.6				
02/28/11	0.0	0.0	0.0	0.0	104.3	104.5	104.9	0.0			258	231
03/01/11	108.5	103.0	106.1	97.8	0.0	0.0	112.5	112.7	187	41	0	53
03/02/11	110.7	105.7	111.4	111.2	0.0	0.0	0.0	108.3	329	320		
03/03/11	0.0	0.0	0.0	0.0	176.7	151.7	133.8	99.9			27	15
03/04/11	159.6	130.1	143.9	119.4	121.9	105.7	121.3	103.0	99	67	80	294
03/05/11	131.6	115.4	118.6	107.1	104.8	95.9	114.0	101.1	387	341	262	284
03/06/11	104.8	105.1	99.2	98.1	96.4	95.0	103.1	107.2	384	296	315	409
03/07/11	109.7	109.7	111.4	111.8	107.3	106.3	108.1	103.0	610	497	335	174
03/08/11	106.6	97.0	136.2	115.4	207.0	197.9	121.8	105.7	136	105	24	53
03/09/11	126.6	117.0	121.4	108.1	108.5	101.6	108.1	97.0	95	262	246	320
03/10/11	102.2	102.6	102.7	103.6	102.4	103.0	104.5	99.3	345	367	386	383
03/11/11	107.9	105.4	97.6	94.4	94.1	95.9	97.9	108.3	420	117	18	106
03/12/11	94.6	90.9	102.3	97.5	107.8	99.4	103.2	94.4	246	217	168	58
03/13/11	0.0	0.0	106.3	97.5	123.3	105.1	132.3	102.6	0	39	45	36
03/14/11	153.4	123.4	147.2	119.4	100.2	100.8	109.0	103.0	96	78	17	11
03/15/11	161.0	119.4	142.8	119.4	80.7	81.3	115.2	103.0	57	21	3	36
03/16/11	89.9	88.0	99.2	95.6	101.8	97.5	115.6	108.7	33	213	171	10
03/17/11	108.7	97.6	124.0	111.2	123.3	116.7	115.3	113.0	40	49	87	164
03/18/11	105.0	104.2	104.8	100.8	142.3	108.0	127.3	105.1	243	184	16	27
03/19/11	125.5	108.6	126.8	114.2	99.5	94.4	133.0	96.9	146	35	61	22
03/20/11	128.9	119.4	145.9	119.7	0.0	0.0	125.3	100.2	71	14	0	27
03/21/11	112.9	97.5	103.6	102.0	103.6	104.2	100.2	98.2	83	276	357	144
03/22/11	96.9	97.8	103.0	98.1	138.4	120.6	122.0	90.0	20	63	25	5
03/23/11	194.4	135.6	198.6	138.3	425.0	365.8	112.9	103.0	13	9	8	101
03/24/11	0.0	0.0	99.1	97.5	105.8	105.7	94.2	95.9		78	8	26

03/25/11	113.9	104.5	110.9	103.0	116.3	108.4	114.9	103.3	57	80	227	169
03/26/11	131.1	113.9	117.2	108.4	102.0	97.9	100.1	99.9	180	173	142	47
03/27/11	175.3	156.6	107.2	100.2	105.6	97.8	111.5	130.1	10	72	71	151
03/28/11	139.5	108.7	112.9	101.7	100.0	97.5	108.4	113.9	240	153	63	22
03/29/11	101.2	93.2	128.5	116.4	134.2	115.3	153.2	0.0	45	111	58	20
03/30/11	157.4	157.2	140.7	119.4	110.1	97.5	138.4	100.2	31	40	77	26
03/31/11	0.0	0.0	110.1	99.6	0.0	0.0	0.0	108.4	0	68		
04/01/11	108.4	110.4	110.1	104.8	120.9	95.6	103.2	128.6	390	220	135	200
04/02/11	95.1	95.2	97.3	96.9	64.4	47.8	128.3	102.3	134	69	16	23
04/03/11	104.4	93.2	113.9	105.1	129.0	113.9	154.9	101.7	69	72	33	5
04/04/11	113.9	105.8	107.9	103.0	98.0	95.6	103.6	111.2	5	205	331	172
04/05/11	0.0	0.0	108.4	110.6	106.5	107.5	104.1	146.5	0	4	233	150
04/06/11	108.4	105.4	110.0	102.6	133.2	106.3	154.6	117.9	241	169	172	34
04/07/11	0.0	0.0	147.9	130.1	222.1	227.9	188.5	121.4		49	3	13
04/08/11	212.8	169.4	172.2	135.6	131.3	111.2	143.3	95.0	31	57	13	16
04/09/11	122.8	97.5	158.8	124.6	101.9	103.0	139.2	103.6	27	49	15	50
04/10/11	125.0	102.3	176.8	127.3	132.3	124.6	95.7	0.0	32	7	23	35
04/11/11	76.2	75.1	105.5	102.0	110.2	106.6	106.2	115.1	22	145	277	233
04/12/11	103.1	99.0	122.4	103.9	0.0	0.0	0.0	110.3	67	22		
04/13/11	0.0	0.0	0.0	0.0	0.0	0.0	136.6	99.6				8
04/14/11	316.0	304.0	154.3	119.4	155.3	102.6	129.5	0.0	10	40	5	45
04/15/11	114.7	100.1	109.9	98.7	103.2	103.0	105.5	103.0	68	175	243	226
04/16/11	105.3	103.0	107.8	108.4	0.0	0.0	0.0	99.6	298	367		
04/17/11	107.2	108.1	103.2	102.6	102.1	103.0	106.9	96.9	508	317	205	131
04/18/11	95.9	102.3	106.8	97.5	130.9	134.2	121.6	101.7	9	68	6	9
04/19/11	117.9	103.7	133.5	104.2	107.9	97.5	109.8	100.5	56	40	105	61
04/20/11	108.5	103.9	103.9	97.5	103.7	99.8	114.9	100.8	129	38	46	19
04/21/11	0.0	0.0	102.0	97.5	123.7	105.7	113.2	101.0	0	102	163	34

04/22/ 11	231.4	201.4	186.4	135.6	216.9	211.5	108.0	108.4	4	13	3	73
04/23/ 11	0.0	0.0	0.0	0.0	110.8	97.5	106.8	90.2			53	85
04/24/ 11	99.2	98.1	102.8	96.2	0.0	0.0	133.0	96.9	34	11		11
04/25/ 11	43.6	38.6	163.2	123.5	0.0	0.0	107.5	103.0	11	21	0	7
04/26/ 11	124.4	124.6	100.6	95.6	100.1	100.4	103.1	0.0	3	68	178	122
04/27/ 11	102.9	103.0	105.3	97.5	106.4	98.8	105.4	127.9	71	70	248	305
04/28/ 11	100.2	98.7	112.3	111.2	0.0	0.0	0.0	133.9	310	396		
04/29/ 11	91.4	91.4	106.9	100.4	130.5	119.4	152.6	82.2	1	27	25	17
04/30/ 11	110.7	110.7	190.4	138.9	0.0	0.0	198.5	123.4	3	19	0	7
05/01/ 11	151.6	102.0	121.2	99.3	101.0	84.4	104.7	91.1	38	59	25	7
05/02/ 11	0.0	0.0	189.4	154.0	172.8	177.9	139.7	93.4	0	29	71	27
05/03/ 11	115.1	103.0	106.6	97.5	104.2	95.8	97.3	95.0	13	117	290	124
05/04/ 11	99.9	92.4	95.7	92.9	0.0	0.0	103.7	108.4	182	97		67
05/05/ 11	110.1	99.6	130.7	108.0	131.2	114.8	128.1	124.6	98	68	5	7
05/06/ 11	116.2	104.9	115.5	103.3	104.3	97.5	126.8	105.7	40	133	147	67
05/07/ 11	165.2	124.1	138.2	112.7	128.6	103.0	158.5	103.0	88	103	125	9
05/08/ 11	93.5	94.7	119.5	100.8	90.4	96.4	137.4	99.6	4	26	10	4
05/09/ 11	172.3	214.8	139.7	111.2	155.7	124.6	108.0	91.1	3	12	5	45
05/10/ 11	99.6	90.2	102.0	98.1	101.9	97.2	101.8	152.3	97	113	165	153
05/11/ 11	94.9	92.4	101.2	97.5	95.4	92.9	98.8	113.9	102	103	43	15
05/12/ 11	111.1	109.8	111.6	100.8	126.0	113.9	171.9	89.5	10	22	58	2
05/13/ 11	0.0	0.0	179.7	158.3	97.5	97.5	110.2	91.7	0	2	1	1
05/14/ 11	0.0	0.0	131.8	108.4	309.3	309.3	100.7	94.7	0	18	1	19
05/15/ 11	73.0	73.1	104.9	97.2	100.2	100.2	95.5	0.0	8	53	2	20
05/16/ 11	92.2	90.0	114.4	97.5	107.8	103.3	96.8	95.3	74	101	78	74
05/17/ 11	87.7	85.6	103.8	98.7	0.0	0.0	0.0	95.3	68	136		
05/18/ 11	93.9	90.8	100.3	95.0	99.7	90.8	99.9	89.7	122	230	226	256
05/19/ 11	88.4	89.2	91.4	90.5	102.4	92.6	124.6	105.7	231	47	76	20

05/20/11	216.9	216.9	228.5	185.9	0.0	0.0	111.8	92.0	1	6	0	2
05/21/11	0.0	0.0	254.4	188.6	106.8	59.2	121.6	103.0	0	5	10	12
05/22/11	92.5	88.8	118.9	103.0	89.6	78.6	98.6	102.0	34	23	13	57
05/23/11	104.6	95.8	105.0	97.2	99.8	97.5	106.5	97.5	134	219	192	339
05/24/11	97.0	95.8	99.6	94.4	126.7	113.9	126.0	93.8	214	71	17	6
05/25/11	227.9	227.9	259.6	162.7	91.9	90.5	109.8	101.1	1	5	6	10
05/26/11	0.0	0.0	164.6	95.9	98.5	97.5	101.8	89.4	0	12	42	31
05/27/11	179.4	131.6	109.2	93.8	113.9	106.0	107.9	97.5	6	16	11	25
05/28/11	206.5	147.0	125.4	102.3	0.0	0.0	87.5	40.6	20	109	0	1
05/29/11	114.6	79.2	126.8	103.3	110.7	92.3	103.9	158.9	5	27	23	123
05/30/11	110.8	97.8	124.1	105.8	86.0	92.3	56.2	99.9	213	52	3	1
05/31/11	266.2	48.7	227.0	160.6	135.3	161.8	172.7	90.2	3	10	3	5
06/01/11	321.5	249.0	115.1	103.0	0.0	0.0	103.7	113.9	3	175		185
06/02/11	117.8	86.0	111.0	97.5	100.7	89.8	105.1	92.0	60	93	104	29
06/03/11	102.9	101.6	109.7	94.3	115.5	129.2	127.9	124.9	52	19	6	22
06/04/11	147.4	116.4	159.8	116.4	97.0	92.6	103.3	149.4	40	53	115	21
06/05/11	305.0	338.0	253.2	189.8	185.2	211.5	144.1	102.8	3	16	8	1
06/06/11	64.1	54.6	269.1	212.7	204.9	200.8	157.7	102.3	52	8	53	9
06/07/11	119.0	119.0	174.6	129.3	128.6	112.2	126.7	0.0	2	19	42	14
06/08/11	166.0	109.0	182.4	120.8	171.0	204.1	110.2	0.0	9	51	54	33
06/09/11	130.6	128.9	0.0	0.0	0.0	0.0	0.0	0.0	8			
06/10/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
06/11/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
06/12/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
06/13/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	124.0				
06/14/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	127.3				
06/15/11	0.0	0.0	0.0	0.0	0.0	0.0	136.6	96.1				5
06/16/11	129.6	100.7	148.1	119.4	127.7	115.0	147.0	107.1	22	18	66	22

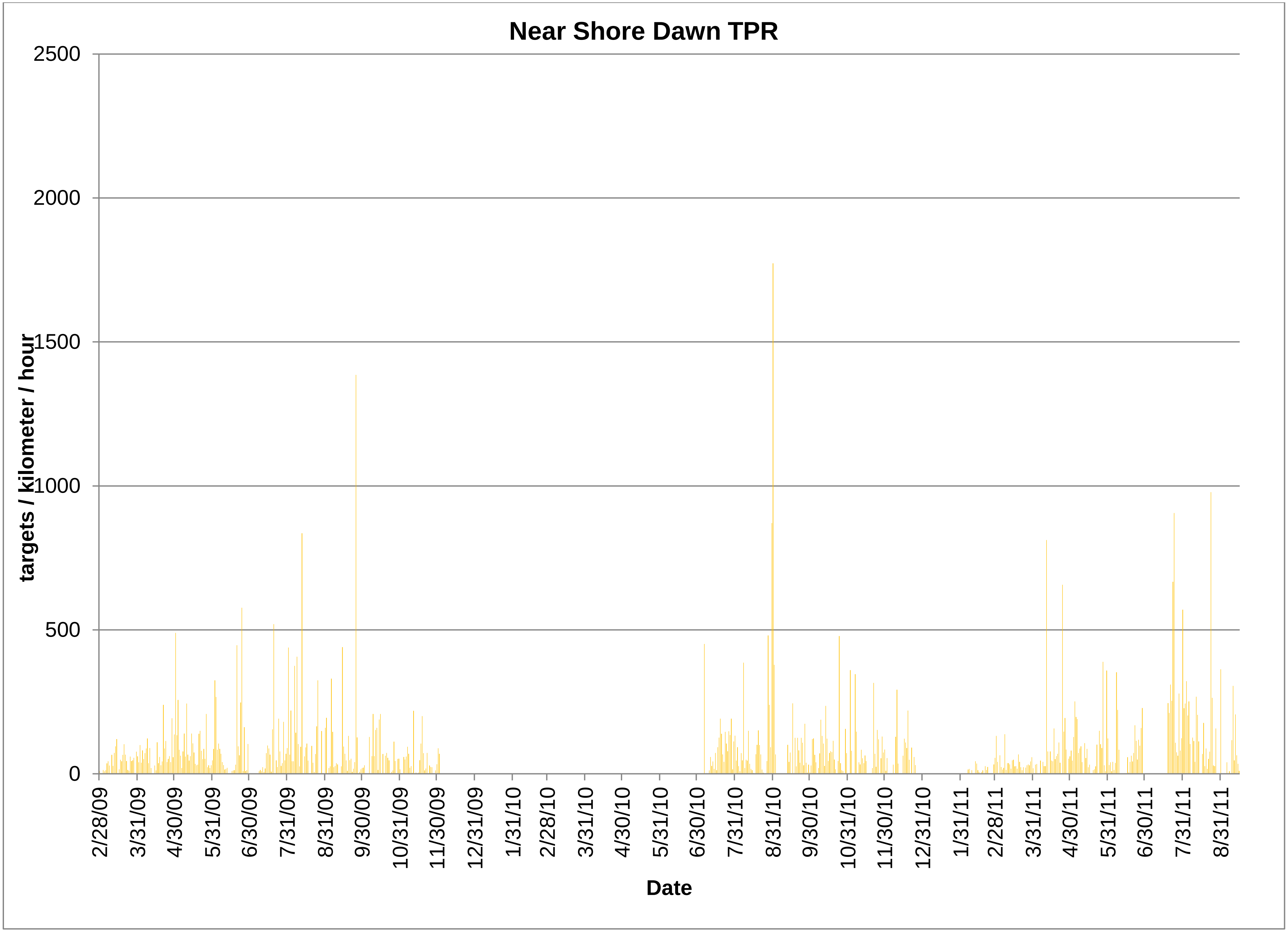
06/17/11	158.5	124.0	0.0	0.0	97.8	97.3	100.0	199.0	8		284	126
06/18/11	98.0	90.0	170.7	131.0	116.6	111.3	150.6	121.4	8	38	38	6
06/19/11	0.0	0.0	217.4	148.2	141.8	122.2	173.0	141.4	0	28	76	18
06/20/11	151.7	140.9	195.2	141.1	184.9	162.8	132.1	89.5	22	23	54	28
06/21/11	116.8	97.5	213.9	143.3	145.0	141.4	189.8	99.4	23	6	11	5
06/22/11	184.6	184.6	270.0	200.8	106.6	97.8	97.2	92.6	1	17	28	43
06/23/11	98.7	98.7	201.9	126.7	95.0	93.0	102.8	88.0	1	6	38	3
06/24/11	153.9	95.2	209.8	129.2	109.1	95.0	95.1	90.8	8	34	79	112
06/25/11	148.1	122.8	200.8	157.8	65.2	65.2	114.5	157.2	15	5	1	6
06/26/11	81.8	76.3	304.5	237.7	0.0	0.0	102.4	133.1	4	74	0	4
06/27/11	97.5	97.5	241.9	178.8	86.5	86.5	201.9	112.7	1	27	1	5
06/28/11	0.0	0.0	309.0	245.6	0.0	0.0	185.4	121.9	0	38	0	4
06/29/11	0.0	0.0	186.5	135.6	122.0	119.4	141.0	118.8		21	17	4
06/30/11	122.2	111.2	140.0	113.9	117.3	106.0	147.7	86.2	12	94	108	38
07/01/11	211.1	178.5	165.9	107.7	0.0	0.0	112.6	95.0	6	19	0	5
07/02/11	112.4	94.9	191.0	143.5	282.3	282.3	171.6	126.0	18	22	2	4
07/03/11	102.3	102.3	160.8	110.0	42.1	33.6	92.3	113.9	1	20	12	0
07/04/11	0.0	0.0	153.7	117.7	132.9	106.6	151.6	97.5	0	83	31	7
07/05/11	148.6	144.4	194.2	137.5	143.4	119.4	138.6	48.7	17	21	57	52
07/06/11	120.8	94.4	122.1	100.2	100.2	90.2	116.1	0.0	11	119	91	20
07/07/11	0.0	0.0	187.4	112.4	0.0	0.0	113.0	59.8	0	13	0	3
07/08/11	0.0	0.0	222.0	162.7	0.0	0.0	0.0	122.5	0	9		
07/09/11	210.4	117.0	173.5	130.1	108.4	108.4	64.1	95.0	29	53	1	3
07/10/11	205.0	168.6	192.8	147.5	194.4	201.7	140.9	98.1	18	71	12	10
07/11/11	179.1	108.0	180.8	125.5	112.6	103.0	99.8	92.6	32	64	168	249
07/12/11	102.8	97.5	107.5	98.1	89.2	90.8	110.6	202.3	320	105	16	3
07/13/11	88.5	103.0	201.6	143.8	119.5	121.9	109.5	157.7	4	16	12	8
07/14/11	110.7	97.9	110.6	97.5	0.0	0.0	229.6	122.2	84	67	0	3

07/15/11	250.7	219.2	184.0	151.7	168.4	203.8	183.8	97.5	8	58	9	27
07/16/11	252.5	204.8	199.6	168.2	261.4	245.0	145.5	99.9	136	92	93	23
07/17/11	162.8	137.5	120.5	103.0	103.9	95.3	102.7	108.4	98	151	205	183
07/18/11	108.3	101.4	110.4	97.2	97.9	92.6	107.7	140.6	138	99	79	28
07/19/11	138.3	135.6	226.5	157.2	0.0	0.0	153.4	95.0	23	13	0	7
07/20/11	172.7	172.3	173.1	135.6	181.5	184.9	157.4	109.7	4	43	9	9
07/21/11	361.4	361.4	108.8	97.5	99.2	97.9	101.7	117.0	2	224	226	93
07/22/11	97.2	104.3	149.0	106.6	168.1	152.3	130.6	97.0	8	10	14	4
07/23/11	188.8	176.3	173.5	130.1	108.4	108.4	151.3	97.5	4	20	1	5
07/24/11	322.1	322.1	196.7	146.5	152.5	125.8	105.0	91.8	1	18	18	73
07/25/11	87.5	92.9	121.3	97.2	309.1	295.3	104.5	151.7	32	46	10	49
07/26/11	168.1	132.1	209.6	130.1	0.0	0.0	252.8	115.3	16	7		4
07/27/11	285.8	110.0	157.9	130.1	154.6	108.1	165.7	92.3	7	26	15	24
07/28/11	145.9	125.8	151.4	135.0	104.8	104.8	153.2	153.5	49	23	2	2
07/29/11	168.2	104.5	113.4	99.4	151.8	99.6	99.6	135.9	9	8	68	119
07/30/11	129.3	111.2	167.1	139.2	226.0	168.2	169.9	90.3	21	17	5	115
07/31/11	161.7	149.3	181.6	151.7	167.3	170.8	158.3	113.6	189	171	40	29
08/01/11	129.1	111.2	126.9	103.6	0.0	0.0	94.5	171.8	8	56		20
08/02/11	0.0	0.0	170.9	130.1	124.1	108.3	126.6	84.4	0	32	128	17
08/03/11	153.2	120.8	204.9	146.8	111.9	108.4	287.9	113.9	4	9	9	7
08/04/11	0.0	0.0	133.0	97.5	135.6	135.6	194.2	0.0	0	7	2	1
08/05/11	208.0	193.8	234.9	198.1	180.2	144.9	123.1	97.5	4	21	16	25
08/06/11	123.9	119.4	129.5	103.0	111.4	97.5	0.0	89.5	49	102	281	
08/07/11	0.0	0.0	125.2	100.2	158.3	107.5	122.4	98.7		202	30	9
08/08/11	0.0	0.0	271.6	173.7	270.0	189.8	164.8	108.4		16	8	4
08/09/11	372.2	349.7	155.4	121.5	0.0	0.0	109.1	118.2	24	140		247
08/10/11	0.0	0.0	131.0	108.4	110.7	102.5	122.4	140.1	0	84	126	24
08/11/11	0.0	0.0	177.5	137.1	215.5	152.9	136.1	132.5	0	13	8	2

08/12/11	0.0	0.0	198.0	151.7	0.0	0.0	165.0	0.0	0	22	0	25
08/13/11	179.2	157.2	0.0	0.0	202.0	158.4	164.0	88.9	59		10	2
08/14/11	119.9	94.9	0.0	0.0	114.3	103.0	0.0	95.6	24		153	
08/15/11	0.0	0.0	0.0	0.0	96.9	91.7	93.6	170.9			115	25
08/16/11	362.0	358.1	143.1	106.6	0.0	0.0	132.2	100.2	4	11	0	0
08/17/11	217.6	156.3	189.6	130.1	201.6	184.3	193.2	143.2	23	20	4	3
08/18/11	94.0	94.0	119.7	101.1	94.6	88.6	119.3	88.3	2	65	85	80
08/19/11	117.2	110.9	187.1	135.6	165.6	141.1	213.7	98.1	21	19	7	19
08/20/11	271.0	111.0	194.7	141.1	72.2	65.2	174.4	127.3	4	30	3	6
08/21/11	199.8	125.8	139.8	109.0	102.9	99.9	110.7	117.9	12	76	173	228
08/22/11	99.5	103.0	107.8	103.0	0.0	0.0	155.9	98.4	34	20	0	3
08/23/11	219.3	219.8	123.2	97.5	92.8	81.3	113.5	95.0	4	31	22	3
08/24/11	0.0	0.0	125.4	103.0	101.6	97.5	102.2	0.0	0	66	159	137
08/25/11	95.7	90.2	102.0	97.2	101.1	97.2	96.5	0.0	133	226	301	46
08/26/11	0.0	0.0	116.4	104.8	65.2	65.2	0.0	0.0	0	6	1	0
08/27/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0			
08/28/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
08/29/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
08/30/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
08/31/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
09/01/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
09/02/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	95.0				
09/03/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	78.6				
09/04/11	0.0	0.0	0.0	0.0	112.0	94.9	119.7	90.8			150	138
09/05/11	120.4	97.5	91.3	85.0	0.0	0.0	82.0	84.2	50	109		67
09/06/11	0.0	0.0	0.0	0.0	98.4	90.5	90.7	105.7			166	254
09/07/11	92.4	91.7	86.0	83.4	87.0	86.2	90.4	210.5	263	162	53	122
09/08/11	0.0	0.0	0.0	0.0	113.4	99.1	111.5	91.4			282	205

09/09/11	106.0	102.3	102.0	97.5	85.3	96.9	207.6	90.9	311	83	13	2
09/10/11	46.6	46.6	124.6	97.5	112.4	97.5	103.6	105.4	1	61	213	194
09/11/11	112.9	89.4	116.8	95.0	107.4	93.7	101.3	97.5	118	144	26	7
09/12/11	86.8	86.8	145.8	104.9	138.8	116.5	121.7	97.8	1	18	18	14
09/13/11	162.8	136.2	130.9	109.7	119.8	102.0	118.3	92.3	4	95	233	139
09/14/11	138.5	103.0	114.4	95.2	129.8	99.6	122.5		40	93	32	51
09/15/11	101.9	90.5	136.3	103.0	114.2	104.8	96.6		83	81	36	161

Near Shore VSR


Near Shore Dawn TPR
2500
2000
1500
1000
500
0
targets / kilometer / hour
2/28/09
3/31/09
4/30/09
5/31/09
6/30/09
7/31/09
8/31/09
9/30/09
10/31/09
11/30/09
12/31/09
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12/31/10
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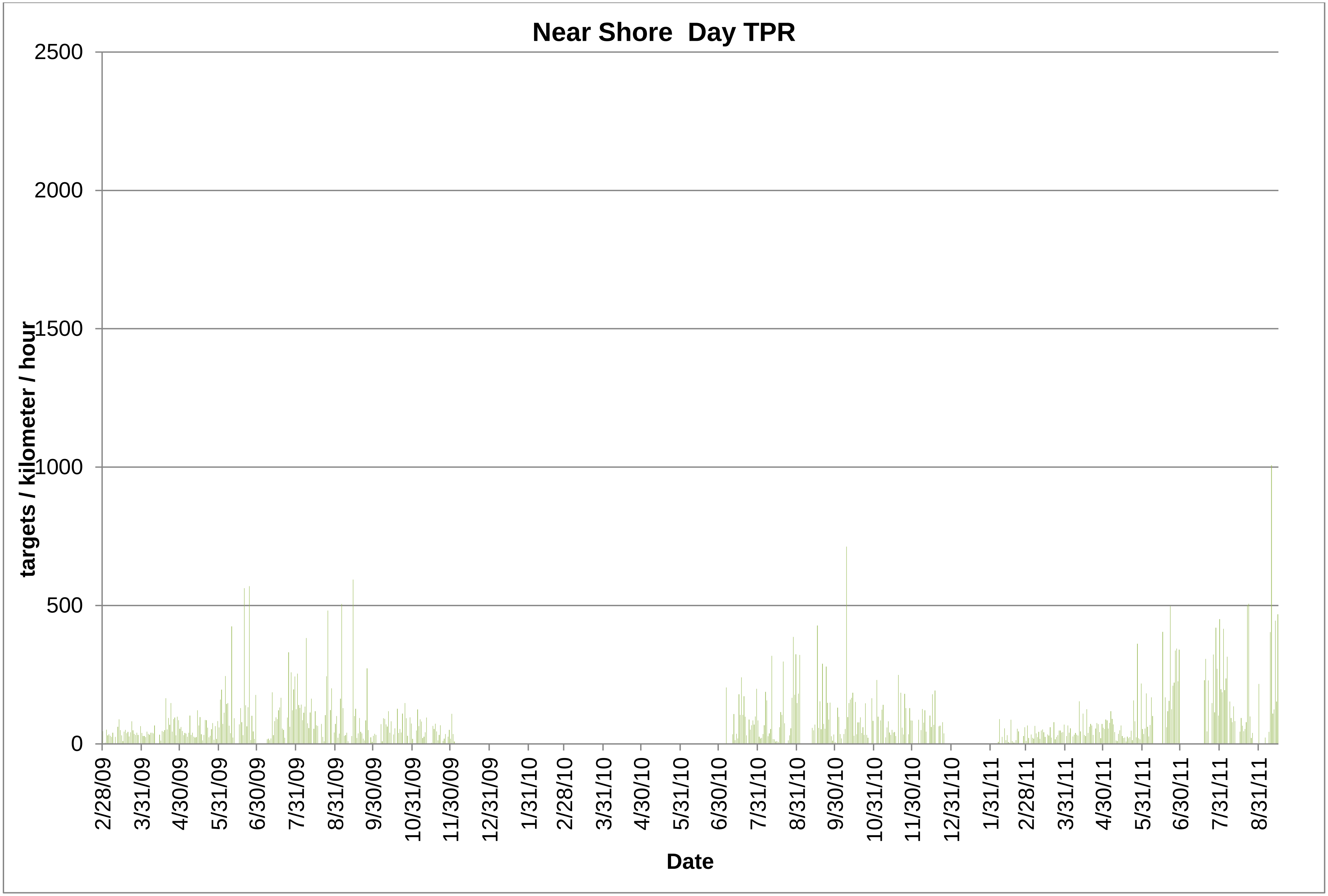
5/31/11
6/30/11
7/31/11
8/31/11
Date



Near Shore Day TPR
targets / kilometer / hour
2500
2000
1500
1000
500
0
2/28/09
3/31/09
4/30/09
5/31/09
6/30/09
7/31/09
8/31/09
9/30/09
10/31/09
11/30/09
12/31/09
1/31/10
2/28/10
3/31/10
4/30/10
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6/30/10
7/31/10
8/31/10
9/30/10
10/31/10
11/30/10
12/31/10
1/31/11
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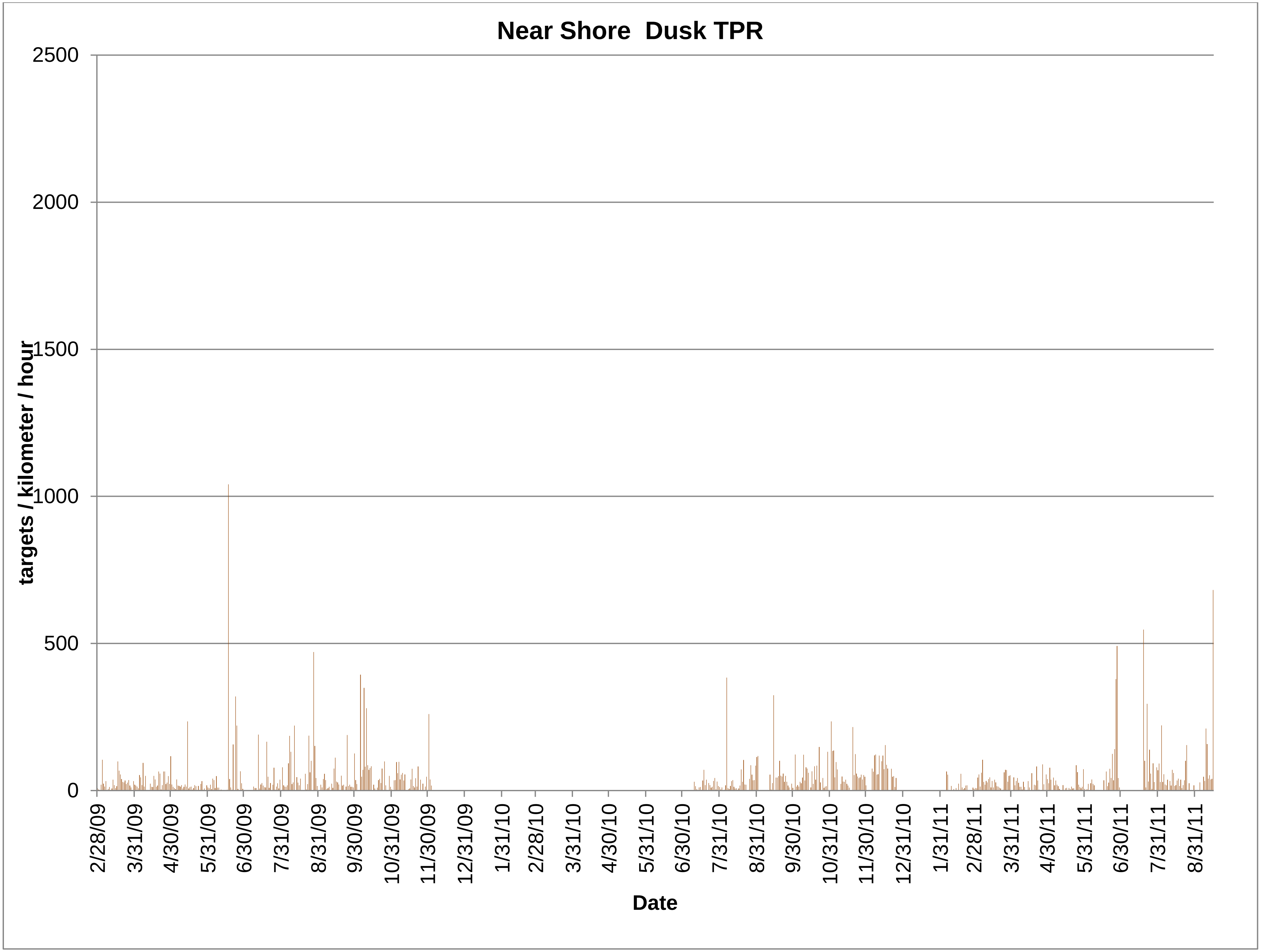
3/31/11
4/30/11
5/31/11
6/30/11
7/31/11
8/31/11
Date


Near Shore Dusk TPR
targets / kilometer / hour
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2000
1500
1000
500
0
2/28/09
3/31/09
4/30/09
5/31/09
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8/31/09
9/30/09
10/31/09
11/30/09
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12/31/10
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3/31/11
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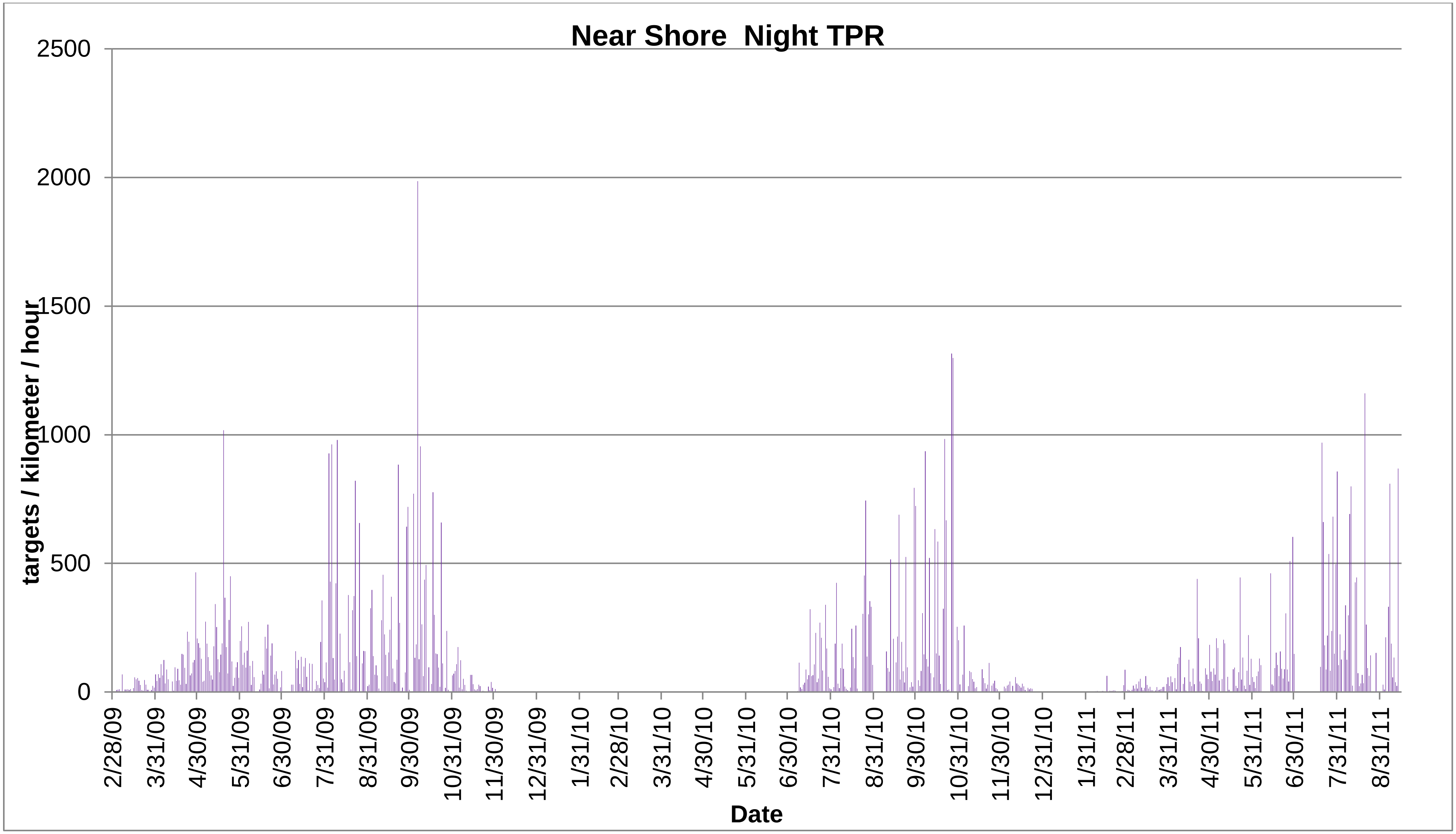
5/31/11
6/30/11
7/31/11
8/31/11
Date


Near Shore Night TPR
targets / kilometer / hour
2500
2000
1500
1000
500
0
2/28/09
3/31/09
4/30/09
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7/31/09
8/31/09
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11/30/09
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12/31/10
1/31/11
2/28/11
3/31/11
4/30/11
5/31/11
6/30/11
7/31/11
8/31/11
Date

Date	Dawn_Avg_AGL_m	Dawn_Median_AGL_m	Day_Avg_AGL_m	Day_Median_AGL_m	Dusk_Avg_AGL_m	Dusk_Median_AGL_m	Night_Avg_AGL_m	Night_Median_AGL_m	Dawn TPR	Day TPR	Dusk TPR	Night TPR
2/28/09	39.2	38.2	110.8	66.4	43.4	34.5	85.5	78.0	10	46	8	2
3/1/09	0.0	0.0	0.0	0.0	171.2	180.4	0.0	0.0			4	3
3/2/09	0.0	0.0	77.1	53.4	0.0	0.0	187.0	38.3		4		3
3/3/09	119.2	36.2	80.6	56.6	122.6	59.8	153.0	83.0	14	51	20	8
3/4/09	144.5	126.1	103.7	71.6	80.6	69.4	240.9	151.9	9	31	105	10
3/5/09	117.3	105.4	91.9	57.5	45.0	40.9	165.5	114.8	13	34	24	11
3/6/09	52.2	41.7	60.4	48.1	71.9	53.4	180.8	146.2	37	29	14	
3/7/09	149.9	87.7	99.8	53.6	98.9	46.9	192.8	131.0	44	25	32	69
3/8/09	125.0	62.7	72.4	45.0	0.0	0.0	0.0	0.0	29	40		
3/9/09	0.0	0.0	0.0	0.0	50.9	46.9	308.8	292.2			6	10
3/10/09	82.8	38.3	70.3	42.1	49.6	36.5	0.0	0.0	66	25	12	10
3/11/09	40.3	33.8	0.0	0.0	366.1	366.1	128.7	59.7	28		2	11
3/12/09	58.3	40.8	132.2	70.8	66.4	62.4	120.0	61.7	73	62	7	8
3/13/09	106.0	82.1	134.0	103.9	85.2	45.0	171.0	104.8	96	88	37	12
3/14/09	207.1	138.6	116.6	57.5	121.7	55.4	179.8	138.3	121	50	19	3
3/15/09	0.0	0.0	114.6	59.8	65.7	35.6	115.6	81.6		31	9	15
3/16/09	68.0	65.2	61.5	55.4	71.6	67.6	117.1	104.2	16	10	1	11
3/16/09	63.1	28.4	51.0	46.0	46.3	44.4	158.8	90.2	4	1	15	57
3/17/09	62.7	61.2	67.8	58.1	79.2	67.9	144.1	108.4	32	16	3	34
3/17/09	68.3	39.9	85.7	44.4	174.5	117.0	212.3	157.1	49	44	99	50
3/18/09	57.1	55.6	68.7	55.4	104.0	74.3	260.1	160.9	44	51	41	5
3/18/09	82.6	32.5	77.1	41.1	79.0	59.2	171.7	120.5	36	44	68	55
3/19/09	80.5	58.8	0.0	0.0	0.0	0.0	105.7	88.6	27			10
3/19/09	125.8	43.1	107.7	42.6	231.2	113.9	205.2	134.0	66	38	55	44
3/20/09	84.3	67.7	70.8	56.3	77.3	76.7	136.7	109.2	28	14	16	28
3/20/09	171.8	99.0	109.8	48.7	105.2	60.0	225.7	145.9	103	44	39	10
3/21/09	85.1	70.3	85.6	58.1	107.1	89.8	173.9	113.9	67	27	29	8
3/21/09	100.6	35.7	116.7	41.7	58.6	57.4	151.8	87.7	54	13	10	

3/22/09	68.2	58.1	74.7	56.3	85.9	92.6	126.4	93.7	45	42	5	5
3/22/09	0.0	0.0	0.0	0.0	67.7	42.9	0.0	0.0			28	
3/23/09	112.8	67.0	141.1	64.9	63.5	49.0	91.7	74.5	14	81	34	4
3/23/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				47
3/24/09	68.9	64.5	90.6	61.2	72.0	58.5	109.5	99.3	11	20	4	29
3/24/09	50.4	42.3	69.6	43.4	51.6	31.6	148.1	98.4	11	49	22	19
3/25/09	77.7	71.1	67.4	57.5	65.1	51.4	199.2	122.9	17	12	5	2
3/25/09	67.9	43.5	72.2	44.7	57.4	52.7	231.1	138.6	60	36	27	9
3/26/09	74.2	63.0	65.1	54.2	0.0	0.0	0.0	0.0	45	32		4
3/26/09	0.0	0.0	84.7	45.5	80.8	54.0	159.0	88.9		14	36	9
3/27/09	84.2	65.2	77.8	57.8	86.4	84.7	132.7	79.5	15	27	17	
3/27/09	140.3	122.2	115.1	83.4	69.0	73.4	165.2	119.4	47	40	12	2
3/28/09	63.9	50.8	57.7	50.2	354.3	302.3	0.0	0.0	7	12	11	8
3/28/09	63.1	60.9	77.9	70.9	49.6	39.4	70.4	50.1	56	32	8	
3/29/09	0.0	0.0	0.0	0.0	0.0	0.0	142.1	87.3				24
3/29/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				4
3/30/09	69.5	62.9	74.9	65.2	87.8	85.6	116.6	95.6	77	64	32	17
3/30/09	0.0	0.0	0.0	0.0	30.4	26.0	118.7	70.0			9	17
3/31/09	79.4	67.6	131.1	67.6	88.4	62.0	189.4	109.0	61	40	20	
3/31/09	51.4	35.7	66.6	52.1	72.9	52.7	132.4	74.6	10	8	11	69
4/1/09	75.3	56.5	58.2	53.0	262.7	262.7	0.0	0.0	13	28	4	3
4/1/09	206.1	194.4	83.6	46.6	52.9	46.9	135.7	93.5	40	15	17	43
4/2/09	0.0	0.0	0.0	0.0	68.3	58.1	106.2	52.2			1	70
4/2/09	77.6	41.2	66.5	38.9	44.3	30.0	180.5	120.0	100	28	14	3
4/3/09	50.7	49.5	0.0	0.0	80.9	58.5	211.5	138.3	4	5	8	18
4/3/09	196.2	190.4	79.9	40.8	120.4	156.6	420.6	390.7	39	24	3	55
4/4/09	75.0	69.9	75.2	63.6	70.0	66.4	112.2	89.2	82	44	26	109
4/4/09	396.7	394.3	126.5	49.3	43.3	35.9	182.4	113.8	8	25	53	52
4/5/09	61.1	59.5	69.3	62.1	73.7	61.5	318.8	217.9	29	36	12	32
4/5/09	247.2	231.9	134.3	69.1	93.3	81.3	257.4	199.9	51	30	45	65

4/6/09	88.3	56.3	0.0	0.0	0.0	0.0	260.7	195.5	53			16
4/6/09	120.0	70.2	142.8	56.6	159.4	139.8	251.3	192.6	72	33	19	124
4/7/09	74.8	62.1	78.6	60.9	64.5	56.0	162.2	111.2	88	21	3	34
4/7/09	119.7	53.9	112.9	52.5	96.3	63.5	265.4	258.1	46	40	94	16
4/8/09	79.3	61.2	105.2	60.4	64.4	60.1	201.5	135.3	38	41	14	88
4/8/09	350.6	377.3	195.1	83.0	154.8	28.3	411.4	466.0	123	39	3	8
4/9/09	109.8	73.1	119.2	65.5	158.9	71.4	232.5	140.9	37	38	50	50
4/9/09	513.8	544.0	0.0	0.0	0.0	0.0	128.0	84.7	35			
4/10/09	131.2	90.8	150.2	69.0	0.0	0.0	299.1	229.0	90	66		
4/10/09	65.1	56.6	0.0	0.0	0.0	0.0	0.0	0.0	29			
4/11/09	82.1	60.9	0.0	0.0	0.0	0.0	0.0	0.0	20			
4/11/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
4/12/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				41
4/12/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
4/13/09	0.0	0.0	113.0	64.5	180.9	115.8	192.4	135.4			24	5
4/13/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
4/14/09	105.5	72.2	118.2	54.2	101.0	69.7	136.0	95.0	29	33	13	96
4/14/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				5
4/15/09	58.1	57.4	58.5	56.9	67.3	51.4	420.9	390.1	12	11	5	44
4/15/09	0.0	0.0	0.0	0.0	67.0	65.3	165.1	100.7			12	
4/16/09	63.5	62.0	68.2	56.9	297.6	349.4	255.5	130.7	19	9	50	90
4/16/09	51.6	46.9	83.5	56.0	82.6	27.1	0.0	0.0	109	47	6	6
4/17/09	75.8	64.2	97.8	67.3	174.6	103.6	168.1	123.8	37	44	38	46
4/17/09	29.0	27.7	89.1	40.8	0.0	0.0	161.9	125.5	9	10		13
4/18/09	65.1	53.6	106.3	62.4	70.5	58.1	217.1	116.1	26	50	13	7
4/18/09	58.6	45.7	123.2	76.7	42.5	36.8	121.8	82.8	59	42	12	29
4/19/09	0.0	0.0	65.3	59.4	71.8	58.0	122.7	99.0		19	17	
4/19/09	76.8	45.5	143.6	96.9	93.1	33.5	162.8	74.6	30	165	11	149
4/20/09	74.9	63.9	67.5	59.2	0.0	0.0	0.0	0.0	43	52		145
4/20/09	67.5	40.8	133.9	52.5	109.0	61.2	163.5	123.1	32	38	65	30

4/21/09	371.2	379.7	0.0	0.0	0.0	0.0	486.8	514.6	59			
4/21/09	154.8	79.5	301.1	104.2	259.5	101.3	270.4	231.6	240	94	58	94
4/22/09	209.2	180.2	164.0	91.1	75.0	69.0	0.0	0.0	88	69	4	32
4/22/09	128.5	68.8	284.7	132.1	0.0	0.0	187.7	151.7	57	34		17
4/23/09	99.5	70.9	86.4	67.9	63.7	59.7	109.4	88.3	114	38	14	131
4/23/09	78.9	47.0	99.9	52.1	38.6	33.5	188.6	125.5	46	148	19	235
4/24/09	76.4	68.1	98.3	63.3	71.9	64.1	244.7	195.9	38	44	47	196
4/24/09	64.3	40.8	97.7	49.6	63.4	42.9	327.7	261.1	41	37	65	
4/25/09	149.8	75.5	171.2	71.9	152.4	78.6	290.6	238.0	52	89	51	65
4/25/09	288.5	173.1	0.0	0.0	348.7	405.3	0.0	0.0	32		65	
4/26/09	162.7	79.3	127.1	68.8	126.6	115.1	307.8	253.5	62	46	22	73
4/26/09	0.0	0.0	485.8	502.5	0.0	0.0	0.0	0.0		95		14
4/27/09	282.2	253.2	202.9	147.1	275.2	263.6	318.0	283.4	41	31	27	115
4/27/09	0.0	0.0	77.0	43.2	38.9	42.0	101.3	76.6		27	13	21
4/28/09	304.3	323.6	137.1	70.9	70.9	61.8	230.8	149.3	187	69	49	20
4/28/09	78.8	70.9	69.7	45.7	38.2	37.0	117.3	108.0	193	98	28	125
4/29/09	79.3	61.5	78.7	58.1	61.6	60.3	137.5	101.4	34	30	23	87
4/29/09	75.1	65.6	60.6	40.0	34.6	34.4	155.3	105.7	58	85	15	466
4/30/09	150.5	67.3	169.1	62.4	66.5	58.5	209.2	128.1	66	55	8	208
4/30/09	65.6	44.4	125.3	58.1	87.0	54.2	279.7	241.6	137	55	117	136
5/1/09	322.1	324.5	0.0	0.0	0.0	0.0	337.2	304.7	490	49		147
5/1/09	290.4	278.2	243.8	113.3	167.6	91.7	288.7	245.9	171	61	21	190
5/2/09	0.0	0.0	123.4	63.3	88.1	65.5	187.9	142.6		33	9	
5/2/09	180.2	85.7	172.1	77.2	250.2	257.8	346.3	278.8	134	46	13	172
5/3/09	279.3	207.7	0.0	0.0	0.0	0.0	0.0	0.0	36			15
5/3/09	286.3	129.5	130.0	66.7	179.4	36.2	200.9	153.2	257	31	9	130
5/4/09	0.0	0.0	0.0	0.0	0.0	0.0	270.7	204.9		15		
5/4/09	237.9	120.5	160.4	51.7	71.7	36.5	175.3	127.3	84	39	5	40
5/5/09	0.0	0.0	74.3	51.4	66.7	62.9	0.0	0.0		11	0	
5/5/09	81.4	51.4	91.4	48.4	83.3	36.5	264.7	197.1	63	37	38	44

5/6/09	53.3	53.3	272.0	111.6	0.0	0.0	0.0	0.0	7	26		274
5/6/09	375.9	411.0	0.0	0.0	37.6	31.6	110.4	60.9	20		17	68
5/7/09	0.0	0.0	452.1	422.2	0.0	0.0	238.6	182.5		40		188
5/7/09	57.2	48.9	122.0	67.1	171.4	108.1	270.8	208.3	78	39	16	23
5/8/09	177.6	85.9	153.5	74.3	87.1	54.0	238.1	156.0	105	50	14	136
5/8/09	404.6	470.4	146.2	81.6	61.3	35.3	132.9	75.2	140	102	8	12
5/9/09	0.0	0.0	193.9	79.8	117.5	65.5	242.5	153.5		21	19	82
5/9/09	64.1	42.5	86.9	48.4	32.4	30.4	86.1	61.5	60	32	5	81
5/10/09	93.0	66.4	83.2	60.4	63.9	55.7	104.4	85.0	244	38	7	65
5/10/09	88.8	63.3	105.4	63.2	45.0	29.8	159.3	83.3	26	40	7	19
5/11/09	68.9	60.6	88.4	61.2	69.1	60.9	195.7	141.5	67	26	13	49
5/11/09	75.3	36.5	118.3	57.1	148.6	38.0	162.8	138.9	59	24	11	20
5/12/09	104.8	60.6	108.0	58.3	103.6	58.5	150.9	106.6	46	23	11	19
5/12/09	0.0	0.0	0.0	0.0	150.8	88.0	217.2	116.7			21	178
5/13/09	88.2	56.0	76.4	54.2	67.7	63.9	173.7	87.4	62	24	1	
5/13/09	94.7	36.5	145.7	59.8	125.2	124.6	233.3	249.3	37	16	14	342
5/14/09	90.0	93.7	343.2	97.2	0.0	0.0	0.0	0.0	33	31		107
5/14/09	475.0	505.6	161.6	121.9	279.1	263.6	282.0	238.9	140	121	235	253
5/15/09	76.1	76.1	169.6	78.9	78.1	56.9	175.4	114.2	10	25	4	11
5/15/09	109.8	69.9	123.1	64.2	128.1	43.8	215.0	119.0	106	66	7	128
5/16/09	146.1	64.5	124.9	61.2	59.1	59.1	90.1	66.4	29	17	0	78
5/16/09	220.6	53.7	159.4	96.2	97.8	54.8	160.3	66.1	74	96	12	50
5/17/09	0.0	0.0	143.7	65.2	0.0	0.0	123.2	84.1		23		145
5/17/09	257.4	147.8	132.9	52.7	206.3	89.2	186.9	127.8	35	35	14	26
5/18/09	0.0	0.0	77.3	57.5	57.1	50.2	206.3	146.2		12	4	189
5/18/09	184.9	90.9	0.0	0.0	0.0	0.0	281.7	297.1	30			68
5/19/09	109.7	56.3	116.0	67.9	77.4	58.9	265.8	233.1	32	32	9	114
5/19/09	264.4	201.7	89.2	43.2	0.0	0.0	197.2	132.2	4	4		1018
5/20/09	283.8	216.0	165.9	68.2	160.3	79.6	269.0	233.1	139	43	16	366
5/20/09	331.3	245.9	111.6	68.8	118.8	68.2	184.4	150.5	37	86	19	29

5/21/09	322.2	313.9	164.1	60.6	84.6	57.5	404.9	388.4	73	86	12	175
5/21/09	409.9	453.0	282.9	103.7	294.9	131.6	192.3	105.4	150	50	15	10
5/22/09	385.6	387.6	169.7	64.5	122.8	60.7	249.5	185.7	80	59	2	72
5/22/09	125.9	49.0	179.4	96.9	0.0	0.0	266.1	200.3	15	6	0	17
5/23/09	351.6	341.9	281.6	233.9	199.7	71.3	358.9	352.7	51	23	16	281
5/23/09	52.6	42.3	182.4	105.5	557.4	557.4	147.5	70.9	4	9	2	67
5/24/09	438.2	466.3	277.6	206.9	216.8	216.8	318.9	213.6	87	29	0	450
5/24/09	87.4	42.9	89.6	32.8	172.8	33.8	196.5	134.3	13	7	3	259
5/25/09	407.3	425.1	230.5	117.0	185.3	54.9	197.9	141.8	52	53	23	
5/25/09	360.6	265.1	72.7	38.6	77.5	63.6	248.2	225.8	16	22	3	119
5/26/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				14
5/26/09	318.2	331.4	113.8	57.8	202.2	117.7	240.6	145.9	208	75	32	24
5/27/09	0.0	0.0	59.0	51.1	113.3	49.0	296.5	291.3		9	2	
5/27/09	101.2	49.9	109.4	36.5	36.6	38.6	170.8	100.7	23	14	3	55
5/28/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
5/28/09	97.1	52.4	96.9	77.7	153.4	139.5	251.6	232.5	30	64	7	96
5/29/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
5/29/09	376.5	425.0	112.4	51.4	0.0	0.0	276.1	224.9	20	18		116
5/30/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
5/30/09	341.6	236.6	147.5	62.1	130.7	46.1	172.3	91.8	30	82	18	56
5/31/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				199
5/31/09	206.2	198.7	158.8	76.6	491.5	523.3	449.0	458.5	47	59	11	108
6/1/09	99.7	60.9	138.2	84.7	134.2	99.6	301.8	280.0	40	22	8	256
6/1/09	391.3	359.3	101.0	64.9	0.0	0.0	230.6	148.7	87	160		18
6/2/09	235.2	206.3	236.1	199.1	99.9	50.2	266.2	225.8	325	196	20	
6/2/09	402.6	433.4	311.3	277.6	258.6	276.1	351.8	293.1	33	20	5	105
6/3/09	282.3	257.5	154.8	67.0	0.0	0.0	0.0	0.0	267	72		153
6/3/09	351.4	351.1	280.0	231.3	374.3	403.8	269.9	246.2	5	8	5	57
6/4/09	0.0	0.0	227.6	125.7	212.7	134.3	273.6	232.5		80	41	
6/4/09	335.6	368.1	162.4	102.3	90.0	56.2	279.9	245.6	84	112	40	95

6/5/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				161
6/5/09	425.0	422.4	111.0	72.8	111.5	65.9	375.0	363.9	105	245	36	80
6/6/09	216.2	116.4	95.7	64.4	245.7	163.3	226.4	202.6	17	19	9	273
6/6/09	365.0	392.8	143.4	72.8	0.0	0.0	202.5	142.9	87	144		116
6/7/09	351.7	340.2	188.4	98.1	234.7	147.5	226.5	194.7	70	147	45	54
6/7/09	71.3	46.3	158.0	92.6	45.5	42.0	139.1	92.7	21	38	49	102
6/8/09	236.0	124.9	203.2	93.2	91.1	59.1	187.5	129.2	41	66	7	28
6/8/09	156.4	88.0	181.7	88.0	123.5	99.8	167.0	101.0	11	33	10	
6/9/09	144.5	61.2	137.0	66.1	61.7	62.7	278.5	218.2	11	31	10	14
6/9/09	156.2	49.6	162.0	114.8	0.0	0.0	0.0	0.0	31	39		121
6/10/09	51.3	48.5	130.4	56.3	57.9	50.7	235.8	160.9	15	14	1	3
6/10/09	0.0	0.0	455.1	453.2	0.0	0.0	355.4	314.5		424		58
6/11/09	0.0	0.0	266.9	77.7	116.1	116.1	113.3	103.0		23	4	
6/11/09	255.6	124.0	147.3	57.2	126.2	93.4	271.9	264.2	17	19	4	
6/12/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
6/12/09	130.5	54.5	104.4	88.0	0.0	0.0	0.0	0.0	21	93		
6/13/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
6/13/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
6/14/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				10
6/14/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
6/15/09	0.0	0.0	0.0	0.0	54.1	52.4	134.3	89.2			1	33
6/15/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
6/16/09	76.2	59.7	219.0	173.1	85.4	53.9	165.0	112.7	10	70	3	4
6/16/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				83
6/17/09	54.9	50.8	251.5	188.9	534.9	572.3	103.2	94.7	12	130	1041	
6/17/09	0.0	0.0	0.0	0.0	155.3	83.8	214.7	142.0			42	68
6/18/09	55.9	56.6	0.0	0.0	0.0	0.0	0.0	0.0	13			215
6/18/09	78.5	56.9	96.0	40.8	50.4	32.5	145.0	87.4	13	79	39	55
6/19/09	0.0	0.0	180.4	70.9	124.4	94.4	184.6	121.5		10	11	
6/19/09	213.8	125.8	149.3	49.9	176.7	118.7	395.4	399.4	32	32	4	169

6/20/09	100.8	60.9	166.9	58.3	69.3	62.3	0.0	0.0	17	17	1	3
6/20/09	139.6	85.6	90.8	69.1	86.5	88.6	211.5	140.4	447	563	3	262
6/21/09	0.0	0.0	58.5	55.1	51.4	49.2	150.9	86.0		1	1	15
6/21/09	339.5	322.1	199.7	150.5	62.3	43.5	291.0	227.6	96	140	157	
6/22/09	104.7	64.9	107.5	57.5	0.0	0.0	128.5	83.1	5	11		74
6/22/09	394.1	411.1	275.1	237.7	0.0	0.0	0.0	0.0	65	63		141
6/23/09	75.4	64.9	78.8	58.1	78.8	66.7	146.9	97.5	3	4	18	42
6/23/09	113.3	48.5	133.4	64.2	63.5	61.0	205.8	136.2	248	133	320	189
6/24/09	100.4	68.2	133.4	61.3	68.8	50.7	139.2	93.7	51	20	33	29
6/24/09	121.8	80.1	75.2	62.7	68.1	63.6	170.8	121.5	577	570	221	
6/25/09	88.0	61.2	85.7	54.2	93.6	64.5	294.8	181.0	10	14	6	17
6/25/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				68
6/26/09	316.2	254.1	246.1	180.7	0.0	0.0	177.4	108.0	162	102		81
6/27/09	163.0	87.1	168.8	114.8	89.5	58.6	216.6	160.0	10	45	66	52
6/28/09	137.4	68.8	115.0	58.5	125.3	125.4	184.3	141.1	13	18	25	
6/29/09	199.7	123.1	218.9	98.4	78.5	58.0	172.5	122.2	104	177	6	18
6/30/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				82
7/7/09	0.0	0.0	0.0	0.0	0.0	0.0	307.9	303.2				29
7/8/09	294.6	55.4	186.0	112.2	325.3	344.0	299.8	298.2	9	16	14	29
7/9/09	421.8	452.7	133.0	67.1	231.3	154.2	248.3	215.4	14	19	9	
7/10/09	289.5	373.3	262.2	149.7	120.3	79.2	209.8	144.4	9	13	9	159
7/11/09	326.3	156.6	156.0	60.9	353.2	353.2	0.0	0.0	23	20	2	93
7/12/09	636.1	640.0	106.0	83.8	70.6	65.8	173.5	123.7	6	186	190	124
7/13/09	248.0	209.3	203.5	111.6	166.2	74.3	235.8	195.0	19	31	7	31
7/14/09	310.7	217.9	141.7	79.9	390.7	385.8	239.1	197.3	72	82	21	137
7/15/09	385.2	359.9	207.2	103.3	151.4	103.9	338.5	306.9	99	96	26	19
7/16/09	156.7	83.4	120.3	79.2	254.4	174.9	300.3	254.1	88	90	17	99
7/17/09	190.7	92.0	243.1	76.7	348.0	329.4	320.1	308.4	67	121	11	132
7/18/09	287.9	182.0	125.1	47.8	268.0	88.6	238.4	197.4	8	131	11	59

7/19/09	140.1	61.2	172.5	74.9	107.4	69.3	264.5	218.2	155	167	166	7
7/20/09	527.2	518.5	254.3	169.9	205.6	180.7	208.4	186.0	520	56	47	111
7/21/09	0.0	0.0	92.5	73.5	427.2	243.8	270.0	227.6		50	10	
7/22/09	162.6	85.3	137.1	61.5	119.0	65.0	248.2	220.6	47	22	26	110
7/23/09	399.2	386.9	0.0	0.0	0.0	0.0	0.0	0.0	24			4
7/24/09	252.1	236.2	438.4	459.0	479.1	438.1	416.6	412.2	192	95	20	11
7/25/09	108.5	61.0	201.2	108.4	123.2	67.3	263.1	149.4	78	331	78	43
7/26/09	154.6	52.8	177.2	88.3	599.6	613.8	356.6	371.5	28	62	3	28
7/27/09	276.2	248.0	85.0	63.0	115.0	78.3	301.8	276.7	37	259	14	15
7/28/09	163.4	95.0	174.4	83.8	389.9	398.3	343.5	299.5	181	121	25	195
7/29/09	420.9	309.0	189.4	94.1	222.0	145.6	237.5	226.4	47	197	7	356
7/30/09	261.8	91.2	74.9	43.2	401.5	456.8	254.3	220.0	70	244	37	53
7/31/09	261.9	235.8	142.9	53.7	0.0	0.0	285.6	234.9	90	125		38
8/1/09	449.4	496.8	351.9	312.0	169.6	64.5	311.7	249.3	439	253	79	115
8/2/09	225.5	99.6	240.6	111.2	331.0	285.5	324.3	317.5	67	140	18	17
8/3/09	338.9	319.1	329.6	307.8	443.8	494.5	294.0	254.7	220	130	14	927
8/4/09	545.1	570.2	199.9	75.8	204.5	46.9	377.4	351.1	44	142	13	429
8/5/09	365.0	337.2	148.5	54.9	336.3	280.7	301.7	284.3	44	85	18	962
8/6/09	413.2	415.4	273.3	277.0	466.5	466.9	301.7	237.7	375	113	93	132
8/7/09	241.6	220.6	236.4	189.5	242.7	227.6	288.0	279.1	143	135	186	49
8/8/09	403.2	427.0	285.6	239.5	468.7	463.5	402.6	408.1	407	382	132	422
8/9/09	484.9	487.8	396.5	326.1	515.7	659.2	337.8	332.8	104	74	22	979
8/10/09	242.9	203.1	166.7	85.6	124.0	54.6	311.9	259.9	26	57	28	
8/11/09	255.6	144.6	285.3	235.2	226.8	164.2	223.5	197.4	94	113	221	227
8/12/09	471.6	454.7	384.4	414.2	0.0	0.0	0.0	0.0	836	163		50
8/13/09	0.0	0.0	0.0	0.0	260.6	159.3	340.4	302.6			46	37
8/14/09	158.4	113.0	257.0	174.9	246.5	191.0	277.2	203.8	61	55	27	83
8/15/09	182.9	72.9	258.9	153.4	210.8	108.9	317.4	301.8	92	118	18	
8/16/09	154.4	83.8	212.5	110.7	530.1	592.5	380.4	380.9	105	67	41	
8/17/09	314.4	297.1	202.9	120.0	0.0	0.0	0.0	0.0	46	65		377

8/18/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				116
8/19/09	0.0	0.0	0.0	0.0	0.0	0.0	303.6	269.4			0	10
8/20/09	451.4	459.3	384.9	374.8	326.4	294.7	418.2	415.4	97	72	57	318
8/21/09	416.7	439.5	359.4	377.3	276.3	213.7	390.2	405.6	39	25	4	373
8/22/09	581.0	636.8	185.6	60.4	155.4	129.3	388.1	413.8	6	9	22	821
8/23/09	303.8	330.9	328.7	310.5	412.6	425.7	343.5	318.4	69	104	187	140
8/24/09	452.8	431.5	246.1	218.5	199.2	54.2	296.8	254.4	165	244	62	
8/25/09	432.6	426.3	304.0	257.5	460.7	499.2	291.6	236.8	325	482	101	657
8/26/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
8/27/09	0.0	0.0	280.8	198.1	400.0	380.9	392.2	392.7		122	471	111
8/28/09	500.1	559.5	326.4	199.3	536.8	555.9	0.0	0.0	149	201	152	160
8/29/09	0.0	0.0	0.0	0.0	296.7	284.9	315.2	300.0			43	159
8/30/09	0.0	0.0	426.1	400.0	293.0	257.5	207.4	169.4		41	16	
8/31/09	271.2	252.0	210.1	129.5	0.0	0.0	296.7	261.4	160	72	0	23
9/1/09	261.2	175.8	286.7	264.5	0.0	0.0	0.0	0.0	195	100		29
9/2/09	0.0	0.0	228.5	146.8	275.1	232.5	312.0	221.5		22	20	326
9/3/09	435.0	538.4	261.1	143.8	204.1	204.8	279.9	209.6	20	37	11	397
9/4/09	384.9	483.8	328.5	303.4	155.9	75.8	294.5	250.5	26	163	39	140
9/5/09	224.0	170.0	282.8	220.0	205.8	101.4	336.1	308.4	331	506	57	68
9/6/09	339.4	322.3	420.4	380.6	172.0	129.5	274.4	214.8	146	129	36	104
9/7/09	119.1	47.8	325.4	284.0	148.5	46.3	319.6	288.1	23	29	6	65
9/8/09	284.3	246.8	274.8	199.6	340.3	359.0	239.9	162.1	28	32	9	13
9/9/09	278.0	249.0	265.5	221.2	569.1	667.4	319.8	248.2	37	40	13	4
9/10/09	171.6	50.8	149.7	74.9	97.2	97.2	347.4	313.9	33	9	1	279
9/11/09	0.0	0.0	0.0	0.0	407.3	420.4	198.5	124.0			24	456
9/12/09	0.0	0.0	0.0	0.0	482.2	503.8	479.4	489.7			10	225
9/13/09	423.1	425.6	232.4	147.9	254.8	251.7	260.4	205.1	26	28	75	144
9/14/09	290.7	282.5	225.2	189.2	99.6	48.7	239.2	172.8	440	594	112	62
9/15/09	284.1	269.4	262.6	213.3	254.5	277.0	262.4	227.0	95	101	31	154
9/16/09	226.8	163.2	220.9	204.1	267.9	145.0	365.1	349.8	70	127	28	243

9/17/09	218.4	99.3	147.9	93.7	153.9	109.0	219.6	132.5	47	21	21	371
9/18/09	358.9	316.3	209.2	122.6	186.0	186.0	212.8	144.7	11	38	2	91
9/19/09	313.9	250.2	172.3	97.8	221.6	172.4	249.4	197.0	132	94	51	39
9/20/09	375.1	314.6	263.3	219.2	303.3	220.9	260.8	206.6	48	43	17	33
9/21/09	425.3	454.1	307.7	321.6	387.2	522.1	269.6	167.0	53	38	20	126
9/22/09	185.3	58.1	183.1	84.1	0.0	0.0	216.7	129.2	7	18	0	884
9/23/09	247.0	161.0	378.0	416.0	424.9	496.9	435.1	426.8	18	13	14	269
9/24/09	337.2	297.4	339.2	342.7	290.6	251.7	309.6	263.0	41	85	189	4
9/25/09	272.4	302.1	304.0	310.8	276.9	183.6	355.3	323.3	1386	273	16	18
9/26/09	274.5	205.1	226.8	176.4	214.2	239.8	234.3	192.4	127	50	20	
9/27/09	0.0	0.0	0.0	0.0	541.1	583.9	293.4	241.9		na	13	76
9/28/09	103.0	63.3	277.0	242.9	157.7	97.5	0.0	0.0	7	23	13	643
9/29/09	377.4	264.8	261.6	163.5	355.1	370.3	233.3	181.0	16	7	11	719
9/30/09	370.1	364.6	201.4	109.7	193.3	168.0	205.1	135.9	20	29	126	9
10/1/09	293.4	196.2	197.3	103.0	215.7	163.9	290.8	256.9	22	36	36	
10/2/09	251.2	108.3	195.0	93.8	150.7	117.0	318.2	329.3	30	33	22	
10/3/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				771
10/4/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				133
10/5/09	0.0	0.0	0.0	0.0	258.9	237.7	203.0	136.5			394	185
10/6/09	317.8	273.3	271.9	250.2	254.8	264.2	300.9	277.0	128	71	47	1986
10/7/09	0.0	0.0	220.7	93.0	169.9	153.5	166.3	111.5		9	71	128
10/8/09	110.6	68.1	140.9	84.7	277.8	252.9	253.9	198.4	62	93	349	955
10/9/09	361.5	341.2	375.1	384.3	324.3	413.5	389.0	435.9	208	90	81	263
10/10/09	315.9	288.6	150.5	72.9	239.4	221.1	270.2	215.1	62	70	280	62
10/11/09	203.3	155.7	268.0	248.0	237.3	224.6	212.7	155.7	153	62	86	437
10/12/09	138.9	65.3	167.7	114.5	153.4	128.6	189.2	125.5	160	118	71	494
10/13/09	157.6	77.0	109.1	57.8	103.5	63.0	369.2	321.5	14	40	77	
10/14/09	151.4	129.5	161.1	103.3	161.5	130.7	232.1	154.2	189	81	83	96

10/15/09	119.9	70.8	0.0	0.0	0.0	0.0	0.0	0.0	208			
10/16/09	0.0	0.0	124.3	69.7	153.1	129.8	311.0	291.3		34	20	32
10/17/09	88.1	58.8	137.3	90.2	140.5	89.5	0.0	0.0	69	56	7	776
10/18/09	0.0	0.0	0.0	0.0	0.0	0.0	245.8	133.1				300
10/19/09	79.2	50.2	104.2	64.5	338.7	307.9	298.5	199.1	63	127	10	150
10/20/09	286.4	228.2	219.1	158.7	238.6	190.1	243.7	171.5	73	40	36	147
10/21/09	242.1	151.9	294.4	234.3	300.0	302.3	273.9	199.1	56	54	40	95
10/22/09	384.0	363.6	300.8	172.0	324.5	336.4	223.6	172.4	47	41	26	21
10/23/09	0.0	0.0	127.8	74.0	171.3	79.5	129.3	105.1		109	75	659
10/24/09	96.2	82.2	0.0	0.0	0.0	0.0	266.1	232.8	7			111
10/25/09	204.0	137.7	104.2	58.1	142.4	132.8	300.2	205.4	12	148	99	
10/26/09	199.4	154.2	232.7	102.6	357.0	377.7	352.3	305.0	112	93	18	17
10/27/09	73.0	42.9	61.4	47.2	0.0	0.0	0.0	0.0	45	30		237
10/28/09	0.0	0.0	0.0	0.0	0.0	0.0	166.8	111.6				9
10/29/09	192.5	130.8	120.7	74.9	101.8	51.6	411.2	407.6	52	96	50	
10/30/09	146.6	110.9	100.5	55.6	100.9	98.1	118.7	73.7	53	74	13	
10/31/09	55.3	41.5	46.4	40.8	46.1	44.7	0.0	0.0	16	18	4	64
11/1/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				72
11/2/09	0.0	0.0	0.0	0.0	92.0	57.2	216.4	155.4			35	82
11/3/09	89.0	62.7	106.8	57.5	50.5	32.5	179.8	112.2	59	48	36	108
11/4/09	81.6	42.9	122.8	72.8	97.0	60.3	200.7	138.8	50	125	97	175
11/5/09	48.7	34.5	109.0	70.0	151.4	86.8	170.1	110.6	60	64	59	18
11/6/09	63.9	45.0	106.1	58.5	100.5	72.0	293.6	197.6	94	89	98	124
11/7/09	167.0	52.8	101.5	59.7	92.2	67.3	112.3	75.8	70	81	38	11
11/8/09	48.7	44.4	79.8	36.5	78.4	33.9	257.6	172.1	21	21	54	52
11/9/09	318.9	390.1	174.0	46.9	46.6	36.8	171.3	101.1	27	26	60	28
11/10/09	336.8	258.6	154.8	42.8	96.9	37.0	269.9	203.8	4	42	34	5
11/11/09	102.2	61.2	121.7	73.7	99.8	77.7	189.7	131.9	219	95	55	

11/12/09	0.0	0.0	0.0	0.0	0.0	0.0	121.9	92.0				2
11/13/09	53.5	41.4	0.0	0.0	0.0	0.0	0.0	0.0	5			66
11/14/09	0.0	0.0	0.0	0.0	56.4	33.9	200.7	65.5			5	67
11/15/09	36.7	35.3	200.3	92.1	84.2	49.3	274.1	207.2	5	4	7	31
11/16/09	133.3	43.2	71.9	43.4	74.7	50.2	313.6	200.2	48	65	38	11
11/17/09	107.3	86.2	111.2	80.1	103.3	82.2	196.0	125.2	105	54	74	6
11/18/09	78.0	58.8	91.8	65.5	60.9	48.4	146.2	92.6	201	72	16	12
11/19/09	53.3	30.1	76.2	44.4	50.9	33.5	252.0	141.1	72	45	11	29
11/20/09	48.4	34.8	95.9	48.7	55.4	37.0	131.1	78.0	12	12	42	23
11/21/09	68.2	33.2	70.9	43.2	155.7	74.3	223.0	163.9	19	32	14	
11/22/09	74.6	46.9	81.9	57.8	101.5	82.4	160.5	118.8	73	67	82	5
11/23/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				3
11/24/09	44.4	36.8	59.5	48.1	66.1	62.4	166.9	89.1	29	11	37	
11/25/09	119.7	51.4	118.2	54.8	0.0	0.0	178.0	111.8	24	19	0	
11/26/09	78.7	36.5	68.1	39.4	44.6	41.1	0.0	0.0	23	35	24	21
11/27/09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				7
11/28/09	0.0	0.0	46.1	34.7	91.2	40.3	127.5	79.9		26	14	39
11/29/09	53.0	28.6	80.8	54.2	65.4	63.3	171.3	74.0	12	51	47	17
11/30/09	63.7	43.1	75.9	50.5	0.0	0.0	205.7	114.5	33	19		
12/1/09	93.3	57.2	103.1	67.3	85.8	54.8	165.3	99.9	89	108	260	12
12/2/09	94.4	42.3	105.4	39.2	91.2	33.5	0.0	0.0	70	35	38	
12/3/09	0.0	0.0	76.8	51.4	41.6	41.4	184.5	85.0		8	17	
7/6/10	341.9	281.6	234.6	107.2	0.0	0.0	0.0	0.0	451	204		
7/7/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				4
7/8/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				115
7/9/10	0.0	0.0	0.0	0.0	0.0	0.0	277.2	192.3				19
7/10/10	188.5	83.4	0.0	0.0	112.7	85.1	168.5	125.2	12		30	12
7/11/10	224.3	166.0	218.1	164.4	338.4	337.6	286.5	278.7	59	35	15	29
7/12/10	350.2	362.3	123.0	103.9	199.3	147.5	231.0	184.0	28	108	5	37

7/13/10	130.5	104.2	110.7	61.8	0.0	0.0	257.2	219.7	43	13	0	88
7/14/10	264.5	268.8	132.1	71.3	152.1	134.0	245.7	241.0	17	37	11	50
7/15/10	139.2	105.7	180.4	128.3	206.1	191.5	187.3	145.3	73	19	12	66
7/16/10	283.7	290.7	108.7	78.0	222.6	278.8	333.1	335.4	13	179	3	322
7/17/10	313.2	335.5	217.7	141.1	155.8	62.9	263.0	247.6	93	104	34	62
7/18/10	208.4	115.6	75.3	52.7	95.1	52.4	234.2	198.5	126	240	71	66
7/19/10	175.2	93.7	157.3	85.3	175.9	141.7	247.6	192.0	192	105	19	107
7/20/10	245.0	200.2	244.4	225.3	236.3	158.4	221.6	141.1	139	172	37	230
7/21/10	233.4	205.5	177.8	73.4	0.0	0.0	200.5	147.5	68	99		39
7/22/10	237.9	241.2	239.3	167.0	197.9	153.2	177.7	139.2	42	31	26	52
7/23/10	239.9	195.8	0.0	0.0	127.4	135.6	209.7	148.4	146		19	270
7/24/10	115.4	57.5	149.1	94.1	94.1	35.6	220.7	151.9	105	88	10	211
7/25/10	334.7	335.8	187.0	123.7	66.7	64.5	206.4	169.4	79	51	13	84
7/26/10	300.6	277.6	276.2	202.9	147.0	97.8	180.4	127.6	148	67	33	5
7/27/10	244.7	184.6	229.1	178.8	208.9	122.2	315.7	309.9	135	84	43	339
7/28/10	99.8	56.3	105.8	56.3	235.4	148.5	303.7	316.8	192	70	4	169
7/29/10	409.3	439.5	103.2	79.6	257.2	251.4	275.7	257.5	16	99	31	59
7/30/10	344.9	402.0	264.7	294.7	162.9	113.0	335.9	324.2	113	199	16	15
7/31/10	182.0	138.3	163.3	130.4	405.6	321.0	156.4	113.0	133	85	12	11
8/1/10	221.5	243.9	155.3	139.8	230.3	116.2	211.4	153.7	46	26	4	4
8/2/10	196.2	158.1	156.4	109.0	246.3	106.0	253.9	184.5	93	20	11	19
8/3/10	158.0	77.3	206.1	102.6	679.3	679.3	301.1	332.2	27	22	1	188
8/4/10	209.9	67.0	236.2	110.3	601.6	631.2	309.5	295.4	9	36	3	424
8/5/10	324.5	320.4	233.7	149.1	240.9	242.1	267.8	244.7	72	67	18	32
8/6/10	376.1	360.8	290.9	269.4	236.9	212.7	197.1	172.8	47	188	384	15
8/7/10	265.9	193.3	312.8	285.2	91.6	91.4	169.6	102.3	386	157	9	93
8/8/10	286.5	132.1	187.4	144.1	203.6	91.1	332.6	329.7	20	28	5	188
8/9/10	405.2	386.7	282.2	211.3	221.7	111.8	270.0	247.7	49	38	16	91
8/10/10	375.3	394.3	230.9	116.4	155.1	88.6	251.7	205.7	46	53	32	21
8/11/10	166.4	139.2	295.9	259.6	286.1	286.0	310.1	280.7	150	318	36	13

8/12/10	197.4	126.7	236.5	199.9	235.9	163.3	264.5	255.7	35	17	13	7
8/13/10	208.8	107.8	182.5	85.0	323.8	336.1	246.7	176.9	17	16	7	3
8/14/10	181.5	43.2	217.2	109.7	212.4	65.0	196.7	138.6	13	9	8	18
8/15/10	140.7	145.6	301.8	194.1	221.9	147.1	168.4	59.7	3	10	3	246
8/16/10	0.0	0.0	253.7	187.7	334.5	239.8	453.5	529.1	0	7	7	136
8/17/10	388.5	390.1	331.6	340.4	184.7	97.8	239.3	202.8	68	60	17	93
8/18/10	271.5	234.9	301.5	302.3	344.7	395.6	227.9	177.5	101	115	72	258
8/19/10	260.7	233.4	315.6	290.7	116.1	72.3	265.1	244.7	151	104	30	14
8/20/10	322.3	299.2	275.5	239.5	176.3	143.5	250.0	217.4	100	298	104	
8/21/10	250.6	169.2	194.7	175.2	137.6	123.4	203.2	116.1	68	75	21	
8/22/10	186.7	60.9	0.0	0.0	449.0	544.0	0.0	0.0	15		20	
8/23/10	132.4	66.4	0.0	0.0	0.0	0.0	0.0	0.0	4			304
8/24/10	0.0	0.0	143.1	85.9	0.0	0.0	0.0	0.0		13		453
8/25/10	0.0	0.0	223.1	165.4	250.1	234.2	272.2	263.7		30	40	744
8/26/10	192.3	185.9	177.2	129.6	180.4	136.8	213.3	148.1	45	56	86	138
8/27/10	260.3	256.6	248.6	242.1	138.7	64.1	264.7	235.2	481	166	54	302
8/28/10	321.8	279.4	230.3	194.4	97.3	51.4	274.8	195.0	240	386	35	354
8/29/10	363.8	336.1	284.2	227.3	128.1	70.6	213.1	139.2	93	177	36	332
8/30/10	225.8	196.8	252.3	245.9	103.5	60.6	251.5	184.0	871	324	85	106
8/31/10	359.4	326.7	212.3	170.5	96.4	59.5	240.0	171.2	1773	147	114	
9/1/10	322.2	303.5	259.1	184.6	151.5	115.9	267.9	241.6	379	182	118	
9/2/10	316.9	333.4	262.2	231.4	0.0	0.0	0.0	0.0	68	321		
9/3/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
9/4/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
9/5/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
9/6/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
9/7/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
9/8/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
9/9/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				158
9/10/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				93

9/11/10	0.0	0.0	0.0	0.0	261.5	229.3	370.3	372.4			54	79
9/12/10	147.4	103.0	175.4	135.7	279.7	302.9	194.4	159.6	101	58	4	516
9/13/10	190.9	88.6	285.8	210.9	156.3	58.5	226.0	187.1	42	49	26	
9/14/10	305.0	281.1	282.1	261.4	174.9	148.1	188.7	135.3	74	70	324	207
9/16/10	221.2	157.8	274.2	249.9	205.1	226.4	0.0	0.0	245	428	44	115
9/17/10	0.0	0.0	127.0	73.5	99.7	53.4	272.6	203.1		58	44	216
9/18/10	139.2	54.8	150.8	92.3	77.4	38.0	277.0	190.7	125	153	49	689
9/19/10	159.1	60.0	240.9	142.9	384.4	423.6	271.2	243.2	26	53	101	49
9/20/10	131.5	40.2	315.4	292.1	212.4	160.6	305.1	256.6	125	290	51	195
9/21/10	273.7	191.6	194.7	136.5	115.1	47.2	277.5	269.4	82	72	48	81
9/22/10	230.3	70.9	271.7	310.7	241.9	239.0	260.6	234.0	39	55	58	37
9/23/10	231.5	127.9	282.1	274.3	175.6	37.0	259.8	201.7	125	279	30	525
9/24/10	359.8	376.8	287.1	302.3	293.4	283.2	253.1	265.1	108	148	50	96
9/25/10	220.3	266.0	299.6	301.4	207.2	126.7	268.9	241.9	30	88	30	5
9/26/10	203.3	73.4	298.5	333.1	83.0	58.8	255.1	214.7	174	149	17	18
9/27/10	289.5	293.1	222.3	143.3	117.4	44.4	69.6	39.9	39	27	11	38
9/28/10	61.3	36.2	91.7	35.3	0.0	0.0	100.2	31.9	5	12		21
9/29/10	248.6	281.4	234.0	180.7	155.6	63.5	212.5	162.1	32	34	24	793
9/30/10	77.5	47.5	38.4	29.8	30.0	28.6	34.1	29.2	5	6	9	723
10/1/10	44.3	32.5	0.0	0.0	0.0	0.0	243.1	148.1	29			
10/2/10	165.5	67.9	269.9	220.0	295.9	321.5	253.1	202.3	121	130	123	46
10/3/10	128.3	60.6	127.7	84.7	52.4	34.7	0.0	0.0	123	98	14	24
10/4/10	73.6	39.2	98.1	46.0	53.7	35.3	220.2	115.8	66	36	19	82
10/5/10	58.3	35.6	87.7	36.8	80.7	39.1	107.7	64.5	40	20	14	307
10/6/10	0.0	0.0	0.0	0.0	229.1	252.2	221.7	153.1			30	146
10/7/10	148.8	48.7	198.9	127.9	98.7	49.0	175.2	102.6	20	36	25	936
10/8/10	211.4	167.0	186.5	120.9	129.8	59.8	197.3	159.2	71	54	44	128
10/9/10	155.2	105.7	170.1	120.6	145.2	127.5	232.7	150.8	188	712	122	99

10/10/10	264.0	190.4	132.0	67.3	159.7	97.8	214.6	195.0	132	97	34	522
10/11/10	317.0	234.3	178.3	84.5	216.2	84.1	282.5	193.8	105	148	79	73
10/12/10	209.6	135.1	146.4	99.1	175.8	57.8	229.4	160.6	28	160	75	
10/13/10	170.7	149.4	235.9	131.3	76.1	41.4	213.3	116.4	236	166	61	58
10/14/10	140.5	59.5	131.3	82.2	0.0	0.0	0.0	0.0	122	185		633
10/15/10	57.6	41.7	73.3	42.3	37.8	32.2	101.7	65.5	45	29	11	151
10/16/10	45.3	38.0	68.4	40.8	63.6	48.9	235.3	123.4	73	152	66	585
10/17/10	151.6	61.2	143.2	62.0	86.4	51.4	189.0	105.7	79	35	23	142
10/18/10	51.5	34.4	109.3	51.1	123.0	83.8	222.8	140.1	76	78	83	32
10/19/10	135.5	61.5	152.5	60.7	69.8	46.9	224.2	135.3	115	78	37	
10/20/10	124.0	44.9	86.6	49.6	54.8	42.0	151.8	94.1	50	96	85	324
10/21/10	87.1	30.6	77.5	48.4	0.0	0.0	0.0	0.0	16	40		984
10/22/10	0.0	0.0	71.3	41.4	57.0	40.3	160.3	113.0		60	148	667
10/23/10	73.7	49.0	93.7	43.5	49.9	35.7	227.4	172.1	45	32	28	8
10/24/10	106.3	51.7	100.4	54.5	0.0	0.0	223.1	153.5	479	146		9
10/25/10	200.0	111.8	114.7	47.5	65.5	38.0	83.8	35.6	37	32	43	
10/26/10	76.9	29.5	100.8	36.5	232.0	224.9	91.6	34.7	13	22	10	1315
10/27/10	70.9	33.3	0.0	0.0	53.5	38.0	0.0	0.0	10		14	1299
10/28/10	0.0	0.0	0.0	0.0	93.8	32.5	292.5	234.9			15	
10/29/10	258.2	152.8	212.1	92.6	80.9	56.6	219.5	135.0	156	165	132	
10/30/10	193.1	90.6	139.5	53.9	0.0	0.0	0.0	0.0	72	83		254
10/31/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				202
11/1/10	0.0	0.0	0.0	0.0	79.6	53.6	322.5	178.2			235	30
11/2/10	132.8	73.1	161.5	102.8	72.3	45.3	254.7	147.8	360	230	135	
11/3/10	98.6	40.6	111.3	61.8	145.8	94.4	80.5	49.0	80	98	136	68
11/4/10	0.0	0.0	0.0	0.0	73.3	38.2	0.0	0.0			45	258
11/5/10	0.0	0.0	119.3	35.3	75.1	31.0	90.0	32.5		85	97	
11/6/10	80.9	65.9	92.5	60.3	93.4	36.2	284.3	188.6	346	124	72	

11/7/10	143.2	89.2	97.7	56.0	0.0	0.0	0.0	0.0	147	141		23
11/8/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				82
11/9/10	81.0	44.3	109.5	46.0	107.9	49.6	145.0	75.8	40	24	23	77
11/10/10	94.9	53.9	147.2	95.3	243.1	125.7	331.4	257.6	33	60	48	50
11/11/10	133.0	107.1	170.1	122.2	208.1	74.3	317.6	216.9	84	82	31	40
11/12/10	92.5	50.5	74.4	39.2	65.3	30.0	158.6	41.7	54	41	30	15
11/13/10	78.3	33.5	103.1	37.4	96.8	40.2	212.1	135.3	37	32	37	19
11/14/10	64.4	33.3	103.8	56.3	61.1	42.9	114.1	81.6	64	51	23	
11/15/10	58.6	40.8	50.6	40.8	78.6	29.2	178.0	121.2	45	41	17	
11/16/10	0.0	0.0	55.5	41.2	53.7	42.6	0.0	0.0		42	10	
11/17/10	0.0	0.0	49.8	36.5	0.0	0.0	0.0	0.0		28		88
11/18/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				55
11/19/10	0.0	0.0	119.6	84.4	108.7	67.1	222.0	152.3		249	216	34
11/20/10	93.7	43.4	47.2	41.8	52.1	42.6	132.2	78.7	20	1	53	13
11/21/10	123.9	115.6	134.0	109.4	169.5	108.1	106.7	66.4	316	185	124	28
11/22/10	67.5	47.2	77.8	64.5	57.2	46.4	120.6	65.2	70	59	58	113
11/23/10	136.0	88.9	72.7	47.6	43.4	39.4	94.7	61.5	25	34	48	
11/24/10	48.2	35.3	54.5	42.9	35.8	31.0	243.5	117.0	153	181	42	25
11/25/10	55.3	41.8	63.4	46.0	65.3	38.6	0.0	0.0	120	129	45	34
11/26/10	0.0	0.0	0.0	0.0	51.6	32.2	102.4	70.2			54	44
11/27/10	41.8	35.4	62.7	42.6	48.2	33.9	115.1	65.2	54	35	38	15
11/28/10	77.2	54.0	133.2	90.8	53.0	41.7	251.5	141.7	130	130	53	11
11/29/10	65.1	40.9	93.3	56.0	77.6	49.0	107.2	61.5	74	85	47	
11/30/10	80.4	71.3	79.7	70.0	45.1	35.9	76.1	49.9	85	84	18	
12/1/10	31.5	27.1	0.0	0.0	0.0	0.0	0.0	0.0	11			
12/2/10	61.7	41.4	0.0	0.0	0.0	0.0	0.0	0.0	55			
12/3/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				21
12/4/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				14

12/5/10	0.0	0.0	71.8	53.0	60.3	38.0	79.7	55.6		87	75	25
12/6/10	0.0	0.0	0.0	0.0	53.0	40.3	53.4	36.5			64	29
12/7/10	41.7	31.3	65.3	43.8	74.2	48.5	74.7	47.5	32	50	120	41
12/8/10	0.0	0.0	89.8	60.4	87.5	48.7	77.9	42.9		126	123	
12/9/10	55.1	47.2	63.9	46.0	46.6	38.8	133.1	81.0	129	77	54	24
12/10/10	101.4	79.3	112.3	89.2	71.4	39.9	0.0	0.0	292	121	56	
12/11/10	53.4	45.0	73.1	51.0	52.5	47.5	93.8	64.2	36	44	119	58
12/12/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				33
12/13/10	0.0	0.0	0.0	0.0	32.6	29.8	36.2	29.8			100	29
12/14/10	0.0	0.0	65.3	40.2	58.1	38.6	49.5	31.9		102	119	24
12/15/10	48.2	35.9	53.5	41.4	39.0	33.5	125.8	45.7	63	61	73	17
12/16/10	63.5	36.8	89.7	58.6	67.4	46.0	97.9	59.7	122	179	125	33
12/16/10	0.0	0.0	178.3	112.4	172.9	145.0	111.1	67.6		74	155	31
12/17/10	44.5	37.9	55.8	39.9	44.9	39.6	172.2	90.8	60	69	32	22
12/17/10	58.4	49.0	72.5	47.5	77.5	47.5	223.8	137.1	109	44	88	16
12/18/10	52.9	35.4	95.4	74.9	60.9	39.1	163.3	88.0	90	193	48	
12/18/10	41.5	35.6	107.7	57.5	121.1	72.5	109.0	75.8	49	46	75	8
12/19/10	79.6	55.6	0.0	0.0	0.0	0.0	0.0	0.0	220			
12/19/10	62.2	46.6	0.0	0.0	0.0	0.0	98.8	36.5	54			
12/20/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/20/10	60.6	35.3	0.0	0.0	0.0	0.0	0.0	0.0	49			17
12/21/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/21/10	0.0	0.0	49.7	41.4	48.0	36.5	140.5	52.7		64	74	11
12/22/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/22/10	48.9	43.8	70.2	55.1	42.2	34.4	72.1	33.2	91	66	47	14
12/23/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/23/10	0.0	0.0	0.0	0.0	37.8	32.5	112.9	41.7			49	12
12/24/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				

12/24/ 10	49.7	38.6	96.4	75.1	57.8	43.5	211.9	114.8	59	78	12	
12/25/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/25/ 10	39.5	38.0	81.2	63.2	39.8	37.1	0.0	0.0	31	38	43	
12/26/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/26/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/27/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/27/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/28/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/28/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/29/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/29/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/30/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/30/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/31/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
12/31/ 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/1/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/1/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/2/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/2/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/3/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/3/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/4/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/4/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/5/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/5/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/6/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/6/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/7/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/7/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/8/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/8/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				

1/9/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/9/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/10/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/10/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/11/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/11/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/12/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/12/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/13/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/13/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/14/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/14/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/15/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/15/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/16/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/16/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/17/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/17/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/18/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/18/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/19/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/19/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/20/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/20/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/21/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/21/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/22/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/22/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/23/1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				

1												
1/23/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/24/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/24/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/25/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/25/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/26/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/26/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/27/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/27/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/28/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/28/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/29/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/29/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/30/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/30/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/31/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
1/31/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/1/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/1/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/2/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/2/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/3/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/3/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/4/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				2
2/4/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/5/11	0.0	0.0	0.0	0.0	56.0	42.9	81.9	46.1			65	1
2/5/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/6/11	42.6	34.4	62.7	43.8	57.1	47.0	116.8	37.1	15	7	54	
2/6/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/7/11	33.0	28.6	83.0	57.4	0.0	0.0	0.0	0.0	17	89		3

2/7/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/8/11	0.0	0.0	0.0	0.0	24.0	24.0	104.2	56.3			1	4
2/8/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/9/11	58.7	36.2	94.0	66.7	82.4	39.7	180.6	120.2	13	25	16	
2/9/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/10/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				2
2/10/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/11/11	0.0	0.0	69.4	53.6	112.6	26.4	98.0	53.3		56	5	3
2/11/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/12/11	39.8	33.3	78.3	44.6	43.2	43.2	72.7	38.3	44	13	1	4
2/12/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/13/11	43.5	36.5	70.5	51.4	56.2	43.5	71.0	40.5	36	32	9	3
2/13/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/14/11	37.4	29.2	57.4	39.4	34.8	34.8	83.0	57.8	13	6	2	
2/14/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/15/11	32.6	28.7	67.7	47.5	62.8	39.1	0.0	0.0	6	3	24	63
2/15/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/16/11	0.0	0.0	412.8	406.1	0.0	0.0	513.7	566.9		87		
2/16/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/17/11	42.0	39.9	83.3	53.3	71.9	53.9	0.0	0.0	6	10	57	5
2/17/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/18/11	59.8	58.3	73.3	37.7	41.4	36.2	101.1	54.8	12	5	11	4
2/18/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/19/11	30.9	30.9	57.3	45.7	43.4	41.7	82.8	45.0	2	4	5	5
2/19/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/20/11	75.2	36.2	113.5	58.8	31.1	29.8	113.3	75.4	27	13	9	7
2/20/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/21/11	64.8	44.4	66.6	49.2	42.2	38.0	124.3	62.4	14	54	17	5
2/21/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				

2/22/11	137.0	46.4	76.3	49.9	37.4	34.7	204.3	90.5	24	45	18	
2/22/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/23/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/23/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/24/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/24/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/25/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/25/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/26/11	0.0	0.0	246.1	112.4	0.0	0.0	0.0	0.0		28		4
2/26/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
2/27/11	76.1	58.1	378.6	289.8	54.6	52.4	137.1	79.5	33	60	10	6
2/27/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				27
2/28/11	56.9	37.6	64.3	38.8	159.5	43.5	103.6	67.0	56	11	6	87
2/28/11	0.0	0.0	0.0	0.0	0.0	0.0	56.6	28.6				13
3/1/11	0.0	0.0	43.8	34.4	29.0	27.7	525.6	567.3		36	9	4
3/1/11	56.3	44.7	129.1	93.4	78.8	35.3	178.3	120.9	132	67	9	
3/2/11	69.2	38.9	86.2	44.7	58.6	27.8	136.4	110.6	42	20	8	8
3/2/11	133.5	53.0	53.9	43.8	0.0	0.0	0.0	0.0	17	21		6
3/3/11	0.0	0.0	0.0	0.0	0.0	0.0	211.9	133.0			0	
3/3/11	0.0	0.0	0.0	0.0	114.0	58.1	146.2	85.3			44	6
3/4/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				2
3/4/11	83.8	50.2	87.2	65.8	79.4	57.2	65.6	47.5	65	34	55	4
3/5/11	0.0	0.0	158.6	67.9	165.9	83.6	135.5	55.7		8	4	9
3/5/11	38.8	36.2	73.8	42.0	48.0	47.9	58.6	30.9	24	22	14	
3/6/11	98.8	99.8	90.9	49.9	81.5	60.0	129.8	74.6	4	19	61	25
3/6/11	34.5	32.5	44.3	41.8	29.7	27.4	0.0	0.0	15	17	4	19
3/7/11	155.1	36.5	70.3	43.2	52.4	44.1	181.1	114.8	21	37	105	14
3/7/11	0.0	0.0	43.8	31.6	53.1	40.2	50.7	29.8		65	95	7
3/8/11	73.8	39.6	95.0	54.8	60.6	38.3	121.7	69.1	13	20	9	17
3/8/11	139.3	144.3	108.8	62.1	50.3	39.6	94.3	51.0	138	38	29	31
3/9/11	49.5	31.3	94.4	52.5	55.3	36.8	202.5	102.0	13	24	20	14

3/9/11	136.5	43.4	62.7	49.6	92.4	101.3	311.8	319.5	14	20	4	4
3/10/11	86.3	43.5	107.1	42.0	113.5	42.6	214.2	112.7	37	43	33	1
3/10/11	37.5	31.3	52.4	45.3	0.0	0.0	37.3	29.2	10	15		42
3/11/11	166.7	96.9	89.2	43.8	41.1	41.8	97.3	52.4	37	18	28	
3/11/11	28.0	27.4	0.0	0.0	298.3	237.2	283.7	233.6	9		6	51
3/12/11	37.9	32.8	38.5	36.5	0.0	0.0	0.0	0.0	21	19		
3/12/11	109.2	76.4	114.3	72.8	108.0	64.9	207.0	164.1	33	48	39	17
3/13/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
3/13/11	111.0	96.4	79.9	53.9	57.1	42.6	100.9	64.9	18	52	45	7
3/14/11	99.5	27.1	86.2	37.0	159.3	78.0	0.0	0.0	15	12	5	1
3/14/11	93.4	43.2	109.2	59.1	57.6	50.2	101.3	65.5	47	42	11	17
3/15/11	0.0	0.0	287.7	251.4	0.0	0.0	68.7	57.1		4	0	13
3/15/11	113.2	51.4	91.9	55.4	42.3	36.8	124.4	91.1	49	25	33	62
3/16/11	55.2	29.0	0.0	0.0	54.0	34.7	139.8	94.4	26		11	28
3/17/11	75.4	42.3	114.4	61.2	96.3	73.7	168.4	140.0	27	34	37	14
3/18/11	127.3	54.5	78.7	54.8	44.7	37.9	108.9	66.2	18	30	28	20
3/19/11	111.5	47.9	108.4	58.8	45.4	45.0	137.0	78.3	68	60	15	7
3/20/11	181.5	119.7	66.0	44.7	101.8	59.8	139.7	100.5	42	23	14	7
3/21/11	41.2	36.8	0.0	0.0	114.2	36.8	170.1	63.9	23		10	
3/22/11	36.9	33.2	217.7	72.2	76.3	59.7	114.3	83.3	13	78	7	6
3/23/11	113.7	110.3	74.5	48.4	0.0	0.0	0.0	0.0	23	16		19
3/24/11	0.0	0.0	69.5	46.0	340.5	340.5	99.8	55.9		25	3	8
3/25/11	127.9	30.1	118.4	77.8	132.5	79.3	137.4	84.1	22	32	62	9
3/26/11	53.2	38.2	92.7	56.0	40.2	35.6	101.0	59.5	30	48	71	11
3/27/11	113.2	37.1	81.2	51.7	39.1	33.8	64.6	42.9	33	48	70	19
3/28/11	59.8	35.9	73.9	47.5	39.4	37.9	72.2	55.6	30	41	30	20
3/29/11	57.3	38.9	80.4	45.3	46.3	35.9	113.7	72.5	43	43	50	
3/30/11	90.7	41.7	73.1	45.3	69.5	60.7	153.5	112.4	58	70	52	31

3/31/11	34.3	30.4	0.0	0.0	0.0	0.0	0.0	0.0	20			57
4/1/11	0.0	0.0	51.6	34.1	0.0	0.0	139.5	139.7		29		24
4/2/11	44.8	44.4	70.6	53.0	46.0	40.8	135.2	111.2	32	66	45	61
4/3/11	51.1	34.8	60.2	47.2	38.4	33.5	194.2	80.1	34	40	18	39
4/4/11	0.0	0.0	82.2	51.7	45.2	33.8	282.8	364.8		56	33	
4/5/11	0.0	0.0	52.7	28.6	34.9	29.8	66.5	34.7	0	1	43	54
4/6/11	56.0	37.4	87.5	56.0	55.9	41.4	0.0	0.0	46	27	27	10
4/7/11	0.0	0.0	62.0	44.1	73.4	42.6	184.1	129.8		33	13	109
4/8/11	149.7	77.7	86.3	47.2	50.6	48.7	147.0	96.6	42	39	13	134
4/9/11	316.0	345.3	110.3	52.1	51.3	56.9	159.7	122.2	27	33	4	175
4/10/11	323.0	304.7	112.2	52.7	137.5	58.1	411.2	428.2	27	30	30	
4/11/11	447.9	433.5	482.2	491.4	131.1	29.3	281.1	254.4	812	154	12	31
4/12/11	88.4	48.7	206.1	53.9	0.0	0.0	0.0	0.0	78	45		57
4/13/11	0.0	0.0	0.0	0.0	715.0	715.0	429.0	475.1			2	6
4/14/11	65.9	52.8	116.8	74.8	121.2	54.8	228.2	162.7	78	109	32	
4/15/11	75.4	40.2	72.9	53.3	52.2	39.6	204.9	132.8	46	33	11	126
4/16/11	52.5	52.4	58.4	51.7	0.0	0.0	0.0	0.0	44	28		40
4/17/11	347.0	354.3	103.3	78.9	131.6	76.7	222.8	188.1	158	125	59	23
4/18/11	54.7	38.6	108.4	53.6	0.0	0.0	311.8	252.2	51	39		91
4/19/11	157.2	83.4	172.6	67.7	214.8	66.4	453.5	497.1	62	61	20	30
4/20/11	523.5	552.2	434.4	503.8	65.8	36.4	300.9	277.0	70	72	18	
4/21/11	66.8	47.2	76.2	57.7	49.5	36.5	114.0	76.1	109	66	82	439
4/22/11	97.1	55.1	70.9	44.3	69.0	53.9	0.0	0.0	39	32	34	209
4/23/11	0.0	0.0	0.0	0.0	40.8	27.5	418.4	418.9			4	41
4/24/11	414.6	397.7	167.0	54.8	0.0	0.0	439.2	459.0	657	55		32
4/25/11	456.2	462.6	401.6	415.2	70.3	70.3	469.5	466.3	147	75	2	4
4/26/11	502.1	506.8	159.8	44.7	80.4	70.3	355.5	380.8	194	71	89	
4/27/11	377.3	412.6	76.0	52.1	96.2	75.2	120.6	37.1	85	42	22	93
4/28/11	0.0	0.0	39.3	31.2	0.0	0.0	0.0	0.0		20		68
4/29/11	359.2	343.1	129.5	38.9	109.5	73.1	137.2	85.1	53	72	55	50

4/30/11	76.5	35.3	94.5	51.7	53.7	42.9	208.5	135.6	61	58	39	183
5/1/11	140.5	50.5	75.4	41.7	89.9	43.8	187.6	113.6	81	54	25	79
5/2/11	166.8	87.3	115.5	47.8	138.8	60.6	288.5	260.4	46	88	78	43
5/3/11	278.9	274.7	148.6	43.1	96.7	42.6	322.2	290.3	128	84	37	92
5/4/11	253.9	97.5	234.7	82.4	0.0	0.0	110.6	71.7	252	55		67
5/5/11	66.7	64.5	63.5	40.8	39.2	33.6	168.5	105.1	198	76	44	209
5/6/11	96.1	67.3	172.2	75.2	76.7	63.0	284.8	227.0	190	118	18	171
5/7/11	204.3	74.9	240.1	96.1	181.1	53.6	222.7	153.4	73	90	34	45
5/8/11	206.2	115.9	79.6	42.9	53.5	34.5	243.0	204.1	88	70	20	
5/9/11	136.3	44.4	63.0	37.4	134.6	32.8	169.1	88.3	96	43	15	51
5/10/11	91.2	36.2	125.2	39.2	36.0	33.8	0.0	0.0	41	13	6	203
5/11/11	0.0	0.0	48.4	31.9	26.4	26.4	153.2	79.8		10	2	189
5/12/11	67.4	40.8	56.3	40.2	26.4	26.4	120.9	67.9	107	36	1	
5/13/11	143.2	47.8	66.4	38.5	52.1	46.6	241.6	179.2	55	49	19	59
5/14/11	92.4	44.7	67.6	40.8	0.0	0.0	0.0	0.0	87	66		9
5/15/11	213.6	34.1	68.7	35.3	45.0	47.6	237.1	153.9	23	28	8	
5/16/11	118.0	37.9	66.1	40.5	28.4	28.3	150.5	31.9	32	21	10	
5/17/11	0.0	0.0	40.2	32.2	0.0	0.0	0.0	0.0		23		88
5/18/11	0.0	0.0	156.5	35.4	90.3	27.7	0.0	0.0		8	9	95
5/19/11	58.4	36.5	237.3	88.0	174.3	50.2	263.8	217.3	13	26	5	24
5/20/11	141.5	84.7	149.3	49.0	137.6	84.4	197.6	157.7	16	20	14	15
5/21/11	513.2	515.2	146.1	38.0	458.0	468.7	280.2	97.9	26	24	7	78
5/22/11	59.1	37.1	61.7	40.8	53.1	36.2	140.8	56.5	102	47	8	446
5/23/11	0.0	0.0	78.7	41.7	0.0	0.0	346.1	287.7		13		49
5/24/11	408.1	424.5	267.8	169.7	250.1	175.2	313.5	211.8	150	157	86	134
5/25/11	316.7	149.0	123.8	44.7	116.9	104.2	221.3	119.4	103	82	63	25
5/26/11	213.2	64.2	227.6	112.4	233.2	159.0	471.0	476.3	90	23	20	11
5/27/11	439.4	462.3	181.9	70.9	59.3	42.8	214.5	137.1	389	362	12	83
5/28/11	71.8	35.4	100.5	39.9	94.3	48.9	364.3	342.5	30	20	8	221
5/29/11	191.6	163.9	106.7	37.4	123.5	38.3	368.1	339.2	9	16	13	28

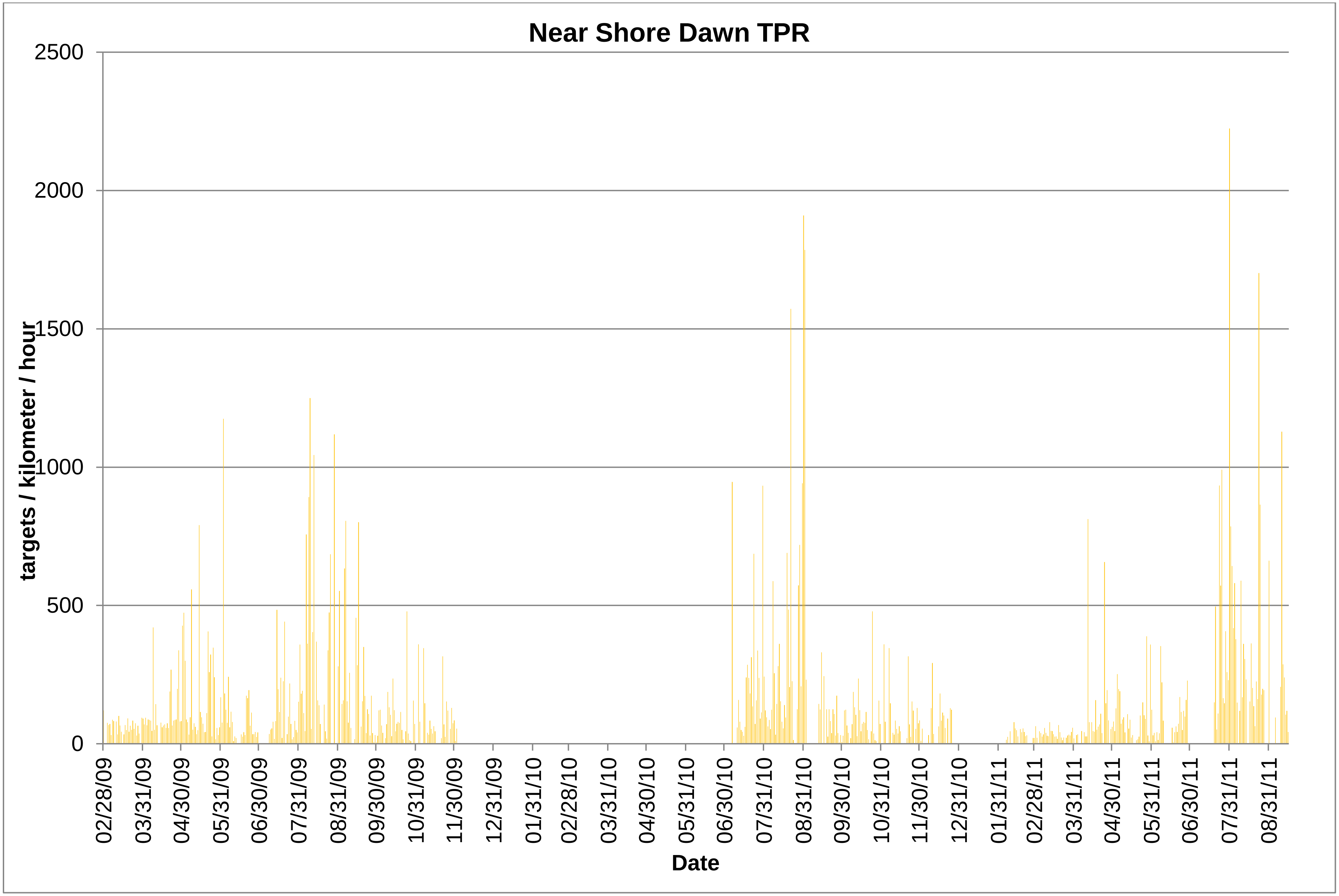
5/30/11	542.8	560.8	207.6	61.8	126.5	58.1	227.0	135.6	359	218	73	129
5/31/11	418.1	499.5	234.5	130.7	255.7	102.8	206.6	117.6	123	54	6	58
6/1/11	389.7	356.5	327.8	316.0	0.0	0.0	336.5	345.0	31	36		40
6/2/11	142.0	83.9	101.5	60.0	50.1	35.9	241.6	169.2	40	56	5	15
6/3/11	64.5	42.9	135.9	91.7	60.2	38.9	320.1	206.6	9	183	23	62
6/4/11	227.1	95.6	135.0	59.7	38.9	38.9	247.0	147.5	42	61	2	80
6/5/11	135.8	58.3	135.2	41.4	49.5	33.5	338.1	296.2	14	26	25	130
6/6/11	202.8	35.0	142.7	57.5	106.3	60.0	252.3	199.4	38	68	38	105
6/7/11	71.9	60.9	85.6	53.0	156.9	101.7	261.5	187.4	353	168	23	
6/8/11	66.0	37.7	132.0	51.3	163.7	60.4	224.7	181.3	222	100	18	
6/9/11	76.3	34.2	0.0	0.0	0.0	0.0	0.0	0.0	84			
6/10/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
6/11/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
6/12/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
6/13/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				462
6/14/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				30
6/15/11	0.0	0.0	0.0	0.0	0.0	0.0	502.7	518.4				25
6/16/11	116.7	54.5	105.9	83.1	85.5	66.7	210.9	146.2	58	405	35	94
6/17/11	269.3	116.7	0.0	0.0	0.0	0.0	256.5	203.8	5			153
6/18/11	351.2	361.0	108.5	78.3	86.2	83.1	157.5	122.6	42	168	65	106
6/19/11	155.1	91.7	143.5	50.7	143.1	70.9	390.7	390.7	63	60	15	62
6/20/11	293.1	230.7	160.5	77.0	169.0	131.9	208.8	151.4	43	118	27	158
6/21/11	212.5	67.6	100.1	49.0	95.2	98.2	236.3	260.1	73	156	74	90
6/22/11	139.0	93.8	103.4	78.9	229.8	188.6	290.3	263.9	169	498	43	53
6/23/11	373.7	377.9	250.1	115.0	632.9	679.9	438.7	457.6	115	126	125	88
6/24/11	443.0	437.2	191.9	94.7	257.5	115.1	479.7	493.7	50	210	35	306
6/25/11	551.9	572.6	267.7	98.4	124.3	50.2	382.1	399.8	119	221	141	88
6/26/11	422.2	421.2	176.8	81.0	66.3	50.8	187.6	152.9	98	337	379	41
6/27/11	304.1	277.0	163.0	77.7	112.9	81.5	199.1	128.1	159	344	492	509
6/28/11	265.5	129.8	228.0	141.1	200.2	152.9	353.7	321.3	229	226	43	

6/29/11	0.0	0.0	130.7	62.4	134.9	64.9	218.2	168.5		340	11	603
6/30/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				148
7/19/11	235.7	85.9	221.0	95.0	356.5	352.6	358.1	348.6	246	230	547	98
7/20/11	435.8	486.7	294.6	139.2	516.1	594.6	441.3	446.5	212	307	101	969
7/21/11	476.0	475.9	347.5	299.9	129.3	92.3	414.0	386.7	310	45	11	661
7/22/11	263.5	211.8	95.3	59.7	148.0	146.2	289.0	248.0	254	229	295	181
7/23/11	464.0	448.7	0.0	0.0	95.1	40.8	288.9	247.4	667		31	88
7/24/11	422.6	443.7	0.0	0.0	172.9	163.3	284.7	282.8	906		139	220
7/25/11	368.4	423.1	278.3	250.5	401.2	435.8	214.5	171.2	108	148	58	537
7/26/11	255.8	171.8	204.8	112.4	246.2	246.2	222.1	180.4	75	323	6	82
7/27/11	135.5	88.6	171.4	63.5	85.4	48.7	355.0	336.4	63	114	93	237
7/28/11	397.3	416.6	208.3	159.3	465.6	536.7	258.5	197.7	279	419	29	682
7/29/11	452.1	508.9	195.7	129.6	0.0	0.0	325.2	306.7	81	272		149
7/30/11	253.8	186.6	188.8	92.6	197.3	125.2	332.0	340.2	124	102	79	496
7/31/11	444.2	473.9	229.0	151.7	422.7	399.8	337.0	295.4	570	451	69	857
8/1/11	492.3	575.1	243.8	76.4	373.1	394.0	267.1	229.7	228	197	92	105
8/2/11	296.5	277.6	209.7	89.2	235.1	109.7	333.4	310.8	244	187	29	224
8/3/11	389.4	418.4	224.6	176.1	472.2	483.3	411.6	452.9	322	416	222	127
8/4/11	331.8	284.0	228.1	195.0	382.8	493.1	332.3	288.3	203	194	29	
8/5/11	408.1	444.3	266.5	217.9	336.0	375.9	387.7	367.5	252	236	56	162
8/6/11	222.1	162.4	177.6	141.4	433.2	436.7	0.0	0.0	104	315	21	337
8/7/11	0.0	0.0	0.0	0.0	203.7	227.5	342.0	301.7			18	126
8/8/11	197.8	120.8	260.9	217.4	398.4	412.0	355.4	338.3	126	153	38	298
8/9/11	379.7	304.3	246.5	147.3	0.0	0.0	221.4	162.4	114	94		692
8/10/11	211.4	90.5	95.1	39.2	75.5	56.6	224.4	203.1	42	78	33	799
8/11/11	308.0	205.7	202.9	135.6	159.8	80.1	375.3	353.2	268	136	17	25
8/12/11	221.1	169.1	170.6	73.1	188.6	33.2	392.2	390.4	205	82	71	
8/13/11	311.8	252.0	0.0	0.0	527.7	630.4	305.6	213.0	113		60	426
8/14/11	0.0	0.0	0.0	0.0	187.4	181.3	0.0	0.0			16	445
8/15/11	0.0	0.0	0.0	0.0	105.9	76.4	289.4	280.0			19	74

8/16/11	180.4	112.7	177.8	110.1	256.0	201.9	292.0	254.0	69	44	34	23
8/17/11	165.5	103.6	248.8	158.3	280.9	319.7	307.9	272.9	177	94	41	34
8/18/11	238.7	176.7	303.6	250.5	406.3	457.6	355.5	367.2	27	66	16	67
8/19/11	457.2	477.7	224.0	86.3	119.5	38.6	225.6	129.8	88	45	37	35
8/20/11	253.2	128.3	179.6	68.8	395.4	489.4	255.2	174.9	17	54	9	1161
8/21/11	318.1	240.3	271.5	180.7	222.3	144.1	357.0	345.0	52	78	19	262
8/22/11	281.7	219.1	335.0	306.6	153.1	91.4	252.3	199.9	77	502	35	93
8/23/11	231.0	206.0	299.9	294.1	137.1	83.1	188.3	135.3	978	506	101	63
8/24/11	126.2	61.2	189.1	113.5	187.3	162.1	283.5	206.1	264	99	155	142
8/25/11	190.7	114.5	188.7	142.7	0.0	0.0	346.2	311.7	29	21		
8/26/11	415.9	478.8	304.0	253.4	487.9	478.8	302.8	260.2	27	39	25	
8/27/11	306.5	231.1	0.0	0.0	0.0	0.0	0.0	0.0	158			
8/28/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				152
8/29/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
8/30/11	0.0	0.0	0.0	0.0	271.1	63.6	283.8	205.1			18	
8/31/11	285.2	268.5	350.7	285.2	0.0	0.0	0.0	0.0	363	217		
9/1/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
9/2/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				28
9/3/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				9
9/4/11	0.0	0.0	0.0	0.0	222.3	146.5	317.2	300.8			28	213
9/5/11	338.1	339.2	323.3	342.5	88.2	88.2	239.6	171.2	40	23	2	
9/6/11	0.0	0.0	0.0	0.0	0.0	0.0	366.2	354.7				331
9/7/11	327.7	397.7	0.0	0.0	126.2	108.4	0.0	0.0	9		47	810
9/8/11	0.0	0.0	94.4	53.3	67.3	28.9	243.0	210.4		44	33	188
9/9/11	209.1	36.8	355.6	395.9	102.7	48.7	274.3	202.9	117	404	211	57
9/10/11	334.8	312.0	261.9	240.4	287.6	284.5	370.6	370.3	306	1006	158	134
9/11/11	230.9	115.4	414.8	425.1	169.1	99.9	278.1	206.3	47	109	41	38
9/12/11	435.6	440.1	321.2	266.0	167.2	132.5	230.7	168.6	207	124	52	24
9/13/11	436.9	484.3	361.0	349.8	193.3	109.7	313.9	254.4	65	445	38	869
9/14/11	345.0	297.1	311.5	247.4	142.7	49.3	247.6	169.4	35	153	40	

9/15/11	405.1	392.5	328.8	277.1	144.6	123.5	351.8	308.7	11	468	682	

Onshore VSR



Near Shore Dawn TPR
targets / kilometer / hour
2500
2000
1500
1000
500
0
02/28/09
03/31/09
04/30/09
05/31/09
06/30/09
07/31/09
08/31/09
09/30/09
10/31/09
11/30/09
12/31/09
01/31/10
02/28/10
03/31/10
04/30/10
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07/31/10
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12/31/10
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06/30/11
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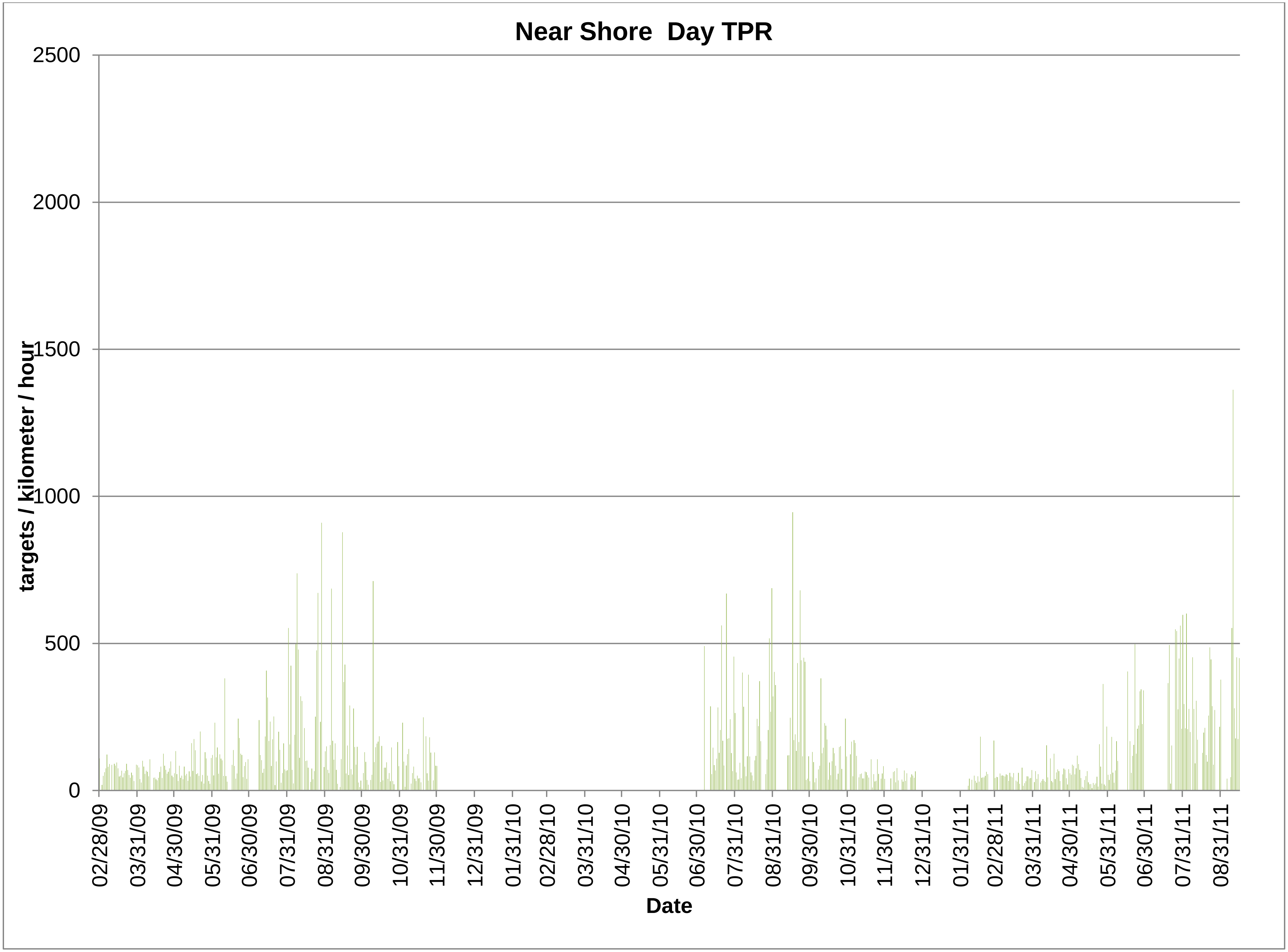
08/31/11
Date



Near Shore Day TPR
2500
2000
1500
1000
500
0
targets / kilometer / hour
02/28/09
03/31/09
04/30/09
05/31/09
06/30/09
07/31/09
08/31/09
09/30/09
10/31/09
11/30/09
12/31/09
01/31/10
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12/31/10
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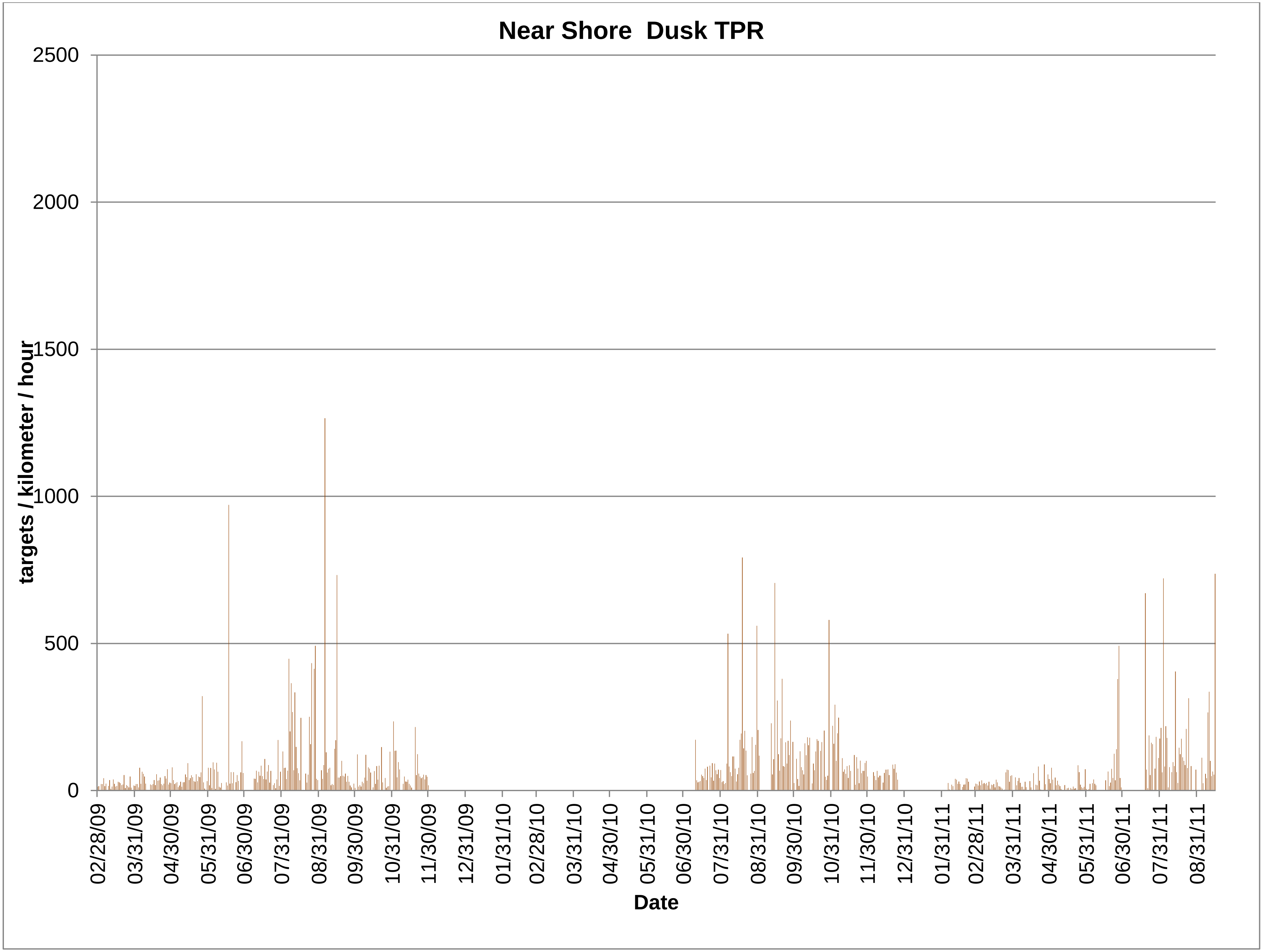
07/31/11
08/31/11
Date


Near Shore Dusk TPR
2500
2000
1500
1000
500
0
targets / kilometer / hour
02/28/09
03/31/09
04/30/09
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07/31/09
08/31/09
09/30/09
10/31/09
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01/31/11
02/28/11
03/31/11
04/30/11
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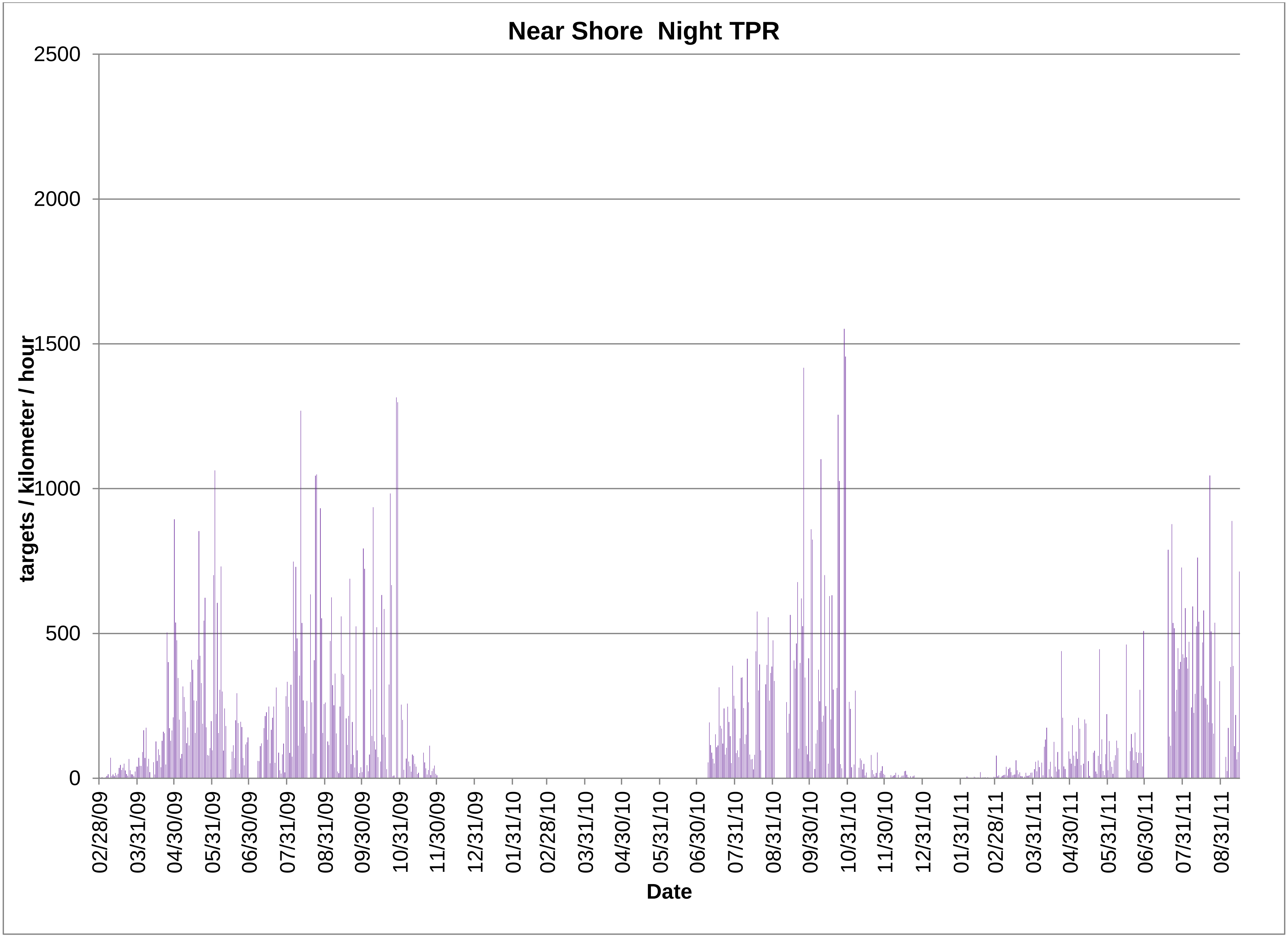
06/30/11
07/31/11
08/31/11
Date



Near Shore Night TPR
targets / kilometer / hour
2500
2000
1500
1000
500
0
02/28/09
03/31/09
04/30/09
05/31/09
06/30/09
07/31/09
08/31/09
09/30/09
10/31/09
11/30/09
12/31/09
01/31/10
02/28/10
03/31/10
04/30/10
05/31/10
06/30/10
07/31/10
08/31/10
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10/31/10
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12/31/10
01/31/11
02/28/11
03/31/11
04/30/11
05/31/11
06/30/11
07/31/11
08/31/11
Date

Date	Dawn_Avg_AGL_m	Dawn_Median_AGL_m	Day_Avg_AGL_m	Day_Median_AGL_m	Dusk_Avg_AGL_m	Dusk_Median_AGL_m	Night_Avg_AGL_m	Night_Median_AGL_m	Dawn TPR	Day TPR	Dusk TPR	Night TPR
02/28/09	49.0	42.4	82.1	37.2	54.5	64.9	82.1	60.4	121	109	13	4
03/01/09					73.2	48.5					15	
03/02/09			50.0	37.0			94.4	48.8		19		3
03/03/09	45.4	38.1	53.6	30.2	42.9	33.7	145.7	41.1	76	50	22	2
03/04/09	38.5	34.7	52.2	31.4	56.3	33.5	53.8	43.0	68	62	22	2
03/05/09	37.6	33.2	45.6	29.3	48.5	37.2	210.9	118.0	72	76	42	3
03/06/09	52.1	40.2	35.3	31.1	49.0	43.0	105.1	73.5	31	122	15	8
03/07/09	36.5	29.6	35.6	25.6	55.7	49.2	120.7	72.4	87	81	24	14
03/08/09	36.3	32.8	38.1	29.0					82	90		
03/09/09					68.1	78.2	260.2	236.8			16	71
03/10/09	47.8	41.8	39.1	30.8	48.3	35.1	62.2	33.2	81	87	36	8
03/11/09	63.8	59.4			173.5	55.8	94.8	59.3	34		6	14
03/12/09	54.2	41.8	71.0	35.4	38.7	32.6	93.4	65.2	101	91	14	8
03/13/09	61.5	44.5	63.5	33.8	39.4	27.7	68.3	36.3	66	85	38	18
03/14/09	72.1	42.8	54.6	32.6	77.5	57.6	139.2	95.7	44	95	23	10
03/15/09			47.3	30.5	47.7	43.1	108.7	83.5		76	14	15
03/16/09	43.3	37.5	34.0	31.1	31.2	31.4	148.3	92.7	30	18	9	36
03/16/09	44.6	41.8	38.1	32.0	48.2	44.2	93.7	80.8	34	48	16	8
03/17/09	69.8	46.8	55.7	36.0	58.8	45.4	185.9	117.7	68	38	30	46
03/17/09	39.3	37.8	44.4	34.7	55.8	44.5	120.7	85.0	46	50	22	16
03/18/09	74.5	34.9	51.1	35.5	62.3	36.3	143.0	78.5	50	36	24	29
03/18/09	33.7	32.2	45.3	32.0	80.6	50.9	236.7	137.5	32	68	28	29
03/19/09	69.6	50.3	64.1	32.0	44.8	39.0	170.5	123.7	69	45	25	36
03/19/09	57.1	35.4					82.3	65.2	92			22
03/20/09	99.6	49.7	81.2	36.9	57.8	46.0	280.3	223.0	44	36	14	51
03/20/09	60.9	44.3	47.4	32.9	53.9	53.3	113.3	85.8	42	58	19	19

03/21/09	61.7	46.9	62.2	34.7	83.7	66.4	150.5	90.5	65	67	15	27
03/21/09	59.8	34.7	60.1	32.9	55.0	52.7	84.4	54.3	53	22	21	23
03/22/09	44.8	34.7	51.3	32.9	62.5	69.2	103.0	70.3	51	91	14	15
03/22/09					77.4	51.8					53	
03/23/09	89.4	43.6	117.7	41.5	40.1	25.6	68.3	51.1	84	70	9	9
03/23/09												
03/24/09	47.9	39.9	65.7	41.8	38.5	33.4	127.9	83.8	49	53	10	67
03/24/09	45.5	41.1	67.2	37.8	48.6	35.1	86.1	75.9	54	48	19	12
03/25/09	54.3	47.7	44.0	34.1	41.7	28.0	175.8	99.5	48	44	16	28
03/25/09	74.3	36.7	52.7	38.4	100.2	70.3	202.3	81.1	74	39	16	18
03/26/09	0.0	0.0	49.3	36.0	105.5	50.3	95.7	67.7		30	11	14
03/26/09	50.8	39.6	41.7	30.8					30	61		
03/27/09	133.6	69.8	88.6	42.7	23.6	21.3	109.3	65.2	65	49	48	13
03/27/09	60.8	41.8	54.4	34.4	63.0	61.3	109.3	56.1	55	52	25	12
03/28/09	42.0	39.9	43.0	35.7	41.2	31.1	61.8	58.7	35	27	10	8
03/28/09	40.5	27.4	34.3	26.8	330.9	278.9			37	32	3	
03/29/09							118.7	63.9				23
03/29/09												
03/30/09	46.1	39.5	51.5	41.8	64.4	62.2	93.2	72.2	94	88	17	40
03/30/09					49.4	45.1	72.2	76.8			13	11
03/31/09	43.1	36.3	36.9	31.7	45.5	48.3	122.7	81.1	43	42	8	40
03/31/09	56.0	44.2	107.7	44.2	65.0	38.6	166.0	85.6	91	86	16	27
04/01/09	45.6	39.0	83.2	38.4	45.7	30.6	154.4	107.9	55	50	22	71
04/01/09	51.9	33.1	34.8	29.6	239.3	239.3			70	79	4	
04/02/09	93.5	52.6	54.6	33.5	37.4	31.9	178.3	107.3	94	39	22	43
04/02/09					44.9	34.7	82.8	28.8			9	8
04/03/09	27.3	26.1			57.5	35.1	188.1	114.9	14		11	42
04/03/09	57.7	40.2	57.1	34.1	25.2	21.0	230.8	100.6	67	27	3	5

04/04/09	251.1	223.9	118.1	40.5	73.6	45.4	222.9	140.8	16	33	34	91
04/04/09	51.6	46.5	51.8	40.2	46.6	43.0	88.8	65.8	88	101	78	29
04/05/09	37.7	36.1	45.9	38.7	50.3	38.1	295.4	194.5	86	82	21	166
04/05/09	105.4	45.4	59.5	33.5	133.8	50.0	299.3	274.9	86	37	23	137
04/06/09	136.8	62.6	157.2	35.8	191.0	150.9	283.6	243.4	84	57	64	70
04/06/09	64.9	32.9					237.3	172.1	72			48
04/07/09	232.8	126.5	221.7	121.3	210.3	92.4	269.5	223.4	47	37	21	175
04/07/09	51.4	38.7	55.2	37.5	41.1	32.6	138.8	87.8	40	68	57	43
04/08/09	55.9	37.8	81.8	37.0	41.0	36.7	178.1	111.9	87	64	48	41
04/08/09	249.5	231.3	165.4	66.4	108.0	80.9	222.4	73.8	421	55	40	28
04/09/09	86.4	49.7	95.8	42.1	135.5	48.0	209.1	117.5	51	48	24	67
04/09/09	244.9	185.3					81.7	67.7	21			15
04/10/09	107.8	67.4	126.8	45.6			275.7	205.6	143	106		21
04/10/09	45.0	40.2							65			
04/11/09	58.7	37.5							67			
04/11/09												
04/12/09												
04/12/09												
04/13/09			89.6	41.1	157.5	92.4	169.0	112.0		44	21	55
04/13/09												
04/14/09	82.1	48.8	94.8	30.8	77.6	46.3	112.6	71.6	77	44	19	13
04/14/09												
04/15/09	34.7	34.0	35.1	33.5	43.9	28.0	397.5	366.7	60	38	7	127
04/15/09					46.4	41.5	137.1	72.8			22	9
04/16/09	40.1	38.6	44.8	33.5	274.2	326.0	232.1	107.3	54	33	36	60
04/16/09	37.6	36.1	80.1	40.7	32.0	32.0			66	34	2	
04/17/09	52.4	40.8	74.4	43.9	151.2	80.2	144.7	100.4	70	43	19	101
04/17/09	45.7	41.1	84.4	44.5			77.8	65.8	26	31		15

04/18/09	41.7	30.2	82.9	39.0	47.1	34.7	193.7	92.7	46	63	56	80
04/18/09	48.4	42.7	114.9	57.2	60.0	58.7	115.7	76.7	57	57	14	28
04/19/09	51.1	34.6	139.7	67.2	49.9	43.9	127.1	75.6	74	81	34	38
04/19/09			41.9	36.0	48.4	34.6	99.3	75.6		43	24	17
04/20/09	54.7	35.1	66.6	43.9	127.0	59.4	139.1	105.9	44	42	35	129
04/20/09	51.5	40.5	44.1	35.8					57	43		
04/21/09	347.8	356.3					463.4	491.2	34			161
04/21/09	240.7	175.0	264.4	177.2	170.3	84.7	268.5	207.9	189	126	44	88
04/22/09	412.7	442.7	198.4	100.0			175.8	140.7	268	57		156
04/22/09	185.8	156.8	140.6	67.7	51.6	45.6			58	84	22	
04/23/09	76.1	47.5	63.0	44.5	40.3	36.3	86.0	64.9	66	70	17	48
04/23/09	61.2	38.4	98.5	58.8	40.1	33.8	141.3	91.4	39	59	18	34
04/24/09	50.1	34.0	84.4	48.8	58.6	43.3	307.9	235.9	42	44	16	504
04/24/09	53.0	44.7	74.9	39.9	48.5	40.7	221.3	172.5	84	57	24	126
04/25/09	126.4	52.1	147.8	48.5	129.0	55.2	267.2	214.6	68	64	40	401
04/25/09	256.9	170.4			261.6	218.8			87		49	
04/26/09	139.3	55.9	103.7	45.4	103.2	91.7	284.4	230.1	88	65	41	173
04/26/09			245.0	249.0						76		
04/27/09	258.8	229.8	179.5	123.7	251.8	240.2	294.6	260.0	199	99	73	129
04/27/09			74.0	36.0	43.1	38.6	91.2	74.1		47	18	25
04/28/09	280.9	300.2	113.7	47.5	47.5	38.4	207.4	125.9	338	41	21	165
04/28/09	78.0	71.2	66.6	43.3	38.0	36.9	125.8	103.2	76	51	10	36
04/29/09	56.0	42.1	61.3	43.6	47.7	39.0	135.0	108.5	57	46	27	210
04/29/09	55.9	38.1	55.3	34.7	38.2	36.9	114.1	78.0	81	41	23	39
04/30/09	95.1	49.7	80.7	43.6	134.8	59.1	221.3	189.0	56	53	21	894
04/30/09	127.1	43.9	145.7	39.0	43.1	35.1	185.8	104.7	82	59	25	31
05/01/09	191.6	119.8	150.2	66.8	162.3	116.4	211.5	130.8	427	134	79	538
05/01/09	298.7	301.1					313.8	281.3	41			187

05/02/09	330.4	318.2	202.7	103.6	125.3	71.6	313.0	262.4	474	56	21	477
05/02/09			100.0	39.9	64.7	42.1	164.5	119.2		45	36	198
05/03/09	363.1	361.2	119.0	43.3	72.9	36.4	163.9	122.5	300	33	22	346
05/03/09	255.9	184.3							184			
05/04/09	104.8	52.1	157.2	51.2	51.1	39.0	130.0	89.9	88	84	25	202
05/04/09							247.3	181.5				14
05/05/09	69.4	41.1	90.1	36.7	104.1	37.8	145.7	68.9	78	44	29	69
05/05/09			50.9	28.0	43.3	39.5				21	16	
05/06/09	356.2	408.4			77.0	35.7	115.6	64.6	9		12	84
05/06/09	29.9	29.9	248.6	88.2					33	51		
05/07/09			428.7	398.8			215.2	159.1		22		317
05/07/09	69.4	43.0	73.6	37.2	94.7	43.0	252.6	198.9	96	39	17	144
05/08/09	154.2	62.5	130.1	50.9	63.7	30.6	214.7	132.6	140	55	30	281
05/08/09	388.0	389.1	179.3	130.1	38.1	30.8	129.7	92.4	558	81	14	38
05/09/09			170.5	56.4	94.1	42.1	219.1	130.1		17	13	230
05/09/09	44.5	38.1	56.1	40.5	38.0	40.2	69.3	57.3	51	51	6	26
05/10/09	69.6	43.0	59.8	37.0	40.5	32.3	81.0	61.6	74	56	28	121
05/10/09	77.2	45.1	79.0	42.4	47.7	44.8	121.7	70.4	55	41	19	109
05/11/09	45.5	37.2	65.0	37.8	45.7	37.5	172.3	118.1	61	31	29	175
05/11/09	51.7	42.7	69.2	37.2	71.0	52.7	167.1	104.9	43	33	17	58
05/12/09	81.4	37.2	84.6	34.9	80.2	35.1	127.5	83.2	35	66	55	113
05/12/09					74.7	50.1	122.0	83.4			24	36
05/13/09	212.9	65.2	76.8	37.5	111.0	65.1	229.1	239.0	39	48	16	332
05/13/09	64.8	32.6	53.0	30.8	44.3	40.5	150.3	64.0	49	34	46	34
05/14/09	357.9	348.7	163.9	93.0	222.8	215.5	254.9	203.3	791	161	93	408
05/14/09	66.6	70.3	319.8	73.8					58	54		
05/15/09	156.2	71.9	89.1	38.7	48.5	29.1	142.3	72.5	115	67	36	375
05/15/09	52.7	52.7	146.2	55.5	54.7	33.5	152.0	90.8	1	31	32	203

05/16/09	223.3	149.5	102.1	47.9	89.1	32.0	114.0	57.2	96	175	42	269
05/16/09	122.7	41.1	101.5	37.8	35.7	35.7	66.7	43.0	61	29	7	59
05/17/09			120.3	41.8			99.8	60.7		37		156
05/17/09	154.8	69.5	81.6	38.4	58.6	41.5	148.3	87.8	73	137	52	106
05/18/09			53.9	34.1	33.7	26.8	182.9	122.8		55	46	267
05/18/09	133.7	62.9					284.7	299.6	42			19
05/19/09	86.3	32.9	92.6	44.5	54.0	35.5	242.4	209.7	43	58	32	410
05/19/09	145.3	48.2	65.3	36.4			156.5	94.5	9	14		124
05/20/09	255.8	162.5	137.0	62.9	44.3	30.5	176.8	144.6	65	32	8	853
05/20/09	260.4	192.6	142.5	44.8	136.9	56.2	245.6	209.7	111	50	30	196
05/21/09	298.8	290.5	140.7	37.2	61.2	34.1	381.5	365.0	93	22	19	423
05/21/09	265.3	194.0	244.4	143.7	130.8	67.1	99.2	66.4	406	201	56	122
05/22/09	362.2	364.2	146.3	41.1	99.4	37.3	226.1	162.3	259	31	32	329
05/22/09	81.5	34.3	63.4	30.2			118.2	63.1	22	20	14	38
05/23/09	328.2	318.5	258.2	210.5	176.3	47.9	335.5	329.3	323	53	48	189
05/23/09	39.6	38.4	50.1	28.0	41.7	40.8	100.3	70.1	40	10	6	36
05/24/09	414.8	442.9	254.2	183.5	193.4	193.4	295.5	190.2	27	18	20	545
05/24/09	74.7	39.6	49.8	28.0	60.5	30.8	193.8	111.3	11	24	46	113
05/25/09	383.9	401.7	207.1	93.6	161.9	31.5	174.5	118.4	348	131	62	623
05/25/09	156.2	50.7	92.5	39.3	36.1	29.9	229.2	215.8	38	27	15	343
05/26/09	337.2	360.3	132.1	50.9	312.3	302.4	205.1	118.9	241	109	321	176
05/26/09												
05/27/09	50.7	34.1	52.7	35.1	83.2	26.8	116.4	69.5	16	51	28	80
05/27/09			35.6	27.7	89.9	25.6	273.1	267.9		7	7	66
05/28/09	52.6	33.5	94.1	45.1	51.7	27.4	229.5	188.8	57	32	7	78
05/28/09												
05/29/09	283.0	109.0	122.0	46.0			228.2	173.4	32	23		105
05/29/09												

05/30/09	235.8	142.5	111.1	42.7	227.4	92.4	193.9	120.5	60	111	32	197
05/30/09												
05/31/09	157.7	97.7	135.4	46.9	117.6	43.4	280.2	219.8	168	121	78	97
05/31/09												
06/01/09	76.3	37.5	114.8	61.3	110.8	76.2	278.4	256.6	66	44	18	701
06/01/09	306.3	313.0	182.2	49.2			198.3	148.3	77	51		205
06/02/09	211.8	182.9	212.7	175.7	76.5	26.8	242.8	202.4	1175	230	77	1063
06/02/09	157.9	60.7	170.4	83.5	192.0	42.7	203.1	128.9	75	121	9	58
06/03/09	295.5	306.6	245.3	190.2	331.7	262.7	197.8	136.2	15	6	9	223
06/03/09	258.9	234.1	131.4	43.6					182	113		
06/04/09			204.2	102.3	189.3	110.9	250.2	209.1		126	96	606
06/04/09	167.8	95.1	212.5	171.0	79.0	38.4	190.0	120.7	123	146	46	138
06/05/09	383.2	396.1	171.2	97.2	51.6	25.8	274.1	222.5	76	57	72	157
06/05/09												
06/06/09	192.8	93.0	72.3	41.0	222.3	139.9	203.0	179.2	25	23	6	306
06/06/09	281.3	259.1	197.5	65.2			194.3	126.2	242	123		114
06/07/09	328.3	316.8	165.0	74.7	211.3	124.1	203.1	171.3	60	99	27	732
06/07/09	90.1	43.6	101.0	46.9	35.3	28.7	139.6	93.4	39	109	95	136
06/08/09	212.6	101.5	179.8	69.8	67.7	35.7	164.1	105.8	116	103	40	300
06/08/09	96.8	41.8	94.4	47.5	42.5	27.9	141.7	91.1	64	83	64	147
06/09/09	121.1	37.8	113.6	42.7	38.3	39.3	255.1	194.8	79	28	13	96
06/09/09	74.6	52.4	80.4	34.4					69	50		
06/10/09			420.7	404.2			235.4	126.8		381		241
06/10/09	27.9	25.1	107.0	32.9	34.5	27.3	212.4	137.5	10	21	10	47
06/11/09	108.5	50.1	77.3	40.2	31.4	29.3	176.5	107.9	27	50	26	180
06/11/09			243.5	54.3	92.7	92.7	89.9	79.6		19	1	11
06/12/09												
06/12/09	103.2	50.0	84.2	38.4					21	30		

06/13/09												
06/13/09												
06/14/09												
06/14/09												
06/15/09					30.7	29.0	110.9	65.8			28	31
06/15/09												
06/16/09	52.8	36.3	195.6	149.7	62.0	30.5	141.6	89.3	34	87	17	92
06/16/09												
06/17/09					142.8	68.7	174.0	116.4			50	114
06/17/09	31.5	27.4	228.1	165.5	511.5	548.9	79.8	71.3	26	138	971	42
06/18/09	112.6	41.6	107.6	51.2	102.8	55.6	144.5	94.5	42	83	24	70
06/18/09	32.5	33.2							30			
06/19/09			157.0	47.5	101.0	71.0	161.2	98.1		27	63	201
06/19/09	145.6	62.3	123.9	43.7	86.5	42.4	256.9	200.7	32	41	38	97
06/20/09	328.6	328.3	332.8	316.4	109.7	93.4	173.0	122.5	174	58	22	294
06/20/09	77.4	37.5	143.5	34.9	45.9	38.9			37	29	25	
06/21/09	244.5	193.2	158.3	108.8	172.2	106.4	207.6	146.8	165	244	63	191
06/21/09			35.1	31.7	28.0	25.8	127.5	62.6		26	12	3
06/22/09	81.3	41.5	84.1	34.1			105.1	59.7	39	30		16
06/22/09	277.4	212.4	198.7	94.6					194	179		
06/23/09	117.6	54.3	138.3	85.3	118.8	50.9	156.0	106.7	65	125	29	195
06/23/09	52.0	41.5	55.4	34.7	55.4	43.3	123.5	74.1	31	22	10	70
06/24/09	214.4	180.7	170.4	94.0	147.7	67.1	142.8	91.0	113	121	53	177
06/24/09	77.0	44.8	110.0	37.9	45.4	27.3	115.8	70.3	52	38	48	94
06/25/09	64.6	37.8	62.3	30.8	70.2	41.1	271.4	157.6	35	46	33	70
06/25/09												
06/26/09	292.8	230.7	222.7	157.3			154.0	84.6	35	83		45
06/27/09	139.6	63.7	145.4	91.4	66.1	35.2	193.2	136.6	43	97	62	117

06/28/09	114.0	45.4	91.6	35.1	101.9	102.0	160.9	117.7	25	40	168	124
06/29/09	176.3	99.7	195.5	75.0	55.1	34.6	149.1	98.8	41	106	60	141
07/07/09							302.5	90.5				60
07/08/09	107.6	41.8	72.9	50.6	166.2	68.3	217.2	181.7	36	239	41	59
07/09/09	155.2	59.0	48.6	33.4	87.9	34.4	179.5	126.6	52	121	40	112
07/10/09	127.9	43.0	69.4	39.3	66.6	54.1	193.0	129.5	56	103	68	121
07/11/09	256.6	158.3	98.4	38.1	69.1	35.7			80	60	28	
07/12/09	171.4	64.9	81.7	40.2	121.2	63.9	206.8	153.0	18	74	64	173
07/13/09	144.0	58.2	69.8	39.3	108.6	35.4	210.4	157.6	82	184	51	215
07/14/09	190.9	108.2	94.9	49.4	137.9	39.9	263.8	233.2	484	408	85	228
07/15/09	207.4	137.8	64.5	39.0	134.6	38.4	262.1	241.1	197	317	49	133
07/16/09	198.9	139.6	147.6	43.0	76.7	35.1	233.0	184.1	115	169	39	248
07/17/09	203.8	155.1	161.8	63.1	106.2	93.7	139.6	79.2	239	234	107	52
07/18/09	260.9	190.8	173.0	46.9	127.5	41.9	228.6	188.7	21	84	38	167
07/19/09	242.0	204.2	132.7	51.2	109.9	52.1	217.0	156.1	226	175	65	209
07/20/09	314.2	283.8	82.1	42.1	157.7	164.6	189.0	185.6	442	252	87	248
07/21/09			48.2	34.6	48.0	27.7	163.2	116.7		18	27	54
07/22/09	187.7	161.8	71.8	43.9	118.5	66.8	197.6	145.4	35	99	67	314
07/23/09	129.6	38.1							98			
07/24/09	237.4	255.3	183.6	56.4	244.4	221.3	178.9	97.8	218	200	19	88
07/25/09	126.4	56.5	211.7	126.8	87.2	43.3	92.7	60.2	72	139	25	28
07/26/09	185.2	52.3	174.8	53.3	94.1	36.9	107.2	54.1	16	27	8	16
07/27/09	186.6	77.7	168.7	57.2	102.5	38.4	249.3	196.1	24	60	38	82
07/28/09	237.5	170.7	140.4	68.6	98.6	58.5	180.5	84.4	83	161	172	120
07/29/09	390.7	374.1	242.0	175.6	61.5	61.1	162.9	69.2	50	72	16	21
07/30/09	229.7	89.0	152.2	52.7	182.8	58.1	209.2	159.3	41	67	64	284
07/31/09	247.5	167.6	215.7	132.9			268.6	219.8	152	69		333
08/01/09	276.4	256.0	180.8	120.2	152.4	119.5	216.0	153.2	359	552	133	247

08/02/09	303.1	209.1	207.6	104.9	257.9	213.2	237.1	168.2	181	157	77	88
08/03/09	289.2	267.8	178.2	106.7	154.1	90.1	230.3	175.3	192	424	78	323
08/04/09	252.2	188.7	228.5	128.2	235.0	153.0	190.0	130.0	111	70	39	74
08/05/09	234.0	226.9	178.2	51.2	84.1	48.5	261.6	242.3	46	24	68	749
08/06/09	210.4	169.2	203.0	126.3	196.2	167.2	245.8	196.6	757	190	448	440
08/07/09	201.3	147.1	116.9	57.0	98.0	51.8	246.4	223.1	362	498	201	730
08/08/09	248.7	202.4	149.3	83.2	198.5	161.8	279.5	238.7	892	738	365	483
08/09/09	269.7	242.5	225.1	159.4	92.6	75.9	160.0	101.3	1250	479	267	112
08/10/09	191.9	96.8	98.1	36.3	132.4	112.8	204.0	164.0	54	111	69	354
08/11/09	251.0	205.4	173.4	80.6	215.6	151.9	224.7	202.1	404	321	334	1269
08/12/09	247.1	189.9	145.1	48.8	209.2	166.3	415.8	407.5	1044	304	149	537
08/13/09					218.1	134.6	268.5	242.8			76	269
08/14/09	252.0	225.9	132.4	66.1	242.7	160.6	195.5	113.4	369	212	59	178
08/15/09	255.6	213.4	222.3	136.6	202.9	98.1	241.7	179.8	157	100	35	156
08/16/09	244.2	190.5	215.0	123.1	306.0	267.3	262.9	184.1	139	102	247	268
08/17/09	219.9	181.2	174.1	60.8					72	78		
08/18/09												
08/19/09			196.6	74.4			226.2	156.1		30	0	635
08/20/09	288.8	244.3	226.3	142.6	117.2	68.9	143.2	82.3	142	75	58	263
08/21/09	332.9	329.8	190.3	73.2	105.7	76.5	88.4	61.9	45	38	27	85
08/22/09	289.2	296.6	114.4	41.8	98.2	77.9	269.8	189.0	19	66	54	408
08/23/09	285.2	262.9	204.9	113.4	303.2	252.1	241.2	164.0	338	251	251	1045
08/24/09	279.9	228.0	213.1	175.1	227.6	193.4	247.4	197.8	475	476	158	1049
08/25/09	228.0	180.7	254.4	233.5	301.5	271.3			685	672	433	
08/26/09												
08/27/09			195.9	115.8	210.9	172.1	307.2	263.0		233	414	933
08/28/09	278.2	247.5	346.5	319.4	238.8	190.5	168.5	125.9	1119	911	492	553
08/29/09					167.6	47.5	183.3	122.2			40	157

08/30/09			193.5	65.8	265.7	271.6	208.0	160.6		80	36	256
08/31/09	211.1	172.2	135.6	65.1			263.6	228.6	280	133	0	262
09/01/09	225.0	182.6	227.1	187.8					553	150		
09/02/09			162.8	50.6	170.4	131.7	253.7	204.5		70	69	127
09/03/09	208.6	97.2	132.1	41.8	123.5	96.0	215.9	173.3	144	59	40	115
09/04/09	275.6	260.3	279.6	286.2	178.7	124.7	275.1	212.9	157	155	87	474
09/05/09	262.9	203.6	260.7	205.7	150.9	97.2	268.3	223.6	634	687	1266	625
09/06/09	206.1	165.2	388.2	347.8	173.5	133.8	211.2	168.6	806	169	130	321
09/07/09	249.1	226.3	243.1	177.4	143.9	105.5	258.1	222.7	154	105	61	252
09/08/09	197.1	88.4	129.3	61.3	206.1	146.6	222.4	173.4	77	160	74	362
09/09/09	334.0	322.2	164.3	59.4	143.9	87.3	184.2	139.6	257	71	78	155
09/10/09	178.1	69.2	97.0	42.5	90.1	42.2	178.9	137.2	57	23	18	23
09/11/09					204.9	320.0	117.3	86.0			22	17
09/12/09			211.3	43.6	291.6	171.3	440.0	451.4		12	19	248
09/13/09	364.8	357.8	155.8	81.8	175.7	148.6	215.4	130.1	17	107	142	559
09/14/09	235.7	204.2	242.8	217.3	239.3	244.1	234.5	181.7	455	878	171	361
09/15/09	269.8	256.0	184.2	116.7	92.0	75.0	289.9	225.9	284	369	733	356
09/16/09	178.9	146.3	238.1	250.4	241.6	107.1	251.6	194.5	801	428	44	
09/17/09	341.7	361.2	127.3	57.3	161.3	139.3	206.9	122.8		58	44	207
09/18/09	223.3	162.0	236.1	214.3	124.0	62.8	247.6	183.2	62	153	49	115
09/19/09	196.2	147.8	189.6	146.0	101.5	68.1	242.2	170.4	154	53	101	216
09/20/09	238.3	212.1	181.7	117.3	167.5	109.3	262.2	216.3	350	290	51	689
09/21/09	272.1	242.9	232.2	180.6	214.8	124.5	265.2	210.0	173	72	48	49
09/22/09	130.1	52.1	145.4	50.0	92.7	57.3	209.0	149.8	39	55	58	195
09/23/09	231.0	175.4	189.6	135.3	173.2	73.5	255.2	210.6	125	279	30	81
09/24/09	265.0	239.6	235.7	202.8	254.2	230.7	279.9	211.4	108	148	50	37
09/25/09	270.3	306.2	257.3	223.7	198.4	177.7	316.2	257.9	30	88	30	525
09/26/09	219.3	179.5	133.8	64.3	126.5	78.5	113.6	92.7	174	149	17	96

09/27/09					109.8	68.9	289.2	260.3	39	27	11	5
09/28/09	184.3	88.7	247.1	218.2	203.5	130.0			5	12		18
09/29/09	313.1	296.0	223.9	169.2	122.9	54.3	264.2	249.0	32	34	24	38
09/30/09	196.1	116.4	160.1	57.3	155.8	130.3	257.1	164.4	5	6	9	21
10/01/09	140.6	57.9	106.5	44.7	160.1	144.8	239.9	197.2	29	59		793
10/02/09	118.8	50.0	134.7	61.6	130.1	123.7	111.4	89.0	121	130	123	723
10/03/09									123	98	14	
10/04/09									66	36	19	46
10/05/09			316.4	337.9	240.3	231.5	220.6	138.1	40	20	14	24
10/06/09	163.8	71.5	139.8	57.3	215.7	183.2	256.8	189.9			30	82
10/07/09			113.0	48.2	214.7	190.2	224.2	171.8	20	36	25	307
10/08/09	117.5	55.3	138.1	88.1	231.0	194.8	236.9	171.3	71	54	44	146
10/09/09	262.3	233.5	261.7	221.3	191.1	104.1	213.4	154.4	188	712	122	936
10/10/09	299.1	265.5	114.1	55.9	246.5	215.2	266.3	176.2	132	97	34	128
10/11/09	162.5	86.3	124.0	56.7	173.9	135.3	229.7	160.6	105	148	79	99
10/12/09	128.2	51.1	137.7	75.0	141.5	111.3	149.0	92.7	28	160	75	522
10/13/09	123.6	48.9	94.7	44.8	87.2	52.4	345.9	325.5	236	166	61	73
10/14/09	108.0	55.5	131.0	56.7	166.0	133.2	196.9	118.3	122	185		
10/15/09	161.6	114.5							45	29	11	58
10/16/09			88.6	47.5	114.5	55.0	236.9	198.0	73	152	66	633
10/17/09	77.3	41.5	107.4	45.7	115.8	45.3			79	35	23	151
10/18/09							218.8	134.1	76	78	83	585
10/19/09	72.7	43.6	91.6	44.7	118.7	51.5	262.0	151.2	115	78	37	142
10/20/09	113.0	77.7	113.2	45.7	223.6	191.4	230.6	160.6	50	96	85	32
10/21/09	89.0	53.6	117.2	45.1	147.3	97.1	248.8	182.3	16	40		
10/22/09	147.3	46.9	202.9	53.6	87.3	38.1	210.8	138.5		60	148	324
10/23/09			131.4	45.4	122.6	94.5	113.6	89.9	45	32	28	984
10/24/09	63.3	40.7							479	146		667

10/25/09	81.3	49.1	116.0	47.2	112.8	59.6	293.4	210.0	37	32	43	8
10/26/09	105.2	58.2	174.6	68.3	148.7	84.9	245.8	156.4	13	22	10	9
10/27/09	56.5	39.6	46.1	38.3					10		14	
10/28/09			37.3	34.1			121.6	58.5			15	1315
10/29/09	55.8	38.7	91.2	39.6	88.8	47.9	347.2	286.2	156	165	132	1299
10/30/09	78.4	64.0	57.1	40.2	68.1	45.1	96.1	61.9	72	83		
10/31/09	35.2	32.9	42.6	36.6	41.8	37.8						
11/01/09											235	254
11/02/09			65.7	38.4	40.6	35.7	178.8	124.5	360	230	135	202
11/03/09	77.6	57.0	102.3	49.5	85.2	52.0	214.3	139.6	80	98	136	30
11/04/09	51.1	47.9	91.8	46.9	77.3	57.0	183.7	120.1		13	45	
11/05/09	70.6	60.7	54.5	36.0	73.9	50.9	190.0	124.1		85	97	68
11/06/09	58.1	42.8	104.8	48.2	73.8	44.2	274.1	201.5	346	124	72	258
11/07/09	126.1	90.2	102.5	66.4	84.8	49.1	102.2	60.4	147	141		58
11/08/09	43.0	38.9	67.4	39.6	76.6	40.8	245.9	164.6				42
11/09/09	112.9	49.8	71.1	39.0	61.9	43.1	177.0	82.1	40	24	23	23
11/10/09	50.4	40.2	101.2	42.7	81.2	51.5	223.1	125.6	33	60	48	82
11/11/09	79.1	47.5	96.5	50.9	57.9	37.3	117.5	62.8	84	82	31	77
11/12/09							57.3	43.6	54	41	30	50
11/13/09	41.4	40.2							37	32	37	40
11/14/09					38.0	35.1	51.4	37.8	64	51	23	15
11/15/09	34.8	33.7	39.5	27.4	37.3	27.7	252.4	168.6	45	41	17	19
11/16/09	58.5	46.8	73.7	46.6	71.4	47.5	292.5	220.1		42	10	
11/17/09	59.3	43.9	65.0	42.7	104.0	52.4	181.5	116.4		28		
11/18/09	141.7	64.9	62.8	45.7	44.2	39.9	170.2	95.6				
11/19/09	63.7	56.1	45.5	41.1	47.1	45.1	111.4	66.0		249	216	88
11/20/09	41.0	38.4	53.0	38.7	61.0	46.0	183.8	133.8	20	1	53	55
11/21/09	54.6	46.3	70.3	48.8	68.4	46.2	224.0	160.3	316	185	124	34

11/22/09	56.9	45.4	61.6	43.0	122.6	41.5	164.4	122.8	70	59	58	13
11/23/09									25	34	48	28
11/24/09	47.4	43.3	42.6	38.1	44.1	36.9	118.5	82.3	153	181	42	113
11/25/09	70.9	41.8	62.2	42.2	38.3	41.8	80.4	27.1	120	129	45	11
11/26/09	58.2	55.5	48.9	45.0	53.6	49.7					54	25
11/27/09									54	35	38	34
11/28/09	40.6	40.5	47.7	37.2	57.6	41.1	118.9	72.1	130	130	53	44
11/29/09	37.3	36.3	82.7	50.6	51.6	40.5	92.5	52.0	74	85	47	15
11/30/09	37.9	33.2	43.0	39.5					85	84	18	11
12/01/09	55.5	47.5	99.8	58.8	67.8	49.4	185.4	112.5	11			
12/02/09	41.2	37.8	53.8	37.8	63.1	52.1			55			
12/03/09	#REF!	#REF!	38.8	36.0	40.9	39.8	158.5	83.8				
07/06/10	268.3	221.3	175.3	95.4					947	491		
07/07/10												
07/08/10												
07/09/10							88.4	56.1				55
07/10/10	52.4	40.2			42.2	30.8	140.8	111.7	59		173	193
07/11/10	165.5	70.1	92.8	55.2	87.7	25.3	147.4	77.1	159	286	35	115
07/12/10	107.0	38.7	96.1	37.8	111.2	39.8	88.9	50.6	80	56	28	89
07/13/10	146.9	38.6	49.3	39.0	66.9	38.3	130.6	72.5	50	146	30	68
07/14/10	93.9	43.6	78.4	40.8	86.5	36.9	127.2	68.0	44	87	32	52
07/15/10	143.8	90.2	93.2	34.4	71.0	42.1	147.0	98.8	29	68	54	152
07/16/10	116.8	86.3	102.3	36.3	73.5	31.7	166.3	82.3	61	109	49	108
07/17/10	169.1	110.9	111.5	52.1	57.6	25.9	214.1	160.9	240	283	43	113
07/18/10	239.1	225.4	145.3	57.9	237.9	203.6	207.5	173.3	286	128	75	314
07/19/10	198.3	163.2	138.4	60.7	124.7	85.2	157.4	97.8	238	206	36	181
07/20/10	201.5	125.3	147.1	109.4	128.8	59.1	192.1	132.3	182	562	81	172
07/21/10	239.9	205.1	148.3	65.4			145.3	97.2	313	169		120

07/22/10	152.2	98.5	128.2	51.7	139.7	53.9	193.2	139.8	135	85	85	241
07/23/10	228.6	204.2			66.7	60.0	122.9	69.8	687		45	82
07/24/10	215.8	177.2	137.9	110.9	109.7	58.2	158.6	86.6	72	670	93	105
07/25/10	173.7	117.7	115.0	59.1	164.3	49.8	182.7	140.8	157	176	34	247
07/26/10	256.3	207.9	127.4	57.6	107.3	58.1	161.6	105.2	337	178	92	194
07/27/10	183.7	135.5	125.5	59.1	114.2	36.0	223.5	174.3	238	243	69	145
07/28/10	212.0	180.1	142.9	48.9	116.1	86.0	110.0	79.6	91	127	56	53
07/29/10	151.1	97.2	171.2	72.5	145.0	56.4	229.1	197.8	114	66	71	389
07/30/10	230.3	206.0	186.9	149.0	159.0	118.3	190.2	145.1	933	455	43	285
07/31/10	201.2	156.1	108.6	59.6	63.1	28.7	157.8	128.6	243	264	70	240
08/01/10	132.0	83.5	104.5	54.7	92.2	44.2	144.4	97.8	121	61	29	87
08/02/10	239.5	230.1	93.1	38.7	179.7	100.0	180.0	134.7	96	37	32	97
08/03/10	190.4	132.9	144.5	47.9	92.1	36.1	108.1	89.0	63	37	22	73
08/04/10	158.7	66.0	127.6	45.7	62.5	31.5	124.9	84.7	86	95	26	138
08/05/10	268.3	280.1	139.6	47.9	150.1	100.0	194.1	156.5	53	42	92	348
08/06/10	226.3	176.5	172.5	101.2	245.6	231.6	152.6	113.1	123	401	533	349
08/07/10	172.7	149.4	234.5	178.0	100.1	38.7	189.9	132.9	588	285	82	242
08/08/10	208.3	174.7	139.3	63.6	118.3	44.5	111.5	83.2	255	82	63	119
08/09/10	206.0	61.9	174.2	64.0	205.6	120.4	195.9	118.9	33	49	49	151
08/10/10	176.3	107.7	128.2	71.3	96.6	78.3	180.1	121.5	144	117	116	413
08/11/10	210.8	169.8	263.4	256.3	158.2	125.7	204.2	148.4	281	394	116	263
08/12/10	223.3	181.1	168.5	96.3	133.0	105.2	133.9	93.3	361	116	75	82
08/13/10	229.4	196.0	109.5	44.5	94.9	30.8	107.7	74.7	154	61	31	65
08/14/10	177.7	65.5	72.1	37.9	79.2	32.9	132.9	88.4	80	51	56	67
08/15/10	106.0	40.7	76.4	32.9	354.4	150.0	124.2	65.7	56	34	78	31
08/16/10	179.8	140.5	166.9	97.8	254.8	263.7	120.4	82.9	140	102	173	81
08/17/10	232.3	202.5	185.0	118.3	125.7	102.6	193.1	137.2	95	118	194	439
08/18/10	256.8	231.6	222.5	178.6	221.5	193.5	207.7	159.4	690	244	792	576

08/19/10	224.6	194.8	209.5	119.2	130.5	66.4	227.0	164.3	485	219	144	303
08/20/10	188.7	155.4	219.3	169.8	114.2	56.4	207.3	162.5	205	372	203	393
08/21/10	190.7	172.8	193.8	130.5	104.4	68.6	126.1	83.8	1572	168	136	97
08/22/10	192.1	159.4			245.1	282.4			226		52	
08/23/10	44.3	31.7							14			
08/24/10												
08/25/10			114.4	47.9	145.9	78.9	247.9	223.6		56	58	325
08/26/10	118.4	52.7	131.2	71.3	158.8	126.3	210.3	153.0	125	106	182	392
08/27/10	215.2	196.6	193.3	130.1	87.8	52.0	226.7	187.1	573	206	60	556
08/28/10	255.5	218.5	198.3	173.4	94.2	50.6	211.3	167.0	719	518	67	268
08/29/10	228.8	165.8	235.4	174.8	152.6	134.6	196.6	152.4	208	268	156	364
08/30/10	170.4	148.3	225.1	182.9	142.5	143.1	198.1	148.1	942	688	560	386
08/31/10	322.2	291.8	215.6	165.2	158.6	99.1	197.3	151.2	1910	320	206	477
09/01/10	279.5	252.4	206.4	143.9	240.8	213.4	197.2	143.0	1785	404	119	336
09/02/10	209.8	186.7	273.4	258.3					232	359		
09/03/10												
09/04/10												
09/05/10												
09/06/10												
09/07/10												
09/08/10												
09/09/10												
09/10/10												
09/11/10					173.9	143.9	234.7	148.4			229	263
09/12/10	198.4	145.5	192.5	144.8	127.0	65.5	150.5	120.4	144	120	55	157
09/13/10	246.9	232.0	188.6	125.9	128.7	59.4	174.0	121.6	124	120	107	223
09/14/10	229.9	210.3	227.6	184.4	136.6	111.1	204.3	153.3	331	248	706	564
09/16/10	211.2	183.5	154.6	119.8	121.3	79.7			245	946	306	

09/17/10			137.2	74.7	135.7	99.4	204.1	153.5		171	124	407
09/18/10	170.7	92.0	167.6	95.1	66.5	34.6	181.4	126.9	125	191	68	379
09/19/10	152.9	110.6	172.6	96.2	217.1	148.4	189.1	150.6	26	135	178	466
09/20/10	213.8	196.3	224.4	157.1	70.1	38.1	291.1	250.2	125	433	380	678
09/21/10	287.0	209.1	168.6	100.3	67.7	32.9	184.2	130.8	82	165	83	102
09/22/10	203.7	192.9	185.7	178.6	144.0	39.0	161.5	119.2	39	680	81	398
09/23/10	241.4	223.6	252.2	259.1	146.2	89.2	171.2	135.3	125	443	164	621
09/24/10	191.8	121.3	219.3	212.1	134.1	106.2	148.6	134.7	108	116	92	526
09/25/10	177.4	167.0	153.7	123.4	136.8	81.1	228.5	197.5	30	452	169	1417
09/26/10	209.6	191.1	245.9	249.3	107.3	90.5	162.7	128.0	174	437	121	348
09/27/10	149.2	31.7	250.1	269.1	113.2	106.1	97.7	85.6	39	36	238	112
09/28/10	37.9	22.9	58.2	25.1			181.2	88.1	5	41		82
09/29/10	207.3	67.4	190.5	146.2	183.3	168.7	200.7	177.4	32	117	166	414
09/30/10	50.0	30.2	25.4	24.1	22.8	24.1	37.4	34.7	5	32	26	58
10/01/10	30.9	27.1					252.1	161.2	29			860
10/02/10	281.3	259.7	218.9	141.4	196.1	157.6	228.0	172.8	121	131	108	824
10/03/10	206.8	166.6	154.4	113.7	91.7	43.0			123	97	39	
10/04/10	58.2	28.3	72.5	31.7	27.6	22.3	86.7	48.5	66	28	16	32
10/05/10	60.9	35.1	44.3	27.1	53.0	28.8	114.7	80.5	40	42	134	120
10/06/10					86.1	32.6	197.0	127.7			80	167
10/07/10	87.8	29.3	119.7	40.4	63.3	30.5	169.9	78.0	20	72	69	375
10/08/10	138.5	46.9	137.1	77.4	123.6	39.6	176.7	125.9	71	84	55	266
10/09/10	157.0	73.5	185.7	132.6	98.3	43.0	214.0	125.9	188	381	161	1102
10/10/10	192.4	96.9	132.6	60.0	47.1	29.3	185.7	126.5	132	127	120	195
10/11/10	148.5	41.1	115.3	54.1	108.7	40.2	225.0	175.3	105	146	181	216
10/12/10	90.1	36.6	102.2	52.4	103.0	38.7	237.2	160.8	28	229	154	702
10/13/10	112.9	52.7	214.5	122.5	57.4	36.3	147.9	79.9	236	220	180	249
10/14/10	113.2	69.6	111.7	52.6					122	174		

10/15/10	44.5	32.9	45.1	27.1	43.6	24.8	119.4	51.2	45	37	25	50
10/16/10	60.4	34.1	57.4	31.4	40.9	29.4	192.6	87.2	73	96	92	629
10/17/10	96.5	37.8	63.8	29.0	43.6	29.6	146.2	71.5	79	52	69	203
10/18/10	52.6	33.5	82.8	35.1	56.8	32.0	190.4	113.4	76	100	133	632
10/19/10	89.1	43.9	77.6	36.0	48.4	36.0	172.8	96.0	115	145	175	306
10/20/10	72.4	57.2	55.1	32.3	53.2	36.0	113.8	74.1	50	127	169	103
10/21/10	48.0	36.3	41.1	26.2					16	84		
10/22/10			57.6	32.0	52.6	36.3	120.3	69.0		37	135	312
10/23/10	30.8	27.7	57.4	30.5	37.6	32.3	213.1	147.5	45	57	165	1256
10/24/10	114.1	64.3	61.6	28.3			155.9	104.9	479	148		1027
10/25/10	58.1	41.1	40.8	25.9	47.5	46.8	72.1	38.4	37	151	204	49
10/26/10	28.3	25.3	35.8	23.5	22.5	19.2	66.3	36.9	13	73	47	35
10/27/10	36.6	21.9			38.7	29.1	0.0	0.0	10		36	
10/28/10					65.4	40.8	259.5	185.3			51	1552
10/29/10	110.2	52.6	144.6	42.4	55.8	39.3	160.3	81.7	156	244	580	1456
10/30/10	55.0	31.5	109.3	46.9					72	116		
10/31/10												
11/01/10					48.9	30.9	254.0	106.5			220	264
11/02/10	123.2	36.4	122.6	38.7	36.1	28.7	211.9	115.5	360	123	159	240
11/03/10	72.3	53.6	103.7	44.7	83.9	53.2	77.5	51.5	80	166	292	38
11/04/10			21.6	22.1	27.5	23.8	0.0	0.0		48	101	
11/05/10			71.2	28.7	51.1	30.2	160.4	84.1		171	195	48
11/06/10	46.9	37.2	57.3	35.1	44.4	36.6	267.1	159.4	346	162	248	303
11/07/10	66.0	38.9	68.4	34.4					147	118		
11/08/10												
11/09/10	50.6	32.5	58.6	29.1	39.7	25.9	128.8	58.2	40	45	110	37
11/10/10	57.1	30.6	118.4	45.1	184.6	32.9	317.2	243.5	33	56	64	68
11/11/10	101.7	40.8	152.2	53.0	88.9	32.5	293.8	200.6	84	58	72	62

11/12/10	72.2	32.5	81.1	26.1	49.1	25.9	188.9	90.4	54	41	57	31
11/13/10	54.8	35.1	62.3	27.1	33.4	26.8	232.2	152.4	37	41	83	50
11/14/10	50.3	31.1	41.8	29.3	28.0	24.7	120.5	68.0	64	64	43	10
11/15/10	44.5	34.9	31.1	28.8	36.6	35.4	121.2	66.9	45	62	86	20
11/16/10			32.4	27.7	37.1	32.9				52	67	
11/17/10			37.9	27.7						44		
11/18/10												
11/19/10			113.4	70.1	58.0	30.8	236.7	167.3		107	121	80
11/20/10	29.6	22.6	22.9	21.3	46.8	32.8	168.7	95.1	20	10	20	29
11/21/10	94.2	60.0	119.4	86.6	169.4	124.2	132.5	87.8	316	56	114	14
11/22/10	31.4	27.4	42.9	30.5	41.8	38.4	172.7	70.3	70	31	75	6
11/23/10	28.7	20.1	69.9	24.5	33.4	33.8	150.1	86.4	25	33	25	19
11/24/10	45.3	35.1	39.4	29.9	40.9	26.4	235.0	113.5	153	106	102	89
11/25/10	50.6	30.2	46.0	25.3	30.8	28.0			120	57	59	
11/26/10					37.6	31.4	128.5	97.2			67	19
11/27/10	27.2	26.7	37.7	26.5	34.0	28.7	110.7	60.4	54	41	67	26
11/28/10	63.2	34.7	94.8	42.1	35.2	32.9	276.8	187.9	130	58	94	42
11/29/10	46.3	34.1	70.7	27.3	38.8	29.6	75.5	17.1	74	83	101	15
11/30/10	31.8	26.8	48.8	32.9	32.8	32.2	72.8	53.9	85	40	48	12
12/01/10	30.0	27.7							11			
12/02/10	45.9	36.3							55			
12/03/10												
12/04/10												
12/05/10			69.8	43.7	40.8	28.7	86.4	54.9		41	63	11
12/06/10					34.1	28.0	53.5	43.9			50	5
12/07/10	28.2	26.2	35.7	25.6	60.5	34.9	87.7	53.3	32	63	36	9
12/08/10	0.0	0.0	71.1	38.6	47.4	32.3	150.1	88.5		66	67	11
12/09/10	30.8	28.3	52.5	28.7	46.9	30.5	167.0	107.6	129	28	45	19

12/10/10	94.2	46.2	44.4	18.3	35.7	33.8	0.0	0.0	292	76	51	
12/11/10	27.5	27.1	67.6	37.8	44.6	43.6	106.9	78.0	36	35	51	12
12/12/10	68.0	68.0										
12/13/10					36.6	32.3	103.5	69.0			27	3
12/14/10			74.1	40.7	64.7	39.8	90.7	58.2		37	60	9
12/15/10	37.4	28.3	42.2	29.6	36.2	28.0	202.7	75.7	63	30	71	9
12/16/10	65.4	48.9	95.6	55.2	66.7	42.1	111.2	72.2	182	68	71	24
12/16/10	32.5	28.8	124.7	69.5	121.5	50.7	152.5	80.9	65	44	56	6
12/17/10	34.7	33.8	72.4	33.4	50.3	40.7	228.3	150.3	82	23	38	26
12/17/10	46.3	39.3	68.7	43.9	54.2	40.7	192.5	123.4	84	33	72	21
12/18/10	62.4	42.4	86.1	59.7	40.9	33.2	194.4	113.7	71	36	53	13
12/18/10	30.8	30.5	92.8	33.7	36.3	32.6	133.6	58.2	113	58	45	6
12/19/10	35.6	34.9					103.9	80.3	102			4
12/19/10	63.6	53.6							74			
12/20/10												
12/20/10	40.0	32.3							57			
12/21/10			34.6	25.9	37.2	32.3	187.7	67.8		45	88	7
12/21/10												
12/22/10	39.4	33.2	53.6	34.7	40.0	29.9	90.6	70.1	91	55	74	2
12/22/10												
12/23/10			28.0	23.5	28.7	27.6	167.1	65.2		51	90	7
12/23/10												
12/24/10	49.2	36.3	65.0	42.7	38.5	36.0	229.0	139.4	129	43	61	10
12/24/10												
12/25/10												
12/25/10	40.1	33.2	48.8	24.1	35.1	32.3			123	65	37	
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02/05/11					52.8	36.6	44.3	29.0			26	6
02/05/11												
02/06/11	49.1	39.3	45.4	36.0	50.5	44.8	103.4	52.0	15	16	4	3
02/06/11												

02/07/11	41.4	39.9	58.4	41.5					25	40		
02/07/11												
02/08/11					33.3	33.1	112.2	63.4			20	2
02/08/11												
02/09/11	36.3	36.0	68.8	36.6	35.4	36.9	69.5	67.2	45	37	15	2
02/09/11												
02/10/11												
02/10/11												
02/11/11			44.2	36.3	45.9	37.2	63.0	52.1		50	40	5
02/11/11												
02/12/11	42.4	42.5	48.7	33.2	39.3	37.2	64.5	51.2	78	33	37	3
02/12/11												
02/13/11	39.6	37.9	46.6	35.1	33.5	31.7	131.4	60.0	56	27	23	2
02/13/11												
02/14/11	37.4	37.8	42.0	36.0	38.2	35.7	64.9	47.5	49	49	31	3
02/14/11												
02/15/11	36.1	27.4	39.2	30.8	47.8	35.8			27	30	22	
02/15/11												
02/16/11			387.8	384.8			632.2	690.4		183		21
02/16/11												
02/17/11	42.2	35.7	39.0	29.6	78.8	74.5			53	43	13	
02/17/11												
02/18/11	46.2	41.3	39.5	32.0	54.4	40.4	74.8	51.4	42	45	20	3
02/18/11												
02/19/11	39.8	34.4	34.5	31.1	86.2	37.5	76.9	57.6	56	45	21	3
02/19/11												
02/20/11	40.6	40.8	42.1	32.6	41.1	36.6	75.8	64.9	43	50	42	3
02/20/11												

02/21/11	42.7	37.6	55.3	39.0	42.7	38.7	132.8	78.9	28	64	41	2
02/21/11												
02/22/11	88.1	43.6	61.9	38.1	30.8	30.9	64.5	24.4	31	56	30	4
02/22/11												
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02/26/11												
02/27/11	43.7	39.0	349.1	276.8	44.9	39.3	51.1	25.3	21	170	14	5
02/27/11												
02/28/11							107.0	53.0				4
02/28/11	39.1	39.9	49.8	35.4	65.2	44.8	85.8	38.4	21	43	24	3
03/01/11			41.5	35.4	36.9	36.3	512.2	546.8		35	22	78
03/01/11	53.8	39.2	86.5	44.2	26.6	24.4	204.0	143.6	64	46	21	11
03/02/11	79.3	54.3	50.6	38.4	25.4	24.7	76.6	50.9	22	46	17	7
03/02/11	82.3	46.9	38.6	30.6					17	36		
03/03/11					54.1	24.7	70.3	14.5			27	10
03/03/11					51.7	36.0	140.5	77.7			31	6
03/04/11	33.0	27.1	39.8	24.7	109.8	73.5	68.6	68.3	45	58	18	2
03/04/11												
03/05/11			55.6	30.8	36.5	33.5	85.0	65.2		26	11	6
03/05/11	65.0	29.9	33.6	26.4	65.4	65.2	66.3	46.6	39	50	35	4
03/06/11	49.1	46.9	75.4	52.4	71.2	66.8	101.1	70.3	17	46	23	9
03/06/11	36.2	25.8	34.3	29.0	20.4	17.4			26	51	9	

03/07/11	52.1	42.5	60.0	44.2	50.5	46.3	139.2	78.0	34	50	26	11
03/07/11			42.7	31.7	58.7	52.7	68.4	56.7		47	15	9
03/08/11	44.9	36.0	49.2	36.3	66.6	37.9	93.6	69.2	30	44	22	13
03/08/11	43.6	29.6	34.3	23.5	25.7	23.3	57.9	51.4	57	47	18	8
03/09/11	30.6	27.1	29.6	23.2	30.9	32.6	295.0	296.3	39	52	15	40
03/09/11	48.6	42.5	58.7	43.9	41.9	29.7	119.5	66.4	40	55	26	18
03/10/11	49.6	45.7	61.7	36.6	97.4	56.4	133.9	60.4	29	30	17	10
03/10/11	50.5	36.1	31.6	25.3			35.0	35.4	26	53		1
03/11/11	21.2	19.7			26.8	19.8	248.3	195.4	9		7	32
03/11/11	71.7	39.8	44.2	33.5	62.7	62.6	65.4	71.0	28	33	30	4
03/12/11	58.2	32.6	81.6	33.5	172.3	32.6	254.8	156.7	78	60	7	37
03/12/11	48.3	44.8	35.2	33.5					34	29		
03/13/11	36.9	26.2	48.2	29.6	32.8	28.2	77.8	64.2	47	48	20	22
03/13/11												
03/14/11	33.8	25.1	53.6	29.6	66.5	73.8	78.5	72.8	46	45	19	10
03/14/11	87.8	44.8	104.6	37.6	43.4	47.7			23	20	9	
03/15/11	69.1	39.3	38.8	24.1	29.3	16.2	75.3	74.8	35	60	13	12
03/15/11			133.5	36.3	41.5	43.7	67.1	52.6		19	23	6
03/16/11	31.8	5.6			30.6	11.3	116.4	71.0	26		11	13
03/17/11	52.0	18.9	91.0	37.8	72.9	50.3	145.0	116.6	27	34	37	62
03/18/11	103.9	31.1	55.3	31.4	21.3	14.5	85.5	42.8	18	30	28	28
03/19/11	88.1	24.5	85.0	35.4	22.0	21.6	113.6	54.9	68	60	15	14
03/20/11	158.1	96.3	42.6	21.3	78.4	36.4	116.3	77.1	42	23	14	20
03/21/11	17.8	13.4			90.8	13.4	146.7	40.5	23		10	7
03/22/11	13.5	9.8	194.3	48.8	52.9	36.3	90.9	59.9	13	78	7	7
03/23/11	90.3	86.9	51.1	25.0					23	16		
03/24/11			46.1	22.6	317.1	317.1	76.4	32.5		25	3	6
03/25/11	104.5	6.7	95.0	54.4	109.1	55.9	114.0	60.7	22	32	62	19

03/26/11	29.8	14.8	69.3	32.6	16.8	12.2	77.6	36.1	30	48	71	8
03/27/11	89.8	13.7	57.8	28.3	15.7	10.4	41.2	19.5	33	48	70	9
03/28/11	36.4	12.5	50.5	24.1	16.0	14.5	48.8	32.2	30	41	30	11
03/29/11	33.9	15.5	57.0	21.9	22.9	12.5	90.3	49.1	43	43	50	19
03/30/11	67.3	18.3	49.7	21.9	46.1	37.3	130.1	89.0	58	70	52	20
03/31/11	10.9	7.0							20			
04/01/11			28.2	10.7			116.1	116.3		29		31
04/02/11	21.4	21.0	47.2	29.6	22.6	17.4	111.8	87.8	32	66	45	57
04/03/11	27.7	11.4	36.8	23.8	15.0	10.1	170.8	56.7	34	40	18	24
04/04/11			58.8	28.3	21.8	10.4	259.4	341.4		56	33	61
04/05/11			29.3	5.2	11.5	6.4	43.1	11.3	0	1	43	39
04/06/11	32.6	14.0	64.1	32.6	32.5	18.0			46	27	27	
04/07/11			38.6	20.7	50.0	19.2	160.7	106.4		33	13	54
04/08/11	126.3	54.3	62.9	23.8	27.2	25.3	123.6	73.2	42	39	13	10
04/09/11	292.6	321.9	86.9	28.7	27.9	33.5	136.3	98.8	27	33	4	109
04/10/11	299.6	281.3	88.8	29.3	114.1	34.7	387.8	404.8	27	30	30	134
04/11/11	424.5	410.1	458.8	468.0	107.7	5.9	257.7	231.0	812	154	12	175
04/12/11	65.0	25.3	182.7	30.5					78	45		
04/13/11					691.6	691.6	405.6	451.7			2	31
04/14/11	42.5	29.4	93.4	51.4	97.8	31.4	204.8	139.3	78	109	32	57
04/15/11	52.0	16.8	49.5	29.9	28.8	16.2	181.5	109.4	46	33	11	6
04/16/11	29.1	29.0	35.0	28.3					44	28		
04/17/11	323.6	330.9	79.9	55.5	108.2	53.3	199.4	164.7	158	125	59	126
04/18/11	31.3	15.2	85.0	30.2			288.4	228.8	51	39		40
04/19/11	133.8	60.0	149.2	44.3	191.4	43.0	430.1	473.7	62	61	20	23
04/20/11	500.1	528.8	411.0	480.4	42.4	13.0	277.5	253.6	70	72	18	91
04/21/11	43.4	23.8	52.8	34.3	26.1	13.1	90.6	52.7	109	66	82	30
04/22/11	73.7	31.7	47.5	20.9	45.6	30.5			39	32	34	

04/23/11					17.4	4.1	395.0	395.5			4	439
04/24/11	391.2	374.3	143.6	31.4			415.8	435.6	657	55		209
04/25/11	432.8	439.2	378.2	391.8	46.9	46.9	446.1	442.9	147	75	2	41
04/26/11	478.7	483.4	136.4	21.3	57.0	46.9	332.1	357.4	194	71	89	32
04/27/11	353.9	389.2	52.6	28.7	72.8	51.8	97.2	13.7	85	42	22	4
04/28/11			15.9	7.8						20		
04/29/11	335.8	319.7	106.1	15.5	86.1	49.7	113.8	61.7	53	72	55	93
04/30/11	53.1	11.9	71.1	28.3	30.3	19.5	185.1	112.2	61	58	39	68
05/01/11	117.1	27.1	52.0	18.3	66.5	20.4	164.2	90.2	81	54	25	50
05/02/11	143.4	63.9	92.1	24.4	115.4	37.2	265.1	237.0	46	88	78	183
05/03/11	255.5	251.3	125.2	19.7	73.3	19.2	298.8	266.9	128	84	37	79
05/04/11	230.5	74.1	211.3	59.0			87.2	48.3	252	55		43
05/05/11	43.3	41.1	40.1	17.4	15.8	10.2	145.1	81.7	198	76	44	92
05/06/11	72.7	43.9	148.8	51.8	53.3	39.6	261.4	203.6	190	118	18	67
05/07/11	180.9	51.5	216.7	72.7	157.7	30.2	199.3	130.0	73	90	34	209
05/08/11	182.8	92.5	56.2	19.5	30.1	11.1	219.6	180.7	88	70	20	171
05/09/11	112.9	21.0	39.6	14.0	111.2	9.4	145.7	64.9	96	43	15	45
05/10/11	67.8	12.8	101.8	15.8	12.6	10.4			41	13	6	
05/11/11			25.0	8.5	3.0	3.0	129.8	56.4		10	2	51
05/12/11	44.0	17.4	32.9	16.8	3.0	3.0	97.5	44.5	107	36	1	203
05/13/11	119.8	24.4	43.0	15.1	28.7	23.2	218.2	155.8	55	49	19	189
05/14/11	69.0	21.3	44.2	17.4					87	66		
05/15/11	190.2	10.7	45.3	11.9	21.6	24.2	213.7	130.5	23	28	8	59
05/16/11	94.6	14.5	42.7	17.1	5.0	4.9	127.1	8.5	32	21	10	9
05/17/11			16.8	8.8						23		
05/18/11			133.1	12.0	66.9	4.3				8	9	
05/19/11	35.0	13.1	213.9	64.6	150.9	26.8	240.4	193.9	13	26	5	88
05/20/11	118.1	61.3	125.9	25.6	114.2	61.0	174.2	134.3	16	20	14	95

05/21/11	489.8	491.8	122.7	14.6	434.6	445.3	256.8	74.5	26	24	7	24
05/22/11	35.7	13.7	38.3	17.4	29.7	12.8	117.4	33.1	102	47	8	15
05/23/11			55.3	18.3			322.7	264.3		13		78
05/24/11	384.7	401.1	244.4	146.3	226.7	151.8	290.1	188.4	150	157	86	446
05/25/11	293.3	125.6	100.4	21.3	93.5	80.8	197.9	96.0	103	82	63	49
05/26/11	189.8	40.8	204.2	89.0	209.8	135.6	447.6	452.9	90	23	20	134
05/27/11	416.0	438.9	158.5	47.5	35.9	19.4	191.1	113.7	389	362	12	25
05/28/11	48.4	12.0	77.1	16.5	70.9	25.5	340.9	319.1	30	20	8	11
05/29/11	168.2	140.5	83.3	14.0	100.1	14.9	344.7	315.8	9	16	13	83
05/30/11	519.4	537.4	184.2	38.4	103.1	34.7	203.6	112.2	359	218	73	221
05/31/11	394.7	476.1	211.1	107.3	232.3	79.4	183.2	94.2	123	54	6	28
06/01/11	366.3	333.1	304.4	292.6			313.1	321.6	31	36		129
06/02/11	118.6	60.5	78.1	36.6	26.7	12.5	218.2	145.8	40	56	5	58
06/03/11	41.1	19.5	112.5	68.3	36.8	15.5	296.7	183.2	9	183	23	40
06/04/11	203.7	72.2	111.6	36.3	15.5	15.5	223.6	124.1	42	61	2	15
06/05/11	112.4	34.9	111.8	18.0	26.1	10.1	314.7	272.8	14	26	25	62
06/06/11	179.4	11.6	119.3	34.1	82.9	36.6	228.9	176.0	38	68	38	80
06/07/11	48.5	37.5	62.2	29.6	133.5	78.3	238.1	164.0	353	168	23	130
06/08/11	42.6	14.3	108.6	27.9	140.3	37.0	201.3	157.9	222	100	18	105
06/09/11	52.9	10.8							84			
06/10/11												
06/11/11												
06/12/11												
06/13/11												
06/14/11												
06/15/11							479.3	495.0				462
06/16/11	93.3	31.1	82.5	59.7	62.1	43.3	187.5	122.8	58	405	35	30
06/17/11	245.9	93.3					233.1	180.4	5			25

06/18/11	327.8	337.6	85.1	54.9	62.8	59.7	134.1	99.2	42	168	65	94
06/19/11	131.7	68.3	120.1	27.3	119.7	47.5	367.3	367.3	63	60	15	153
06/20/11	269.7	207.3	137.1	53.6	145.6	108.5	185.4	128.0	43	118	27	106
06/21/11	189.1	44.2	76.7	25.6	71.8	74.8	212.9	236.7	73	156	74	62
06/22/11	115.6	70.4	80.0	55.5	206.4	165.2	266.9	240.5	169	498	43	158
06/23/11	350.3	354.5	226.7	91.6	609.5	656.5	415.3	434.2	115	126	125	90
06/24/11	419.6	413.8	168.5	71.3	234.1	91.7	456.3	470.3	50	210	35	53
06/25/11	528.5	549.2	244.3	75.0	100.9	26.8	358.7	376.4	119	221	141	88
06/26/11	398.8	397.8	153.4	57.6	42.9	27.4	164.2	129.5	98	337	379	306
06/27/11	280.7	253.6	139.6	54.3	89.5	58.1	175.7	104.7	159	344	492	88
06/28/11	242.1	106.4	204.6	117.7	176.8	129.5	330.3	297.9	229	226	43	41
06/29/11			107.3	39.0	111.5	41.5	194.8	145.1		340	11	509
06/30/11												
07/19/11	279.4	242.8	147.9	61.9	305.2	304.5	252.0	220.1	150	365	671	789
07/20/11	242.8	213.4	301.5	282.9	191.2	84.7	237.6	107.6	496	495	71	144
07/21/11	367.8	377.8	209.6	158.2	137.7	22.3	300.7	251.5	52	23	8	113
07/22/11	286.9	248.7	187.2	80.8	269.3	246.0	213.4	168.2	110	153	188	878
07/23/11	266.4	224.3			109.7	61.6	229.7	198.1	934		53	536
07/24/11	217.6	173.1			160.5	166.1	230.5	219.8	572		163	518
07/25/11	284.6	289.6	279.5	249.6	309.4	298.1	175.9	110.6	991	548	158	231
07/26/11	173.1	78.9	166.4	120.4			217.2	163.4	165	542		306
07/27/11	178.7	123.1	107.0	51.2	141.8	46.9	205.6	150.9	147	276	75	449
07/28/11	222.5	176.2	137.1	63.4	128.7	61.3	194.6	135.9	407	449	183	377
07/29/11	400.7	434.0	297.7	255.4			163.8	90.5	259	561		402
07/30/11	228.3	174.3	136.4	50.0	124.6	82.0	245.9	217.0	230	210	111	727
07/31/11	286.7	266.2	204.6	145.4	252.7	172.2	289.5	239.3	2224	597	177	428
08/01/11	318.0	290.9	269.4	223.4	253.2	217.3	253.7	204.8	786	295	214	416
08/02/11	290.6	254.8	188.7	104.9	210.1	137.2	264.0	229.5	643	212	62	587

08/03/11	219.2	184.6	152.1	102.1	203.9	175.0	233.3	187.5	418	602	721	418
08/04/11	323.4	301.8	153.4	60.4	175.2	46.9	222.8	160.6	581	209	82	378
08/05/11	223.1	185.6	139.9	75.0	189.9	130.5	195.1	148.4	378	277	219	471
08/06/11	171.2	129.8	261.8	220.1	263.0	234.4			149	199	179	
08/07/11					58.0	23.8	225.5	137.5			11	245
08/08/11	195.0	133.2	140.1	76.2	268.0	173.1	234.4	178.5	119	453	80	593
08/09/11	288.1	262.9	184.0	81.1			144.4	88.1	590	277		226
08/10/11	148.7	96.6	93.9	32.9	59.6	26.8	174.1	117.8	168	92	63	291
08/11/11	199.9	146.0	180.6	105.2	102.4	40.2	201.6	153.8	361	305	97	525
08/12/11	200.5	137.8	93.8	32.0	86.0	35.4	236.0	188.1	307	173	83	762
08/13/11	233.3	184.4			286.4	235.3	218.2	155.8	233		405	541
08/14/11					79.8	25.3					63	
08/15/11					44.7	23.0	244.4	223.4			26	320
08/16/11	193.3	103.6	101.9	47.2	121.0	40.1	246.4	188.1	153	128	146	469
08/17/11	227.8	169.8	133.0	55.8	153.1	94.6	274.4	228.3	363	197	124	580
08/18/11	233.6	185.3	273.1	239.0	151.6	59.4	169.2	116.6	202	213	176	278
08/19/11	203.1	100.4	228.3	138.4	123.4	45.1	159.7	110.3	136	121	113	275
08/20/11	141.0	44.8	183.6	60.2	105.5	49.1	231.7	157.6	64	99	101	254
08/21/11	253.6	201.2	305.0	270.4	152.5	59.7	183.1	108.5	225	255	87	193
08/22/11	214.8	130.0	277.2	240.2	88.7	36.4	240.3	174.0	162	487	210	1046
08/23/11	239.9	215.8	278.1	273.7	123.9	72.8	258.0	207.0	1702	446	77	507
08/24/11	211.1	151.8	308.3	275.8	168.4	113.2	203.0	119.2	865	287	314	190
08/25/11	160.7	94.5	199.9	138.7			274.8	212.3	178	88		154
08/26/11	236.3	186.8	141.7	78.2	230.2	94.5	226.8	157.6	199	274	83	537
08/27/11	249.6	234.7							194			
08/28/11												
08/29/11												
08/30/11					99.3	60.0	223.8	169.5		217	71	335

08/31/11	237.2	214.6	218.9	123.7					662	377		
09/01/11												
09/02/11												
09/03/11												
09/04/11					182.8	104.9	183.9	107.6			112	74
09/05/11	224.2	141.1	203.7	68.6	69.9	38.7	137.8	63.7	95	40	25	25
09/06/11							294.8	272.5				174
09/07/11					103.3	75.6					57	
09/08/11			110.6	48.5	97.6	44.8	194.2	118.9		45	42	384
09/09/11	283.0	243.7	274.0	234.2	175.8	137.6	249.2	179.5	206	553	266	888
09/10/11	223.7	162.2	258.3	235.0	230.6	221.4	281.1	219.5	1128	1362	336	388
09/11/11	296.8	274.3	427.9	434.6	175.8	78.6	218.0	140.2	287	279	101	111
09/12/11	289.0	259.4	237.5	186.5	195.2	135.9	224.1	168.2	240	177	49	219
09/13/11	287.6	237.0	329.8	311.8	220.8	96.0	229.4	161.4	106	453	65	65
09/14/11	257.6	204.2	315.9	286.8	121.6	82.9	188.1	130.5	119	175	54	91
09/15/11	122.1	74.7	298.7	244.1	128.7	96.6	320.4	259.7	43	450	737	714

APPENDIX C: SUPPLEMENTAL VESPER RADAR DATA

This section contains summary notes for VESPER Images and the 316 VESPER images produced from the data collected at Block Island for the fall 2009 and spring 2010 seasons. Bookmarks in the PDF file identify the date and time for each of the time series images, one image per page. The notes and images are arranged in chronological order.

NOTES:
DWW Block Island_Vesper_2009_8_17_9Lf.gif: afternoon and early evening steep ascent and descent targets >350m suggesting insect eating birds and later bats.
DWW Block Island_Vesper_2009_8_18: early hours of the day very little activity, insects constrained to the first 100m or so of the atmosphere. Afternoon is a small number of steep ascent and descent targets >350m suggesting insect eating birds.
DWW Block Island_Vesper_2009_8_19_9Lf.gif: early hours of the day very little activity, afternoon steep ascent and descent targets >350m suggesting insect eating birds, some normal bird activity just passing through beam at same altitude. Late afternoon activity drops off sharply. Early night steep ascent and descent targets mostly >350m but some to 100m suggesting bat foraging activity, late night activity tapers of quickly.
DWW Block Island_Vesper_2009_8_19_9Lf.gif: activity is higher and layer of activity is above rotor swept zone by quite a margin.
DWW Block Island_Vesper_2009_8_20_9Lf.gif: Dense layer for 50 mins early evening.
DWW Block Island_Vesper_2009_9_3_12Lf.gif: likely virga
DWW Block Island_Vesper_2009_9_4_18Lf.gif: distinct 600 band of activity very early hours of the AM
DWW Block Island_Vesper_2009_9_5_12Lf.gif: possibly bragg scatter from rain
DWW Block Island_Vesper_2009_9_5_18Lf.gif: Dense insect layer under 450m
DWW Block Island_Vesper_2009_9_8_9Lf.gif: rain
DWW Block Island_Vesper_2009_9_8_12Lf.gif: low altitude bird layer 100 <300m
DWW Block Island_Vesper_2009_9_8_18Lf.gif: rain
DWW Block Island_Vesper_2009_9_12_12Lf.gif: bragg scatter
DWW Block Island_Vesper_2009_9_12_18Lf.gif: bragg scatter
DWW Block Island_Vesper_2009_10_1_9Lf.gif: rain
DWW Block Island_Vesper_2009_10_10_12Lf.gif: dense migration bugs and birds
DWW Block Island_Vesper_2009_10_12_12Lf.gif: period of 50 mins or so ascent and descent targets mostly >350m
DWW Block Island_Vesper_2009_10_12_18Lf.gif: showers and bragg scatter
DWW Block Island_Vesper_2009_10_15_9Lf.gif: just rain
DWW Block Island_Vesper_2009_10_15_12Lf.gif: just rain
DWW Block Island_Vesper_2009_10_15_18Lf.gif: rain
DWW-BlockIsland\DWW Block Island_Vesper_2009_10_17_9Lf.gif: showers
DWW Block Island_Vesper_2009_10_17_18Lf.gif: rain
DWW Block Island_Vesper_2009_10_19_12Lf.gif: layer birds 750-1000m

Spring
DWW Block Island_Vesper_2010_4_6_18Lf.gif: Light layer >150m
DWW Block Island_Vesper_2010_4_7_10Lf.gif: layer >200m
DWW Block Island_Vesper_2010_4_7_22Lf.gif: slightly denser >200m layer
DWW Block Island_Vesper_2010_4_8_12Lf.gif: first heavier migration
DWW Block Island_Vesper_2010_4_9_12Lf.gif: rain

DWW Block Island_Vesper_2010_4_9_18Lf.gif: rain then very little activity
DWW Block Island_Vesper_2010_4_11_12Lf.gif: layer of light migration early in image 300m
DWW Block Island_Vesper_2010_4_11_18Lf.gif: very light layer of migration 300m
DWW Block Island_Vesper_2010_4_12_12Lf.gif: episodic bugs
DWW Block Island_Vesper_2010_4_15_10Lf.gif: light showers
DWW Block Island_Vesper_2010_4_15_18Lf.gif: shower at end
DWW Block Island_Vesper_2010_4_16_10Lf.gif: rain then bragg scatter
DWW Block Island_Vesper_2010_4_16_18Lf.gif: consistent showers
DWW Block Island_Vesper_2010_4_17_12Lf.gif: showers
DWW Block Island_Vesper_2010_4_17_18Lf.gif: showers
DWW Block Island_Vesper_2010_4_18_18Lf.gif: isolated showers
DWW Block Island_Vesper_2010_4_19_12Lf.gif: layer 150 to 300m
DWW Block Island_Vesper_2010_4_21_10Lf.gif: light migration to 900m
DWW Block Island_Vesper_2010_4_21_18Lf.gif: first twenty mins and last of previous image shows very low layer of targets
DWW Block Island_Vesper_2010_4_22_12Lf.gif: migration before and after shower
DWW Block Island_Vesper_2010_4_22_18Lf.gif: highly variable layer at low alts with rain shower in middle of image
DWW Block Island_Vesper_2010_4_24_10Lf.gif: migration layer >150m
DWW Block Island_Vesper_2010_4_6_18Lf.gif: light layer at 200 to 300m
DWW Block Island_Vesper_2010_4_7_10Lf.gif: layer at 200 to 300m
DWW Block Island_Vesper_2010_4_8_12Lf.gif: late band 100 to 650m
DWW Block Island_Vesper_2010_4_8_18Lf.gif: light band 100 to 650 m
DWW Block Island_Vesper_2010_4_9_12Lf.gif: rain
DWW Block Island_Vesper_2010_4_9_18Lf.gif: first 20 mins rain
DWW Block Island_Vesper_2010_4_24_10Lf.gif: light layer of migration 300 to 600m
DWW Block Island_Vesper_2010_4_24_18Lf.gif: 100 to 1000m band late in image, lower earlier in session
DWW Block Island_Vesper_2010_4_24_22Lf.gif: all rain
DWW Block Island_Vesper_2010_4_25_10Lf.gif: all rain
DWW Block Island_Vesper_2010_4_25_12Lf.gif: two thin light layers of migration, one low > 100m and one high >1000m
DWW Block Island_Vesper_2010_4_25_18Lf.gif: mostly rain, before rain low layer of migration gets below 100m and second higher layer gets to around 600m likely due to cloud base
DWW Block Island_Vesper_2010_4_25_22Lf.gif: rain, small number of targets (birds) in rain.
DWW Block Island_Vesper_2010_4_26_10Lf.gif: spectacular example of birds under virga and also in rain
DWW Block Island_Vesper_2010_4_26_12Lf.gif: birds and rain
DWW Block Island_Vesper_2010_4_26_18Lf.gif: birds and rain
DWW Block Island_Vesper_2010_4_26_22Lf.gif: rain and very few birds
DWW Block Island_Vesper_2010_4_29_12Lf.gif: light layer from 200-325m
DWW Block Island_Vesper_2010_4_30_10Lf.gif: distinct layers possible ascending and descending targets in early AM
DWW Block Island_Vesper_2010_4_30_12Lf.gif: 150 to 900 meter layer
DWW Block Island_Vesper_2010_4_30_18Lf.gif: 150m layer of migrants
DWW Block Island_Vesper_2010_5_1_10Lf.gif: 300m layer, late higher layer is visible
DWW Block Island_Vesper_2010_5_1_12Lf.gif: 150m layer
DWW Block Island_Vesper_2010_5_1_18Lf.gif: 150m layer plus band above of migrants

DWW Block Island_Vesper_2010_5_1_22Lf.gif: layer 200 to 300m
DWW Block Island_Vesper_2010_5_2_10Lf.gif: rain, low layer of migrants, higher migrants descend after the rain
DWW Block Island_Vesper_2010_5_2_12Lf.gif: layer 200 to 300m
DWW Block Island_Vesper_2010_5_2_18Lf.gif: layer 200 to 300m
DWW Block Island_Vesper_2010_5_2_22Lf.gif: rain
DWW Block Island_Vesper_2010_5_3_12Lf.gif: late in this image band ascends to low altitude
DWW Block Island_Vesper_2010_5_3_18Lf.gif: low altitude layer first hour or so
DWW Block Island_Vesper_2010_5_4_10Lf.gif: late pulse of activity
DWW Block Island_Vesper_2010_5_5_10Lf.gif: some bragg scatter, layer at 300m
DWW Block Island_Vesper_2010_5_5_22Lf.gif: 200m to 1200 m band of migration
DWW Block Island_Vesper_2010_5_6_18Lf.gif: 200m plus layer early in image
DWW Block Island_Vesper_2010_5_11_10Lf.gif: rain
DWW Block Island_Vesper_2010_5_20_10Lf.gif: small number of ascending and descending targets
DWW Block Island_Vesper_2010_5_20_12Lf.gif: 200m plus band
DWW Block Island_Vesper_2010_5_20_18Lf.gif: targets low in altitude by end of image
DWW Block Island_Vesper_2010_5_20_22Lf.gif: low altitude band
DWW Block Island_Vesper_2010_5_21_10Lf.gif: pulse of targets
DWW Block Island_Vesper_2010_5_21_18Lf.gif: low altitude pulse mid image
DWW Block Island_Vesper_2010_5_22_18Lf.gif: several pulse of targets
DWW Block Island_Vesper_2010_5_24_12Lf.gif: 200m plus band
DWW Block Island_Vesper_2010_5_26_10Lf.gif:
DWW Block Island_Vesper_2010_5_26_12Lf.gif: migration
DWW Block Island_Vesper_2010_5_26_18Lf.gif: migration, rain at end
DWW Block Island_Vesper_2010_5_27_10Lf.gif: periods with targets that persist in the beam
DWW Block Island_Vesper_2010_5_27_18Lf.gif: ascending descending and persistence in the beam
DWW Block Island_Vesper_2010_5_31_18Lf.gif: 200m layer early and higher layer appears later
DWW Block Island_Vesper_2010_6_5_10Lf.gif: couple descending targets
DWW Block Island_Vesper_2010_6_5_12Lf.gif: 2-300m layer
DWW Block Island_Vesper_2010_6_5_18Lf.gif: rain shower couple of layers of migrants
DWW Block Island_Vesper_2010_6_5_22Lf.gif: two layers of migrants
DWW Block Island_Vesper_2010_6_9_10Lf.gif: rain
DWW Block Island_Vesper_2010_6_9_12Lf.gif: rain
DWW Block Island_Vesper_2010_6_9_18Lf.gif:
DWW Block Island_Vesper_2010_6_10_10Lf.gif: rain bragg scatter
DWW Block Island_Vesper_2010_6_10_12Lf.gif: rain showers
DWW Block Island_Vesper_2010_6_10_18Lf.gif: showers, bird in showers
DWW Block Island_Vesper_2010_6_10_22Lf.gif: showers and bragg

APPENDIX D: SUPPLEMENTAL NEXRAD DATA

NEXRAD SITE INFORMATION: KBOX

Site ID	KBOX
Site Name	Boston, MA
Location	41.9558N, 71.1369W
Elevation	118'
NWS Office Website	http://www.erh.noaa.gov/er/box/
Nearby NEXRAD Within 350 miles	Albany, NY: 155 miles, bearing 282 Binghamton, NY: 249 miles, bearing 272 Burlington, VT: 203 miles, bearing 321 Dover AFB, DE: 313 miles, bearing 233 Loring AFB, ME: 327 miles, bearing 39 Montague, NY: 261 miles, bearing 291 New York City, NY: 116 miles, bearing 237 Philadelphia, PA: 220 miles, bearing 238

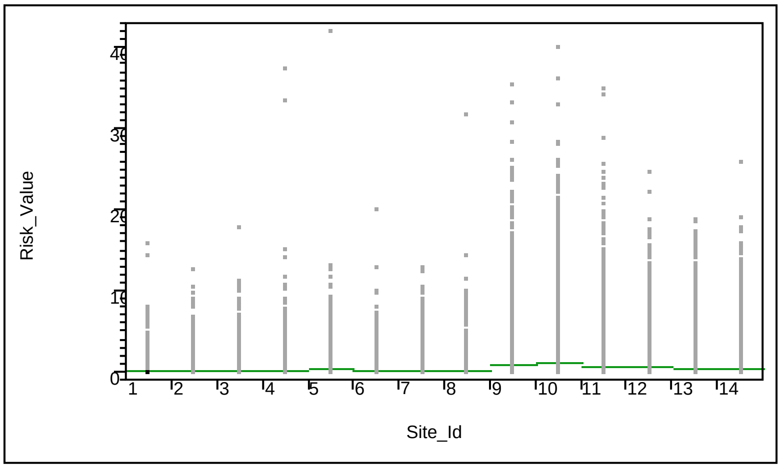
NEXRAD SITE INFORMATION: KOKX

Site ID	KOKX
Site Name	New York City, NY
Location	40.8656N, 72.8639W
Elevation	85'
NWS Office Website	http://www.erh.noaa.gov/er/okx
Nearby NEXRAD Within 350 miles	Albany, NY: 134 miles, bearing 325 Binghamton, NY: 185 miles, bearing 293 Boston, MA: 116 miles, bearing 57 Buffalo, NY: 334 miles, bearing 289 Burlington, VT: 252 miles, bearing 355 Dover AFB, DE: 196 miles, bearing 231 Montague, NY: 246 miles, bearing 315 Norfolk/Richmond, VA: 348 miles, bearing 226 Philadelphia, PA: 103 miles, bearing 239 Portland, ME: 247 miles, bearing 40 State College, PA: 268 miles, bearing 270 Sterling, VA: 277 miles, bearing 247 Portland, ME: 140 miles, bearing 24

All Months All Years (2006–2010)

All Sites, All Months (Years pooled by month)

Oneway Analysis of Risk_Value By Site_Id



Oneway Anova

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Site_Id	13	139840546	10756965	534.7671	<.0001*
Error	121585	2445710676	20115.234		
C. Total	121598	2585551222			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	8694	15.968	1.5211	12.99	18.95
2	8694	12.509	1.5211	9.53	15.49
3	8694	13.533	1.5211	10.55	16.51
4	8694	16.071	1.5211	13.09	19.05
5	8677	34.719	1.5226	31.73	37.70
6	8677	23.808	1.5226	20.82	26.79
7	8677	33.106	1.5226	30.12	36.09
8	8694	16.101	1.5211	13.12	19.08
9	8677	99.273	1.5226	96.29	102.26
10	8678	118.736	1.5225	115.75	121.72
11	8678	78.764	1.5225	75.78	81.75
12	8677	79.493	1.5226	76.51	82.48
13	8694	55.194	1.5211	52.21	58.18
14	8694	52.817	1.5211	49.84	55.80

Std Error uses a pooled estimate of error variance

Comparisons for all pairs using Tukey-Kramer HSD

Level	*Homogenous Groups*	*Mean*
10	A	118.73575
9	B	99.27271
12	C	79.49279
11	C	78.76437
13	D	55.19387
14	D	52.81698
5	E	34.71881
7	E	33.10589
6	F	23.80816
8	G	16.10088
4	G	16.07085
1	G	15.96759
3	G	13.53344
2	G	12.50888

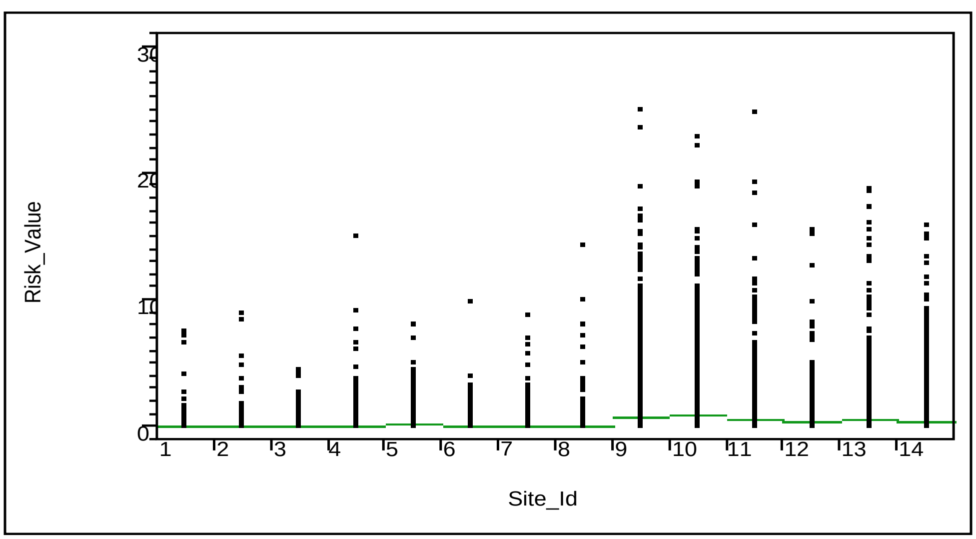
Levels not connected by same letter are significantly different.

Seasonal Analyses (all years, 2006-2010)

Spring: 16 March through 30 June
Summer: 1 July through 15 September
Fall: 16 September through 15 December
Winter: 16 December through 15 March

Spring:

Oneway Analysis of Risk_Value By Site



Oneway Anova

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Site_Id	13	30691390	2360876	197.4745	<.0001*
Error	35111	419764261	11955		
C. Total	35124	450455651			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	2509	5.804	2.1829	1.526	10.08
2	2509	4.878	2.1829	0.599	9.16
3	2509	4.860	2.1829	0.582	9.14
4	2509	13.027	2.1829	8.749	17.31
5	2509	18.464	2.1829	14.185	22.74
6	2509	14.237	2.1829	9.958	18.52
7	2509	14.137	2.1829	9.858	18.42
8	2509	11.231	2.1829	6.953	15.51
9	2508	83.366	2.1833	79.087	87.65
10	2509	100.398	2.1829	96.120	104.68
11	2509	53.944	2.1829	49.665	58.22
12	2509	42.710	2.1829	38.432	46.99
13	2509	53.001	2.1829	48.723	57.28
14	2509	43.352	2.1829	39.074	47.63

Std Error uses a pooled estimate of error variance

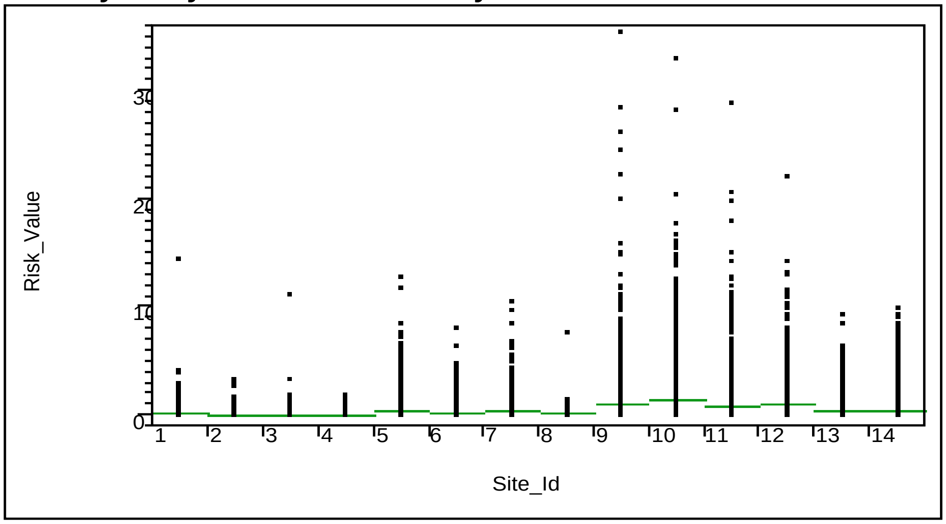
Comparisons for all pairs using Tukey-Kramer HSD for Spring season

Level	*Homogeneous Groups*						*Mean*
10	A						100.39828
9		B					83.36594
11			C				53.94383
13			C	D			53.00106
14				D			43.35234
12				D			42.71009
5					E		18.46364
6					E	F	14.23692
7					E	F	14.13695
4					E	F	13.02738
8					E	F	11.23103
1						F	5.80411
2						F	4.87799
3						F	4.86040

Levels not connected by same letter are significantly different.

<u>Summer:</u>

Oneway Analysis of Risk_Value By Site



Oneway Anova

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Site_Id	13	49188892	3783761	231.3586	<.0001*
Error	25428	415862959	16355		
C. Total	25441	465051851			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	1825	14.894	2.9936	9.0	20.76
2	1825	8.771	2.9936	2.9	14.64
3	1825	11.288	2.9936	5.4	17.16
4	1825	4.866	2.9936	-1.0	10.73
5	1809	40.315	3.0068	34.4	46.21
6	1810	30.106	3.0059	24.2	36.00
7	1809	40.543	3.0068	34.6	46.44
8	1825	14.160	2.9936	8.3	20.03
9	1810	115.656	3.0059	109.8	121.55
10	1810	145.351	3.0059	139.5	151.24
11	1810	93.669	3.0059	87.8	99.56
12	1809	108.683	3.0068	102.8	114.58
13	1825	49.677	2.9936	43.8	55.54
14	1825	42.643	2.9936	36.8	48.51

Std Error uses a pooled estimate of error variance

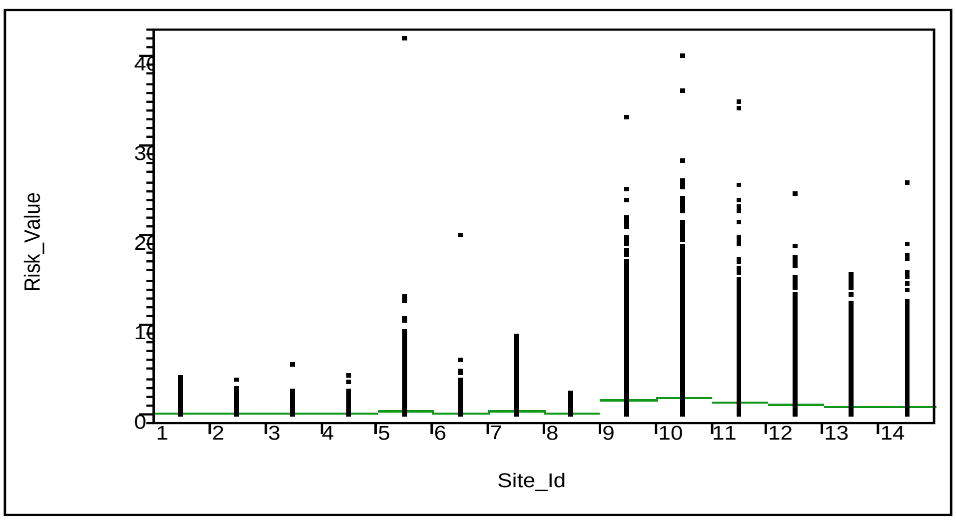
Comparisons for all pairs using Tukey-Kramer HSD for Summer season

Level	*Homogenous Groups*	*Mean*
10	A	145.35095
9	B	115.65561
12	B	108.68344
11	C	93.66872
13	D	49.67697
14	D E	42.64257
7	D E	40.54264
5	D E	40.31486
6	E	30.10631
1	F	14.89366
8	F	14.15977
3	F	11.28794
2	F	8.77064
4	F	4.86615

Levels not connected by same letter are significantly different.

Fall:

Oneway Analysis of Risk_Value By Site



Oneway Anova

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Site_Id	13	119196332	9168949	229.6808	<.0001*
Error	30477	1216654078	39920		
C. Total	30490	1335850410			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	2178	18.677	4.2812	10.29	27.07
2	2178	10.649	4.2812	2.26	19.04
3	2178	11.762	4.2812	3.37	20.15
4	2178	11.766	4.2812	3.37	20.16
5	2178	54.027	4.2812	45.64	62.42
6	2177	24.157	4.2822	15.76	32.55
7	2178	51.417	4.2812	43.03	59.81
8	2178	11.925	4.2812	3.53	20.32
9	2178	172.959	4.2812	164.57	181.35
10	2178	196.830	4.2812	188.44	205.22
11	2178	137.525	4.2812	129.13	145.92
12	2178	129.332	4.2812	120.94	137.72
13	2178	89.222	4.2812	80.83	97.61
14	2178	95.927	4.2812	87.54	104.32

Std Error uses a pooled estimate of error variance

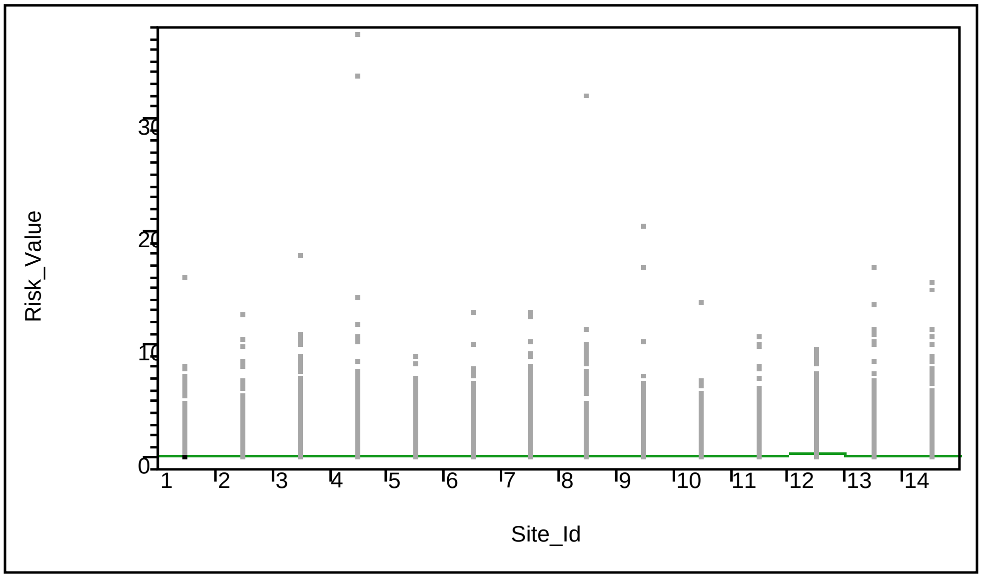
Comparisons for all pairs using Tukey-Kramer HSD for Fall season

Level	*Homogeneous Groups*	*Mean*
10	A	196.82956
9	B	172.95880
11	C	137.52527
12	C	129.33167
14	D	95.92722
13	D	89.22228
5	E	54.02706
7	E	51.41720
6	F	24.15744
1	F	18.67722
8	F	11.92496
4	F	11.76608
3	F	11.76212
2	F	10.64909

Levels not connected by same letter are significantly different.

Winter:

Oneway Analysis of Risk_Value By Site



Oneway Anova

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Site_Id	13	1050016	80770.5	8.2570	<.0001*
Error	30527	298617938	9782.1		
C. Total	30540	299667954			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	2182	25.8478	2.1173	21.698	29.998
2	2182	26.2664	2.1173	22.116	30.416
3	2182	27.1524	2.1173	23.002	31.302
4	2182	33.2388	2.1173	29.089	37.389
5	2181	29.4953	2.1178	25.344	33.646
6	2181	29.2434	2.1178	25.092	33.394
7	2181	30.4731	2.1178	26.322	34.624
8	2182	27.4923	2.1173	23.342	31.642
9	2181	30.3836	2.1178	26.233	34.535
10	2181	39.7568	2.1178	35.606	43.908
11	2181	36.2685	2.1178	32.118	40.420
12	2181	47.8251	2.1178	43.674	51.976
13	2182	28.3635	2.1173	24.213	32.514
14	2182	29.1786	2.1173	25.029	33.329

Std Error uses a pooled estimate of error variance

Comparisons for all pairs using Tukey-Kramer HSD for Winter season

Level	*Homogeneous Groups*				*Mean*
12	A				47.825123
10	A	B			39.756796
11		B	C		36.268547
4		B	C	D	33.238788
7		B	C	D	30.473139
9		B	C	D	30.383580
5			C	D	29.495340
6			C	D	29.243400
14			C	D	29.178579
13			C	D	28.363524
8			C	D	27.492313
3			C	D	27.152434
2			C	D	26.266367
1				D	25.847763

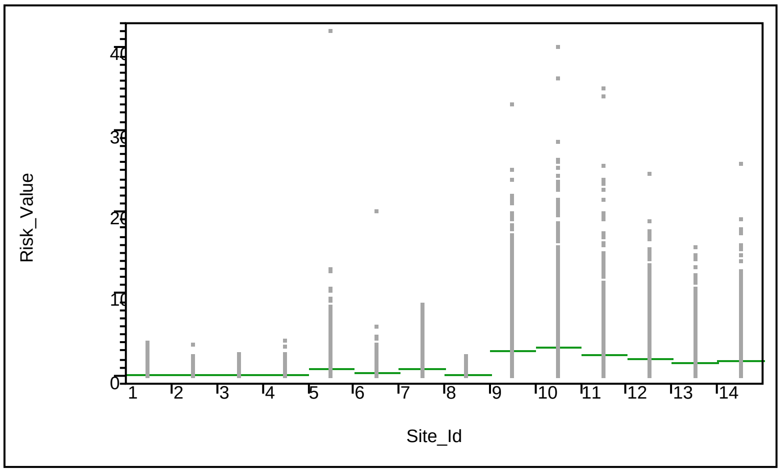
Levels not connected by same letter are significantly different.

Data Analysis

Fall Night Migration (all years 2006-2010)

Fall Night (16 September through 15 December)
1800 hrs through 0600 EST

Oneway Analysis of Risk_Value By Site_Id



Oneway Anova

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Site_Id	13	206149963	15857689	240.7478	<.0001*
Error	15217	1002320360	65868.46		
C. Total	15230	1208470323			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	1089	32.183	7.7772	16.94	47.43
2	1089	16.897	7.7772	1.65	32.14
3	1089	17.797	7.7772	2.55	33.04
4	1089	16.917	7.7772	1.67	32.16
5	1087	97.657	7.7844	82.40	112.92
6	1086	40.637	7.7880	25.37	55.90
7	1087	91.742	7.7844	76.48	107.00
8	1089	17.886	7.7772	2.64	33.13
9	1087	317.484	7.7844	302.23	332.74
10	1087	363.871	7.7844	348.61	379.13
11	1087	260.290	7.7844	245.03	275.55
12	1087	218.214	7.7844	202.96	233.47
13	1089	165.690	7.7772	150.45	180.93
14	1089	183.746	7.7772	168.50	198.99

Std Error uses a pooled estimate of error variance

Means Comparisons
Comparisons for all pairs using Tukey-Kramer HSD

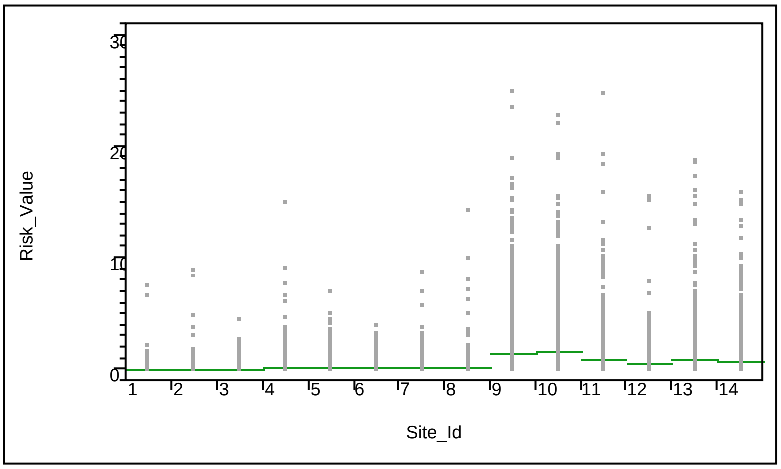
Level	***Homogeneous Groups***							***Mean***
10	A							363.87149
9		B						317.48402
11			C					260.28988
12				D				218.21383
14				D	E			183.74610
13					E			165.68966
5						F		97.65709
7						F		91.74233
6							G	40.63677
1							G	32.18331
8							G	17.88600
3							G	17.79713
4							G	16.91675
2							G	16.89715

Levels not connected by same letter are significantly different.

Data Analysis

Spring Night Migration (all years, 2006-2010)
Spring Night (16 March through 30 June)
1800 hrs through 0600 EST

Oneway Analysis of Risk_Value By Site_Id



Oneway Anova

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Site_Id	13	45165484	3474268	168.8759	<.0001*
Error	17549	361033974	20573		
C. Total	17562	406199458			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	1260	7.552	4.0408	-0.3681	15.47
2	1260	6.795	4.0408	-1.1	14.71
3	1260	6.173	4.0408	-1.7	14.09
4	1260	19.883	4.0408	12.0	27.80
5	1249	26.603	4.0585	18.6	34.56
6	1249	18.625	4.0585	10.7	26.58
7	1249	21.059	4.0585	13.1	29.01
8	1260	16.055	4.0408	8.1	23.98
9	1249	143.457	4.0585	135.5	151.41
10	1249	167.142	4.0585	159.2	175.10
11	1249	88.214	4.0585	80.3	96.17
12	1249	52.736	4.0585	44.8	60.69
13	1260	91.620	4.0408	83.7	99.54
14	1260	72.306	4.0408	64.4	80.23

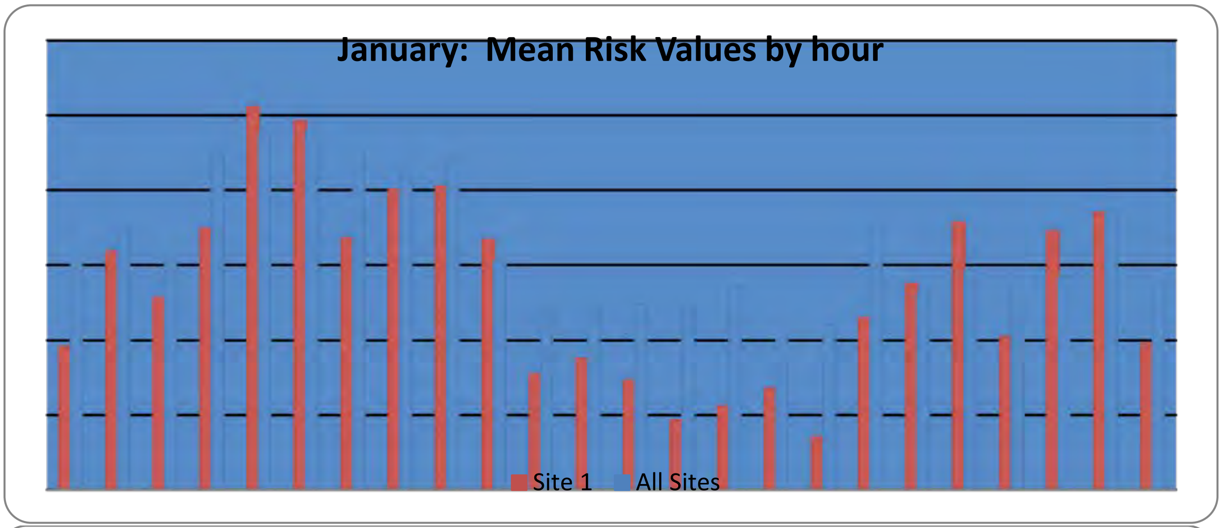
Std Error uses a pooled estimate of error variance

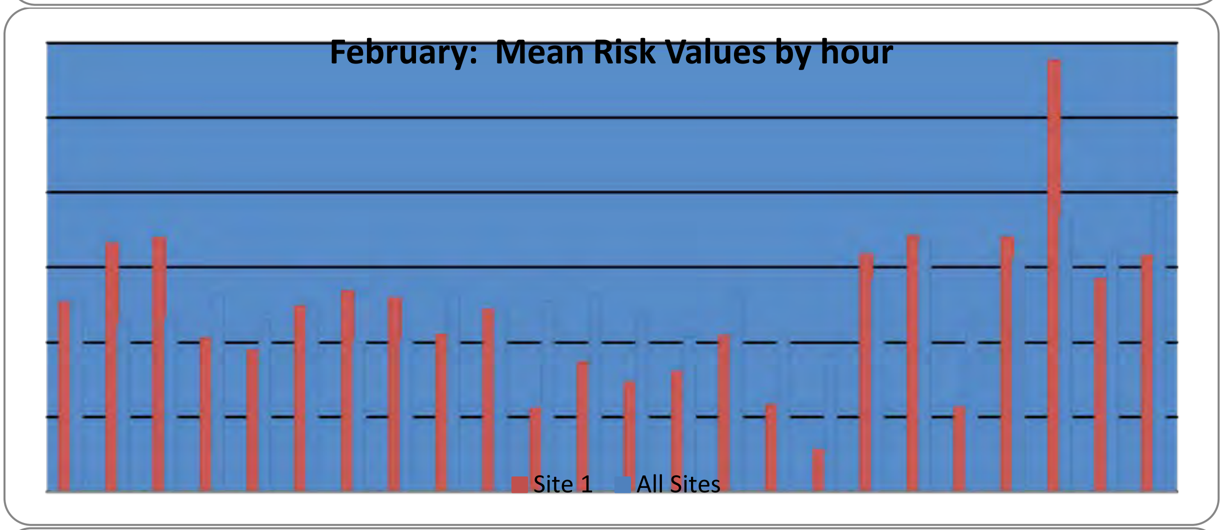
Means Comparisons
Comparisons for all pairs using Tukey-Kramer HSD

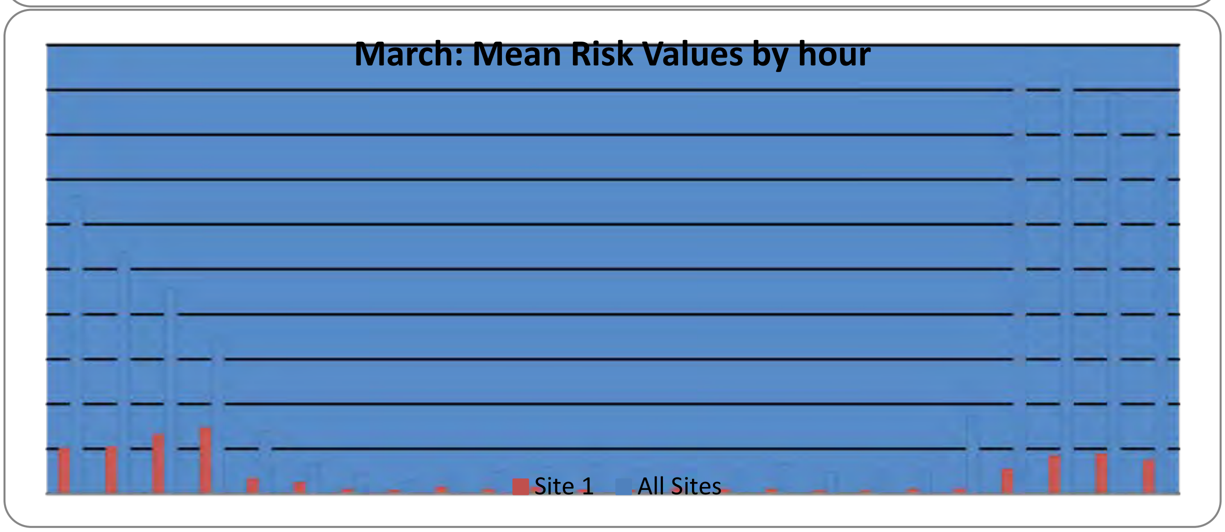
Level	*Homogeneous Groups*							*Mean*
10	A							167.14206
9		B						143.45741
13			C					91.61959
11			C	D				88.21421
14				D				72.30578
12					E			52.73617
5						F		26.60306
7						F	G	21.05851
4						F	G	19.88325
6						F	G	18.62455
8						F	G	16.05542
1						F	G	7.55214
2							G	6.79471
3							G	6.17336

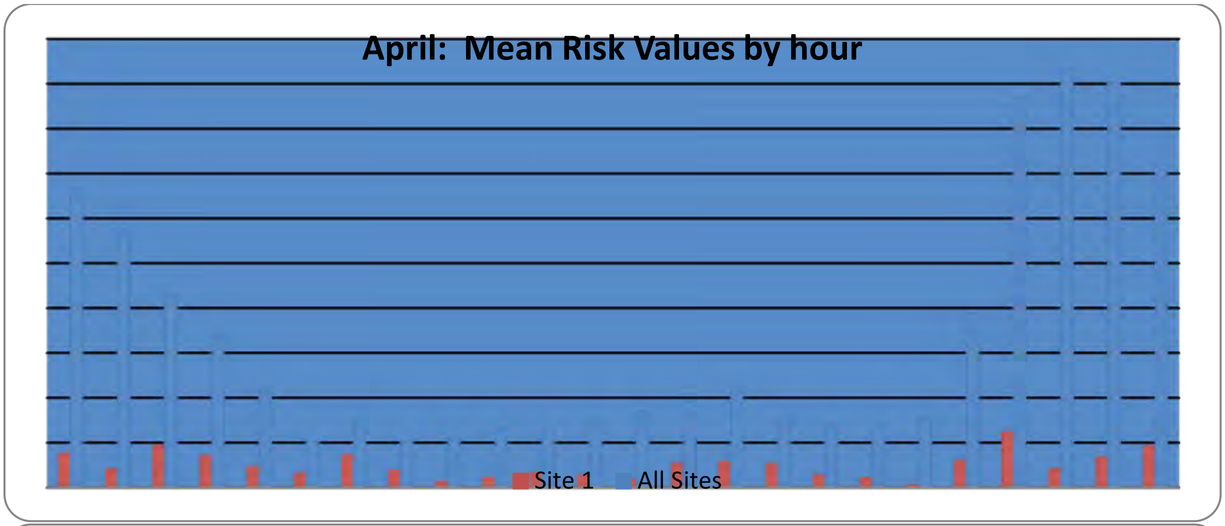
Levels not connected by same letter are significantly different.

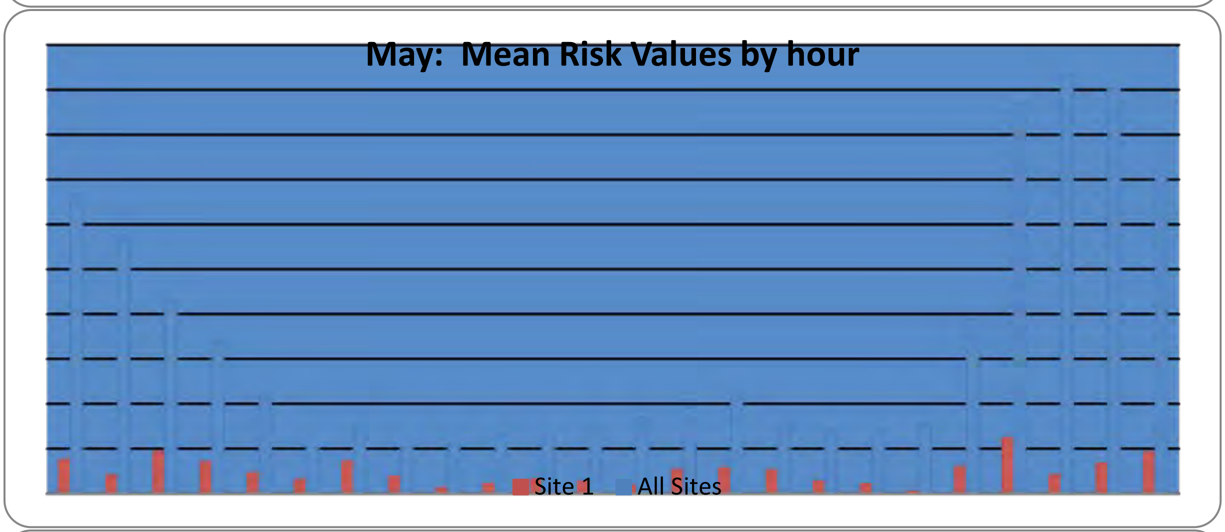
Site 1 and all sites Activity by Hour for each month (months combined 2006–2010)

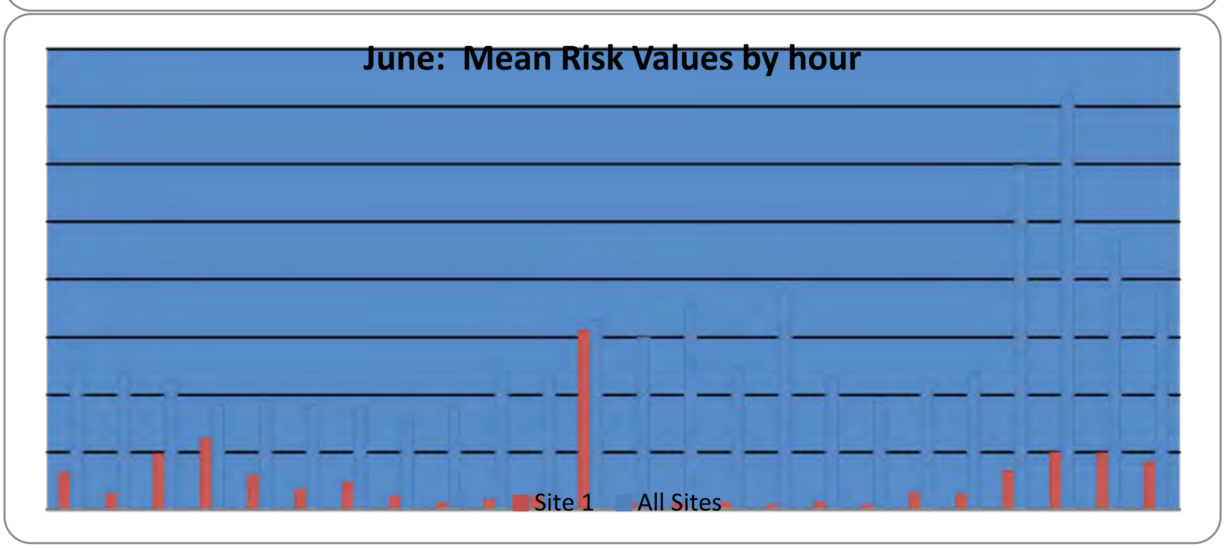


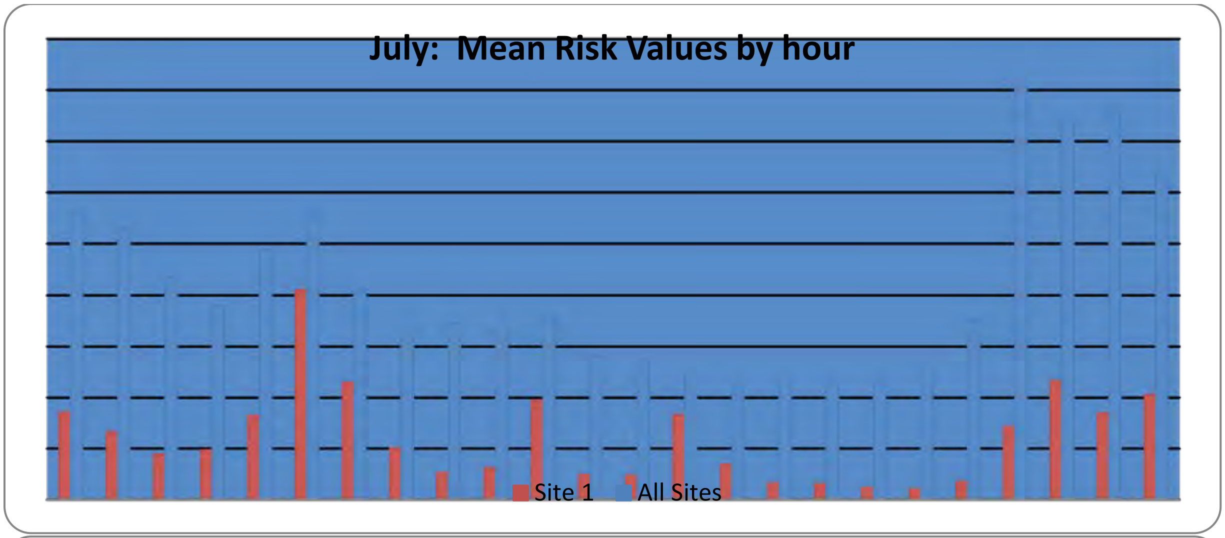


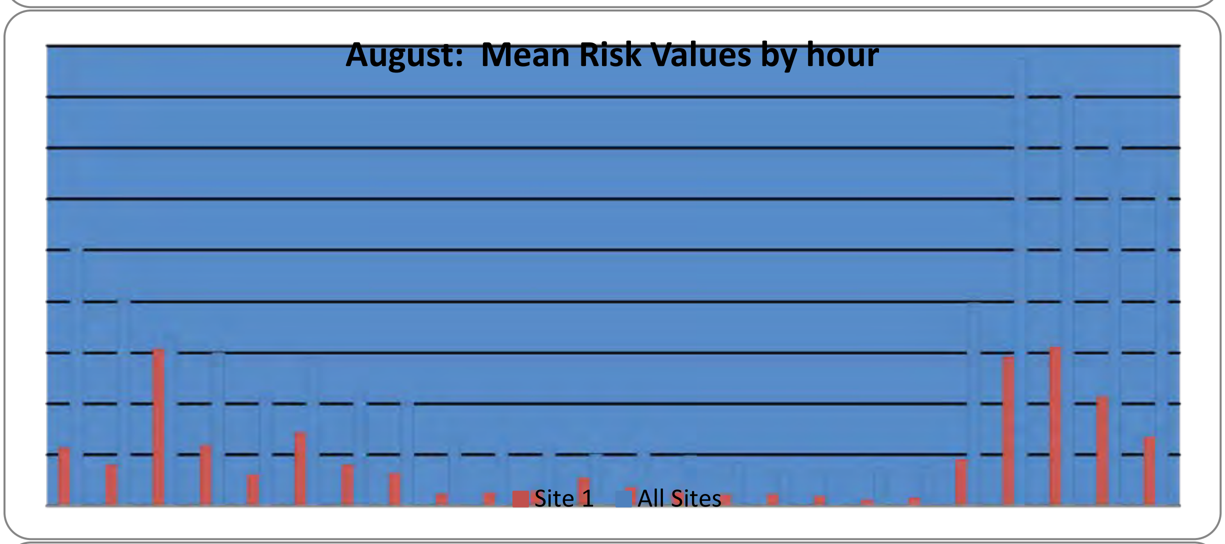


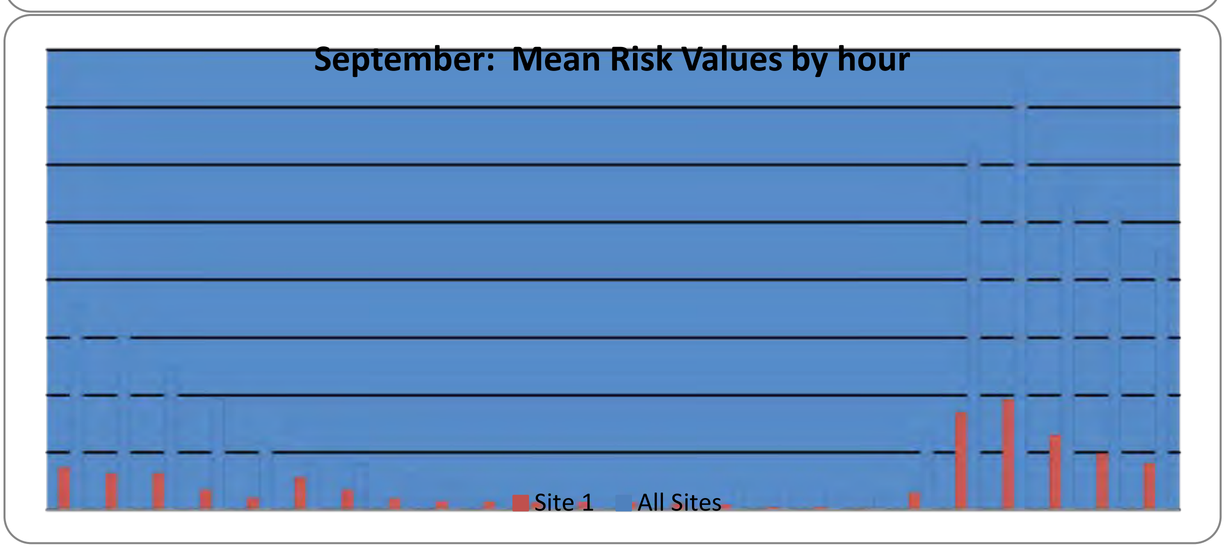

April: Mean Risk Values by hour
Site 1
All Sites

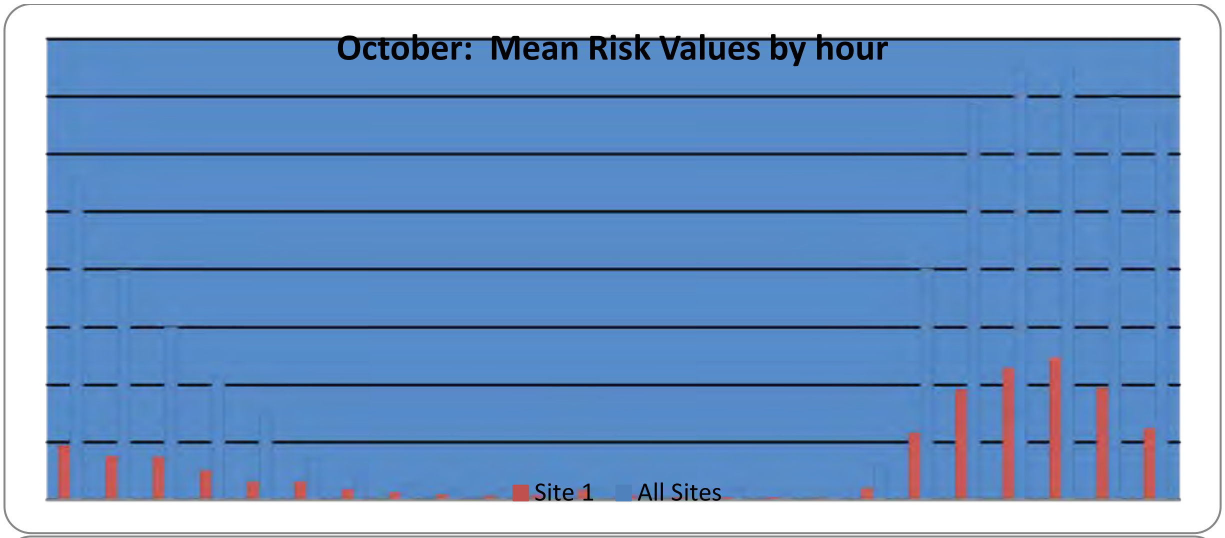

May: Mean Risk Values by hour
Site 1
All Sites

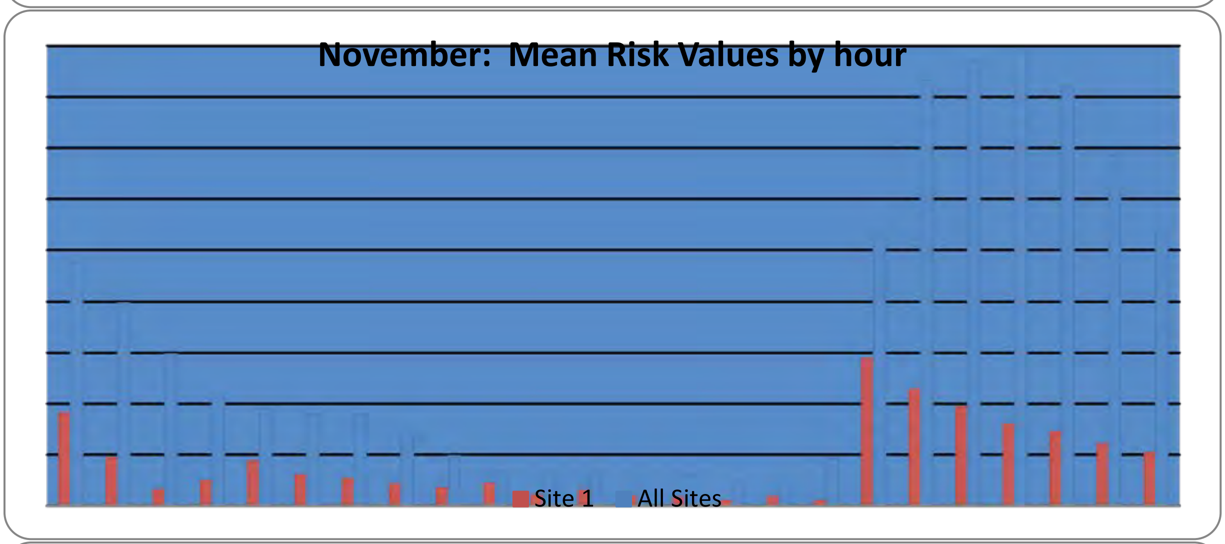

June: Mean Risk Values by hour
Site 1
All Sites

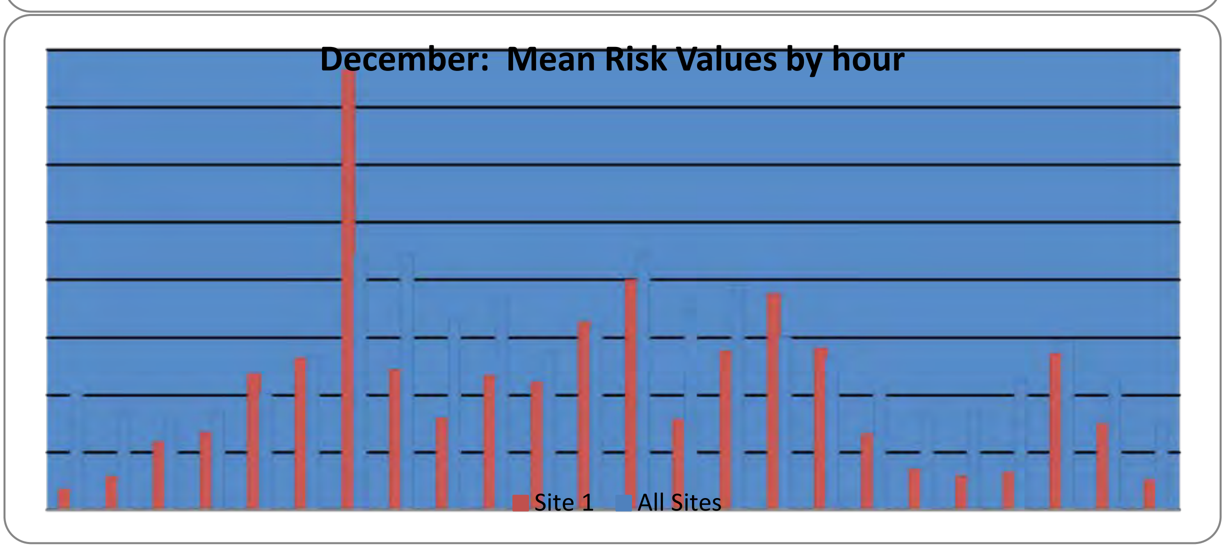

July: Mean Risk Values by hour
Site 1
All Sites


August: Mean Risk Values by hour
Site 1
All Sites


September: Mean Risk Values by hour
Site 1
All Sites


October: Mean Risk Values by hour
Site 1
All Sites


November: Mean Risk Values by hour
Site 1
All Sites


December: Mean Risk Values by hour
Site 1
All Sites

Viewshed images for KBOX and KOKX radars at a beam height of 410 m.